Western Technology and Soviet Economic Development 1917 to 1930

By

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To

Mum and Dad

Preface

BY far the most significant factor in the development of the Soviet economy has been its absorption of Western technology and skills. Previously this technological transfer has not been treated in detail; hence the data that comprise Part I of this study are thoroughly documented. Without such documentation, the argument of Part II would appear less than credible. The reader may, however, wish to pass on to Part II after briefly satisfying himself with the general content of Part I. Chapter two discussing Soviet oil, and chapter eleven, on electrical equipment, are representative of the empirical treatment of key sectors in Soviet industry.

The primary sources for data are the U.S. State Department Decimal File and the German Foreign Ministry Archives, supplemented by journals in half a dozen languages from a dozen countries. Of these, the journals published by Soviet trade representatives abroad were of particular help.

Grateful appreciation is due the Relm Foundation for funds to purchase several hundred thousand microfilmed documents. Acknowledgment is also due to California State College at Los Angeles and to the Economic Opportunity Program for secretarial and research assistance. The National Archives, the Library of Congress, and the Hoover Institution library were unfailingly responsive and remarkably adept at interpreting requests for information. Without their sympathetic aid, this study could have been neither attempted nor completed. In addition, Dr. Stefan Possony of the Hoover Institution was very helpful in making research suggestions which, in the final analysis, turned out to be of fundamental importance. The Hoover Institution also accepted the considerable burden of preparing the manuscript for publication; particular thanks is due London G. Green for his capable and understanding work as editor.

Finally, acknowledgment is made to F. W. B. Coleman, resident United States Minister in Riga, Lativa, during the 1920s. Riga was the main American 'listening post' of this time, and dispatches by Coleman to Washington, D.C.,

suggest a deep understanding of events in the Soviet Union. These detailed and accurate reports were of major help in this study.

It is especially important in a study which breaks substantially new ground in a controversial area to point out that any criticism concerning the interpretation of data must fall squarely on the shoulders of the writer, and not on his sources. Such criticism is, of course, to be welcomed.

A. C. S.

Pasadena, California
April 1, 1966

Contents

Tables

CHARTS AND MAPS

Glossary

Artel:	Collective labor group
Basmach:	Counter-revolutionary bandit
Bedniak:	'Poor' peasant
Centrosoyuz:	Central Union of Consumers Co-operatives
Chervonetz:	Ten ruble bank note
Dessiatin	2.7 acres
Glavk:	Central board or committee
Glavkontsesskom:	Chief Concessions Committee
Geolro:	State Commission for Electrification
Gosbank:	State Bank
Gosplan:	State Planning Commission
Guberniia:	Province
Hectare:	2.47 acres
Kolkhoz:	Collective farm
Kopeck:	Small coin, 1/100 of a ruble
Koustarny:	Home industry, handicraft wares
Krai:	Region
Kroner:	Swedish monetary unit
Kulak:	Literally 'fist' (term applied to 'rich' peasant)
Oblast':	Province
Pood:	36.1128 pounds
Rayon:	District (of an oblast')
Ruble, gold:	Ruble valued in gold at 0.222168 grams
Sazhen:	2.3333 yards
Seredniak:	'Middle' peasant
Usufruct:	Legal term for operation of an economic activity without ownership rights
Uyezd:	District
Verst:	0.6629 miles

VSNKh (Vesenkha):	Vysshyi Sovet Narodnogo Khozaistva—Supreme Council of National Economy
Zemstvos	Elected rural councils in tsarist Russia
Zolotnik	0.15 of an ounce (4.265 grams)

PART ONE

An Empirical Examination of Foreign Concessions and Technological Transfers

CHAPTER ONE

Introduction

ECONOMIC DEVELOPMENT AND THE INTERNATIONAL TRANSFER OF TECHNOLOGY

It is accepted that a significant factor in the economic growth of those countries undergoing rapid development during the twentieth century is the 'advantage of coming late.' Advanced industrial and agricultural technology can be effectively transferred, reducing the latecomer's investment in research and development. Indeed, continuing investment in technology by advanced countries has generally made for a dramatic decrease in capital-output ratios, during the last sixty years.[1]

Massell[2] argues, with empirical support, that the productivity increase in United States manufacturing between 1919 and 1955 is attributable far more to technological change than to increased capital investment. Traditionally it has been assumed that capital investment exceeds technological advance as the major factor in economic development. According to Massell however, 90 percent of the increase in the U.S. output per man-hour is to be attributed to technological improvement and only 10 percent to increases in capital investment. Improvement in labor skills is included as technological advance.

In the sphere of Soviet development, other things being equal, we would then look for technology as a contributing factor of some significance. Development literature in the West omits this factor, although recognition of its importance is implicit in the Soviet emphasis on technological advance.

[1] Paul S. Anderson, 'The Apparent Decline in Capital-Output Ratios,' *The Quarterly Journal of Economics*, LXXV, No. 4 (November 1961), 629.

[2] B. F. Massell, 'Capital Formation and Technological Change in United States Manufacturing,' *Review of Economics and Statistics*, XLII (May 1960), 182–8. In economic terminology, the change in productivity is due to a shift of the production function to the right rather than a deepening in capital intensity and a movement along the production function. Other writers have arrived at similar conclusions. Massell's conclusions coincide with those of Solow and Fabricant, who use different data and methodology.

Considerable evidence will be presented to show that Soviet technology was completely dependent on the West in the decade of the 1920s. Thus we can argue that a major portion of Soviet economic development would have been dependent on the technological contribution of Western enterprises even had there been no capital transfers. There were, however, such capital transfers—of at least sufficient magnitude to support the transfer of technology.

The argument of this study hinges indeed on the contribution of Western technology to Soviet economic development. As technology in the period between 1917 and 1930 originated in the West and not in the Soviet Union, it is concluded that the Western contribution was decisive in Soviet economic development during this period. The essential technology can usually be acquired for significantly less than the cost of the overall project. For example, the total cost of the Volkhov hydroelectric project was 90 million rubles, the major part of which was absorbed by the construction of the dam, the access roads, and the supporting buildings, while only 6 million was spent on imported equipment. However, it was the imported equipment—the turbines, generators, and switchgear—that determined the technical success of the project.

This, of course, is not to argue that technology is the only factor in economic development. Political, social and psychological factors play their respective roles. This interplay is particularly interesting in the Soviet example but is, unfortunately, outside the scope of this study.

THE SOVIET UNION AND THE TRANSFER OF TECHNOLOGY

A study of the influence of Western technology upon the early stages of Soviet economic development may then be a profitable field for research and, in fact, may change our view of those forces allegedly 'released' by socialism and traditionally held responsible for Soviet economic growth. No rigorous analysis of this technological transfer has yet been attempted, although its existence has been noted within the Western world.[3]

The mechanisms for this transfer were in fact many and varied, and include some not found elsewhere in world economic development. First, there was a carryover of internal capital investment from prerevolutionary industrial Russia.[4] This industrial structure was but slightly affected by the Revolutions and subsequent Civil War; evidence to be developed in this study indicates

[3] Werner Keller, *Ost minus west = null* (Munich: Droemersche Verlagsanstalt, 1960).

[4] Anton Crihan, *Le capital étranger en Russie* (Paris: Pichon, 1934). P. V. Oll, *Les capitaux étrangers en Russie* (Petrograd: 1922), estimated this capital, expropriated by the Soviet government, to be over $1 billion, a figure quoted in S. N. Prokopovitch, *Histoire Economique de l'U.R.S.S.* (Paris: Flammarian, 1952), p. 281.

that the popular story of substantial physical destruction is, except in the case of the Don Basin, a myth. More damage was done to Russian industry by the ineptitudes of War Communism than by World War I, the Revolutions, the Civil War, and the Allied Intervention combined. Many of the largest plants worked at full capacity right through the Revolutions and Civil War under their 'capitalist' managers. Others, with equipment intact, were placed in a state of 'technical preservation' until managers with skills requisite to recommence operations could be found.

Second, the New Economic Policy (NEP) denationalized certain economic activities and restored some measure of free enterprise to both foreign and domestic capitalists. Internally, the relaxation of controls affected retailing, wholesaling, and small industries employing less than twenty persons. However, the 'commanding heights' of the economy (iron and steel, electrical equipment, transportation, and foreign trade) were retained under Communist control and grouped into trusts and syndicates. Foreign capital and technology were then invited into these units through concessions and mixed joint-stock companies, both with and without domestic private and state participation. The concession, in its varying forms, was the most significant vehicle for the transfer of foreign technology.

At the beginning of the NEP, the emphasis was on concessions to Western entrepreneurs. In the middle and last years of the decade the concession was replaced by technical-assistance contracts and the import of complete plants and equipment. After the acquisition of a specific technology, by either concession, purchase, or confiscation, came duplication in Soviet plants. Major acquisitions were supplemented by the purchase or appropriation of designs, plans, patents, and prototypes. This process extended even to agriculture. For instance, the purchase of pedigreed stock provided for rapid multiplication—equivalent in its way to the reproduction of technical processes.[5]

A third transfer vehicle was the employment of individual Western engineers and experts and the corresponding dispatch of Soviet engineers and workers to training positions in foreign plants. When foreign assistance was required on a substantial and continuing scale, the technical-assistance contract was utilized. The study trip abroad by Soviet engineers was used both as prelude

[5] Numerous examples are given in detail below. One interesting importation of Western agricultural technology was the acquisition of Australian and American stud merinos. In 1929, the Soviet government purchased between 20,000 and 30,000 pedigreed breeding sheep. In order to maintain Australian flocks, the Australian government placed an embargo, still maintained today, on the export of sheep for breeding purposes. (House of Representatives, Commonwealth of Australia, *Parliamentary Debates*, 12th Parliament, 1st Session, p. 315.)

to a technical-assistance contract and when minor foreign training or technical help was required.[6]

The transfer of technical knowledge sometimes took forms easily overlooked. For example, the number of subscriptions taken out by the Soviet government for American technical and scientific publications jumped dramatically as the industrialization process got under way.[7]

The penetration of early Soviet industry by Western companies and individuals was remarkable. Western technical directors, consulting engineers, and independent entrepreneurs were common in the Soviet Union. In retrospect, perhaps the most surprising examples were the directorships held by General Electric affiliates on the boards of Soviet electrical trusts.[8]

Although the technological transfer took many forms, dictated by political and economic circumstances, the central mechanism was the concession, around which this study is built. The concession was also interrelated with other mechanisms and the very small amount of internally originated research, development, and innovation. It is true that after 1930 the importance of the concession declined greatly as other forms of technological transfer came into use but for the period from 1917 to 1930 the concession is central.

THE ROLE OF THE FOREIGN CONCESSION, 1917 TO 1930

The use of concessions was suggested in December 1917 at the first All Russian Congress of Councils of the National Economy. After extensive debate it was agreed that concessions were desirable for the restoration of the Russian economy. Subsequent negotiations with American, German, French, and British capital however, were temporarily halted by the Allied Intervention and Civil War.

In 1920, when political conditions were more stabilized, Lenin issued a decree allowing concessions to be granted by simple departmental permission. However, negotiations with Urquhardt, a British financier and well-known capitalist in prewar Russia, ended in failure; and so ended the second attempt to establish foreign concessions. Urquhardt sensed the likelihood of con-

[6] A partial list is in Saul G. Bron, *Soviet Economic Development and American Business* (New York: Horace Liveright, 1930), pp. 144–6. Bron was chairman of the Amtorg Trading Corporation in New York.

[7] In 1925 the Soviet government held 200 subscriptions to United States technical journals, in 1926–7 about 1,000, in 1927–8 about 8,000, and in 1928–9 more than 12,000, as noted in Amtorg Trading Co., *Economic Review of the Soviet Union* (New York: 1928), III, 383.

[8] The General Electric Co. was represented on the board of Electroexploatsia, which was responsible for new electrical power stations and systems construction. Swedish General Electric (ASEA) was a 'founder and a principal shareholder' of Electroselstroi, responsible for electrification of rural areas, as noted in *Annuaire Politique et Economique*, (Moscow: N.K.I.D., 1926), p. 25 (rear).

fiscation and would not embark without ironclad guarantees. An agreement between Krassin and Urquhardt was rejected by Lenin, who had problems with the more unrealistic members of the Party, who refused to accept a return of foreign capital under any guise.

A third, successful, attempt stemmed from the decree of March 8th, 1923, replaced by the law of August 21, 1923, which was further amended in December 14, 1927 and supplemented by special ordinances of May 23, 1926 and April 17, 1928. The August 1923 law established a Chief Concessions Committee (Glavkontsesskom) and the legal structure for the conduct of negotiations and the transfer of Russian property to foreign enterprises.[9]

A pure concession is an economic enterprise in which a foreign company enters into a contract with the host country to organize, equip, and exploit a specific opportunity, under the legal doctrine of *usufruct*. In return for the burden of development, exploitation, and production, the foreign company receives a non-contractual surplus or profit, usually taxed by the host country. The Soviets even considered the foreign commune, wherein foreign settlers entered the U.S.S.R. with their tools and equipment, as an agreement 'in lease *usufruct*.'[10] A variant of the pure concession found in Soviet development is the credit or contract concession. Here the foreign firm has the function of organization and finance, but operation is by a Soviet organization. Mixed companies are of this nature, and are still utilized in Soviet economic relations with satellite countries. Technical-assistance contracts are sometimes viewed as concession operations by the Soviets but rarely by the West. The return allowed to the foreign participant in a technical-assistance agreement is usually determined by contract and is not merely a surplus accruing to the entrepreneur. On the other hand, not all economic agreements lacking contractual payment features can be described as concessions. The design competitions, such as the Locomotive Design Competition of 1927, had non-contractual rewards but were not concessions, although they had elements of technological transfer.

The mixed corporation was also used in agriculture, as were credit and contract concessions financed by foreign firms but operated by Soviet organizations. In addition, technical-assistance contracts were used to acquire advice on particular agricultural problems, and in some cases concessions participated in the financing of equipment purchases.

Concessions, however, operated within all sectors of the economy, although the largest single group numerically was in raw materials development. Indus-

[9] The Concession Law of 1923 is reprinted in the *Journal of the Workmen-Peasant Government of the U.S.S.R.*, No. 13, 1923. The amendment is reprinted in *Collection of Laws of the U.S.S.R.* (Moscow: 1927), Part I, No. 69.

[10] The Imkommune Uhlfeld (Austria) is a good example. See page 129.

trial concessions formed a smaller but, as will be seen, strategically important group. Although concessions were offered in housing and public utilities, they were not, with the exception of a few housing developments, attractive to foreign investors.

In size, concessions ranged from the gigantic Lena Goldfields, Ltd., of the United Kingdom, operating thirteen separate industrial complexes and valued, after Soviet expropriation, at over $89 million, to small factories manufacturing pencils (the Hammer concession) or typewriter ribbons (the Alftan concession).

The Soviet definition of a concession is sometimes broader than that used in the West, and to avoid confusion the broader definition is utilized in this study. Concessions are here categorized in three ways; each category refers to a distinct organizational type.

The 'pure' concession (or Type I) was an agreement between the U.S.S.R. and a foreign enterprise whereby the foreign firm was enabled to develop and exploit an opportunity within the U.S.S.R., under the legal doctrine of *usufruct*, i.e., without acquiring property rights. Royalty payments to the U.S.S.R. were an essential part of the agreement, and in all cases the foreign enterprise was required both to invest stipulated capital sums and to introduce the latest in Western technology and equipment.

The 'mixed' company concession (or Type II) utilized a corporation in which Soviet and foreign participation were on equal basis (at first 50:50 but later 51: 49), with a Soviet Chairman of the Board who had the deciding vote in cases of dispute. Normally the foreign company invested capital and technology or skills and the Soviets provided the opportunity and the location. Labor, both skilled and unskilled, was partly imported, and profits were to be split.

Whereas the first two types are clearly recognized as concessions, the technical-assistance contract (or Type III concession) has not usually been so designated, except in the U.S.S.R. Probably the Soviets were well aware of the negligible marginal cost to Western companies of supplying technical knowledge, patents, designs, and similar technological vehicles. In essence, Type III was a 'reverse technical concession,' in that the Soviets were making payments to exploit foreign technological resources; the Western company was not, in this case, making payment to exploit Russian natural resources or opportunities.

All known concessions can be grouped into these three categories, as table 1–1 demonstrates. The common link is that each type, in its own way, acted as a mechanism for the transfer of Western technology and skills, although only Types I and II involved the transfer of capital.

Table 1-1 CONCESSION APPLICATIONS AND AGREEMENTS, 1921-30

Year	*Applications*[1]	*Number of agreements Types I and II*[1]	*Type III*[2]
1921–2	224	18	0
1922–3	579	44	1
1923–4	396	55	0
1924–5	256	103	4
1925–6	482	110	7
1926–7	263	Not available	13
1927–8	200	Not available	17
1928–9	270	Not available	33
1929–30	Not available	Not available	59
Total	2,670 (to 1928–9)	330 (to 1925–6)	134 (to 1929–30)

Sources: [1] A. A. Santalov and L. Segal, *Soviet Union Yearbook, 1930* (London: Allen and Unwin, 1930), p. 206.
[2] U.S.S.R. Chamber of Commerce, *Economic Conditions in the U.S.S.R.* (Moscow: Vneshtorgizdat, 1931), p. 162.

THE PLACE OF THE CONCESSION IN THE ECONOMIC HISTORY OF THE U.S.S.R.

Analyses of Soviet economic growth and the processes by which it has been attained have been restricted by lack of accurate data and firsthand knowledge of decision-making processes. The Soviets have, in fact, continually attempted to disguise the true rate and process of this economic growth.

It has been almost universally accepted that the foreign concessions policy of the 1920s and 30s did *not* aid the industrial development of the U.S.S.R. Certainly this interpretation has been propagated by the Soviets. N. Liubimov, former professor of economics at the University of Moscow, argues:

> Any discussion of concessions in the Union of Soviet Socialist Republics must emphasize their relative unimportance in Soviet activity. . . .[11]

Western writers, whether Marxist or non-Marxist in orientation, have taken a similar viewpoint. For instance, Maurice Dobb, a Marxist, argues that:

> . . . the policy of granting concessions on a larger scale to foreign companies had little success, apart from one or two special cases, while the concessions which were granted were more often in the sphere of foreign trade than in production.[12]

[11] 'The Soviets and Foreign Concessions,' *Foreign Affairs*, IX, No. 1 (October 1930), 95.

[12] *Soviet Economic Development since 1917* (5th ed.; London: Routledge and Kegan Paul, 1960), p. 142.

Then he adds:

> The policy of granting concessions to foreign firms to undertake trading and industrial ventures was unsuccessful in yielding more than about 10 million rubles (gold) of foreign capital in the first years of the concession policy.[13]

This is a meaningless statement unless the period in question is indicated. Several concessions contributed much more than 10 million rubles of investment apiece.

Soviet sources, which would hardly overstate the investment of concession capital, give figures for 1927 and 1928 indicating an investment, at least five times greater than that given by Dobb. Nevertheless, Dobb continues:

> In the early '20s' an attempt had been made to invite the aid of foreign capital on a limited scale in the form of concessions grants. But we have seen that the policy did not meet with any great success. . . .[14]

Dobb's conclusions are, in fact, unsound and unsupported by the available concessions data.

Non-Marxist writers have also assigned a minor role to the foreign concession. A. Baykov[15] does not mention concessions. A. Yugoff[16] holds that they had only a slight effect on economic development. Their ineffectuality, he argues, was due mainly to a prohibitive currency policy and restrictions on the free export of foreign bills of exchange. On this basis, Yugoff generally discounts the technological and economic impact of the concession.

M. Hwang Jen[17] ignores restrictions on export of proceeds mentioned by Yugoff, and instead argues that export of proceeds was a source of loss to the Soviets, and that generally the concession was an inefficient vehicle for the transfer of either capital or technology. Jen is impressed with the ingenuity of the concession but concludes that it was unrealistic as a method of development.

There has been some difference of opinion within the executive branch of the United States government on the importance of the concession in Soviet economic development. The State Department has not considered the concession particularly important.[18]

13 *Ibid.*, p. 150.
14 *Ibid.*, p. 180.
15 *The Development of the Soviet Economic System* (New York: Macmillan, 1947).
16 *Economic Trends in Soviet Russia* (New York: R. Smith, 1930), pp. 221–3.
17 *Le Régime des Concessions en Russie Soviétique* (Paris: Gamber, 1929).
18 The importance of the concession has been in general toned down. For example, in submitting advice to Professor Raymond T. Bye for a speech before the American Economic Association, the State Dept. suggested that 'a few large concessions' be re-stated as 'one large concession' (316–109–807). (Numeral references to U.S. archival material are explained in Appendix A.)

On the other hand, United States Military Intelligence (MID) arrived at conclusions closer to the theme of this study:

> The lack of capital, the failure of the New Economic Policy to stimulate actively trade and production, and the exhaustion of raw material stocks have influenced the leaders to look outside of Russia for aid in bringing about economic recovery.[19]

and:

> By September 1927, Soviet authorities are reported to have granted 156 concessions, embracing practically all branches of national economy. In February 1928 there were 110 concessions in operation.[20]

In brief, despite the single contrary estimate mentioned, the concession has generally been regarded, in the West and in Russia, as a negligible factor in Soviet economic development. Further, it has been suggested that supportive data is unavailable. Keller claims concession operation records are buried in the files of each firm and that the Soviets will not release their data.[21]

In the light of this almost universal conclusion that the concession was insignificant as a development mechanism, certain essential questions must be clearly answered. Can the data on concessions and transfers be assembled? Is such data reliable? Does the assembled data support the current assumption of a negligible role for the concession? Finally, what was the contribution of the concession to Soviet technological and economic development?

METHODOLOGY OF THE STUDY

A simple but consistent methodology is utilized in this study. Our objective is to estimate in a quantitative manner the impact of Western technology on early Soviet economic development. Each plant in this fairly primitive economy is identified and the origin of its equipment and technical processes traced. Because many of the plants were operated by Western concession operations, the major research task has been to obtain extensive and accurate data on concession operations. This was a complex and time-consuming task, involving a search in sources originating in a dozen countries. The data generally comes from one of five sources distinguished by varying degrees of reliability. This variety however, allows for comparison and informed interpretation of data from different sources on many similar problems.

[19] U.S. War Dept., *Soviet Russia; on Economic Estimate*, March 18, 1928, p. 4319-h (U.S. State Dept. Decimal File, 316-110-306).

[20] *Loc. cit.* The estimate of 156 concessions is not inconsistent with table 1-1. MID probably counted only Type I concessions, while table 1-1 col. 2 includes Types I and II.

[21] Keller, *op. cit.*, p. 219.

The primary sources of data are the United States State Department Decimal File and the German Foreign Ministry Archives for 1917 to 1930. These are a superlative source of detail not available elsewhere; yet a few concessions were not recorded by their respective home governments. In general, concessions and similar agreements were noted in Western news media, but with scanty detail; it is rare that the German or American archives provide data on a concession unmentioned in some newspaper; about 10 percent are recorded only in the archives. Most concessionaires were reluctant to provide details, and considering the shabby treatment the majority received from the Soviets, it is unlikely they wanted to publish the amount of their losses. However Western governments were interested in the progress of concessions, and instructions went out to consular and other officials to acquire data. The U.S. Riga (Latvia) consulate was very active in this collection process.

The State Department Archives contain a number of firsthand reports of visits to Soviet plants made by United States company officials in search of business. In some cases, however, such as the W. A. Harriman manganese concession, the State Department had to glean its information from indirect sources such as European newspapers.[22] Archival sources are, then, incomplete. They have to be utilized concurrently with data from the four other sources.

The second source of data is Western news media and in general consists of voluntary information releases from those companies desiring to publicize their operations. During the 1920s fear of public opinion curbed news concerning the concessions of many companies.[23] Indeed, some concessions known from other sources, are not recorded at all in Western news media. The problem with this second group of sources is incompleteness of detail and possible corporate bias to protect a 'public image.'[24]

The third source of data, and a surprisingly lucrative source, consists of publications of Soviet trade representatives in Western countries. These sources have been treated with the same circumspection as data originating within the Soviet Union. However, it has been found that data from this source usually agrees with news media reports, with specific exceptions noted in the text. The major exception occurs in explanations for liquidation of concessions; official Soviet explanations often diverge considerably from the versions of the expropriated corporation. The explanation for the existence of detailed information in Soviet sources lies in the intent of the publications: to encourage further investment by Western companies. The information

22 U.S. State Dept. Decimal File, 316–138–17/19.

23 *New York Times*, August 17, 1925, p. 3, col. 5.

24 The most useful Western newspapers are the *Times* (London), the *New York Times*, *L'Information* (Paris), and the *Russian Daily News* (Harbin, China).

had to be reasonably accurate—it could be checked, and the greatest problem of the Soviets then, as now, was to instill confidence. There was, however, no requirement to publish adverse information. Although these publications were used to print 'explanations' by some Western businessmen for the expropriation or failure of other concession enterprises, the 'explanations' were consistently pro-Soviet.[25]

A fourth source consists of data originating within the U.S.S.R., particularly in *Pravda*, *Izvestia*, and *Ekonomicheskaya Zhizn*. A series of five maps (dated 1921) suggests the vast plans, involving thousands of projected concessions, which characterized early Soviet thinking. These are reproduced in U.S. State Department Archives (130–1207/1234). An atlas of available concessions was also published in 1926 by the Central Concessions Committee *(Karty kontsessionnykh ob'ektov S.S.S.R.)* together with a few little booklets describing available concessions. These are useful as an indicator of the technological state of the plants being offered.

Soviet sources are viewed here in the light of the 1927 decree making the transmission of economic information prejudicial to Soviet concessions policy a crime against the state. Concessions and foreign companies working within the U.S.S.R. felt the sting of a decree against actions considered criminal only in the Communist world. Representatives of the Swedish firms Alfa Laval and Diabolo-Separator, manufacturers of dairy equipment (particularly cream separators) were accused of economic espionage in 1928 because they determined the probable future requirements of Soviet trusts for cream separators and reported the results of the market survey back to their respective firms in Sweden. The three defendants who worked for the Swedish firm were given five to eight years each in prison. Eight employees of Soviet trusts and commercial organizations, together with a German citizen named Bartsch, were given from one to three years each for accepting bribes and abetting economic espionage.[26] Consequently, after 1927, the flow of data from both the West and from the Soviet internal and external press declined substantially. Whereas detailed reports exist on industrial conditions up to 1927, few are found for the period from 1927 to 1930.[27]

The fifth source consists of a collection of miscellaneous material in several languages, including books written by engineers, consultants, and others who

[25] Amtorg Trading Co. *Economic Review of the Soviet Union* (New York: 1928), III, 373.

[26] Based on article in *Vossische Zeitung* (Berlin), July 1928, as reported by the American Legation in Berlin, Report No. 3750 of July 24, 1928 (U.S. State Dept. File, 316–109–754/5). Bartsch was promptly released.

[27] The report by M. Klemmer, a Western Electric Co. engineer, to the U.S. State Dept. (U.S. State Dept. Decimal File, 316–141–628) is clearly economic espionage within the Soviet meaning of the term. See also chap. 11.

worked in the U.S.S.R., and statistical summaries and handbooks published by Soviet representatives abroad.

In general, the problem of interpretation of Soviet data is not acute, although it is time-consuming. Data distortion had not at this time reached the quagmire stage; the major problem is incompleteness and the pervasive Soviet habit of omitting unfavorable facts and figures.

Use of data from several sources enabled cross-checking. As a general rule, data from Soviet and Western sources had to be consistent before it was utilized (exceptions to this rule are noted). Such a method avoids the problem of choosing between contradictory statements and statistics. For example, statements concerning the condition of the electrical equipment industry in 1922 can be found in the Soviet press which lead to the conclusion that it was, on the one hand, healthy and profitable,[28] and, on the other, in a state of near-collapse.[29] Evidence was also found that the electrical trusts were approaching foreign companies for help.[30] Subsequently foreign engineers entered the U.S.S.R. and their survey reports found their way into Western government archives.[31] With this support, the second conclusion could be accepted as reasonably factual.

Omission, at times, assumed significant proportions. Acceptance of the mineral production figures for 1927–8 published by the Leningrad Academy of Science Geological Committee would lead one to believe that neither gold nor platinum was produced in the U.S.S.R., and that the Lena Goldfields, Ltd., concession produced only limestone, dolomite, and quartz, whereas, in fact, it produced almost 40 percent of Soviet gold, 80 percent of Soviet silver, and significant proportions of copper, lead, zinc, and iron.[32] Similarly, the concession agreement with International Barnsdall Corporation omitted all reference to the specific geographic area covered by the agreement, although

[28] 'Experience proved that the electrical industries had improved very much under Government control. They were working satisfactorily and even giving profit to the State.' *Izvestia*, October 9, 1921 (paraphrased).

[29] Three months before the October 9 statement above, half the electrical plants in Petrograd had been closed due to a fuel crisis and the others drastically slowed, according to *Izvestia*, July 12, 1921. Eight months after the October 9 statement, the industry is described as having no working capital, no credits, no payments, '. . . the position is a very difficult one . . . electric lamps and cables can only be obtained by force . . .' according to *Ekonomicheskaya Zhizn*, No. 124, June 7, 1922.

[30] Electro-Technical Trust (GET) letter to International General Electric Inc., May 2, 1922 (U.S. State Dept. Decimal File, 316–139–58).

[31] Examples are the B. W. Bary report (1921) (U.S. State Dept. Decimal File, 316–139–11); and the Reinke report (1923) (U.S. State Dept. Decimal File, 316–108–672).

[32] V. I. Kruglyakova (ed.), *Sbornik statisticheskikh svedenii po gornoi i gornozavodsk promyshlennosti S.S.S.R. za 1927/8 gg.* (Moscow: 1930) pp. 60, 74, 90, 102, 106, 146, 150, 152. Limestone and quartz were used as a flux for the (statistically non-existent) Lena Goldfields gold-smelting operations.

the W. A. Harriman manganese concession agreement had its geography spelled out in minute detail.[33] A healthy dose of skepticism has proved to be an invaluable research tool.

[33] Reasons for omission in the case of Barnsdall are significant and are outlined in chap. 2.

CHAPTER TWO

Caucasus Oil Fields— The Key to Economic Recovery

THE Caucasus oil fields are a major segment of Russian natural resource wealth. Baku, the most important field, was developed in the 1870s. In 1900 it was producing more crude oil than the United States, and in 1901 more than half of the total world crude output. The Caucasus oil fields survived the Revolution and Intervention without major structural damage and became a significant factor in Soviet economic recovery, generating about 20 percent of all exports by value; the largest single source of foreign exchange. The process by which the oil economy recovered from impending disaster and acquired modern refinery operations in a brief four or five years is the topic of this chapter.

COLLAPSE OF OIL FIELD DRILLING

Caucasian fields require continuous drilling to maintain an oil flow from producing wells. Therefore, oil production in this area is directly proportional to the amount of drilling undertaken. Before the Revolution, drilling averaged in excess of 35,000 feet per month, and had been as high as 50,000 feet in Baku alone.

The Bolsheviks took over the Caucasus in 1920–1, and until 1923 oil field drilling almost ceased. During the first year of Soviet rule ' . . . not one single new well has started giving oil'[1] and even two years after Soviet occupation, no new oil-field properties had been developed. In addition, deepening of old wells virtually ceased. As a result, water percolated into the wells, and the flow of crude oil became first a mixture of oil and water and finally a flow of oily water.

[1] U.S. State Dept. Decimal File, 316–137–221.

Table 2-1 AVERAGE MONTHLY DRILLING IN RUSSIAN OIL FIELDS, 1900–21

1900	*1913*	*1920*	*1921*
48,496 ft.*	36,665 ft.	780 ft.	Jan. 336 ft.* Feb. 406 ft.*

Sources: 1900—A. Beeby Thompson, *The Oil Fields of Russia* (London: Lockwood, 1908), p. 120.
1913—G. Ghambashidze, *The Caucasian Petroleum Industry and Its Importance for Eastern Europe and Asia* (London: Anglo-Georgian Society, 1918), p. 9.
1920–21—*Ekonomicheskaya Zhizn*, May 20, 1921.

* Baku only.

Drilling records are an excellent indicator of the state of oil field maintenance, development, and production. The complete collapse after the Soviet takeover is clearly suggested in Table 2–1. In 1900, Russia had been the world's largest producer and exporter of crude oil; almost 50,000 feet of drilling per month had been required in Baku alone to maintain this production. By early 1921, the average monthly drilling in Baku had declined to an insignificant 370 feet or so (0.7 percent of the 1900 rate), although 162 rigs were in working order. This drilling was concentrated in only eight holes due to lack of steel pipe.[2]

The result was that, by 1922, half of the Baku wells were idle and the remainder were producing increasing quantities of water. In the Grozny field a greater portion of the wells were idle; only eight were in process of drilling, and the Old Grozny section was completely shut down. Smaller fields at Emba and Kuban were in similar chaos; both had received extensive drilling in 1915; consequently there were forty to fifty producing wells in 1922 but no new or maintenance drilling was in progress.[3]

The reasons for the catastrophic decline in oil-field production were four. First the number of available oil-field workers declined from about 40,000 in 1915 to less than 10,000 in 1920–1; coupled with this was the growing technical inefficiency of the remaining workers. Second, there was a breakdown in railroad transportation and a decline in pipeline capacity, because of lack of maintenance. Third, new oil-field supplies and equipment, including repair facilities were almost nonexistent. Last, there was a breakdown in the oil field electrical supply system. One of the largest Baku powerhouses, for example, had twenty-two water tube boilers, none were in operation in 1922.[4]

[2] U.S. State Dept. Decimal File, 316–137–442.

[3] The decline of the Caucasus oil fields is covered in detail in *Ekonomicheskaya Zhizn* for 1921–2.

[4] *Ekonomicheskaya Zhizn*, December 24, 1922 and February 10, 1923.

The paradox was the collapse of one of the few industries capable of generating sufficient foreign exchange for an industrial revival. Serebrovsky, Chairman of Azneft, put forward the program for recovery in a *Pravda* article. The plan for 1923 was to increase oil-well drilling to 35,000 sazhens per year (245,000 feet). This would require 35 rotary drills (to drill 77,000 feet) and 157 percussion drills (to drill 130,000 feet). Serebrovsky pointed out that Azneft had no rotary drills, and that Russian enterprise could not supply them. Rotary drilling, however, was essential for the success of the plan. He then announced:

> But just here American capital is going to support us. The American firm International Barnsdall Corporation has submitted a plan. . . . Lack of equipment prevents us from increasing the production of the oil industry of Baku by ourselves. The American firm . . . will provide the equipment, start drilling in the oil fields and organize the technical production of oil with deep pumps.[5]

During the next few years International Barnsdall, together with the Lucey Manufacturing Company[6] and other major foreign oil-well equipment firms, fulfilled Serebrovsky's program. Massive imports of equipment came from the United States. International Barnsdall inaugurated the rotary drilling program, initiated Azneft drilling crews into its operational problems, and reorganized oil-well pumping with deep-well electrical pumps.

INTERNATIONAL BARNSDALL CORPORATION

Numerous British, Swedish, Dutch, Greek, German, and American oil-field concessions were rumored from 1919 onward, but there is no evidence that any were granted and implemented, in spite of many extravagant claims, before the three Barnsdall concessions in 1921–2.

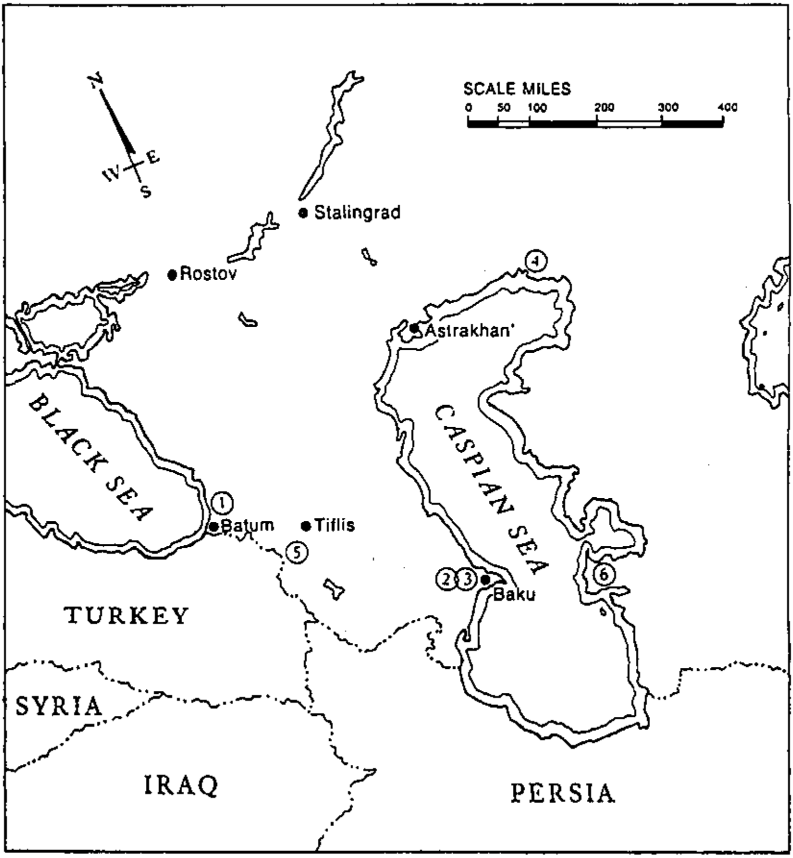
The first International Barnsdall concession was signed in October 1921,[7] and was followed in September of 1922 by two further agreements. There is no doubt that Barnsdall did work under the first agreement. *Pravda* reported groups of American oil-field workers on their way to the oil fields,[8] and a couple of months previously the United States Constantinople Consulate had reported that Philip Chadbourn, the Barnsdall Caucasus representative, had passed through on his way *out* of Russia.[9] In particular, the U.S. State Department Archives contain an intriguing quotation from Rykov (unfortunately with no stated source), dated October 1922:

[5] *Pravda*, September 21, 1922.
[6] Captain J. F. Lucey, founder of the Lucey Manufacturing Co., was the first Chairman of the Committee on Standardization of Rotary Drilling Equipment, organized by the United States petroleum industry in 1926.
[7] *New York Times*, March 29, 1922, p. 24, col. 2.
[8] October 22, 1922.
[9] U.S. State Dept. Decimal File, 316–130–1201/2.

The one comparatively bright spot in Russia is the petroleum industry, and this is due largely to the fact that a number of American workers have been brought into the oil fields to superintend their operation.[10]

MAP 2-1

FOREIGN OIL DRILLING CONCESSIONS IN THE CAUCASUS, 1921-8



Legend: 1. British Petroleum Co. Ltd., Gouria concession (1923, Type I)
2. International Barnsdall Corp., Baku concession (1921–2, Type III)
3. Duverger Baku concession (1923, Type I)
4. Duverger Emba concession (1923, Type II)
5. Società Minere Italo-Belge di Georgia, Shirak concession (1923, Type I)
6. F. Storens concession in Busachi (1925, Type I)

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10 *Ibid.*, 316–107–1167.

In September 1922, two extensive agreements were signed by Serebrovsky, representing Azneft, and Mason Day, president of the International Barnsdall Corporation, a New York-based oil company.[11] Barnsdall agreed to drill for oil in the 'Baku district in the Balakhani oil-field area (sic)'[12] within an area of 400 dessiatins, or 1,080 acres. The work was to consist of deepening old oil wells and drilling new wells under the supervision of a mixed commission containing both Soviet and American members. The maximum depth of these wells was to be 450 sazhens (3,150 feet) with a starting diameter of at least 20 inches and a finishing diameter of not less than 4 inches. Barnsdall agreed to import tools and equipment for the simultaneous drilling of 20 wells; and to drill at least 10,000 feet in the first year, no less than 20,000 in the second, and no less than 30,000 annually thereafter. Electric power, derricks, water, clay, timber, cement, and workshops (without equipment) were to be supplied by Azneft.

Barnsdall imported equipment at its own risk, with cost plus 5 percent to be repaid by Azneft on arrival at the drilling site. Azneft had the option of paying in either gold rubles or oil and oil products at market price. Each oil well drilled was paid for on a schedule based on 80,000 gold rubles per each sazhen (7 feet) drilled for the first 100 feet in each hole, and 10,000 gold rubles for each additional sazhen. As in the case of the equipment, payment could be made either in gold rubles or in oil or oil products, at the option of Azneft. A royalty of 20 percent in oil was paid to Barnsdall on either new or deepened wells, and the term of the agreement was set at fifteen and a half years.

The second Azneft-Barnsdall agreement was an oil-well-pumping contract under which International Barnsdall undertook to install modern pumps in both shut-down and watered wells and in new wells drilled under the first contract.

There was a specific requirement in the pumping contract for electrical deep pumps to be installed in all wells except fountains, gushers, and those requiring air-lift. During the first year, sufficient equipment was to be imported by Barnsdall to develop deep pumping in a minimum of 40 wells, with a further 100 pumps to follow each year for the 15-year term of the agreement. Electrical power was to be supplied free by Azneft.

No payment was made by Azneft for the pumping equipment, which was to pass to the Soviets at the expiration of the agreement. A royalty payment of 15 percent of the gross crude output of each well was assigned to International Barnsdall, with free tank storage at Baku.

[11] The Barnsdall agreements were not published. Mason Day, after some pressure, supplied a copy to the U.S. State Dept. This copy is now in the Archives, and is the basis for this section. Mason Day later joined forces with Sinclair and was convicted in the Teapot Dome oil scandal. Barnsdall financing was by Blair and Co., of New York.

[12] U.S. State Dept. Decimal File 316–137–510.

OIL FIELD PROPERTIES COVERED BY THE BARNSDALL AGREEMENT

To assess the impact of Western technology on the development of the Caucasus oil industry, it is necessary to determine the areas of the Baku fields covered by the Barnsdall agreements. The technological impact was in two forms: the direct oil-field work undertaken by Barnsdall engineers and crews; and the installation by Azneft engineers of equipment supplied by the Lucey Manufacturing Company, Metropolitan-Vickers, Ltd., and other companies and only partly under the technical supervision of Barnsdall.[13]

The geographical area to be covered by the agreement was deliberately obscured not only to the Western public but also to the U.S. State Department. There were major discrepancies in the statements of Mason Day and the Soviet press concerning the actual area placed under development.

The property rights of the prerevolutionary owners and lessees of Baku oil lands were in question, and the probability existed that these claimants would restrict Barnsdall and other Western company operations by legal action. It was therefore important for the U.S.S.R. to convey the impression that all Barnsdall work was being done on land formerly owned by the Crown, so that former private owners and lessees would have no cause for injunctive action in Western courts.

The contract clearly states that the area covered by the first, or drilling, contract, was 400 dessiatins in the Balakhani area of the Baku oil fields, with the option of extension to Sabunchi and Ramuni. A dessiatin is 2.7 acres. In talks with the U.S. State Department, Day used a conversion factor of 1 dessiatin=7/8 acre, and Barnsdall press releases talked about 400 acres rather than 400 dessiatins. In other words, there was a deliberate attempt on the part of Barnsdall to make the area covered by the agreement appear considerably smaller.

The area covered was, in fact, 1,080 acres, and as the location of previously privately-owned and leased property in the Balakhani section was known, it was concluded by the U.S. State Department that:

> There can be no doubt . . . that the vested rights of private owners or lessees will be infringed on from the very outset under either the first or the second contract.[14]

[13] International Barnsdall obtained $1.5 million credit in the United States from Lucey Manufacturing for oil-field equipment. In addition, Lucey obtained a substantial order directly from Azneft. Hill Electrical Drills, EMSCO (Los Angeles), and Metropolitan-Vickers, among others, secured significant orders for oil-field equipment. [W. A. Otis, *The Petroleum Industry of Russia*, U.S. Dept. of Commerce, Trade Information Bulletin No. 263, p. 24. Also *EMSCO Derrick and Equipment Company* (Los Angeles: Banks Huntley, 1929), pp. 26–7].

[14] Memorandum, Durand to Herter, February 1923 (316–137–586).

The substance of the State Department assessment was that it would be difficult, if not impossible, to find 400 dessiatins *not* previously operated or leased by private persons or companies.

A comparison of the four sections of the Baku oil field supports this position.

Table 2–2 DISTRIBUTION OF CRUDE OIL PRODUCTION AND PROPERTY OWNERSHIP IN THE BAKU OIL FIELDS, 1915

Baku Oil Field Section	*Percent Total Production*	*Percent Previously Owned or Leased*
Balakhani	19.5%	93.0%
Sabunchi	41.7	100.0
Ramuni	15.7	100.0
Bibi-Eibat	23.1	100.0

Source: Memorandum, Lewery to Durand (316–137–580/3).

The Sabunchi, Ramuni, and Bibi-Eibat sections had been completely under private ownership or leasing arrangement at the time of the Revolution. The Balakhani section was the only section with some open state land, but this amounted to only 7 percent of the total oil land in the section. The area of this unworked Crown land, which would not be subject to private claims, was less than 45 dessiatins. The balance of this section and the other three sections would all have been subject to injunctive action if worked by International Barnsdall.

The agreement stated that work was to be done on the Balakhani section, i.e., the only section with some Crown land, but contained an option to extend the work to the Sabunchi and Ramuni sections under instruction from Azneft. It was also verbally understood to extend to the Bibi-Eibat section.[15] The technical-assistance and pumping agreements covered all sections of the Baku field; so did the equipment sold by Lucey and other suppliers to Azneft.

In brief, the news releases attendant upon the International Barnsdall contract limited public discussion to 400 acres or less in the Balakhani field for good reason: to avoid legal action in Western courts.

> Whatever may be the purpose of the Barnsdall group, the contract reads as if the Russian authorities expected and intended to assign them for improvement and pumping wells which have been confiscated from former private owners, mostly foreigners.[16]

[15] U.S. State Dept. Decimal File, 316–137–581.

[16] Memorandum, Durand to Herter, February 8, 1923 (316–137–587).

The agreement was intended to cover the whole of the Baku field. Both the Soviets and International Barnsdall, considered it prudent to misrepresent the area covered by the contract.[17]

EXTENT OF BARNSDALL DRILLING

Barnsdall was required to undertake a minimum of 10,000 feet of drilling in the first year of operations and additional amounts in subsequent years, under the direction of a mixed committee, which included Azneft representatives. There is substantial reason to believe that Barnsdall undertook more drilling than the minimum required by the contract, which again may have camouflaged a private agreement. There was certainly substantial financial incentive for Barnsdall to exceed the minimum.

Analysis of drilling reports suggests a rate in excess of 180,000 feet per year. In the month after the arrival of the first group of engineers (June 1923), Barnsdall put down 15 wells in the Kirmaku area of northwest Balakhani.[18] Given an average depth of 1,000 feet for Baku wells, this equalled 15,000 feet a month, or 180,000 feet a year.[19] Also, Barnsdall had six American engineers in Baku, a number hardly warranted by a drilling rate of only 10,000 feet a year. One drilling agreement was in operation for two years. International Barnsdall was 'driven out' of the U.S.S.R. in 1924 after incurring 'very important material losses.'[20] Louis Fischer says the agreement lapsed 'by mutual consent' in 1924.[21]

CHANGES IN DRILLING TECHNOLOGY AT BAKU

Although the exact area and footage drilled will probably never be known, a complete change in Soviet drilling technology has been recorded. The old labor-intensive percussion methods gave way completely to the United States-developed rotary drilling techniques. This changeover is summarized in table 2–3.

[17] Morris, Chief of the Petroleum Division, U.S. Dept. of Commerce, made the succinct comment, ' . . . the Russians knew exactly what they were doing when they assigned Barnsdall's territory' (316–137–584). Lucey Manufacturing later confirmed to the State Dept. that Barnsdall was working throughout the Baku area irrespective of former ownership (316–137–745).

[18] Otis, *op. cit.*, p. 25.

[19] This would be equivalent to sinking 180 wells averaging 1,000 feet each. Scheffer noted that 300 wells were put down in Baku between October 1923 and October 1924 [Paul Scheffer, *Seven Years in Soviet Russia*, (New York: Macmillan, 1932), p. 94].

[20] W. Kokovtzoff, 'Le gouvernement des soviets et les concessions aux étrangers,' *Revue des Deux Mondes*, XXXV Sept. 1, 1926, 158–81.

[21] *Oil Imperialism* (New York: International, 1926), p. 169.

There was no substantial rotary drilling in the U.S.S.R. before 1923.[22] However, in the five years following, the percussion method was almost completely abandoned and the American rotary method substituted. By 1928 the percussion method accounted for only 2 percent of drilling (against 100 percent in 1913) and rotary drilling accounted for 81 percent (against none in 1923). The cable technique had brief use but was abandoned in favor of rotary methods. It should be noted that the Soviet-developed turbine drill had an early but insignificant utilization, and did not gain wide acceptance until later in the 1930s.[23]

Table 2–3 OIL-DRILLING TECHNIQUE, PERCENTAGE UTILIZATION BY AZNEFT (BAKU), 1913–28

Year	OIL-DRILLING TECHNIQUE			
	Rotary	*Cable*	*Percussion*	*Turbine*
1913	—	—	100.0%	—
1924	36.0%	8.0%	56.0	—
1925	54.3	7.7	37.2	0.8%
1926	62.6	20.6	16.2	0.6
1927	71.3	19.7	7.3	1.7
1928	81.3	14.0	2.1	2.6

Source: Adapted from Alcan Hirsch, *Industrialized Russia* (New York: Chemical Catalog Co., 1934), p. 146. Hirsch was Chief Consulting Engineer to Chemtrust.

Note: These figures are supported by less detailed data in *Le Pétrole Russe* (Paris: Editions de la Représentation Commerciale de l'U.R.S.S. en France, 1927) No. 6, p. 5, where the following figures are given for rotary drilling:

1923–4: 34.7% 1924–5: 54.2% 1925–6: 63.7% 1926–7: 71.0%

The insignificant turbine drilling is confirmed in Kruglyakova, *op. cit.*, p. 120. It is stated that, of a total 367,480 meters drilled, 7,164 meters (or 1.9 percent) were turbine-drilled. Of this, 5,685 meters were drilled at an experimental hole at location No. 24, Surachanskaya.

The substitution of rotary drilling for the old percussion methods increased speed of drilling by a factor of ten and reduced costs by more than one half between 1924 and 1928.[24]

Neftsyndicat provides more detailed data which is consistent with Hirsch's statement. In 1920–1, when no rotary drilling was utilized, average drilling rates were 6.8 meters per drill-month. This jumped to 69.8 meters in 1925–6,

[22] A Russian mining engineer, Adiassevich, imported a rotary drilling rig and tools from California and completed a few 22-inch holes between 1913 and 1915 (316–137–210).

[23] These percentages contrast with those of the 1960s. By denying the Soviets Western rotary drills and drill pipe, we have forced them to utilize the turbine and electric drill techniques and to incur the cost of both development and a less efficient technique. The final cost to their oil economy has been substantial.

[24] Alcan Hirsch, *Industrialized Russia* (New York: Chemical Catalog Co., 1934), p. 146.

with a maximum figure of 640 meters. The same source suggests that a 600–700 meter hole required in 1927 only 70–80 days for drilling, whereas under the old drilling system it had required one year. In terms of cost, the advantages were just as significant. In one year, from 1923–4 to 1925–6, drilling costs fell from 413 rubles to 218 rubles per meter, and the number of workers required for one drill-month of operations fell from 49 to 30.[25]

CHANGES IN PUMPING TECHNOLOGY AND OIL FIELD ELECTRIFICATION

There was a parallel revolution in pumping technology. In 1922 oil-well pumping was undertaken by bailing (a primitive, inefficient technique) or by air-lift. About 10 percent of production was free-flowing and did not require mechanical assistance. A small portion was collected by surface methods. There was no deep-well electrical pumping in 1922, and no oil field pumps were produced in the U.S.S.R. until the initiation of the Maschinenbrau A-G technical-assistance agreement with Mosmash,[26] in the mid-1920s.

Table 2–4 CRUDE OIL EXTRACTION TECHNOLOGY IN BAKU OIL FIELDS, 1921-2 AND 1927-8

Method of Extraction		*1921–2*	*1927–8*
Bailing	OLD	49.3%	0.0%
Air-lift	OLD	40.3	27.9
Gushers		9.8	26.0
Pumping	NEW	0.0	44.8
Surface	NEW	0.6	1.3
		100.0%	100.0%

Source: 1921–2, Otis, *The Petroleum Industry of Russia*, p. 19
1927–8, U.S. State Dept., Decimal File, 316–137–1130.

On the other hand, electrical deep-pumping was at this time in general use in the United States and elsewhere and was considerably cheaper than the more primitive extraction methods. The second part of the Barnsdall contract required installation of deep-well pumps in Barnsdall-developed wells; pumps were also purchased from the United States and Germany for Soviet operations. Acquisition of pumps was so rapid that four years after the signing of the Barnsdall contract, 45 percent of Baku crude oil was being pumped rather than bailed.

[25] *Le Pétrole Russe* (Paris: Editions de la Représentation Commerciale de l'U.R.S.S. en France) No. 6 (1927), p. 6.

[26] See page 35.

The change in extraction technology in the Baku fields is summarized in table 2–4. Bailing declined from 49.3 percent in 1921–2 to zero in 1927–8, while pumping increased from zero in 1921–3 to 44.8 percent of output in 1927–8. The other significant change was the increase in production from free-flowing wells (gushers) from 9.8 percent to 26.0 percent, reflecting the increase in new well-drilling activity by International Barnsdall, in Type I concessions, and in newly equipped and trained drilling crews of Azneft. In absolute numbers, there were only 38 wells equipped with modern pumps in May 1924; one year later, in July 1925, over 500 wells had modern pumps.[27]

The general operation of the Baku oil fields was electrified in the same period; by September 1928, of 3,312 oil wells in operation, about 3,212 (97 percent) had pumping powered by electricity, 3 by steam engines, and 96 by gasoline engines. This compares to only 30 percent electrification in 1913. The oil-field electrification program, including the supply of some switchgear and other equipment, was undertaken by Metropolitan-Vickers, Ltd. (United Kingdom), a subsidiary of Westinghouse,[28] while between 1927 and 1930,

> . . . large quantities of General Electric products began to furnish the motive power for drilling oil wells and for pumping oil in the rich fields of Baku and Grozny.[29]

Details in *Le Pétrole Russe* suggest that the electrification program was also concentrated into a very few years and in old wells involved a substitution of electric for gasoline and steam engines rather than just the introduction of electric motors.

Table 2–5 ELECTRIFICATION OF THE GROZNY OIL FIELDS, 1923–7

	Number of Engines (by Type) on Oct. 1				
	1923	*1924*	*1925*	*1926*	*1927*
Steam engines	145	137	127	91	31
Gasoline engines	37	31	27	22	21
Electric motors	76	126	192	276	396
Total	258	294	346	389	448
Percent electric motors	29.5	42.9	55.5	71.0	88.3

Source: Le Pétrole Russe, No. 6, p. 6.

[27] *Financial Times* (London), May 25, 1923.

[28] This was one of the largest of the Metropolitan-Vickers contracts with the U.S.S.R. The breach of relations between the United Kingdom and Soviet Russia in 1927 (following the 'Arcos affair') did not disturb Metropolitan-Vickers. The company worked continually in the U.S.S.R. on a substantial scale from 1921 until after the trials of 1933, when six of their engineers were accused of sabotage and expelled.

[29] *Monogram* (Schenectady: General Electric Co.), November 1943, p. 16.

In Grozny, for example, the number of oil-field motors increased from 258 in 1923 to 448 in 1927. Electric motors formed only 29 percent of the total in 1923 but 88 percent in 1927. During the same period steam engines were virtually eliminated and the number of gasoline engines reduced by almost half.

The same change took place in Baku. At the beginning of 1925–6 there were 1,821 electric and 175 steam engines in Baku. By August 1927 there were 2,810 electric motors and only 27 steam engines.

This technological substitution greatly reduced the cost of producing oil. In 1913 the Baku fields used 1.3 million tons of crude oil (about 15 percent of the total produced) as fuel in the oil fields. By September 1925 this total had fallen to 8.4 percent; and by July 1927 to 3.9 percent. In brief, the substitution of electricity for oil reduced operating costs and also released considerable quantities of crude oil for export.

This export of Western technology—primarily American—was first concentrated in the Baku fields, and later in the Grozneft and Embaneft regions. The lag in regional application is supported by the statistics. In the Azneft field 36 percent of the drilling was done by the rotary method in 1924, but a comparable percentage (35 percent) was not attained by Grozneft until 1927. Whereas Azneft had 54 percent rotary drilling in 1925, Grozneft did not attain this percentage until 1928.

Neither Grozny nor Emba had specific technical-assistance contracts for crude oil production. Their production problems, much less acute, were overshadowed by those of transportation and marketing. Consequently the three-year transfer lag was not of major importance.

Although the first, International Barnsdall was not the only vehicle for technological transfer in the oil fields. This transfer was designed to modernize the most prolific of the oil fields (which was also the field with the most serious production problems) by developing new wells and instituting a rational organizational and technical structure for deepening old wells. The transfer was a complete success.

THE 'PURE' OIL CONCESSIONS

Another transfer vehicle used, outside the Baku field, was the pure (Type I) concession. The fields offered for pure concessions were more remote or smaller, or in less-developed areas. Although Baku, Grozny, and Emba were offered on this basis, there were no serious negotiations for pure concessions after 1925. A typical offering for a pure concession was the Cheleken Island field in the Caspian Sea. As early as 1830, there were more than 3,000 hand-dug oil wells up to 250 feet deep, and production continued until the Revolution. By 1923 only 12 wells were still producing; the rest were inoperative. The field was then offered for concession.[30] There were at least five operating concessions of this type between 1922 and 1928.[31]

In February 1925 the Chief Concessions Committee concluded an agreement with F. Storens, a Norwegian firm, for the industrial and mineral exploitation of the Busachi Peninsula in the Caspian Sea. The area covered 12,000 square versts on the eastern part of the peninsula. Storens was required to make an expenditure of 800,000 rubles on exploration work within five years. The life of the concession was set at 40 years, although the Soviet government had the option to buy out Storens in 30 years. All equipment was imported duty-free, but unstated dues and fees were payable, including 5 percent of any metals output and 15 percent of any oil produced (50 percent if a gusher). A deposit of 50,000 rubles was accepted as a guaranty of the execution of the contract.[32] [33]

At the end of 1923, a concession agreement was concluded between the Società Minere Italo-Belge di Georgia of Turin, Italy, and the Chief Concessions Committee, under which the company agreed to conduct oil exploration on 50,000 acres of the Shirak Steppes near Tiflis. The Società was given the right to explore and drill for three years, and production concessions could be subsequently granted for 30 years, the U.S.S.R reserving the right to buy out the undertaking after 20 years. During the exploration period the grantees paid the Soviet government a royalty for each dessiatin explored. At the end of the exploration period, the company was required to make a report and hand over equipment and all oil produced to the Soviets.

The company was also required to pay a percentage on gross product, pay export taxes, and comply with Soviet law on taxation and labor. At the end of

30 Amtorg, *op. cit.*, II, No. 24 (December 15, 1927): 'Cheleken Oil Field proposed for concession,' p. 6.

31 These were Storens, Italo-Belge, British Petroleum, the Japanese Sakhalin, and the French Duverger group. Others were rumored. At one time the Chief Concessions Committee was considering 62 applications for oil concessions, but little has been recorded concerning their operation. The Comparre Oil Company of New Jersey was formed by W. Averell Harriman specifically for a Baku oil concession.

Type II (mixed company) concessions were not common in oil operations; apart from the Dutch-Soviet trading company mentioned in the text, there was only Duverger and the Turkestan Co. for Raw Materials Preparation, jointly operated by Sorgagen A-G (Germany) and Neftsyndikat (316-111-819).

32 *Ekonomicheskaya Zhizn*, No. 33, February 10, 1925.

33 'One of the most important and largest concessions granted is that for mining and oil concessions given to the Norwegian Company Storen. . . . According to the geological reports, this area is very rich in oil. Considering that it has never been worked before and operations will be more difficult than usual, the concessionaire was given many special privileges.' [L. Segal and A. A. Santalov, *Soviet Union Year Book: 1926* (London: Allen and Unwin), p. 165.] According to *Karty Kontsessionnykh ob'ektov S.S.S.R.* (Moscow: 1926) the Busachi Peninsula oil deposits were known but not worked or delineated at this time.

the concession period, the entire property reverted to the Soviets without compensation. A bond was required from the grantees, who were also required to introduce the latest methods of drilling and oil production.[34]

An extension of the agreement was applied for and granted in September 1926. Preliminary work was completed, and the area for development was increased from the original 415 to 1,515 hectares. The extension was granted with the stipulation that the company sink four oil wells, each at least 500 meters deep.[35]

In 1923 an agreement was signed between the Gouria Petroleum Corporation, Ltd. (United Kingdom), and the Chief Concessions Committee covering the development and exploitation of 1,100 square miles in Gouria, on the Black Sea, between Poti and Batum. A 40-year concession stipulated that rental payments and part of the production were to be assigned to the Soviets, who also had an option to purchase the whole output.[36]

The Duverger group (France) obtained oil concessions in 1923 in both the Baku and the Emba fields. The lease of 'state' lands in Baku was subject to an annual percentage of profits or oil payable to the U.S.S.R. The concessionaires had full management control. The Emba concession was a Type II mixed company arrangement for exploitation of the fields between Samar and Tashkent. The initial capitalization required payment of five million francs.[37]

OIL DEVELOPMENT IN THE SOVIET FAR EAST[38]

Protocol B of the January 1925 convention between the U.S.S.R. and Japan contained the conditions under which petroleum and coal concessions were granted to Japan in North Sakhalin. In effect, these replaced the 1922 Sinclair Exploration Company concessions, cancelled by the U.S.S.R.

The petroleum concessions gave the Northern Sakhalin Petroleum Company (Kita Sagaren Sekio Kigio Koumiay, succeeded by Kita Karafuto Sekio Kabushiki Kasha) the exclusive right to explore and exploit half of the two known oil fields for a period of forty-five years. The other half of each field remained in the hands of the Soviets. In addition to the original area of 2,200 dessiatins, a further area was later granted for exploration work, on the under-

[34] *Corriere Diplomatico e Consolare*, February 10, 1924, and *Ekonomicheskaya Zhizn*, No. 62, December 13, 1923. Oil seepages had been known in the area for many years, but prerevolutionary exploration had not been profitable.

[35] U.S. Consulate in Riga, Report, September 10, 1926 (316–137–991/3).

[36] 'The concessionaire company is extremely reticent concerning the details of the arrangement and the London press has . . . referred to the matter only in a cursory way.' (U.S. Embassy in London, Report No. 14817, March 23, 1923.)

[37] *New York Times*, July 19, 1923, p. 23, col. 2.

[38] This section is based on evidence in the U.S. State Department Decimal File (Rolls 137, 176 and 177 of Microcopy 316).

standing that half of any oil field discovered was to be transferred to the U.S.S.R. for Soviet operation. A royalty was payable on all output, ranging from 5 percent for production not in excess of 30,000 tons per year up to 15 percent for production in excess of 630,000 tons. A royalty of from 15 to 45 percent was payable on gushers depending on yield. For natural gas the royalty ranged from 10 to 35 percent, depending on the composition of the gas. Foreign skilled labor was allowed to the extent of 50 percent of the total labor force and unskilled to 25 percent of labor force. All disputes were subject to the law and courts of the U.S.S.R.

Soviet Far Eastern oil development was completely dependent on Japanese concessions and technical assistance. Beginning in 1925, the Japanese began exploring and developing the extensive oil strata of North Sakhalin.

Table 2–6 NORTH SAKHALIN OIL PRODUCTION, 1926–31

Year	METRIC TONS PRODUCED *Japanese Concessions*	*Soviet Production*	*Total Production*	*Percent Produced by Japanese Concessions*
1926	29,829	—	29,829	160.0
1927	78,700	—	78,700	100.0
1928	104,000	17,000	121,000	85.9
1929	187,000	26,065	213,065	87.8
1930	195,040	96,268	291.308	66.9
1931	275,000	133,172	408,172	67.4

Source: V. Conolly, *Soviet Trade from the Pacific to the Levant* (London: Oxford 1935), p. 43.

The Soviets started work in 1928, after obtaining the necessary credits and technical assistance from the Japanese.[39] As the areas were divided into checkerboard development plots, the Soviet plots alternating with the Japanese, the Soviets were able first to develop their plots by obtaining credits and aid from the Japanese. When the Japanese concessions were expropriated, the whole area came under Soviet control.

OIL EXPLORATION TECHNOLOGY

The adoption of electrical well-logging, one of several methods of well-logging, is an excellent example of the priority given to the acquisition of

[39] 'It is characteristic that in the first place the Russians had to seek a three year credit from Japan, so as to obtain the necessary boring materials, pipes, etc. to start work. . . .' [V. Conolly, *Soviet Trade from the Pacific to the Levant* (London: Oxford, 1923), p. 43.] Conolly refers to a one-million-yen loan granted in 1928 and repaid in crude oil. [*Oil News* (London), September 1, 1928.]

the latest in Western science and technology. Schlumberger and coworkers started working on this technique in France in 1922, and, although he was joined by other researchers throughout the world, this group played an essential and primary role in its development. The first use of electrical well-logging is reported by Schlumberger from France in 1927. A company was formed—the Société de Prospection Electrique Procédés Schlumberger—which almost immediately made a technical-assistance agreement with Azneft to introduce electrical prospecting and subsurface techniques into the U.S.S.R. It appears that Azneft, along with Venezuela, was used as a test field.[40] By 1933 the U.S.S.R. had eighteen electrical well-logging crews in the field, compared to four in the United States and five in Venezuela.

Azneft concluded another contract, with the Radiore Company of Los Angeles, for technical assistance in electrical prospecting (presumably using magnetometer and gravimetric techniques), but no further data is available.[41]

Similarly, well-cementing techniques (Perkins) and core and rock bit manufacturing technology were introduced in the same period.

PIPELINE CONSTRUCTION, 1925–8

Production problems at Baku were, by 1924–5, well on the way to solution. Rotary drilling and deep-well electrical pumps had revolutionized oil-field technology. The bottleneck now became transportation: particularly the means to move an increasing flow of crude oil to the Black Sea ports for export. The pipeline program initiated in 1925 as the solution to this problem is an excellent example of the intricate interlocking of foreign technologies and skills utilized in Soviet economic development. In this sector we find Type I, II, and III concessions with foreign firms and individuals, in addition to the import of equipment, supplies, training skills, supervisory ability, semi-manufactured materials, and oil-field services for cash, credit, or a share in anticipated oil profits.

After the occupation of the Caucasus, two pipelines were available for oil shipments. The 560 miles from Baku on the Caspian Sea to Batum on the Black Sea were spanned by an eight-inch kerosene line built in 1905 by the Nobel interests. Capacity was about 600,000 tons a year, but by 1921 the line operated only at about 50 percent of capacity and was in need of substantial overhauling. By 1922 shipments were only 22 percent of capacity, and half

[40] In September 1931, the following instructions were issued to the Schlumberger field personnel: 'The results in Russia and Venezuela are remarkable. It has been decided to run the SP surveys in all wells.' [American Petroleum Institute, *History of Petroleum Engineering* (New York: 1961) p. 535.] Schlumberger used electrical well-logging at Baku as early as 1929.

[41] U.S.S.R. Chamber of Commerce, *Economic Conditions in the U.S.S.R.* (Moscow: Vneshtorgizdat, 1931), p. 226.

of Azneft oil was moving to Black Sea ports on the overcrowded, badly maintained rail system which paralleled the pipeline.[42]

Table 2–7 RUSSIAN OIL PIPELINES BEFORE 1930

Pipeline	*Km*	*Diameter in inches*	*No. of Stations*	*Years Completed*	*Service*
Baku-Batum	883	8	16	1896–1906	Kerosene
Grozny-Petrovsk	162	8	4	1910–13	Kerosene
Tukha-Krasnodar	102	8	6	1910–11	Crude oil
Grozny-Tuapse	649	10	7	1926–8	Crude oil
Baku-Batum	834	10	13	1927–30	Crude oil

Source: Robert E. Ebel, *The Petroleum Industry of the Soviet Union* (New York: American Petroleum Institute, 1961), p. 143.

The Grozny oil field was linked to Petrovsk on the Caspian Sea by a 110-mile line, used in 1921 only for fuel oil and residues, and operating at about 70 percent of capacity. At Grozny the problem was even more one of transportation than production. Recovery had been aided in 1923–4 by two large gushers. When these ceased in 1926, however, output was cut back by 65 percent.[43] Grozneft's main requirement was a pipeline to the Black Sea, rather than to the Caspian, to connect with European markets.

In brief, the essential problem in 1925 was to get Caucasus oil to the Black Sea ports. This was not within the technical scope of either Azneft or Grozneft; the railways were operating at capacity and were themselves in need of reorganization and new equipment. The rails and ballast were in need of replacement and the tank cars 'in bad shape.'[44]

The position was critical. Over 37 miles of line required replacement on the Baku-Batum line, as well as 18 new diesel pumping engines. It was estimated that repairs to restore prewar capacity would require $1 million. On several occasions between 1923 and 1925, both the Baku and Grozny fields were shut down, as the oil storage tanks at the terminals were full and no transport existed to move the crude oil.[45]

In 1915 Royal Dutch Shell had proposed a Grozny-Novorossisk pipeline, this proposal, together with one to build a 10-inch Baku-Batum line, was later revised. It was decided to build first a 10-inch crude line from Grozny to Tuapse (near Novorossisk) on the Black Sea, then a 10-inch crude line from

42 U.S. State Dept. Decimal File, 316–137–744.

43 U.S. State Dept. Decimal File, 316–137–977.

44 U.S. State Dept. Decimal File, 316–137–1059.

45 Dobb, *op. cit.*, p. 168, suggests, incorrectly, that the shutdown was part of the general 'sales crisis' afflicting Russian industry in 1922–3. The oil was needed in fact, to fulfill foreign purchase contracts.

Baku to Batum, and then to rebuild the existing 8-inch Baku-Batum pipeline. These lines were put into construction in 1925–6 and scheduled for completion by 1928.

The construction of a pipeline may be broken into a standard sequence of operations. Assuming that the route is surveyed and cleared, the first operation is trenching, followed by welding and inserting the pipes, and finally by covering them. The critical skilled functions are those of welding, trenching, and covering. The major inputs are the steel pipe itself, welding equipment, and skilled welding labor. Engines are required for installation at pumping stations along the route. Table 2–8 lists these operations for the two pipe-lines built between 1925 and 1928, together with the enterprise undertaking each operation.

Table 2–8 SOVIET CONSTRUCTION OF THE GROZNY-TUAPSE AND BAKU-BATUM PIPELINES, 1925–8

Sequence	*Construction of Operation*	*Undertaken By*
1.	Manufacture of line pipe	German pipe mills under Russgertorg contract*
2.	Supervision of pipe transportation	Otto Wolff Co.*
3.	Purchase of trenching equipment	Purchased in United States
4.	Training of welders	J. I. Allen Co. (Los Angeles)
5.	Purchase of welding equipment	Purchased in United States by Ragaz (Russian-American Compressed Gas Co.)**
6.	Welding of pipeline	Ragaz**
7.	Supervision of welding	J. I. Allen Co. (Los Angeles)
8.	Purchase of line pumping engines	9 provided by Crossley Co. (United Kingdom) and 30 Mann engines made by Gomza***

Sources: * See chap. 16.
** See chap. 12.
*** Gomza had a Type III concession agreement with Mann A-G (Germany). See chap. 10.

The 10-inch steel pipe required for the lines was bought in Germany by Russgertorg[46] on five-year credit terms. Twenty ships were required to transport the total quantity of 51,000 tons of pipe from Germany to the Black Sea, and German transportation specialists were hired by Wolff to ensure safe arrival of the cargo at Poti, on the Black Sea.[47]

[46] The Otto Wolff Trading Concession (Russgertorg) is covered in detail in chap. 16. Soviet trusts were also trying to get the order for pipe, but their prices were higher (3.85 rubles/pood versus 2.71 rubles/pood), and quality was far inferior to that of the German pipe.

[47] U.S. State Dept. Decimal File, 316–137–1082.

The critical task of welding the line was handled by the Russian-American Compressed Gas Company (or Ragaz) a Type II concession owned jointly by the International Oxygen Corporation of Newark, New Jersey, and Metalosindikat.[48] One of the seven plants manufacturing compressed gases established by Ragaz was at Baku and produced the large quantities of welding gases required for construction. The $100,000 worth of welding and electrical equipment necessary for this operation was purchased by Ragaz in the United States.[49] Automatic thyratron and ignition welding equipment was later manufactured in the U.S.S.R. with the technical assistance of General Electric.[50] The 150 Russian welders were trained by the J. I. Allen Company of Los Angeles. The latter then supervised work on the site under the general contract supervision of Ragaz.[51] It does not appear that either of the two special schools established by Ragaz for the training of welders was used for the pipeline welders. The trenching equipment was purchased in the United States.[52]

Table 2–9 COMPARATIVE PRICE AND DELIVERY SCHEDULES FOR 300-HP DIESEL ENGINES FOR BAKU-BATUM PIPELINE

	Germany	*Russia* (Gomza)
Delivery	8 within 6 months All within 18 months	8 within 14 months All within 27 months
Price	87 rubles per hp.	180–186 rubles per hp.

Source: Adapted from Confidential Report No. 5419 of Polish Consul General, Tiflis, May 25, 1928.

Azneft wanted to purchase all pumping engines for the line stations from abroad and cited lower costs to support its case. A comparison between the relevant German and Russian offers is summarized in table 2–9; Azneft was instructed by Gosplan and Vesenkha, after nine engines had been ordered in the United Kingdom, to purchase the balance of thirty from Gomza (the Soviet State Machine Building Trust).

Thirty Mann-type 300 horsepower diesel engines were finally supplied by the Gomza works and nine by the Crossley Company (United Kingdom). The pumps were supplied by the Moscow machine-building trust, built under

48 The concession agreement between Metalosindikat and the International Oxygen Corp. was signed in January 1926 and is discussed in detail below.

49 Amtorg, *op. cit.*, III, No. 14–15 (August 1, 1927).

50 *Monogram*, November 1943.

51 *New York Times*, April 9, 1928, p. 5, col. 2.

52 U.S. State Dept. Decimal File, 316–137–1082.

license and the technical supervision of German companies, operating under Type III concession agreements.[53]

REFINERY CONSTRUCTION[54]

Prerevolutionary refineries were small units, located primarily at Baku and producing fuel oil, kerosene, and lubricating oils.

The Soviet objective of utilizing crude oil as a means to generate foreign exchange for industrial development required a different approach to refining. Refining had to produce those oil products in demand in the Western world, at a cost reasonably close to that of Western refineries. There was no refinery technology within Russia in the 1920s to design plants of this type;[55] this technology could be found only in Germany and in the United States. There were no cracking units in the U.S.S.R. before 1928. Of nineteen refineries and cracking plants built between the Revolution and 1930, only one had some units manufactured in the U.S.S.R. and even that was under British technical supervision, using the United States Winkler-Koch process.

Although the first United States patent had been granted for a cracking process in 1860 (United States Patent No. 28,246, to L. Atwood), it is usually accepted that 1926 was the year in which it was universally recognized that gasoline from the cracking process was better than that produced by straight distillation.[56] The United States was far ahead of foreign producers in 1926, with more than 2,500 cracking process patents issued, some 26 processes in

[53] Both the state machine-building trust (Gomza) and the Moscow machine-building trust (Mosmash) had technical-assistance agreements with German companies. Gomza had an agreement with Maschinenfabrik Augsburg-Nürnberg A-G to build under license and with technical assistance both two- and four-cycle motors, with and without compressors, and Mann-type diesel motors. Mosmash was formed from nine large prerevolutionary machine-building works in Moscow, including those of the Bromley Brothers, Danhauer and Kaiser, and other Russian, British, French, and German companies. Mosmash had several Type III technical-assistance agreements, and one with Maschinenbrau A-G of Saarbrucken included the manufacture of pumps. See chap. 10 for details.

[54] The refinery section is based extensively on the monthly *Le Pétrole Russe* (a supplement to *La Vie Economique des Soviets*), published by the Neftsyndikat representative in Paris between 1927 and 1930. Although the principal objective of the journal was to further Soviet penetration of Western oil markets, the 22 issues published contain a wealth of detail on Soviet oil-field development and refinery construction. The only complete set in the United States is in the Hoover Institution, Stanford University.

[55] A sample examination of *Neftianoe Khozaistvo*, a Soviet monthly devoted to the oil industry, for 1928 suggests that the problems receiving research attention were those of applying foreign technology to the U.S.S.R., the examination of domestic oil deposits, and the structure of world oil markets. Nothing, except the development turbine drill, suggests any Soviet contribution to world oil technology.

[56] Cracking is a process of breaking down and rearranging oil molecules by high temperatures and pressures. The older straight-run distillation process could produce only a limited amount of gasoline, but cracking enables fuel oil, for example, to be converted into gasoline.

commercial operation, and another 28 in experimental or demonstration pilot plants. There was an enormous American investment in these processes—not only in those utilized commercially but also in those that fell by the wayside.

Russian crudes have gasoline fractions running only 5–10 percent, but the gas-oil fractions are greater, averaging 35–40 percent; consequently cracking is very important for the Soviet petroleum industry. Until the installation of the refinery complexes in 1927–8, only straight-run distillation was used, and this resulted in both a small total production of gasoline and low recovery percentages. To increase both production and recovery percentages, some form of cracking process was vital.

Exports of crude oil had begun again in 1922, and in 1926 an extensive program of refinery and cracking plant construction was begun to upgrade the products exported. Two locations on the Black Sea were selected (Batum and Tuapse) and two in the oilfields (Baku and Grozny) as initial sites for refinery complexes. These complexes were built entirely by Western companies, with the exception of some minor equipment and the partial duplication of a Baku refinery by Azneft in 1929.

Batum, on the Black Sea, was the site of the largest development. Three petroleum refineries, two cracking plants, an asphalt plant, and a kerosene plant were built between 1923 and 1930.

In April 1927 construction was begun on the first petroleum refinery. This utilized the latest United States technology, with a capacity of 1,600,000 tons a year of petroleum products. At the same time two other refineries, duplicates of the first, were placed on order.

The first Batum refinery was built by Craig, Ltd. (United Kingdom), for ten million rubles, advanced on six-year credit terms.[57] The other two units, built by German companies (Heckmann, Wilke and Pintsch) were financed from a 1926 revolving credit of 300 million marks from the German government. A large part of the amount was used for oil-field equipment. These units were financed on four-year credit terms.[58]

The units listed in table 2–10 were fabricated abroad and erected in the U.S.S.R. by Western engineers, some of whom worked on behalf of their own companies and some of whom were employed by Azneft as consultants. Between 1926 and 1929 more than $20 million was expended in the United States alone for oil-field and refinery equipment—by far the greater part on long-term credits.[59] A substantial portion of the 1925–6 German credits was also used for oil-field and refinery equipment. The Batum petroleum refineries utilized the latest United States continuous sulphuric acid process,

[57] U.S. State Dept. Decimal File, 316–137–1031.
[58] U.S. State Dept. Decimal File, 316–137–980.
[59] Alcan Hirsch, *op. cit.*, p. 152.

Table 2-10 CONSTRUCTION OF THE BATUM REFINERY COMPLEX, 1927–30

Unit	*Construction by*	*Capacity**
Refinery I (1928)	Craig Co. (United Kingdom)	1,600,000 tons per year crude oil
Refinery II (1928)	Heckmann (Germany)	1,600,000 tons per year crude oil
Refinery III (1929)	Wilke, Pintsch (Germany)	1,600,000 tons per year crude oil
Cracking Plant I (1928)	Winkler-Koch system (manufactured by Graver Corp.)	Not available
Cracking Plant II (1929)	Winkler-Koch system (manufactured by Graver Corp.)	Not available
Kerosene Plant (1927)	Standard Oil Co. of New York	150,000 long tons per year

Sources: Le Pétrole Russe, various issues, 1927.
U.S. State Dept. Archives.
Amtorg, *op. cit.*

* Refinery capacities are approximate only; several figures exist for each unit. These are maximal. Columns 1 and 2 are confirmed by several sources.

although built by British and German companies.[60] The four gasoline cracking units were built by the Graver Corporation of Chicago as part of an order for ten units valued at $2 million and supplied on long-term credit for installation at Batum, Tuapse, and Yaroslavl. Graver also had a technical-assistance agreement with the U.S.S.R. which covered petroleum refineries.[61] The cracking units utilized the Winkler-Koch and Cross systems of cracking, and the Winkler-Koch Engineering Company, of Wichita, Kansas, also had a technical-assistance agreement with the U.S.S.R. to facilitate the transfer of its cracking technology.

The 150,000-ton kerosene plant was built in 1927 by the Standard Oil Company of New York and then leased back by Azneft. Standard operated the plant under a three-year, Type II contract, loading company tankers with kerosene at Batum for shipment to Middle East and Far East markets.[62]

[60] Azneft ' . . . a choisi le procédé américain de raffinage du pétrole par l'acide sulfurique, en les mélangeant d'une façon uninterrompue par le moyen d'injecteurs.' [*Le Pétrole Russe*, No. 2 (Oct. 5, 1927), p. 15.] Also, Amtorg, *op. cit.*, IV, No. 1 (January 1, 1929), and *Ekonomicheskaya Zhizn*, No. 161, July 17, 1929.

[61] The usual claims of prior discovery were made for the cracking process: ' . . . the eminent constructor Choukhov' discovered the process long before the Americans. Why the Choukhov process was not utilized is left unanswered. (*Le Pétrole Russe*, No. 12, May 5, 1928, p. 18.)

[62] At least ten photographs were traced of a Standard Oil of New York unit at Batum. These were dated between 1927 and 1930, but the unit was described variously as a refinery, kerosene plant, fuel oil plant, etc. It is presumed, but not known with certainty, that there was only one Standard unit—a kerosene plant. While Standard

This was the first United States investment in Russia since the Revolution. There is no evidence that Azneft constructed or fabricated parts for any of the Batum refineries; there was complete reliance on imported technology, supervision, and equipment.

Tuapse, on the Black Sea north of Batum, was the site of the second refinery complex oriented to Western oil products markets. This complex was run by Grozneft, the Grozny oil trust.

Table 2-11 CONSTRUCTION OF THE TUAPSE REFINERY COMPLEX, 1927–30

Unit	*Construction by*	*Capacity*
Refinery I	Heckmann*	1,000,000 tons per year
Refinery II	Heckmann*	1,000,000 tons per year
Cracking Plant I	Cross system (Graver Corp.)	Not available
Cracking Plant II	Cross system (Graver Corp.)	Not available

Source: Le Pétrole Russe, various issues, 1927–9.
* The refinery construction is known to be German, but the firm is not precisely known; it was probably Heckmann.

The equipment for the refineries at Tuapse came from Germany, and the two cracking units were manufactured and installed by the Graver Corporation, of Chicago. The Burrell-Mase Engineering Company (United States) reorganized, modernized, and expanded the overall gas and petroleum production and refining facilities for Grozneft, and between 10 and 20 Burrell-Mase engineers were occupied with the project for a period of two years. One interesting comparison between refinery construction at Tuapse and Batum involves the length of time required to build a refinery under Soviet conditions. Burrell points out that a refinery which could be built in five months in the United States took two years to build in the Soviet Union under Grozneft.[63] On the other hand, a Standard Oil construction engineer, Tompkins, building the Standard-leased Batum refinery for Azneft, is quoted as saying that the company was able to complete construction in only three months 'in light of the complete assistance of Soviet authorities.'[64] This comparison supports

of New York was thus aiding Soviet development at Batum, Soviet agents were busy in the Far East endeavoring to undermine its market position, with the lavish use of bribery and threats. [Naval Intelligence Report No. 159, May 11, 1928 (316–137–1084/5).]

[63] George A. Burrell, *An American Engineer Looks at Russia* (Boston: Stratford, n.d.), p. 269. Burrell has 37 publications in the field of gas and petroleum engineering listed in the Library of Congress card catalog, and was an outstanding expert in the field.

[64] Amtorg, *op. cit.*, II, No. 18 (September 15, 1927), 5.

the observation made elsewhere that Azneft under Serebrovsky was a far more efficient concern in this period than either Grozneft or Embaneft. Serebrovsky was later shifted by Stalin to the gold trusts, to repeat his Azneft success.

Foreign equipment was used throughout these complexes, including even American fire extinguisher equipment and such auxiliary facilities as machine shops.[65] Electrical equipment for refineries, i.e., pumps, compressors, and control apparatus, was largely supplied by the General Electric Company.[66]

Table 2-12 CONSTRUCTION OF THE SOVIET INLAND REFINERIES, 1927-30

Unit	*Constructed by*	*Capacity*
Baku		
Refinery I	United Kingdom technical supervision in Baku	470,000 tons per year
Cracking Plant I	Winkler-Koch system (United Kingdom)*	—
Cracking Plant II	Winkler-Koch system (United Kingdom)*	—
Heavy Oil Plant	Steinschneider (Germany)	3,600,000 tons per year
Grozny		
Refinery I	Borman (Germany)	365,000 tons per year
Refinery II	Pintsch (Germany)	365,000 tons per year
Cracking Plant I (3 Units)	2 Dobbs (Germany); Sakhanov & Tilitchev (Germany)	—
Emba		
Vara Refinery (lubricants)	Borman (Germany)	128,000 tons per year

Source: Le Pétrole Russe, various issues, 1927–9.
* Probably by Vickers.

In both Tuapse and Batum other American corporations—in particular the Foster-Wheeler Corporation of New York, E. B. Badger and Sons of Boston, and the Winkler-Koch Corporation of Wichita—played an important part in the design and construction of cracking units.[67]

The inland refineries at Baku depended more on German and United Kingdom construction aid; but two new factors are apparent. The refinery

[65] The only manufacturer of fire extinguisher equipment in the U.S.S.R. was the concession Boereznsky (Lithuania).

[66] *Monogram*, November 1943.

[67] The Winkler-Koch Corp. of Wichita, had a technical-assistance agreement with Neftsyndikat for the construction of cracking plants. [American-Russian Chamber of Commerce, *Economic Handbook of the Soviet Union* (New York: 1931), p. 101.]

at Baku was partly built by Azneft under a British technical supervisor, but the tuyères and some of the other pipe work were built by Azneft—the only case of Soviet oil-field construction in that decade. In addition, the cracking plant at Grozny was partly Soviet-designed by Sakhanov and Tilitchev but constructed by German companies. These are the same procedures noted in other industries. Soviet construction was at first limited to the simple and the straightforward (i.e., pipework) in less strategic locations (the inland refineries) and then gradually moved into more complex and more important functions at more important locations. Either Soviet designs were first made abroad or prototypes were made both abroad and in the U.S.S.R., presumably for comparison purposes, before complete development was tackled in the U.S.S.R. However, Soviet design and technology were almost nonexistent, and such examples as we have may have been no more than the 'Sovietization' of an existing Western technology; this name-changing was typical in the electrical equipment industry.

ACQUISITION OF FOREIGN MARKETS FOR PETROLEUM PRODUCTS

The technological revolution in oil-field production, construction of new pipelines, repair of pre-Revolutionary pipelines, and the refinery construction program on the Black Sea coast put the Soviets in a position to collect on their investments and development strategy.

Production of crude oil almost tripled from 1923 to 1928, and exports followed a similar development, from 185,000 tons in 1922 to 1.9 million tons in 1927–8. The refinery program enabled a greater proportion of oil derivatives, of higher value (especially gasoline) to be exported. Before 1923 no gasoline had been exported, and most petroleum product exports consisted of kerosene and oils.

In 1923 almost half of Soviet oil exports consisted of kerosene, or heating oil, which could be produced by prewar straight-run distillation refineries. By 1928, as a result of the new refinery and cracking-unit construction programs, the proportion of kerosene dropped to less than one-quarter, and gasoline now made up more than one-quarter of total exports. There was also a significant increase in total petroleum exports, from 430,000 tons to almost 2.75 million tons—a sixfold increase. Light oil fractions figured among the 1928 exports but not in 1923 exports.

In brief, table 2–13 indicates both a very substantial increase in the quantity of oil exported and an increase in the product quality. Both factors resulted directly from the refinery construction program. By 1928, the value of oil exports was 124 million rubles, or 19.1 percent of the value of all Soviet exports, and the largest single earner of foreign exchange.

Table 2–13 COMPOSITION OF SOVIET OIL EXPORTS, 1923 AND 1928

Product	*1923* *Tons*	*Percent*	*1928* *Tons*	*Percent*
Crude oil	35,000	8.1	244,542	8.9
Gasoline	50,000*	11.6	725,840	26.5
Kerosene	200,000	46.5	680,360	24.9
Fuel oil	—	—	640,822	23.4
Gas oil	—	—	191,787	7.0
Solar oil	—	—	49,145	1.8
Light oil	—	—	22,472	0.8
Lubricating oil	100,000	23.3	179·861	6.6
Other types	45,000	10.5	—	—
Totals	430,000	100.0	2,734,829	99.9

Source: Imperial Institute, *The Mineral Industry of the British Empire and Foreign Countries, 1928–30* (London: H.M.S.O., 1931).

* These early (1923) gasoline exports were derived from a German process utilizing natural gas, natural gasoline, and straight-run distillation.

In May–June 1923, coinciding with the start of the Barnsdall drilling and pumping work, a mixed or Type II, agreement was made with Sale and Company of London, for the immediate sale of 30,000 tons of crude oil and follow-on sale of 100,000 tons of kerosene per year. The company was capitalized at £250,000 sterling; both Sale and Company and the Soviets held an equal number of directorships. Neftsyndicat reserved the right to buy out all shares of the company after ten years, no doubt looking forward to the time when they would be strong and knowledgeable enough to establish their own distribution network in the United Kingdom.[68] This appears to have been the first major breach in the solid front presented by the world oil companies against the purchase of Russian oil, or 'stolen oil' as it was called in contemporary business terminology. Royal Dutch Shell then argued that self-interest dictated the purchase of 30,000 tons (and an option for a further 170,000).[69] The Soviet estimate of oil products available for export in 1923 was 430,000 tons; these two sales alone made a sizeable contribution to the re-entry of the U.S.S.R. into the world oil markets.

[68] *Izvestia*, No. 104, May 12, 1923.

[69] Standard Oil in the United States, British, French, and Italian companies had been buying Soviet oil on a minor scale before the 1923 contracts. Vlessing in Holland acted as the agent for continental Europe. It would be difficult to match the hypocrisy displayed by both major oil groups. Sir Henri Deterding, of Royal Dutch Shell, was blasting Standard of New York for buying 'stolen oil' while himself buying it in large quantities and negotiating for a monopoly arrangement with the U.S.S.R. Standard switched dramatically from an anti-Soviet to a pro-Soviet stand in 1927, and its public relations man, Ivy Lee, put out a sycophantic *U.S.S.R.—a World Enigma* (London: Benn, 1929) to reinforce its position. This got Standard of New York into a conflict with Standard of New Jersey.

This breach was followed by the formation of a Dutch-Soviet mixed company for the export of Soviet oil, under an agreement signed on May 11, 1923 between Royal Dutch Shell and the U.S.S.R. Capital participation was 50:50, with £1.25 million sterling being subscribed. The head office was in London and the company sold Soviet oil abroad through exclusive dealerships. The agreement lasted for ten years, and the company earned a 10 percent commission.[70]

In 1924 Royal Dutch Shell was purchasing oil via this mixed company on behalf of Standard, the purchases being split between the two major oil groups. This, however, presented a united front to Neftsyndicat and the trade organization—a front which offset the bargaining power of the Soviet trade monopoly. Since 1924 the Soviets have vehemently protested the formation of such foreign trade groups.

The first goal in the expansion of oil exports at this time was to establish trading relations with existing distributors in each foreign market. The Standard Oil Company handled the Near and Far East markets, and the Blue Bird Motor Company and British-Mexican Petroleum Company handled imports into the United Kingdom and cracked Soviet kerosene in the United Kingdom until refineries were built later in the U.S.S.R. Asiatic Petroleum bought oil for distribution in India and Ceylon. Turkey and Spain bought large quantities (532,000 tons in 1928) for distribution through their government monopoly networks. A five-year agreement in 1925 between Neftsyndicat and Bell Pétrole covered delivery of Grozny crude to France.

Later, when the acceptance of Soviet petroleum had been established, the Soviets began to establish their own distribution networks. Russian Oil Products (ROP), owned jointly by Arcos and Neftsyndicat, was founded in the United Kingdom. By 1925 ROP had established a chain of oil depots in the United Kingdom and was engaged in extensive price warfare with existing distributors. In the mid-1920s the Soviets canceled their agreements with German distributors and established their own subsidiary, the Deutsche-Russische Naptha Company, which established the Derop chain of gasoline service stations in Germany. In Sweden, the Nordiska Bensin Aktiebolaget was established and promptly drove prices down 30 percent to gain entry into the market. Gradually by the end of the decade the Soviets controlled their own distribution networks in most of their major markets, although they still relied on Standard Oil for distribution in the Middle and Far East, while in Spain a mixed company arrangement with the Argus Bank of Barcelona had exclusive rights for Spain, Portugal, and their colonies, with Neftsyndicat receiving 25 percent of the profits and the losses. The export of petroleum

[70] *Handelsblad*, May 12, 1923 (quoted in 316-137-844).

products to Persia was handled through the Persian-Azerbaidjian Naptha Company (a subsidiary founded by Azneft) and Shark (the Russian-Persian Import and Export Company), a Type II concession.[71]

Several very large orders were placed directly by Western governments for Soviet oil. The Italian Navy bought 150,000 tons in 1927, the French Navy bought 33,300 tons in 1927, and the United States Shipping Board bought 200,000 tons—at a time when there were no official diplomatic or trade relations between the two countries.

SUMMARY OF SOVIET OIL DEVELOPMENT, 1917–30

No new oil fields were developed in the 1920s; all the producing fields had been developed by prerevolutionary operators. This inheritance was intact in 1921, when the Caucasian oil fields were occupied by the Soviet armies, but world technological advances, primarily American, put these fields and their products at a distinct competitive disadvantage. Further, the early Bolsheviks had no ability in oil-field operation, and production rapidly declined by 1922–3.

Serebrovsky, Chairman of Azneft, was instrumental in focusing Soviet attention upon foreign oil production techniques and within seven years the Soviet oil fields were modernized: two new pipelines were completed, and three distinct refinery complexes, comprised of nineteen major identifiable units, had been put into operation. Exports by 1926–7 were double those of 1913.

It is overwhelmingly obvious from the preceding discussion that the importation of foreign oil-field technology and administration, either directly or by concession, was the single factor of consequence in this development. Statements that this achievement was 'without foreign assistance and capital'[72] are obviously propagandistic nonsense. Development of an indigenous oil technology comparable to the contemporaneous American technique was not a useful alternative. The only available elements for an indigenous technology were the turbine drill and the Choukov cracking process, and these were more or less dismissed from consideration by the Soviets.[73] The development of domestic technology would have been costly in both time and expense,

[71] U.S. State Dept. Decimal File, 316–137–900.

[72] Such statements may be found in Louis Fischer, *Oil Imperialism* (New York: International, 1926), p. 110; and in T. Gonta, *The Heroes of Grozny, How the Soviet Oil Industry Fulfilled the Five Year Plan in Two and a Half Years* (Moscow: 1932).

[73] The turbine drill did a small percentage of drilling; the Choukov process has never been used. The Export Control Act of 1949 forced the Soviets to develop the less efficient turbine drill (it overheats below about 8,000 feet) and so incur some of the costs of development.

and the oil fields were in no condition to wait; they were rapidly watering, and maintenance operations were nonexistent.

The only rational solution from the Soviet viewpoint was to introduce American rotary drilling and electrical deep-well pumping, while continuing the tsarist oil-field electrification program. This, together with refinery complex construction, was implemented, except in the case of the tuyères of one Baku refinery, by Western firms, engineers, and consultants with Western skills and equipment. This alternative cost far less than developing an oil-field technology from scratch. The marginal cost of supplying refining and cracking units by Western firms to the U.S.S.R. was insignificant, as the research and development cost had already been recouped from units built in the West. Any return in excess of direct costs was profit.

There was no domestic Russian demand for gasoline, and little for light fractions, but there was an urgent demand for foreign exchange to finance the industrialization program.[74] With the installation of modern cracking plants, penetration of Western markets became possible. This overall development strategy was so successful that the declining petroleum industry of 1922–3 was able by 1928 to contribute 20 percent of Soviet foreign exchange. The Soviets developed a completely up-to-date refining and cracking industry within a few years of the United States—an industry destined to play a great role in the Soviet industrialization drive of the early 1930s.

[74] There was no production of automobiles or trucks in the U.S.S.R. until the implementation of the Fiat and Ford Motor Co. agreements of 1928–9. There were very few imported automobiles and trucks, and no motor buses at all until after 1924. The internal demand for oil products was for heating and lighting oils; i.e., fuel oil and kerosene.

CHAPTER THREE

Coal and Anthracite Mining Industries

YEARS OF CRISIS AND STAGNATION

THE most productive Russian coal fields are in the Donetz Basin (Donbas). In 1910 these supplied more than 18 million tons of a total of 24 million tons of coal and anthracite produced in Russia. This prerevolutionary industry was highly labor-intensive, employing 123,000 workers in coal mines and 19,000 in anthracite pits, with little mechanical equipment apart from primitive hand-propelled mine cars. About 4.6 million tons of coal and coke were imported.

From the Revolutions until the mid-1920s, the coal and anthracite mining industries endured a series of crises involving over-production, severe under-production, bad quality, lack of skilled labor, and general technical backwardness. The blame for these crises was laid at a bewildering number of doors: the Revolution, the Civil War, the Intervention, flooding of the mines, housing shortages, food shortages, labor shortages, bad attendance and sickness, lack of bread, 'central authorities,' lack of fireproof bricks, lack of technical materials, non-payment for output, reorganization, inefficient railroads, lack of shipping, technical backwardness, and non-payment of wages all received their share of the blame.

Looking at the situation as a whole one sees two factors that stand out as prime causes for the catastrophic crises: first, the attempt to transform a capitalist system into a socialist system without a clear understanding of the operation of either system; and second, the very low level of technical and economic knowledge of those who assumed the burden of transformation. The causes listed in the contemporary Soviet press were generally no more than symptoms of an imperfect transformation.

These difficulties led to a policy of concentration and a subsequent reduction in the number of operating coal mines. In 1921 there were 1,816 coal mines in the Donbas of which 857 (47 percent) were closed. Of the remaining 959 mines, some 387 (or 41 percent) were leased to former operators or peasants.[1] The 572 state operated shafts were reduced to 202 shafts in 1922, and after several crises further reduced to 175 in mid-1922 and to 36 by mid-1923.[2] These 36 nationalized collieries produced 78 percent of the total Donbas output, 16 percent being produced by other state and railroad trusts and 6 percent by private leased coal pits. An attempt to export coal to earn foreign exchange through an organization formed specifically for the purpose (Exportugol) also failed.

Lack of the technical facilities to produce coal was only part of the problem. Although the mines were not mechanized, the conveyor and mine rail equipment was, according to *Ekonomicheskaya Zhizn*, 80 percent in order.[3] The output per worker was, on the other hand, miserably low; about 5 tons per worker *per month* compared to about 48 tons per worker in the United States. This was barely sufficient to supply enough coal to keep the pits operating, and at one point in 1921 the Donbas mines produced only enough coal for themselves and had no surplus production for shipment. This was due partly to the lack of mechanization and to inefficient organization, and partly to problems created by the attempt to impose 'socialist organization' on a technically backward enterprise. Together they resulted in chaos. Average daily shipments of coal from the Donbas dropped to 57 carloads in the summer of 1921, normally the most advantageous season for mining and transportation. Coal was imported into the Donbas from both the United Kingdom and the United States in 1921–3: truly a case of 'carrying coals to Newcastle.'[4]

From 1923 onward, efforts were made to lease more coal mine operations and smaller pits to private individuals, artels and joint-stock companies, and an effort was made to induce foreign concessionaires into the coal regions.

UNION MINIÈRE AND THE DONETZ BASIN COAL MINES

The major effort in coal mine mechanization was handled under Type III technical-assistance agreements with United States companies between 1927 and 1930, but there were also a number of pure Type I concessions. With one exception, these were on the more distant borders of the U.S.S.R.—those areas more difficult to develop.

[1] P. Zuev, *Ugol'nya Promyshlennost' i ee Polozhenie* (Moscow: 1921), p. 9.
[2] *The Engineer*, November 16, 1923, p. 529.
[3] *Ekonomicheskaya Zhizn*, No. 66, March 21, 1924.
[4] 'In 1870 they produced 9 million poods . . . so we have gone back to the conditions of 50 years ago.' *Pravda*, October 28, 1921.

The single exception was the operation of coal mines in the Donbas by the Union Minière group. Before 1917 part of the Donbas output had been controlled by a French company, Union Minière du Sud de la Russie, whose properties were expropriated after the Bolshevik Revolution. It was reported

Table 3-1 OPERATING FOREIGN CONCESSIONS IN THE U.S.S.R. COAL AND ANTHRACITE MINING INDUSTRY, 1922–30*

Concession Holder	*Country of Origin*	*Concession Type*	*Work Undertaken in U.S.S.R.*
Companies			
Union Minière Group	France	I Production	Opening Krivoi Rog mines
Anglo-Russian Grumant Co., Ltd.	United Kingdom	I Production	Operating Spitzbergen mines
Polar Star Concession	Unknown	I Production	Operating coal mines Spitzbergen, railroad in Murmansk
Kita Karafuto Sekio	Japan	I Production	Opening Sakhalin coal mines
Mitsui Shakeef	Japan	I Production	Opening Sakhalin coal mines
Lena Goldfields, Ltd.	United Kingdom	I Production	Opening Kuzbas coal mines and anthracite mines
Bryner and Company, Ltd.	United Kingdom	I Production	Operating Far East coal mines (Tetiukhe)
American Industrial Corp.	United States	II Production	Operating Kemerovo coal mines
G. Warren, Inc.	United States	II Trade	Importing anthracite to United States
Roberts & Schaefer, Inc.	United States	III Technical assistance	Reorganizing Donbas coal mines
Allen & Garcia, Inc.	United States	III Technical assistance	Reorganizing Donbas coal mines
Stuart, James and Cooke, Inc.	United States	III Technical assistance	Reorganizing Donbas coal mines
Thyssen A-G	Germany	III Technical assistance	Sinking shafts in Donbas coal mines
Stein A-G	Germany	III Technical assistance	Sinking shafts
Goodman Manufacturing, Inc.	United States	III Technical assistance	Providing technical assistance on manufacture of coal cutters
Hilaturas Casablancas S.A.	Spain	III Technical assistance	Providing technical assistance on manufacture of coal cutters
American Commune	United States	Commune	Operating mine No. 2, Donbas
Individual consultants			
J. W. Powell	United States	III Technical assistance	Providing assistance to Giproshaft
T. G. Hawkins	United States	III Technical assistance	Providing assistance to Giproshaft
C. Pierce	United States	III Technical assistance	Providing assistance to Giproshaft.

Source: See text.

* This table contains the important concession agreements. It does not include agreements for supply of equipment, which also included training and installation clauses, such as the Krupp and Sullivan contracts for supply, installation, and operator training for heavy coal cutters.

in December 1923 that an 'extremely valuable' concession to exploit the Donetz Coal Basin had been granted to a French group, and evidence points to the operation of these mines by Union Minière. In the statistical annual for 1927–8, eleven very large coal mines in Makeevka were listed as 'Union' and two in Ekaterinovsk were listed as 'Franco-Russky.'[5] Given the proclivity of the Bolsheviks to propagandize, it is unlikely these shafts would have continued for ten years under their prerevolutionary name except for a specific reason. On the other hand, there was every reason for the Union Company to have completely obscured public knowledge of a concession. There were some two million tsarist shares and bonds held in France, with active representative organizations fighting for total settlement of prewar debts. This was a parallel to the International Barnsdall situation.

THE KUZBAS PROJECT OF THE AMERICAN INDUSTRIAL COLONY

This project is of more than purely historical interest; it enables us quantitatively to establish the effect of United States management methods on a backward Soviet enterprise of the early NEP period. The Kuzbas operation counters any argument that it was lack of equipment alone, or the ravages of the Revolution, that delayed economic development. The removal of socialist methods of operation and substitution of profit-oriented methods, even by a group ideologically sympathetic to the Soviet 'experiment,' brought about an immediate and significant upward change in output. Within six months of the take-over of Kemerovo mines by American workers, output of coal, coke, and sawmill products almost doubled; this occurred *before* the injection of modern equipment.[6] Rutgers, director of the Kuzbas project, held that the Soviets looked upon Kuzbas as a Soviet state enterprise run on American lines and 'unfortunately' needing Americans, strongly implying that counter-revolutionary activity at least hindered Soviet development, but that American labor discipline and organizational methods were required ahead of the

[5] V. I. Kruglyakova, *op. cit.*, p. 175. The original report was in the *New York Times*, November 14, 1923. It was also announced by the Soviet Embassy in Berlin in December 1923 (569–3–150) and confirmed by the United States Consulate in Riga (569–3–155). A hint that the concession operated for at least two years is in a *Times* (London) report of March 30, 1926: 'Following consultation of representatives of all the big French enterprises in Russia, among them. . . . Union Minière du Sud de la Russie . . .'

[6] 'These mines were lying almost idle when they were taken over by the Americans . . . the presence of the Americans has a stimulating effect upon the Russian workmen, there is already a tendency to increase production.' *Ekonomicheskaya Zhizn*, No. 19, January 28, 1923. The 'stimulating effect' is rather overstated, as the Russian workers were, at the least, hostile to these new foreign elements.

machinery itself.[7] A similar situation was reported from the Donbas. A group of American miners near Youzovka nearly trebled former production.[8]

In early 1922 a concession agreement was concluded between the U.S.S.R. and a group of American workers represented by Bill Haywood and an 'American Organization Committee,' formed in New York by the Society for Technical Aid to Soviet Russia, which had the objective of persuading American skilled workers to go to the U.S.S.R. This unit was to exploit the 'almost idle' plants of the Nadejdinsky and Kuznetsk regions. The concession included iron ore and coal mines, forests, and auxiliary industries in Nadejdinsky, and the coal mines, chemical by-products plant, and supplementary industries at Kemerovo. In addition, the unit operated brick kilns, a leather-shoe factory at Tomsk, the Jashkinsky cement plant, Guriev Zavod (pig iron) and other enterprises.

According to the terms of the agreement,[9] the group undertook to import 2,800 fully qualified workers to Kemerovo and 3,000 to Nadejdinsky. A capital subscription was required by the Soviet government of $100 in machinery and $100 in food per worker. These were imported along with the workers. The Committee was responsible for organizing the purchase of machinery and raw materials abroad. The U.S.S.R. undertook to pay expenses and buy machinery to the value of $300,000. The total product of the concession was the property of the U.S.S.R, but some surpluses of coal, wood, bricks, and agricultural produce accrued to the settlers.

In January 1923, five groups of colonists arrived and began work under skilled mining engineers. The total population ultimately reached 400 Ameri-

Table 3-2 EFFECT OF UNITED STATES MANAGEMENT IN KEMEROVO (KUZNETSK) COAL MINES, 1923

	Average Output Per Month	
	Aug. 1, 1922 to Feb. 1, 1923 (Soviet management)	*Feb. 1, 1923 to Aug. 1, 1923 (United States management)*
Coal produced	6,950 metric tons	10,657 metric tons
Coke produced	160 metric tons	288 metric tons
Sawmills	16,800 cubic feet	29,600 cubic feet

Source: Nation, August 8, 1923, p. 146.

[7] R. E. Kennell, 'Kuzbas: A New Pennsylvania,' *Nation*, May 2, 1923. The American Industrial Colony published its own journal, *Kuzbas*. Only issue No. 3 of Vol. I appears to have survived in the United States (at the Hoover Institution Library, Stanford University).

[8] *Pravda*, No. 246, October 31, 1922.

[9] Complete text is in U.S. State Dept. Decimal File, 316-111-1270.

cans and 2,000 Russians. S. J. Rutgers was the chief director; Grindler, the chief engineer; and A. Pearson, technical director, at the Kemerovo project. Despite local opposition from 'counterrevolutionaries,' the group took over full management control on February 1, 1923.

The effect of introducing American skills and methods of organization was both immediate and substantial (table 3-2). One of the first steps was to reduce the number of employees by 20 percent and simultaneously increase output per worker. The Colony installed three sawmills, re-equipped the coal mines, built fifty coke ovens, new bridges, and railroads, and after a year in operation had set up a completely autonomous industrial colony.

Those colonists (the 'White Feather Groups') who, disillusioned with the 'socialist paradise,' made efforts to leave Russia were treated harshly. It took all winter for some to get out of Russia; they were stranded periodically and finally reached Riga, Latvia, destitute and hungry. A graphic and moving story by one of these colonists, a young woman, written at the request of the the United States Consulate in Riga is in the U.S. State Department files.[10]

PURE CONCESSIONS IN REMOTE AREAS

The Anglo-Russian Grumant Company continued to operate its coal concession in the 'no-man's land' of Spitzbergen. Another concession was made in 1923 to the Polar Star Company to operate other mines on Spitzbergen Island and railroads in the Murmansk area. Lena Goldfields operated a Kiselev coal mine and two Yegushin anthracite mines (numbers 1 and 5) in Siberia as part of its 1925 concession.

The Tetyukhe (Bryner) concession operated coal mines in the Far East, as did Japanese concession operators. Only twenty coal mines were in operation in the Far East in 1924; of these six were state-owned enterprises, six operated by Japanese concessionaires on Sakhalin Island, and one operated as a concession by Bryner and Company near Vladivostock.[11] In 1924 the state mines in the Far East produced about 46 percent of total output of coal and lignite while the privately operated concessions (Japanese and Bryner) produced about 54 percent.

The two Japanese Sakhalin coal concessions granted under Protocol B of the 1925 U.S.S.R.-Japanese convention became an important export source later in the 1920's, their export rising from 4,000 metric tons in 1925 to

10 U.S. State Dept. Decimal File, 316-110-795/801. However, the autonomous industrial colony (AIK) at Kuzbas was not broken up until late 1927, when few of the original Americans remained (316-108-391).

11 U.S. Embassy in Tokyo, Report 13, March 1925. This last concession is of interest in relation to the 'arm's length hypothesis.' One of the partners was suspected of being in the pay of the Soviets (Decimal File 861.00/11270).

115,500 in 1929.[12] However, total Far East coal and lignite output was only about 3 percent of the total Soviet production.

In 1920 the independent Georgian government concluded an agreement for the operation of the Tkwarozly region coal mines with the Italian company ILVA Alti Forni e Acciaierie d'Italia s.p.a. The Soviet government offered ILVA a renewal of the agreement, but this was not taken up by the company. The mines, although investigated by several commissions, remained dormant until at least 1928.[13]

TECHNICAL ASSISTANCE FROM GERMANY

Pure technical-assistance (Type III) agreements for the coal mines and particularly Donugol, were sought prior to any others. In the latter half of 1925, a commission of Ruhr industrialists and economic experts began examining the Donbas coal mines. This commission was invited by the U.S.S.R.,

> . . . because it wanted objective economists to make a report to industrialists in Germany on the exact conditions in the Don district . . . and to confer . . . on the basis for collaboration between the two countries.[14]

Dr. Rechlin, a member of the commission, argued that such collaboration was entirely possible because the coal deposits of the two countries were similar from the geological and physical viewpoints; consequently the same type of coal-cutting machines could be used in the Donbas as in the Ruhr. By 1926, Thyssen A-G and other coal-machinery-making firms in Germany were receiving orders for equipment, and coke ovens had been ordered from Koppers A-G in Essen. The anticipated purchase of the Rhenish-Westphalian Metal Products and Machine Company, manufacturers of locomotives in Dusseldorf, by the U.S.S.R. did not materialize.

The Soviets were not completely satisfied with German techniques and in 1926 appointed a commission to make an extensive study of comparative coal mining methods in Germany, France, England, and the United States. 'The result was a victory for American methods and engineers. . . . '[15]

TECHNICAL ASSISTANCE CONTRACTS WITH STUART, JAMES AND COOKE, INC.

In early 1927, Amtorg reported that American coal-mining methods and a major emphasis on mechanization were to be adopted throughout Soviet coal mines. Concurrently with this announcement, Charles E. Stuart, of Stuart,

[12] Amtorg, *op. cit.*, V, 354; and *Times* (London), January 11, 1926. The agreement on Sakhalin coal concessions is in U.S. State Dept. Decimal File, 316–176–426.

[13] U.S. Legation in Warsaw, Report 1699, April 23, 1928 (316–136–1244).

[14] U.S. Embassy in Berlin, Report 1407, August 17, 1926 (316–136–1232).

[15] Amtorg, *op. cit.*, II, No. 7, p. 2.

James and Cooke, Inc., coal-mining consultants in the United States, was making a preliminary inspection of Soviet coal mines:

> . . . with a view to their mechanization in accordance with the most modern American practice and methods. Mr. Stuart stated that several shafts will be operated under the direction of the firm to serve as model mines for the purpose of gradually extending the methods and systems.[16]

Between 1927 and 1930, Stuart, James and Cooke, Inc., signed four technical-assistance contracts with Soviet trusts. Two of these were with coal trusts (Donugol and Moskvugol), the latter for technical assistance in the reorganization of the Dubovaya Balka and October Revolution coal mines in the Moscow area.

Charles E. Stuart was an active promoter of American assistance to the Soviet Union. In a speech before the 1928 annual convention of mining engineers, he stressed '. . . . the traditional friendship between the two countries,' and suggested that 'America will surely play the foremost part in the rehabilitation of Russia.'[17]

A year later, after the four technical-assistance contracts had been implemented, Stuart was even more generous in his praise of Soviet officials. In 1928 he was allowed to make a 10,000-mile trip throughout the U.S.S.R. and recorded it on movie film later shown to the American Association of Mining Engineers.[18]

The Stuart Company drafted a complete five-year reorganization plan for Donugol, modernizing equipment, layout, and working methods. Twelve American engineers, sent to Kharkhov in 1927 to implement the program, were supplied with Russian assistants, clerks and draftsmen. One year later the staff of Russian engineering assistants was arrested by the OGPU. Despite this demoralizing episode, the rationalization continued through the late 1920s and 1930s. At first German and then American coal mining equipment was utilized. Later Soviet-made equipment, manufactured under the Goodman, the Casablancas, and similar technical-assistance agreements, was used. A similar three-year reorganization plan was implemented by the Stuart company for the Moskvugol coal fields, in the Moscow sub-basin.[19]

16 Amtorg, *op. cit.*, II, No. 7, p. 2.

17 *New York Times*, February 23, 1928. Although there were no diplomatic relations between the two countries, the Soviets were allowed to operate *Amtorg* in New York, supposedly to facilitate trading relations. Saul Bron was the president of Amtorg.

18 *New York World*, March 3, 1929. Stuart was hardly a prophet concerning Soviet intentions. For example, he stated: 'The prevailing opinion in the United States that the U.S.S.R. while endeavoring to bring foreign capital into its enterprises has the intention of seizing those enterprises in the future, is entirely wrong.'

19 *Torgovo-Promyshlennaya Gazeta*, No. 246, October 24, 1929. *Izvestia*, No. 128, June 8, 1927. Stuart, James and Cooke, Inc., had similar contracts with Yurt, the

ROBERTS & SCHAEFER AND ALLEN & GARCIA CONTRACTS

In mid-1929 a Type III technical-assistance agreement was signed between Donugol and Roberts & Schaefer, mining consultants and engineers of Chicago. The agreement was to sink five new coal shafts in the Donbas to be completed within thirteen months, and to provide a production of 3.5 million tons per year. The firm manufactured the equipment, installed it in the mines, and brought the mines into operation. For this purpose engineers were sent from Chicago to the Donbas, and a number of Donugol engineers were sent to the United States for training.[20]

Another United States firm of mining consultants, Allen & Garcia, was given a three-year contract with Donugol in late 1927 to plan and build new coal pits in the Donetz Basin, including both surface buildings and shafts.[21] Two years later, in 1929, the firm received a second contract with Donugol to plan and build three new coal pits within three years. The firm provided thirty-five United States mining engineers and accepted ten Soviet engineers per year for training in the United States.[22]

In addition to contracts between American consulting firms and Donugol, there were a number of individual contracts between specialist American engineers and Giproshaft, the Institute for Designing Coal Mines, and Kuzbastrust.

In 1929, under the reorganization plan of the Donetz coal trust, three new large capacity shafts were sunk, with an aggregate output of 1.65 million tons of coal. The one in the Gorlov district had a capacity of 650,000 tons, the one in the Dolzhansk area an annual capacity of 600,000 tons, and the one in the Krindachev area a capacity of 400,000 tons per annum.

For the year 1929–30, some fourteen new shafts were planned, the largest with an output of 1.6 million tons per year. Brukh, chief engineer of Stein A-G coal mine in Germany, designed the 1.6-million-ton shaft in the Scheglov district, and Thyssen A-G designed a similar shaft in the Gorlov district, under the supervision of engineer Drost. Another million-ton shaft was designed by Stuart, James, and Cooke, Inc.[23]

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southern ore Trust; Kiseltrust, a Urals mining trust, and the Kuzbastrust, in the Kuzbas coal fields. The company apparently viewed these undertakings as pure concessions (316–136–372).

When Stuart, James and Cooke, Inc., issued their report on the reorganization of the coal mines in 1931, V. I. Mezhlauk ordered 10,000 copies to be printed and distributed to all executives down to foreman level in the coal and related industries. [E. M. Friedman, *Russia in Transition* (London: Allen & Unwin, 1933).]

20 *Ekonomicheskaya Zhizn*, No. 143, June 26, 1929.

21 U.S. State Dept. Decimal File, 316–136–1242.

22 *Pravda* (Leningrad), No. 246, October 25, 1929.

23 *Bank for Russian Trade Review*, II, No. 7 (July 1929), p. 10.

Lomov, a member of the Central Executive Committee, pointed out in 1929 that reconstruction of the Donetz Coal Basin was impossible without outside aid, as only 350 trained Russian engineers existed for 275 coal and anthracite shafts. The gap would have to be made up with foreign engineers, whom '. . . we are trying to employ on a large scale.'[24] He added that shafts were being designed by two German firms (Thyssen and Stein) and a number of American firms, and that an agreement was about to be concluded with an American firm to develop anthracite shafts. 'In this way we shall be able to solve the problem facing the Donetz Basin.'[25]

RESULTS OF THE MECHANIZATION OF COAL MINES

Russian coal mines before 1923 were highly labor-intensive; there was little, if any, mechanization even of an elementary nature. In 1923 the Donetz Coal Trust imported a few Sullivan coal cutters,[26] followed by seventeen in 1925 and another forty-five in 1926.

In August 1923, the purchase and installation of mining machinery from the United States was placed on a more formal and, from the Soviet viewpoint, more satisfactory basis. J. A. Meyerovitch, who represented in the U.S.S.R. a group of Milwaukee and Chicago equipment manufacturers including Sullivan and Allis-Chalmers, informed the United States Riga Legation that a concession had been concluded between the group and the U.S.S.R. Under this agreement the group was to arrange the export of Russian mineral products and to supply American mining equipment on a matching basis. However, Meyerovitch had the distinct impression that the Soviets were more interested in political recognition than in trade.[27]

Coal-mining equipment purchases were stepped up in 1925–6 and included a significant number of German and American heavy (178) and light (125) coal cutters, conveyors (30), hoists (32), and electric and gasoline tractors and chargers. Both the Sullivan Company and Krupp, the leading sellers, sent engineers to install and introduce the equipment to Soviet miners. Westinghouse installed electric tractors, and Jeffry front-end loaders, while Soviet purchasing commissions visited the United States.[28]

[24] 'Debates on the Five Year Plan,' *Pravda* (Moscow), April 28, 1929.

[25] *Ibid.*

[26] The contract was arranged by Meyerovitch, the Sullivan Co. representative in the U.S.S.R. It involved $210,000 worth of coal mining machinery, on terms of two-thirds cash and one-third in four months, one of the earliest trade credits granted by a Western company (316–130–1274).

[27] U.S. State Dept. Decimal File, 316–131–719. See also chap. 16 on RAITCO.

[28] Amtorg, *op. cit.*, II, No. 16 and No. 19.

Table 3-3 INTRODUCTION OF THE MANUFACTURE OF COAL MINING MACHINERY

*Item No.**	*Description*	*Production (Units) 1927–8*	*1928–9*	*First Soviet Output*
Group A:	*First produced in 1928–9*			
26	Coal cutting machines:			
	Heavy	None	11	1928–9
	Light	None	48	1928–9
28	Pick hammers	None	29	1928–9
29	Mine ventilators (stationary)	None	206	1928–9
Group B:	*First produced in 1930 and after*			
13	Motors for electric mine locomotives	None	None	1932
17	Motors for coal cutting machines	None	None	1931
30	Mine ventilators (mobile)	None	None	1933
32	Mine safety lamps	None	None	1931
39	Grizzly screens for coke	None	None	1930
142	Belt conveyors	None	None	1930

Source: A. Gershenkron, *A Dollar Index of Soviet Machinery Output, 1927–8 to 1937,* (Santa Monica: RAND Corp., 1951).
* Refers to the category of machinery given in Gerschenkron.

There was no production of any type of coal mining machinery in the U.S.S.R. until the end of the decade. Priority was then given to the establishment of coal-cutter and underground-drill production, and Type III agreements were made with two Western companies: Goodman Manufacturing, Inc. of Chicago and Hilaturas Casablancas S.A. of Spain.[29] Production

Table 3-4 EARLY MECHANIZATION OF THE DONETZ COAL BASIN, 1922–8

Year	*Number of Machines in Use* (all imported)*	*Metric Tons of Coal* Production per Machine (per year)	*Metric Tons of Coal* Production per Worker (per month)
1922–3	32	6,264	5.8
1923–4	36	7,541	7.2
1924–5	48	10,682	8.7
1925–6	90	13,007	10.5
1926–7	225	14,196	11.5
1927–8	348	14,300	12.4

Source: L. Liberman, *Trud i Byt Gornitskov Donbassa* (Moscow: 1929), pp. 97–8.
* Heavy coal cutters only.

[29] *Pravda,* No. 246, October 25, 1929.

of electric motors was undertaken after 1930 (Group B) to a General Electric design described by them as unique and used only in Soviet-made coal cutters.[30]

The effect of imported and Soviet-made coal-cutting machinery was significant. In the Donetz Basin the number of coal-cutting machines in operation increased from none in 1921 to 348 in 1927–8, the last year in which the U.S.S.R. was completely dependent on imported equipment. In the peat mining industry reliance was completely on imported drag lines, and it was not until the 1930s that the hydro-peat method, using specially designed General Electric motors, was introduced.[31]

Increase in production per machine from 6,264 metric tons in 1922–3 to 14,300 metric tons per machine in 1927–8 (table 3–4) testifies to the success of the Stuart, James and Cooke rationalization scheme and to the efficient training of workers and installation of equipment by Western manufacturers. In terms of output-per-worker, the increase was also significant: from 5.8 tons per worker *per month* to 12.4 tons in 1927–8, compared to the United States average of 48 tons per worker per month.

Table 3–5 DONETZ BASIN: CHANGES IN NUMBER OF SHAFTS, TOTAL OUTPUT AND MINE AVERAGES, 1913 TO 1926–7

Date	*Number of Shafts*	*Production (in millions of metric tons)*	*Average per Mine (in metric tons)*
1913	1,200	25.3	21,083
1921–2	954	7.2	7,547
1922–3	577	8.1	14,038
1923–4	591	12.2	20,642
1924–5	238	12.5	52,521
1925–6	377	19.6	51,989
1926–7	480	24.5	51,042

Sources: 1913 to 1926–7 U.S. State Dept. Decimal File, 316–136–1304 (based on Central Statistical Office data). Not available after 1926–7.

The effect of Type III technical-assistance agreements can be traced very clearly in table 3–5 covering Donetz Basin output from 1913 to 1926–7. In 1913, 1,200 shafts produced a total of 25 million tons of coal, an average of 21,083 metric tons per shaft per year. The catastrophic decline in production through 1921–2 is followed by the policy of concentration; coincident with introduction of the American and German equipment and training in 1923, there is a climb in output to 12 million tons. The reduction of shafts from 591 to

[30] *Monogram*, November 1943.

[31] *Ibid.*

238 in the same period that output was increasing was due to concentration of the newly imported equipment into comparatively few mines, increasing the output per mine while ruthlessly closing down the non-mechanized mines. In 1925, beginning with German reorganization assistance and continuing with large imports of mechanical coal cutters and conveyors, output increased; and the number of operating shafts increased as the mechanization program spread. The dramatic rise in mine output accompanies the first introduction of mechanical equipment, and the output stabilizes at 51,000 tons per shaft at this date, indicating a methodical program of mechanization and training in an increasing number of mines.

Whereas in 1922–3 only 200,000 tons of coal were mined by machine in the Donbas by 1928–9 about 30 percent (or 7.6 million tons) were machine-mined; and the U.S.S.R. had not at that time begun to manufacture coal cutters.

The Warren Coal Corporation, coal distributors of Boston, concluded an agreement with Amtorg in May 1929 covering the distribution of 160,000 tons of Soviet anthracite per year in the United States. Warren became sole distributor for Russian anthracite in New York and the New England States.[32]

In critical stagnation at the beginning of the decade, the coal mines, technically backward and with inefficient, unskilled labor, were reorganized according to United States coal-mining procedures utilizing first German and later American coal-mining equipment. At the very end of the decade, arrangements were made with Spanish and American companies for technical assistance in the manufacture of coal-mining equipment, all of which had been previously imported. Pure concessions were not of major importance in the aggregate, except that Union Minière operated a number of large Donbas mines at a time when the majority of these mines were either closed or being re-equipped by German (later American) engineers. However, more remote mines, in the Kuzbas and the Far East were extensively operated by foreign concessionaires.

[32] Agreement is in U.S. State Dept. Decimal File, 316–136–1285.

CHAPTER FOUR

Early Development of the Soviet Metallurgical Industry

THE metallurgical industry, *primus inter pares* of the 'commanding heights' of the economy, was kept well within the control of the planning organs and the Party. The decade of the 1920s, which has been called by Clark the 'restoration period'[1] to distinguish it from the massive new metallurgical construction of the 1930s, suggests that only limited technical and economic advances could be made without Western technical assistance.

THE SOUTHERN ORE TRUST (YURT)

Yurt controlled iron ore in Krivoi Rog and manganese in the Nikopol deposits. After 1924 there was an agreement with Rawack and Grunfeld, of Germany, for the operation of these manganese and iron ore mines. Rawack and Grunfeld also held a monopoly for the sale of all South Russian iron ore and manganese in foreign markets. In 1924–5 the company sold 21 million poods of iron and manganese ores to Germany, Italy, Belgium, and the United Kingdom.[2] The Port of Nikolaev was equipped with ore loaders by the company to handle the export of these ores.

Only six mines were operated at the beginning of the year. The major restoration of the Krivoi Rog iron ore and manganese mines took place after 1925 under predominantly German technical assistance. In December 1925, fourteen iron ore and three manganese mines were reopened; these were tsarist mines closed since the Revolution. The mining equipment was purchased in the United Kingdom and Germany by Yurt, on nine months' credit. Company engineers from the United Kingdom and Germany assembled the equipment and put it into operation.

1 M. Gardner Clark, *The Economics of Soviet Steel* (Cambridge: Harvard, 1956), p. 65.

2 U.S. Consulate in Hamburg, Report 360, October 12, 1925 (316–108–1544).

At this point the mines at Krivoi Rog and Nikopol were inspected by a German industrial delegation headed by Steinitz, of Rawack and Grunfeld, which expressed the opinion that the newly equipped mines could produce 500 million poods of iron ore and 150 million poods of manganese within five years and that the members of the delegation were prepared to provide assistance to reach that objective. Its opinion was that new equipment to fulfill the five-year program need only consist of electrical mining equipment; Yurt was instructed by Vesenkha to consider the German suggestions, which were later implemented. It was also agreed that credit would be advanced by Germany to Yurt on the basis of the proceeds from the anticipated export of manganese ore from Nikopol.[3]

In October 1927 Yurt concluded a technical-assistance contract with Stuart, James and Cooke, Inc., for the further preparation of projects and consulting services.[4]

RECONSTRUCTION IN THE METALLURGICAL SECTOR

The position of the Russian iron and steel industry in 1920 was almost unbelievably bad. In 1913 there had been 160 blast furnaces operating in Russia; but in 1920 only 12 were operating intermittently. In 1913 there had been 168 Martin steel furnaces; but in 1920 only 8 were operating intermittently. Production of iron ore was 6 million poods, compared to 551 million poods in 1913. Production of cast iron was 6 million poods, compared to 231 million in 1916 and 6.6 million poods in 1718 under Peter the Great.

Production of rolled iron was 6.4 million poods, compared to 222 million in 1916, and so on. Of sixty-six cast-iron foundries available, only two were in production. However, employment had not fallen in the same proportion: whereas 257,000 were employed in metal works in 1913, there were 159,000 so employed in 1920 despite the catastrophic decline in output.[5]

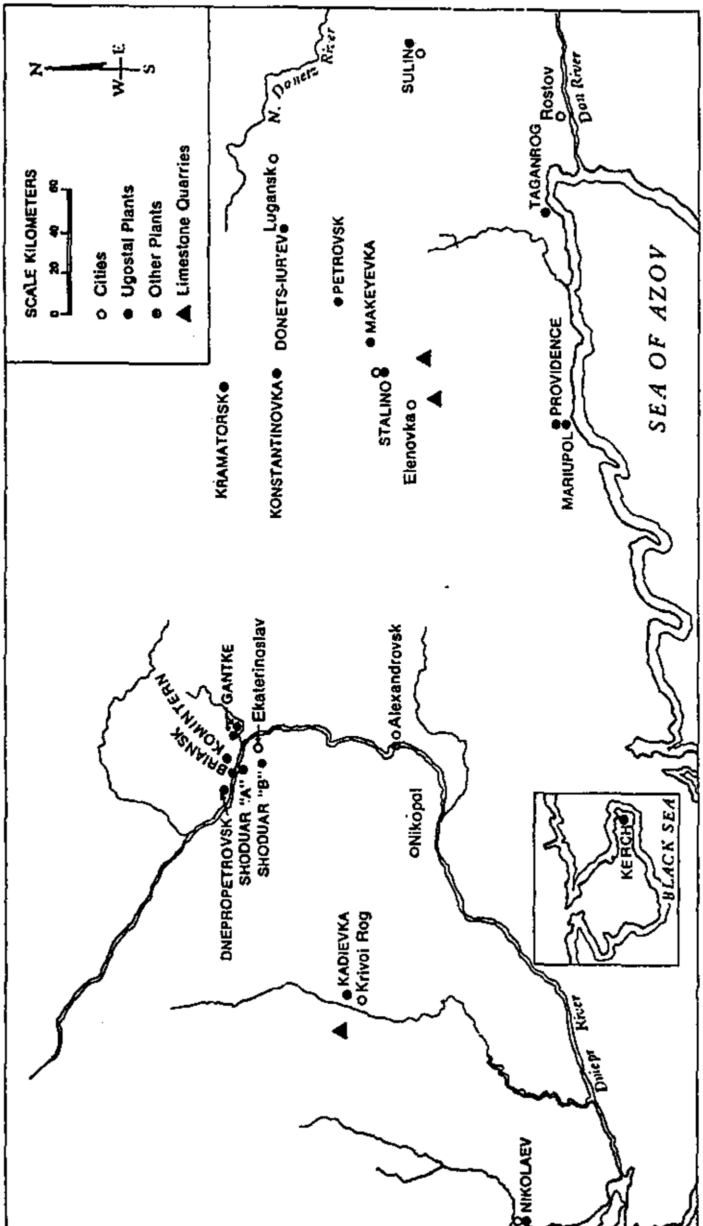
The metallurgical sector, however, received comparatively few concessions until the Type III technical-assistance agreements of 1927–9, which were a prelude to the Five-Year Plan construction. Although, production had partially recovered by the late 1920s, technologically the industry had remained at the level of the tsarist era. Independently attempted technical advances backfired and forced the Soviets to seek out Western assistance—another proof that Soviet development and technical progress in the twenties were essentially dependent on Western technical aid. Soviet-originated projects

[3] U.S. Consulate in Hamburg, Report 417, December 12, 1925 (316–108–1582).

[4] *Torgovo-Promyshlennaya Gazeta*, No. 229, October 7, 1927.

[5] These figures taken from a confidential report in U.S. State Dept. Decimal File (316–107–359). Also see report from General Wrangel's staff, December 1921 (316–107–569).

MAP 4-1 METALLURGICAL PLANTS IN SOUTH RUSSIA, 1926



were fumbling and technically inept, and made little contribution to reconstruction or development. The only successful Soviet work of the period was the restoration of seven small blast furnaces—not a particularly difficult task—and these, as Clark points out,

> . . . are almost never mentioned in Soviet technical or metallurgical literature. Perhaps the Soviets are ashamed of these first attempts, which certainly look like pygmies beside the giants built during the First Five Year Plan.[6]

The Donbas sector is by far the most important of the iron- and steel-producing regions. As shown in figure 4-1, Ugostal (Southern Steel Trust), formed in 1923, divided the inherited plants into four groups: the Donetz group proper, at the east end of the basin; the Ekaterinoslav group, at the western end of the basin and north of the iron-ore fields of the Krivoi Rog; the southern group of plants on the Sea of Azov; and the Kramatorsk and Hartman locomotive plants.

The Donetz group metallurgical industry was in a sorry state in 1921. All plants were closed except for Makeevka and Petrovsk. The latter had no blast furnaces in operation, and rolling was limited to available steel slab stocks. Whereas more than 233 million poods had been produced in all Russia in 1916, only 7 million poods were produced in 1920[7] (i.e., about 3 percent), and much of this was too bad in quality for use. In the Donetz area the position was even worse, with production less than .5 percent of the prewar level.

Contraction of the metallurgical industry continued into mid-1922. Most of the Donbas steel plants remained closed, reportedly because of a lack of purchase orders and working capital. Only South Briansk and Chaudoir operated on a continuous basis; Petrovsk, the largest, continued with one furnace working continually and the others either intermittently or not at all. Makeevka was partially closed in 1922.

In early 1923, the mines supplying Petrovsk became idle, as did the open-hearth steel-making plant. The plant was in fair condition technically but now lacked skilled labor. Makeevka was completely closed, although the workers were retained.

[6] Clark, *op. cit.*, p. 82. Soviet restoration was limited to the simplest of repair work; even furnace lining (a skilled but simple task) was difficult for them. For example, the Perin and Marshall engineers stated that in 1926 the unfinished No. 5 blast furnace at Petrovsk required only a 'comparatively small expenditure' to complete. The furnace had been under construction prior to 1914 and 'nearly all of the metal work (had) been erected for the furnace proper, stoves and skip bridge,' but 'much of the piping' was still lying on the ground where it had rested since 1914. The inference is that completion was beyond the technical capabilities of Ugostal. [Perin and Marshall, *Report on Improvement of the Ugostal Steel Plants of South Russia* (New York: 1926), p. 42.] Petrovsk No. 5 was not working as late as October 1928. (Kruglyakova, *op. cit.*, p. 70.)

[7] *Ekonomicheskaya Zhizn*, No. 106, May 18, 1921. Numerous articles in this and other journals in the period 1920–2 indicate a pitiable condition.

Table 4-1 UGOSTAL (SOUTHERN STEEL TRUST) PRODUCTION, 1913–28, DONETZ GROUP

Plant Name		*Output (metric tons)*						
Prerevolution	*Ugostal*	*1913*			*1923–4*			*1927–8*
		Pig Iron	*O.H. steel*	*Rolled steel*	*Pig Iron*	*O.H. steel*	*Rolled steel*	*Pig Iron*
Neurissiche A-G	Stalino	276,230	231,290	208,680	154,282	92,179	69,861	302,924
Briansk-Alexander	Petrovsk	348,200	315,165	279,040	—	—	—	296,293
Société Minière et Metallurgique 'Union'	Makeevka	229,940	154,835	128,790	—	12,604	12,017	200,881
Alchevsk	Donetz-Iur'ev	246,990	250,245	212,160	—	—	—	223,841
Société des Tuileries	Frunze	60,110	63,170	60,210	—	—	—	58,316

Sources:

1. Perin and Marshall, *Report on Improvement of the Ugostal Steel Plants of South Russia* (New York: 1926).
2. ——, *Report on the Steel Industry of South Russia* (New York: 1926).

One widely held view was that Ugostal should be disbanded and all the South Russian steel works closed. The area was being worked at a loss. There were few orders; most were being placed abroad. However, the trust employed 27,000 people: sufficient argument to keep the mills in intermittent operation!

A compromise was reached by formally closing Makeevka and discharging one half of the workers while transferring the other half to the Ugostal coal mines.[8]

In the next three or four years, several blast furnaces were rebuilt, with Western assistance and by 1927–8 pig-iron output was increased in four of the ten plants which constituted the prewar Donetz group. The Donetz group now produced more than 1 million tons of pig iron (compared to 1.6 million in 1913), including output from blast furnaces at Briansk-Alexander, the Donetz-Iur'ev works, and the Frunze (old Société des Tuileries) works. In 1928 all output from the Donetz section of Ugostal, the largest single group of metallurgical works, was from pre-Revolutionary plants which had been put back into operation.

The second group of works forming the Ugostal trust was in the Ekaterinoslav area, at the western end of the Donbas and to the northeast of the Krivoi Rog iron-ore deposits. This group comprised six prerevolutionary plants, only three of which (Dnieprovsk, Briansk, and Gdantke) had been pig-iron producers with blast furnaces. Of these three only Briansk was producing pig-iron in 1923–4; neither the Dnieprovsk or the Gdantke were operating as pig-iron producers. Consequently in 1923–4 only one of the six works situated near the Krivoi Rog iron ore deposits was producing any pig iron.

Two works, the Dnieprovsk and the Lenin (formerly the Shoduar 'A') were producing small quantities of open-hearth steel and rolled steel products.

In sum, this group was only producing about 140,000 tons of rolled steel products in 1923–4, compared to almost 826,000 tons in 1913.

The third group of Ugostal metallurgical works was the Azov Sea group of four prerevolutionary plants which produced 400,000 tons of pig iron in 1913. No blast furnaces in this group were operating in 1923–4, and only two produced any rolled steel: Zhdanov and Taganrog. As Taganrog produced no slab steel, it was probably importing slabs from the Zhdanov works (formerly the Marioupol), (table 4–3).

The old Providence works was first merged with the Zhdanov, a few miles to the South, and then closed down.

The Kertch works was first built by French and Belgian capital in 1900, but the owners had closed it down as unprofitable after a few years.[9] The

[8] *Pravda*, No. 48, March 3, 1923.

[9] Clark, *op. cit.*, p. 157.

Table 4-2 UGOSTAL (SOUTHERN STEEL TRUST) PRODUCTION, 1913–28, EKATERINOSLAV GROUP

Plant Name		*Output (metric tons)*						
Prerevolution	*Ugostal*	*1913*			*1923–4*			*1927–8*
		Pig Iron	*O.H. steel*	*Rolled steel*	*Pig Iron*	*O.H. steel*	*Rolled steel*	*Pig Iron*
Dnieprovsk	Dzerzhinsk	417,165	386,660	330,270	—	13,305	17,433	426,225
Briansk	Petrovsk	408,975	325,370	259,530	132,899	81,523	79,143	466,964
Shoduar 'A'	Lenin	—	100,730	39,205	—	51,084	17,385	—
Shoduar 'B'	Comintern	—	—	47,305	—	—	—	—
Gdantke	Karl Liebknecht	—	—	—	—	—	17,391	—
Krivoi Rog	Krivoi Rog	75,595	—	—	—	—	—	—

Sources: Perin and Marshall, *Report on Improvement of the Ugostal Steel Plants of South Russia* (New York: 1926); V. I. Kruglyakova (ed.), *Sbornik statisticheskikh svedenii . . .*, pp. 70–71.

Table 4–3 UGOSTAL (SOUTHERN STEEL TRUST) PRODUCTION, 1913–28, AZOV GROUP

Plant Name		*Output (metric tons)*								
		1913			*1923–4*			*1927–8*		
Prerevolution	*Ugostal*	*Pig Iron*	*O.H. steel*	*Rolled steel*	*Pig Iron*	*O.H. steel*	*Rolled steel*	*Pig Iron*	*O.H. steel*	*Rolled steel*
La Providence Russe	Providence } combined	165,670	173,695	145,180	None	None	None	None	None	None
La Providence Russe	Zhdanov } combined	69,675	78,230	53,750	None	56,746	28,650	180,648	None	None
Société Metallurgique de Taganrog	Taganrog (Andreev)	154,480	171,105	144,350	None	None	3,269	None	57,000	49,828
Société Metallurgique de Taganrog	Kertch (Voikov)	9,925	815	—	None	None	None	None	None	None

Source: Perin and Marshall, *Report on Improvement of the Ugostal Steel Plants of South Russia* (New York: 1926).

equipment had survived until 1925 in good condition, and the Soviets reopened the works according to plans drawn up by German and American engineers. The first blast furnace was ready for blowing-in by 1929. The cost of reconstruction, however, greatly exceeded even the most pessimistic estimates, and a search was put under way for the 'criminals' who had miscalculated. The major problem was that the furnaces would not smelt local iron ores.

> The failure of the Kertch works is typical of the actual conditions of the new industrial enterprises which have been organized by inexperienced and inefficient persons for the sake of political propaganda and without any regard of the conditions under which the new plant will have to work.[10]

By late 1929 only two of the projected three blast furnaces had been built, and capital costs already had exceeded 66 million rubles—far in excess of the 18 million originally estimated for the whole project. The operating costs were also significantly greater as local Lipetsk 40-percent-iron ore required additional fuel, which had to be transported from the Donbas. Use of this ore required an additional nine rubles a ton for transportation.[11]

THE STRUCTURE OF UGOSTAL IN 1929

At the end of the decade, Ugostal consisted of eight plants constructed before the Revolution and one reconstructed plant, the Kertsch, whose problems have already been discussed. These plants had produced 3.2 million metric tons of pig iron in 1913, whereas in 1929 they produced less than 2.5 million, with labor productivity about 50 percent below the prewar level. Real wages had declined heavily because of the many compulsory contributions required of the plant workmen.[12]

Several smaller works were included in the trust, including the former Handtke plant, producing iron pipes, and the former Sirius and Taganorog plants, producing railroad equipment.

Although a few American and Polish engineers worked on the Ugostal plants, the bulk of the rehabilitation was carried out by German engineers working under the post-Rapallo economic-cooperation contracts between Germany and the Soviet Union.

10 U.S. State Dept. Decimal File, 316–139–252/8. The American and German engineers said their calculations were correct, but they had failed to take political considerations into account (316–133–858).

11 U.S. State Dept. Decimal File, 316–139–252/8.

12 Based on report from Polish Consulate General in Kharkov, June 5, 1929, from information supplied by a Polish engineer working for Ugostal and believed to be 'absolutely reliable' (316–139–251).

CONCESSION OFFERS IN METALLURGICAL CONSTRUCTION

Large new metallurgical projects and the rehabilitation of prerevolutionary plants were offered as concessions under the broadened post-1927 concessions policy.

The possibility of using the iron-ore reserves of Magnitogorsk with the extensive coking coal deposits of Kuznetsk had been discussed in Russia since the nineteenth century. The Magnitogorsk concession proposal was for a 656,000-ton-capacity plant (rolled products), to produce pig iron, together with steel-making and rolling facilities.[13] The rolling capacity of the suggested plant was planned as follows:

Heavy rails	245,000 tons
Large stanchions (structurals)	33,000 tons
Medium commercial iron and pit rails	65,500 tons
Small commercial iron products	230,000 tons
Casting iron	27,500 tons
	601,000 tons

A preliminary outline of the technical requirements was published. The plant was scheduled to include four blast furnaces, open-hearth and Bessemer furnaces, and rail and continuous blooming mills of American design. Three basic requirements repeatedly emphasized were that the plant had to operate on coke, that the coking had to be undertaken at Magnitogorsk from Kuznetsk coal, and that coke by-products were to be utilized. This emphasis is interesting as it relates to the basic economic weakness of the Magnitogorsk-Kuznetsk project and the technical weakness of the Soviets in coke by-products production.[14]

Given the long haul for coking-coal, transport costs were the major factor in determining profitability. Early discussion, beginning in the 1890s and continuing through the 1920s, had revolved around this point. As late as 1927, I. G. Feigin had stated that 'transportation of raw material and fuel for 2,000 kilometers is completely irrational.'[15] But the official party line was that transportation costs could not be a determinant of location in a Socialist economy, this being bourgeois Weberian theory.

The concession was offered a supply of coking coal from Kuznetsk, then being planned by Freyn and Company, Inc., at a rate of 0.38 kopecks per

[13] P. I. Egorev, *The Magnitogorsky (Magnet Mountain) Metallurgical Works* (Moscow: Glavnyi Kontsessionnyi Komitet, 1929). This was the same technical arrangement suggested by Perin and Marshall two years earlier and rejected as 'technically inadequate.'

[14] See chap. 12.

[15] Clark, *op. cit.*, p. 215.

ton-kilometer. Consequently, any concessionaire with the temerity to undertake construction of Magnitogorsk and install coking facilities dependent on Kuznetsk coal would have been completely at the mercy of the Soviet government. By merely raising transport rates to equal costs, the Soviets could have forced the concessionaire to abandon the project. This was in addition to the immense difficulties which could have been imposed on the concessionaire as a result of the single-track, inadequate, and overcrowded railway already straining under the weight of increased coal tonnages. It will be recalled that the major problem in getting American and British relief to this part of Russia had been a heavily overburdened and inadequate rail system which required several weeks for journeys of a few hundred miles, even though large segments of the population were starving.[16]

The estimated cost of building Magnitogorsk was 171 million rubles. The plant was to employ 6,216 people and return a profit of 10 percent. The concessionaire was given the option either to operate the plant for a number of years as a pure concession and then turn it over to the Soviet government, or to operate it as a credit concession in which erection and operation would be undertaken by the Soviets and the foreign company would grant a ten-to-twelve-year credit.

Clark states that the basic rate of 0.38 kopecks, also used in the argument over the construction of the shuttle under the Five-Year Plan, was about one-third the rate charged for coal hauled the same distance in the general rate schedule. The Magnitogorsk concession lay outside the control of potential concessionaires; one could have fulfilled an agreement, stayed within the cost estimates given, and yet within a few months or years been forced to abandon the concession operation.

Whether this was the intent or not is debatable. The history of other concessions gives support to the probability that this was indeed an aim of concession policy. Chernomordik, referring to the special discount or subsidy given to the Magnitogorsk-Kuznetsk shuttle says,

> The Soviet freight-rate system, based on the principle of costs, includes the use of freight rates as a lever of economic policy.[17]

In brief, the proposed Magnitogorsk concession could have operated only with a subsidy from the Soviet government to the foreign operator. It is unlikely this subsidy would have been long continued.

The restoration of other large metallurgical complexes was offered to foreign capital.

[16] H. H. Fisher, *The Famine in Soviet Russia* (New York: Macmillan, 1927), p. 173.

[17] D. Chernomordik, 'Toward a Theory of Railroad Freight Rates,' *Voprosy Ekonomiki*, No. 9, 1948, p. 32.

The Nadejdinsky Metallurgical Works in the Urals, founded in 1894, battered in the Revolution and Civil War, subsequently operated by the American Industrial concession, and still in a bad state of repair, was one such project. The works comprised the iron ore mines about 90 kilometers away, and the Bogoslovsky brown-coal mine about 50 kilometers away, together with extensive forest properties for the manufacture of charcoal, and both narrow- and wide-gauge railroads.

Production in 1929 was less than half of 1913 output, and the ore and coal mines had received little new equipment since 1899–1907, when the plant had first been placed in operation.

The equipment was out of date. The air and gas blowers dated from between 1905 and 1913. The six rail- and sheet-rolling mills dated from the mid-1890s and were classified in 1929 as only 50-percent fit (three mills), 70-percent fit (two mills) and 90-percent fit (one mill). Even if restored to normal operation, they would have been be well below current engineering standards. The blast-furnace plant operated on a fuel comprising a mixture of brown coal, charcoal, and wood; and occasionally one furnace operated on imported Siberian coke.[18]

Employment in 1929 was over 20,000 workers, producing about 163,000 tons of pig iron per year and converting this into 155,000 tons of steel.

The product totals produced by the plant in 1929 were:

59,600 tons rails
4,600 tons roofing iron
2,500 tons commercial iron
4,000 tons pit rails (light rails).

The concession offered required the prospective concessionaire to drop rail and tire production and rebuild the plant for roofing-iron production only. In effect, this involved the construction of a completely new plant (at a cost of between 47 and 52 million rubles) which, it was claimed, would produce 11.7 to 13.0 percent return on investment.[19]

The Taganrog Metallurgical Works dated from 1895, and was in a very poor state of repair.[20] The furnaces were oil-fired and produced just over 57,000 tons of steel ingots in 1927–8. Of six rolling mills, only the roofing mill was described as satisfactory. The electrical equipment dated from the period 1895–1907.

[18] I. N. Kostrow, *The Nadejdinsky and Taganrog Metallurgical Works* (Moscow: Glavnyi kontsessiony komitet, 1929).

[19] *Ibid.*, p. 21.

[20] *Ibid.*, p. 30. The four Martin furnaces are described as 'exceedingly worn out and of obsolete type.' The three Thomas converters are described as 'partly demolished . . . very much out of date.'

A concession was offered to produce 160,000 tons of roofing iron per year, with the stipulation that coke ovens were to be built together with a plant for the manufacture of chemical by-products. Profit was estimated at 10 percent.

There are interesting parallels between these metallurgical concession offers. Each stipulated (Magnitogorsk and Taganrog) or involved (Nadejdinsky) the construction of coke ovens and the utilization of coke as a fuel. Without control of coking-coal deposits the concessionaire could not have controlled the operation of the metallurgical plant. Using the weapon of transport costs, the Soviets could have squeezed out the concessionaires without violating the letter of the agreement.

The profit estimates, from 10 to 13 percent, indicate a rather naïve concept of the degree of inducement required to enter a new line of endeavor. Even without political risk, as in the United States or Great Britain, an estimated annual return of 20 percent would have been more suitable.

PURE (TYPE I) CONCESSIONS IN THE METALLURGICAL INDUSTRY

Pure concessions were not a major factor in the development of the iron and steel industry, the Soviets were obviously unwilling to allow Western elements to operate freely in the most strategic of the 'commanding heights.'

The Russian-American Steel Works was established in the Soviet Union by emigrant American workers in 1921. They were able to double output in the first year and then ran into problems; insufficient orders were forthcoming from the trust, and the works was diverted into supplying small orders for private firms and repairing automobiles and tools. There were insufficient raw materials—about 30 percent of the steel received was unfit for use—and shortages of oil and coal.[21]

An early Type I concession, perhaps better described as a commune, was granted to 3,000 emigrant American workers about 1922. The Nadejdinsky mines, in Perm okrug, and later part of the Uralmed trust was reportedly being operated along with associated coal mines and forests. They were granted 20,000 dessiatins of land for agricultural use and a loan (at 7 percent) of 350,000 gold rubles for working capital. Each worker was required to bring $100 in cash and $100 worth of tools. The government purchased 50 percent of production and the balance accrued to the concession.[22]

At least two metallurgical works were leased to Russian concessionaires. The Randrun foundry, at Omsk, was leased back to its former owner in

[21] *Pravda*, No. 79, April 12, 1923.

[22] Haywood contract with the Soviet of Labor and Defense (316–111–1270). See chap. 3 for details of the Haywood (American Industrial Corp.) contract.

October 1921 on condition that he undertake the necessary repairs to get it back into production. As soon as the foundry was back in operation, the former owner was again ejected and the Soviets took over operations.[23]

Another large works, the Goloborodov—part of the Eketerinslav group in southeast Russia—was leased for five years with a rent based on output.[24]

In 1924 the Viksun Metal Works, in the Urals, nominally part of the Gomza trust, was leased for forty years to the German firm, Bergman, on a pure concession basis. Bergman was required to restore the equipment and put the plant in operating condition before May 1925. Forests, mineral rights, and mines over a 250-square-verst area were handed over to Bergman for exploitation. The company had the right to hire and fire, with the restriction that foreign personnel were not to comprise more than 25 percent of workmen, 45 percent of foremen, and 75 percent of technical personnel. The only assistance from the Soviets was to provide labor. The concessionaire was required to make payments, beginning in 1928, to comprise 30 percent of the final manufactures (heavy machinery, etc.) or semi-manufactured materials and minerals output in the lease years three through ten. A minimum conversion of five million poods of ore into metal was required, with a corresponding manufactured output. The concessionaire was required to manufacture heavy machinery and various metal goods including guns, shells, and small arms.[25]

The Lena concession operated the blast furnaces and steel works at Sissert and Revda, in the Urals. The company first renovated seven iron ore mines, three limestone quarries, and two quartz quarries in Polevskoi rayon, installed new iron works plant at the Seversky blast furnace, and renovated the Revda iron and steel works. By 1927 the annual combined output of these works was 100,000 tons of roofing iron, almost 30,000 tons of wire, 1,400 tons of nails, and 3,000 tons of cast iron shapes. This was achieved in a plant producing nothing when taken over in 1925 by Lena, who spent more than $2.5 million on imported equipment for these works.

The available evidence indicates that foreign labor was not generally utilized—apart from that in these pure concessions—before about 1927. The Polish Foreign Ministry concluded as late as mid-1929 that:

[23] U.S. State Dept. Decimal File, 316–107–203.

[24] U.S. State Dept. Decimal File, 316–107–52.

[25] The agreement contained a clause that military production could be exported, so it may be assumed that this agreement was part of the wider German-Russian military co-operation of the 1920s. This was not one of the GEFU shell-making plants (316–139–191).

There was also a report from the United States Riga Consulate in late 1923 to the effect that a number of the Krivoi Rog coal and iron ore mines had been turned over to the munitions firm Crouardi for the production of armaments. (U.S. State Dept. Decimal File, 569–3–99.)

> Very few foreigners are among the technical personnel of the Jugostal; but such foreigners as are employed are engineers or skilled workmen from Germany or Czechoslovakia, and occasionally Poles.[26]

The Perin and Marshall report[27] on the reconstruction of the South Russia iron and steel industry was centered around reconstruction and enlargement of one works, the Petrovsk, while including the Stalino, Makeevka, and Donetz-Iur'ev works in a subsidiary role; the others were scheduled to be closed down.

In essence, the Perin and Marshall report proposed three new 750-ton skiploaded blast furnaces and completion of an existing 600-ton furnace to replace smaller hand-fed units. Steel was to be made in three departments: an open-hearth plant with three modern open hearths replacing four obsolete furnaces, a new Bessemer plant, and a duplex plant to make steel from an all hot-metal charge (to overcome the scrap shortage).

The major technological change suggested by Perin and Marshall was installation of a powerful blooming mill to break large ingots into slabs before rolling them into finished products—a very successful process in the United States but not then introduced in Europe or Russia.

> The (consequent) large supply of relatively cheap billets and blooms will permit the small and medium shape, merchant and sheet mills of the Donbass steel works to be remodeled so as to reduce the amount of work which these mills must do with a reduction in labor and an increase in tonnage.[28]

The report pointed out that these proposals would not interfere with existing Ugostal plans but would generate a substantial increase in capacity at reasonable cost. The metallurgy of the duplex process lent itself to the high-sulfur coking coal available. Semi-skilled labor could be used, as was typical in the United States.

A contract was concluded in October 1927 between Percival Farquhar (an American financier) and the Soviet government to develop the Donetz Basin. The contract was based on the findings of the Perin and Marshall report.

26 Report of the Polish Consul General at Kharkov, June 5, 1929 (316–139–255/8). This was reasonably accurate for the period before 1929; T. H. McCormick had a two-year contract as technical director of the Poltava steel mills for 1928–1930, and the Frank Chase Company, Inc., had a contract in 1928 to reorganize the foundry department of the Podolsk plant, but no others, except the Freyn-Gipromez technical agreements, have been traced at this time.

27 Perin and Marshall, *Report on Improvement of the Ugostal Steel Plants of South Russia* (New York: 1926). This was one of three reports prepared for Percival Farquhar in his negotiations for a large concession based on the Don railroad and metallurgical industries. The Farquhar documents covering these negotiations are in the Hoover Institute Library, Stanford University.

28 *Ibid.*, pp. 59–60.

In order to implement this agreement, Farquhar proposed the formation of a Delaware company, the United American German Corporation, which would administer the contract. The capital was to be $2 million: one half subscribed by Percival Farquhar, Ingersoll-Rand Company, and Dillon Reed, and the other half by Vereinigte Stahlwerke and Otto Wolff in Germany.

The contract consisted of two parts: first, a definite agreement to construct a large, modern one-million-ton-capacity iron and steel mill with all ancillary equipment 'according to American standards, specifications and patents in the coal and iron ore district of South Russia';[29] and second, optional for the company, was the reconstruction of the railroad transportation system of the Don 'on American standards,' together with the construction of iron ore concentration plants at Krivoi Rog and elevators, docks and shipyards at Stalingrad.

Under the first part of the contract, the United American German Corporation was to receive drafts from the Soviet State Bank to the amount of $40 million, bearing 6 percent interest, amortizable over a period of six years. The Corporation would then sell in the United States $20 million worth of 6-percent debentures 'guaranteed unconditionally (as to) principal and interest by the German Government.' The balance of the capital would be provided by manufacturers' and bankers' credits. This was not acceptable to the State Department or to the Treasury Department, on the grounds that the benefits would accrue to Germany rather to the United States, and that the transaction would be, in effect, Russian financing and the employment of American credit for the purpose of making an advance to the Soviets. It was held to differ only in form, not in substance, to previous unacceptable proposals.

Subsequent to the failure of this move, an agreement was signed between the Farquhar-Otto Wolff group and the Soviets involving a $40 million credit for the reorganization of the Makeevka metallurgical trust, on a six-year-loan basis. This was a straight credit arrangement involving neither concessions nor sale of the property.[30] [31]

In 1928, Gipromez, staffed by the Freyn Company, rejected the Farquhar proposal for Makeevka as containing serious defects. It was argued that costs were underestimated. Technical defects were found in the rolling-mill arrangement, the equipment selection was not justifiable on either technical or economic grounds, and the project contained no provision for either internal

[29] Based on memorandum submitted to Secretary of State Kellogg by P. Farquhar, dated October 5, 1927 (316–131–975/6). The contract is in U.S. State Dept. Decimal File, 316–131–977/92.

[30] Those readers wishing to explore the Soviet-Farquhar contract in more detail should examine the four boxes of Farquhar's personal papers at the Hoover Institution, Stanford University.

[31] German Foreign Ministry Archives (quoting a Tass report of January 21, 1928), T120–3032–H109353.

transport or power supply. The connection between the rejection of the Farquhar project, the subsequent conclusion of a technical-assistance agreement with Dr. Kuppe (a well-known German rolling-mill specialist), and the earlier agreement between Gipromez and Freyn, under which planning assistance was given to new iron and steel projects, is unknown. It would be reasonable to assume that the events were not disconnected. There is no hard evidence of active competition between the American and German concessionaires and planners, but such competition was certainly not beyond the realm of possibility.[32]

TECHNICAL-ASSISTANCE AGREEMENTS WITH GIPROMEZ

The agreement between Vesenkha (Supreme Council of the National Economy) and the Freyn Company, Inc., of Chicago, signed in August 1928, was the first milestone in the transfer of Western metallurgical technology. This was an extension of an earlier agreement, signed in 1927, under which Freyn gave technical assistance in reconstructing existing metallurgical plants and construction of new plants in the U.S.S.R., and was especially concerned with the design of the new Kuznetz iron and steel plant, estimated to cost $50 million and planned as a key element in the forthcoming Five-Year Plan, and the reconstruction of the old Telbiss iron and steel mill. The second 1928 agreement enabled Gipromez (the State Institute for Planning Iron and Steel Works) to create a new metallurgical section staffed by 'the most prominent' Freyn engineers, twelve of whom took up permanent residence in the U.S.S.R.[33] At the same time, six Gipromez design engineers went to the United States for three to four months, 'visiting American plants and consulting American engineering authorities.'[34] In addition, access was now given to Freyn archives

[32] The real reason for turning down the proposal was that the Soviets were not too assured Farquhar could raise the required capital, and in any event they objected to the sale of 'German machinery at American prices.' He was paid $600,000 for his technical services. (316–131–1088/9, U.S. Embassy in Berlin, Report 4121, November 19, 1928.)

See also Charles A. Gauld, *The Last Titan: Percival Farquhar* (Stanford: Stanford University, Institute of Hispanic American and Luzo-Brazilian Studies, 1964). Gauld makes the point that the Soviets are impressed by those capitalists who suffered their losses in silence. Farquhar lost about $100,000 on the Donetz project but said nothing publically: 'Farquhar's silence impressed the Kremlin . . . (he) was surprised when later the Soviet planners, on resuming the Donetz project, invited him to return to help co-ordinate it. But he had had enough of semi-Asiatic dealings with Soviet 'state capitalism.' He declared 'I learned that capitalists cannot do business with amoral, cynical Communists' (p. 205). Farquhar's impression was not typical—see W. Averell Harriman's adventures, pp. 89–91 below.

[33] 'American Technique Assists Soviet Metallurgy,' *Ekonomicheskaya Zhizn*, No. 182, August 8, 1928, and Clark, *op. cit.*, p. 65. Gipromez was founded April 10, 1926 and was comprised of a council of 237 professors and engineers. The utilization of Freyn designs will be traced in Vol. II.

[34] Amtorg, *op. cit.*, II, No. 14 (July 15, 1927).

and standard metallurgical drawings; and all Soviet project planning was transferred from the United States, where it had been conducted to that time, to the U.S.S.R. In other words, the design and technical experience of the leading United States steel works designer was now at the disposal of Gipromez. The first basic 'Soviet' blast furnace design resulting from this agreement was, according to Clark, used for twenty-two blast furnaces, each with a capacity of 930–1,000 cubic meters and an output of 1,000 tons or more a day—substantially larger than that of any previous Russian furnace.

Under the second agreement, Freyn contracted to plan and supervise the reconstruction of forty metallurgical plants and the building of eighteen completely new iron and steel plants, at an estimated total expenditure of over $1 billion.[35] These plants were to form the basic structure for the Five-Year Plan. In addition to the Freyn assistance, Dr. Kuppe, a prominent German steel-rolling specialist, acted as a consultant to Gipromez.[36]

Amtorg was able to conclude in 1928 that although the U.S.S.R. lagged behind in iron and steel, the 'enormous technical advances made during recent years in . . . the United States and other countries are now being incorporated in the new plants under construction in the U.S.S.R.'[37]

Thus Russia was able to utilize wide-strip mills, a fundamental innovation in iron and steel technology, within six or seven years of their introduction in the United States and at least two years *before* utilization in Europe.[38]

35 Amtorg, *op. cit.*, IV, No. 6 (March 15, 1929).
36 U.S. State Dept. Decimal File, 316-131-1075.
37 Amtorg, *op. cit.*, III, No. 2 (January 15, 1928) p. 24.
38 The first wide-strip mill in the United States was installed in 1926; the first in Europe was the Richard Thomas, Ltd., mill at Ebbw Vale, South Wales, completed in 1937. German continuous mills of the 1920s were not able to produce steel strip wider than 30 inches.

CHAPTER FIVE

Non-ferrous Metal Mining and Smelting; The Manganese Concessions

LEAD-ZINC MINING AND SMELTING

ZINC, lead, silver, and copper production, both in the form of mined ore and smelted metals, are examined in this chapter separately, although in practice they are mined jointly and smelters produce separate metals, as well as by-products.

Some lead-zinc ores were mined and exported in tsarist times, but no smelting on a sizeable scale developed until the 1910 opening, by the British Urquhardt (Ridder) concession, of lead-zinc mines in East Kazakhstan, near the Chinese border. The company installed 120 kilometers of narrow-gauge railroad and the Altai smelting plant. The immediate post-revolutionary history of this complex was unhappy:

> When the Bolsheviks took over the mines, they spent enormous sums for new equipment, much of which deteriorated or was completely ruined through ignorance and deliberate sabotage. From the viewpoint of waste it might have been better . . . if the mines had been developed by foreign capital.[1]

The Ridder mines covered an area of 15,000 square miles and were reopened after the Revolution by the Lena Goldfields, Ltd., Type I concession with the long-term financial assistance of the Deutsche Bank.[2]

The Ridder lead-zinc-silver smelting plant established by the Urquhart concession was not let out to concession after the Revolution, although extensive negotiations took place between the Russo-Asiatic Company and

[1] J. D. Littlepage and D. Bess, *In Search of Soviet Gold* (New York: Harcourt Brace, 1938), p. 266.

[2] *Times* (London), November 20, 1928. V. I. Kruglyakova, *op. cit.*, omits all mention of either the mining or smelting of lead, zinc, or silver ores by Lena Goldfields, Ltd. However, Soviet sources (see page 96 below) confirm Lena operations.

the Soviets toward this end.[3] In 1924, the Ridder smelter became part of the Altai Polymetal Trust, which was formed in lieu of the rejected Urquhardt concession. A commission under the direction of a Professor Gubkin approved a plan for reorganization of the non-ferrous mining and smelting industry submitted by an engineer, van der Better;[4] however, apart from uniting the copper smelters at Kyshtim, Tanalyk, and Kalat with the lead-zinc smelter at Ridder under the same organizational roof, no significant development of mines and smelters was undertaken until the Altai Polymetal Trust made a technical-assistance agreement with Frank E. Downs, who became Technical Director (at $20,000 per year) in 1928.[5]

A New York corporation held the Belukha concession for mineral prospecting in the southern Altai mountains from 1925 to 1927.[6]

Table 5–1 summarizes the sources of metallic zinc production for 1926–32. In 1926 the only operating zinc smelter was the old Sadon-Buron (Alagir), built by a prerevolutionary French concessionaire and operated by Zvetmetzoloto (the Non-Ferrous Metals Trust) but fed with ore mined by 'concessions.'[7] Sadon-Buron produced 1,888 metric tons of metallic zinc—the total Soviet production. By 1932, production had risen, with the help of foreign engineers, to 4,892 metric tons: just under 36 percent of total Soviet zinc metal production.

The Lena Goldfields concessions of 1925 included the construction of a new lead-zinc smelter at Altai, fed with ore from the prewar Ridder mines. The new Altai smelter was built more or less on schedule, started, and expropriated in 1930. In 1932 the plant produced 4,578 metric tons of zinc metal, or almost 34 percent of Soviet production.[8]

[3] The agreement signed by Krassin and Urquhardt, and later rejected by Lenin, covered an extraordinarily large territory in Siberia, including twelve developed metal mines, coal mines, four non-ferrous smelters, a refinery, iron and steel mills, twenty sawmills, the Ridder lead-zinc mines and smelter, the Spassky copper mines, Karaganda coal mines, and other mine and smelting properties in the Altai and Urals regions. (*Le Petit Parisien*, October 27, 1922.) The significance for this study is that all the properties *were in good technical condition and ready to be operated.* [U.S. Embassy in London, Report 1717, September 26, 1922, in U.S. State Dept. Decimal File, 316–136–172/5).]

[4] *Izvestia*, No. 32, February 8, 1924.

[5] U.S. Embassy in Berlin, Report 3114, January 21, 1928 (316–136–512). In 1927–8 the Altai Polymetal Trust was able to smelt only 67 kgs of silver. (Kruglyakova, *op. cit.*, p. 152.)

[6] U.S. State Dept. Decimal File (316–136–1240).

[7] Kruglyakova, *op. cit.*, p. 152, reports the ore was mined by a concession (unnamed). It is inferred that this was the Siemens-Schukert concession.

[8] Liubimov, *op. cit.*, states that the smelter was *not* built. Amtorg, *op. cit.*, IV, 1929, p. 33, and other Soviet sources make clear, however, that it was in fact completed in 1929–30. *The Engineering and Mining Journal*, October 1936, has photographs of the smelter and supporting operations.

Table 5–1 SOURCES OF ZINC METAL PRODUCTION IN U.S.S.R., 1926–32

Operator	*Ore Mines*	*Smelter*	*1927–8*[1]	*1929* (*in metric tons*)	*1930*	*1932*	*Percent (1932)*
Polymetal Trust	North Caucasus	Sadon-Buron (prewar Alagir)	2,246	N.A.*	N.A.	4,892	35.9
Tetyukhe Mines, Ltd.	Far East	Belovo (1930)	—	—	*Startup*	4,152	30.5
Lena Goldfields, Ltd.	Ridder	Altai (1928)	*Startup*	1,600	N.A.	4,578	33.6
Altai Polymetal Trust	Ridder	Ridder (prewar)	*Startup*	N.A.	N.A.	N.A.	N.A.
Total zinc metal production			2,246			13,622	100.0 (excluding Ridder)
Percentage produced by concessions			100.0				64.1

Source: 1. Kruglyakova, *Sbornik statisticheskikh svedenii* . . ., p. 152.

* Not available.

The Tetyukhe mines (Bryner and Company), another Type I concession, made a significant contribution to Soviet foreign exchange earnings from 1927 to 1930 by the export of zinc concentrates. The company re-established the mines, and until the smelter was ready to produce zinc metal, the zinc ore was beneficiated and exported. Conolly gives the exports as 9,000 tons in 1927, 15,000 tons in 1928, and 18,000 tons in both 1929 and 1930. Exports dropped to 6,000 tons in 1931 as the new smelter came into production.[9] The Tetyukhe (Bryner) concession, signed in 1924, exceeded its annual quota of 20,000 tons of zinc and 10,000 tons of lead concentrate by 1928. The plant was equipped with the latest imported equipment in the flotation mill. The company then proceeded to build the Belovo zinc smelter to produce 5,000 tons of lead metal and 10,000 kilograms of silver per year, by 1932 producing 30 percent of Soviet zinc metal.[10]

In 1927–8 lead ore was mined and concentrated at five locations. The Ridder mines of the Altai Polymetal Trust produced 3,699 tons, and the prerevolutionary Alagir mines produced a little in excess of 2,000 tons of lead concentrates. The Auli-Atinski mines of the Atbassvetmet produced just over 1,000 tons of concentrate. The Tirinski Development Company, a privately leased operation, produced just under 150 tons, and the Igergol mine of the Svintsovii Artel produced 16 tons.[11] In brief, these were small operations incapable by themselves of supporting a large-capacity smelter,

Table 5–2 SOURCES OF LEAD METAL PRODUCTION, 1927–8

Smelter Name	*Method of Organization*	*Origin of Smelter*	*1927–8 Production (in metric tons)*
Alagir	Polymetal Trust	(prewar)	939
Igergol	Artel	—	5
Tirinski	Joint Stock Co.	—	96
Ridder	Altai Polymetal Trust	(prewar)	1,225
Auli-Atinski	Atbassvetmet	(prewar)	327
Lena-Altai	Lena Goldfields, Ltd.	(prewar and new)	2,300
Belovo	Tetyukhe Mines, Ltd.	(new)	—
Total lead metal production			4,892
Percentage produced by concessions			47.0%
Percentage produced by concessions and prewar smelters			100.0%

Source: Kruglyakova, *Sbornik statisticheskikh svedenii* . . ., pp. 148–9.

[9] Conolly, *op. cit.*, p. 7.

[10] *Bank for Russian Trade Review*, II, No. 1 (January 1929), 7.

[11] Kruglyakova, *op. cit.*, pp. 148–9.

but able to produce comparatively small quantities of metallic lead from local smelters, as shown in table 5–2.

A concession was also granted in December 1925 to operate the Priamur Mines, developed in the Far East during the tsarist period. The concession was set up to last for thirty-six years, the first three of which were to be spent prospecting—at a cost of 400,000 rubles—in Primorska Gubernia. A land rental of 1.25 rubles per hectare and a royalty on production were payable; the concessionaire undertook to build a port and establish a smelter.[12] Production did not begin before 1930.

COPPER MINING AND SMELTING INDUSTRY; SILVER

Copper ore mines flourished in prerevolutionary Russia in the Urals, the Caucasus, the Khighiz Steppes, and Siberia. These mines were high-grade operations and did not beneficiate low-grade ores; the Atlas Mines, for example, operated on 10–20 percent copper ore and the Spassky on 7–22 percent ore. Geographical isolation required completely self-supporting operation; and all the mining complexes made iron products and owned and operated forests for charcoal. Most of them also operated coal mines, power facilities, and communications. The Kyshtim mine even operated a boot and shoe factory to supply its miners with work boots. All had granaries and food stores.

Tsarist Russia was almost self-sufficient in copper metal production. Output in 1910 was 22,000 tons and in 1912 about 33,000 tons of smelted copper, of which a small quantity was exported. Imports consisted only of electrolytic copper, of which production was insignificant.

Mining operations collapsed with the Revolution. In 1921–2 only an insignificant 13,266 tons of copper ore was mined from the single operating mine, the Korpushinsk, which was part of the Kalatinsk smelter complex in the Urals. A shipment of copper ore in 1922 enabled the Kalatinsk smelter to smelt the first copper metal since 1918, but as *Pravda* said, 'All other copper establishments in Russia are now in a state of technical preservation.'[13] Between 1922 and 1925 only the Kalatinsk smelter was in operation.[14]

Uralmed (the Urals Copper Trust) was formed in December 1921 and took over operation of copper mines in the Verkh-Isset, Revdinsk, and Syssert districts, together with the Kalatinsk, Lower Kyshtim, Kishmino-Kluchevsk,

[12] *Ekonomicheskaya Zhizn*, No. 188, August 20, 1924; and U.S. State Dept. Decimal File, 316–136–357.

[13] No. 184, August 17, 1922.

[14] The Soviets claimed that copper smelters were in a state of 'technical preservation' because there was no demand for copper. However, copper metal imports in 1913 were only 1,150 tons, whereas they were 5,325 tons in 1925–6, 10,921 tons in 1926–7, and 23,087 tons in 1927–8. About one-half of the imports came from the United States. (*Ekonomicheskaya Zhizn*, No. 161, July 17, 1929.)

and Karabash copper-smelting works. Most of the mines and all four smelters were in working order.

Similarly, the Caucasus mines and smelters, the Spassky and Atlas works in the Kirghiz, and the Julia mine in the Yeniseisk region were closed.

Briefly, in 1925, some eight years after the Revolution, of the half-dozen smelters and the dozen copper mines which had survived more or less intact, only the Kalata smelter in Uralmed was producing any copper metal at all: 2,807 tons of copper metal in 1923–4 and 5,588 tons in 1924–5. The missing ingredient for production was the technical ability to get existing mines and smelters into production. This ingredient was provided by the Lena and Siemens concessions and by Type III technical-assistance agreements.

Considerable emphasis was placed by the U.S.S.R. on the development of its non-ferrous potential, clearly for strategic reasons. By the end of the 1920s, the non-ferrous mining and smelting industry (lead, zinc, copper, and silver) employed 65 engineers and 157 technicians from the United States alone.[15] The overall plan for reconstruction was developed by an engineer, van der Better, under the auspices of Uralsvetmet,[16] which united the copper smelters in the Urals with the lead-zinc complex at Ridder. Capital sums of $5 million were then allocated to Kyshtim and Ridder and $1.5 million to Kalata.

The component sectors of the copper mining and smelting industry are divided (table 5–3) into seven groups. The largest in terms of 1927–8 production was the Kalata-Karabash combine (Group I), consisting of numerous mines and smelters developed before the Revolution. The chief engineer for this group was Littlepage,[17] and with the aid of American engineers the group rebuilt ore tonnages and copper smelting substantially after 1925. Group II also consisted of Urals mines and smelters, and was taken over by the Lena Goldfields concession in 1925. The tsarist-era Gumishev copper smelter was restarted, and a new much larger smelter, the Degtiarka, was completed by 1930. By 1927 Lena had the new smelter, including a 500-ton-per-day concentrating plant, under construction. This was the first use in the U.S.S.R. of selective flotation of ferrous sulphides in copper production.[18] The mines to feed Gumishev and the new smelters were reorganized tsarist mines at Soyuzelski and Degtiarinskii. In 1928 these were also producing 53,000 tons of sulphur pyrites—the first production of pyrites in the U.S.S.R.[19] By the end

[15] V. Karmashov, 'Non-Ferrous Metal Industry of Soviet Russia,' *Engineering and Mining Journal*, CXXX, July 24, 1930. Karmashov was employed in the Technical Bureau of the industry. These engineers, such as Woods who supervised copper mining for Armmed, and Lerva, an engineer at Uralmed, were hired on renewable two-year contracts (316–136–512).

[16] *Izvestia*, No. 32, February 8, 1924.

[17] Littlepage and Bess, *op. cit.*, p. 108.

[18] *Torgovo-Promyshlennaya Gazeta*, No. 221, September 28, 1927.

[19] Kruglyakova, *op. cit.*, p. 150.

Table 5–3 COPPER ORE MINES AND SMELTERS, PRODUCTION 1923–4 TO 1927–8

Group	*Mine Number*	*Mine Name*	*Combinat/Trust*	*Smelter Supplied*	*1923–4*[1] *Metric tons of ore mined*	*1927–8*[2]
			Uralsvetmet			
I	1	Belorachenskii	Kalata Combinat	Kalata		15,455
	2	Kalatinskii	Kalata Combinat			67,690
	3	Korpushinski	Kalata Combinat			62,070
	4	Obnovlennie	Kalata Combinat		167,004	21,768
	5	Pervomaiski	Karabash Combinat	Karabash		97,424
	6	Rykovski	Karabash Combinat			131,969
	7	Stalinski	Karabash Combinat			43,160
II	8	Sissert (Polesvski)	Lena Goldfields	Polevski (Degtiarsky)	—	28,212
	9	Dagtiark (Pourvouplosk)	Lena Goldfields			6,285
III	10	Kompaneiski (Bogomolstroi)	Kalata Combinat	Bogomolstroi	—	51,061
	11	Levichinski	Uralsvetmet		—	18,450
	12	Third International	Tagilsk Combinat		—	15,870
IV	13	Tubinski	Bashgortrest	Bashgortrest (South Urals)	—	9,280
	14	Julia	Bashgortrest		—	11,795
	15	Siberski	Bashgortrest		—	4,868
V	16	Djerkasganski	Atbastvetmet (1929)	Kazakh	—	269
VI	17	Lenin (Kovart)	Armmed	Zanguezour (Red November)	—	48,541
	18	Lenin (Bashkend)	Armmed		—	5,078
	19	Allarverdy	Armmed	Bambak (Karl Marx)	—	60,230
	20	Shamblugski	Armmed		—	60,230
VII	21	Kedabekski	Agespromcombinat		—	598

Sources: 1. *Ekonomicheskaya Zhizn*, No. 236 (October 15, 1925).
2. Kruglyakova, *Sbornik statisticheskikh svedenii* . . ., p. 102.

of 1927, Lena Goldfields engineers had blocked out more than six million tons of 2.5-percent copper ore at these mines.

The Group III mines were developed by the Kalata combine to feed the $38 million Bogomol copper smelter. This latter was brought into production in the Five-Year Plan and also built by Western companies. Groups V and VII were in the development stage, and mines in Group IV, including the tsarist Julia mine, were being developed to feed the new Bashgortrest smelter, also built after 1930.

The Caucasus smelters and supporting mines were renovated (one with the aid of a Siemens-Schukert concession) and later grouped into the Armmed trust. The Zanguezour district group of copper mines, including the Kovart and Bashkend mines, which had been in operation since 1840, were renamed the Lenin Group and put into the Armmed trust. It is known that they came through the Revolution in good operating condition and required only to be placed into production. In 1927–8 they produced 53,619 tons of copper ore. This ore was shipped to the old prerevolutionary Ougourchaisk copper smelter, renamed the 'Red November', and yielded 665 tons of black fired copper metal, or about 75 percent the prewar capacity.[20]

The Atbastvetmet trust, in the Kazakh area, did not make its contribution until late in the 1920s. This trust included the Karsak Pai 5,000-ton smelter, with a 250-ton-per-day flotation plant which had been begun as a prerevolutionary enterprise and was completed at the end of the 1920s, and also included mines opened up before the Revolution.[21]

Two trusts were completely new: the Bogomolstroi and the Bashgortrest, in the South Urals. These were extensively aided by Western companies, particularly the Southwestern Engineering Corporation and Arthur E. Wheeler of the United States.[22]

The reconstruction and expansion of the copper-mining and smelting industry can be divided, then, into three segments. There was the reconstruction, somewhat delayed, of the prerevolutionary copper smelters in the Urals (Kalata and Karabash complexes) and the Caucasus. Second, and quite distinct from these operations were the Type I pure concession operated by Lena Goldfields in the Urals around the old Gumishev and Polevsky smelters and the new 12,000-ton Degtiarka smelter (which replaced Gumishev), and

[20] *Ibid.*, p. 104; and U.S. State Dept. Decimal File, 316–136–1066.

[21] J. W. Wardell, *In the Kirghiz Steppes* (London: Galley Press, 1961); and letter from Wardell (manager of the prewar operation at Karsak-Pai) to the writer, 1965.

[22] Southwestern Engineering Corp., of Los Angeles, had a technical-assistance agreement with the Non-Ferrous Metals Trust for the design, construction, and operation of non-ferrous metal plants. Archer E. Wheeler and Associates, of New York, had a technical-assistance agreement with the same trust for equipment of the plants. [American-Russian Chamber of Commerce, *Economic Handbook of the Soviet Union* (New York: 1931), p. 101.] See Vol. II.

Table 5–4 CAPACITY, PRODUCTION AND TECHNICAL ASSISTANCE OF SOVIET COPPER SMELTERS, 1929

Smelter	*1929 Capacity Copper Metal*[1] *(in metric tons)*	*Production of Black Fired Copper*[2] *(in metric tons)*	*Origin*[3]	*Foreign Assistance*
Karsak Pai	5,000	—	Partly built prewar by United Kingdom concession. Finished 1928–9.[3]	See col. four.
Degtiarsky Polevski-Gumishev	3,000	2,950	New and reconstructed.[4] Completed 1929.	Lena Goldfields, Ltd.
Bashkirtrest	3,000	1,747	New.	South Western Engineering, Inc.
Kalata	12,000	5,569	Prewar reconstructed.	United States engineers.
Karabash	15,000	2,629	Prewar reconstructed.	United States engineers.
Armmed	3,000	2,038	Reconstructed.	Siemens-Schukert concession and United States mining engineers.

Sources:

1 V. Karmashov, 'Non-Ferrous Metal Industry of Soviet Russia,' *Engineering and Mining Journal*, CXXX (July 24, 1930), 67.

2 Kruglyakova, *op. cit.*, p. 106; and Amtorg, *op. cit.*, III, 34.

3 Wardell, *op. cit.*, and letter of April 1965.

4 Amtorg, IV, 33.

the Siemens-Schukert Type I concession at the Arhaham mine, south of Batum, in the Caucasus. Third, construction of three new smelting plants began within this period, but these had little impact on copper metals output until the early 1930s. They included the completed Karsak Pai smelter, begun before the Revolution, and two new smelters: the Bogomolstroi and the Bashkirtrest, in the South Urals.

Although technical-assistance agreements (Type III) were successfully utilized for construction of copper smelters, it is not clear that agreements made for assistance to the copper mines were equally successful before 1930. Chief engineer Goncharov of Bogomol, while on a study visit to the United States in 1927, invited an American engineer, McDonald, to work at Uralmed, the Urals copper trust responsible for new copper-mine development. MacDonald was installed as manager of all underground mining and adviser on planning mine extensions, particularly for the Kompaneisky group—the largest of those supplying Bogomol. There was overt hostility on the part of Russian mining engineers, and McDonald apparently beat a retreat back to the United States without achieving very much in the way of planning.[23]

At the end of the decade, these trusts were absorbed, along with the gold industry, into Svetmetzoloto, and two further technical-assistance agreements were then made, with the W. A. Wood Company and with Norman L. Wimmler, both of the United States; but these had no impact within this decade.[24]

In 1928 the Lena Goldfields Company produced 80 percent of Russian silver. The Tetyukhe concession, in the Far East, was required to produce 6,000 kilograms of silver per year. It was reported in 1928 that Tetyukhe was fulfilling its agreement. Thus in 1928 all Russian silver was produced by foreign concession.

Even if the technical competence to operate the zinc, lead, silver, and copper mines had been available, the Soviets would have faced enormous difficulties in attempting to restart operations without Western help. These mines had been operated by Western companies before the Revolution, and records of some twenty-five years of work—most importantly of drilling experience and the solution of metallurgical problems—was stored in the home offices. This accumulated knowledge was required to make rational progress, certainly in underground operations.[25] Without it the Soviets could perhaps at some point have restarted the mines and smelters, but only at an enormous cost.

[23] *Pravda*, No. 239, October 16, 1929.

[24] American-Russian Chamber of Commerce, *op. cit.*, p. 101.

[25] Urquhardt estimated that the complete records of 100,000 feet of drilling in Siberia, Caucasus, and the Urals, together with the geological evaluation of thousands of Russian ore deposits, were stored in London and unavailable to the Soviets. [*Times* (London), October 24, 1922.]

A NON-COLLUSIVE DUOPSONY; THE MANGANESE CONCESSIONS

The Soviets acquired modern mining and transportation facilities for their manganese deposits at Chiaturi and Nikopol, acquired foreign exchange, and finally shattered American foreign policy concerning loans to the U.S.S.R., in a series of astute business agreements with the Harriman-Guaranty Trust group in the United States and the Rawack and Grunfeld group in Germany.[26]

In 1913, tsarist Russia supplied 52 percent of world manganese, of which about 76 percent, or one million tons, was mined from the Chiaturi deposits in the Caucasus. Production in 1920 was zero, and by 1924 had risen only to about 320,000 tons per year. The basic problem was

> that further development was seriously retarded by the primitive equipment, which was considered grossly inadequate even according to prewar standards.[27]

The Chiaturi deposits, situated on high plateaus some distance from Batum, were mined in a primitive manner, and the ore was brought on donkeys from the plateaus to the railroads. There was a change of gauge en route, and the manganese had to be transshipped between the original loading point and the port. When at the port the ore was transferred by bucket: a slow, expensive process.

The other deposits of manganese were at Nikopol in the Ukraine and, although somewhat smaller than those at Chiaturi, were significant. These deposits were reopened, before the Rapallo Treaty, by a group of German companies, through a joint-stock company, Tschemo A-G., with a 30-year monopoly grant. The Soviets then demanded a 55-percent share of Tschemo A-G., and, when refused, nationalized the company. They then began negotiations with W. Averell Harriman and the Deutsche Bank, and the Rawack and Grunfeld group.[28]

On July 12, 1925, a Type I concession agreement was made between the W. A. Harriman Company of New York and the U.S.S.R. for exploitation of the Chiaturi manganese deposits and the extensive introduction of modern mining and transportation methods. In the first full year of operation, the Harriman syndicate was able to extract 762,000 tons of ore.

[26] As this study is concerned with the impact of technology on the economy, the Harriman negotiations are not described. The interested reader is referred to over 300 pages of documents in the U.S. State Dept. Decimal File, 316–138–12/331, and the German Foreign Ministry Archives. Walter Duranty described the Harriman contract as 'utterly inept' and von Dirksen of the German Foreign Office as 'a rubber contract.' The full contract was published [Vysshii sovet narodnogo khoziaistva, *Concession Agreement Between the Government of the U.S.S.R. and W. A. Harriman & Co. Inc. of New York* (Moscow: 1925)].

[27] Amtorg, *op. cit.*, II, No. 23 (December 1, 1927), 8.

[28] U.S. State Dept. Decimal File, 316–138–50.

Harriman was associated with Gelsenkirchner Borgwerke A-G. and the Disconte Gesellschaft, to whom a royalty of $1 per ton of manganese ore was payable as settlement for prerevolutionary interests. As the result of a London conference on June 29, 1925, this group obtained 25 percent, 51 percent remaining with Harriman, and the balance going to other interests, including an English group.[29]

Under the Harriman concession agreement, $4 million was spent on mechanizing the mines and converting them from hand to mechanical operation. A washer and reduction plant were built; and a loading elevator at Poti with a two-million-ton capacity and a railroad system were constructed, together with an aerial tramway for the transfer of manganese ore. The expenditure was approximately $2 million for the railroad system and $1 million for mechanization of the mines.[30]

After the conclusion of the Harriman agreement, the Soviets negotiated with Rawack and Grunfeld A-G. for the exclusive sales and export rights for the Nikopol deposits. The latter also mechanized the mines with German technical assistance.[31] The Nikopol-Nikolaev loading equipment was rebuilt by German engineers, using German and British equipment, at a cost of two million rubles on nine months' credit.[32]

Table 5-5 MANGANESE PRODUCTION IN U.S.S.R., 1913-29

Year	*Chiaturi (Harriman)*	*Nikopol (Rawack and Grunfeld)*	*Total U.S.S.R. Production*	*Percent Produced by Concessions*
		(in metric tons)		
1913	970,000	270,000	1,240,000	N.A.***
1922-3	52,177	22,000	74,177	none
1923-4	320,132	173,531	493,663	none
1924-5	335,994*	382,223	676,000**	24
1925-6	772,000	415,000	1,334,000	100
1926-7	775,700	527,000	1,109,000	100
1927-8	540,000	615,000	766,000	100
1928-9	644,300	612,500	1,415,000	100

Source: A. A. Santalov and L. Segal, 'Concessions production,' *Soviet Union Yearbook, 1930* (London: George Allen and Unwin, 1931), p. 135.

* 160,000 tons of the 1925 output produced by the Harriman concession.

** Between 1926 and 1929 the total U.S.S.R. production does not equal the sum of the outputs from Chiaturi and Nikopol. A reconciliation would require taking account of stockpiles, ore fines, transport losses, and the small Urals output.

*** N.A. Not available.

[29] U.S. Embassy in Berlin, Report 334, July 14, 1925 (316-138-12/331).

[30] U.S. Embassy in Berlin, Report 300, June 25, 1925 (316-138-12/331).

[31] U.S. Embassy in Berlin, Report 1775, December 9, 1926 (316-138-12/331).

[32] U.S. Consulate in Hamburg, Report 149, December 12, 1925 (316-138-12/331).

By the end of 1925, the Soviets had thus made agreements on both their major manganese deposits. In both instances they had previously pushed production as far as possible, given the primitive state of mines. To increase production they then had to turn to Western technical assistance and equipment. The agreements differed. Whereas Harriman and his German associates were committed to make specific royalty payments whether or not the output was sold, and also to undertake major capital improvements, the Rawack and Grunfeld group was acting as a sales agent and was paid for its technical assistance. However, so far as the world market was concerned, the Soviets had now placed both concessionaires in a competing position. Table 5–5 indicates that both concessions were able to raise output; this was also their undoing. Prices began to fall, and both concessionaires got into trouble with rising costs and declining returns.[33]

Walter Duranty, writing in the *New York Times* considered the original Harriman contract to be 'utterly inept,' and said that after three years of a 'checkered and unprofitable existence, (it was) about to expire quietly.'[34]

At the time of the Harriman withdrawal it was suggested that a fall in world manganese prices made continued mining of the Chiaturi concession unprofitable; the Soviets certainly utilized the Harriman price policy as its reason for the failure of the concession.[35]

Although market prices for manganese ore dropped in the late 1920s, the decrease was hardly sufficient to force a well-managed mining company out of business. In 1927–8 manganese quotations fell about 2 cents per long ton unit, from the 40-cent average for 1926. Prices in 1929 touched 35 cents toward the end of the year, but it will be noted that this reasonably steep decline came *after* the surrender of the concession. Most metal prices fluctuate, and a fluctuation of 2 cents to 5 cents per long-ton unit is not of major consequence.

Even if some actual contract prices in 1928 were below quoted market price—not an unusual occurrence—they would be reflected fairly quickly in the open market quotations.

Essentially the reasons for failure appear to be threefold:

1. The harsh treatment by the local Georgian government, and the unfavorable attitude of the Soviet government soon after the signing of the agreement in 1925. In one year the concession had to endure visits and inspections from various control commissions on 127 working days.

[33] U.S. Consulate in Hamburg, Report 12, January 16, 1927 (316–138–12/331).

[34] *New York Times*, June 17, 1927, III, p. 3, col. 5. Also see J. E. Spurr, 'Russian Manganese Concessions,' *Foreign Affairs*, V, No. 3 (April 1927), 507. Spurr considers that the terms of the Harriman concession were too hard in the face of world competition.

[35] *Bank for Russian Trade Review*, No. 14, December 1928, p. 15.

2. High production costs. The 'professional proletarians' were constantly demanding more wages.

3. Weaknesses in the original contract: particularly the requirement to pay between $3.00 and $4.00 royalty per ton of ore irrespective of tonnage removed.

THE IMPLICATIONS OF THE HARRIMAN FAILURE

The Harriman negotiations had begun in the United States at the end of 1924 with unofficial representatives of the Soviet government. The State Department was unaware of the negotiations, and Harriman did not inform them.[36] The first word of the agreement reached the State Department via a speech made by Prime Minister Ramsay MacDonald in the House of Commons and reported back by the American Embassy in London.

As word of the negotiations spread, Western governments protested and inquired whether there was a change in United States government trade policy.[37] The British government, for example, pointed out that other companies had been trying to get the concession and that the Soviets desired an agreement for political purposes only:

> Viz., for the purpose of establishing the fact that a big American concern had taken the properties which belonged to foreign concerns and thereby recognizing the right of the Soviet Government to nationalize property.[38]

The Harriman negotiations caused some confusion in the State Department, which for reasons not clearly established by the files did not wish to initiate an investigation, although obviously disturbed by the whole affair.[39]

Harriman was not the first businessman to attempt to circumvent United States policy on trade with the U.S.S.R. There were attempts throughout the 1920s, and the policy had in fact been substantially eroded by 1929. Policy up to 1927 was to view long-term loans and credits with disfavor if they

[36] U.S. State Dept. Decimal File, 316-138-17/19, Washington to London Embassy: 'The memorandum transmitted by you embodies the first information received by the Department concerning the concession other than that which has appeared in the public press.'

[37] The protests of the German, Belgian and Georgian (exile) governments are in the U.S. State Dept. Decimal File, 316-138-17/20/41/84. The German Foreign Office Archives contain a letter from von Dirksen to the United States Embassy in Berlin concerning the effect of the Harriman concession on German firms and, in diplomatic language, implying a breach of agreement.

[38] U.S. State Dept. Decimal File, 316-138-18. Memorandum from U.S. Embassy in London dated October 28, 1924.

[39] Such a move, i.e., to initiate an investigation, was held to be 'very unwise.' (Memorandum, State Dept. to Commerce Dept., U.S. State Dept. Decimal File, 316-138-28.)

involved floating a loan in the United States or using American credit for the purpose of making advances. The State Department stated their policy on three occasions during the 1920s, each time as the result of an attempt of American financiers to utilize a German front group to advance credit to the U.S.S.R.

On July 15, 1926, the State Department informed the New York Trust Company that it would view with disfavor an arrangement to discount certain Russian obligations endorsed by German firms (40 percent) and the German government (60 percent), the discounting to be carried out by American banks, and the financing of Soviet purchases of equipment to be completed in Germany.

On October 14, 1927 Percival Farquhar was informed by the State Department that a scheme to sell $20 million of bonds in the United States in order to place the proceeds at the disposal of the Soviet government for the purchase of goods and materials in Germany would not be viewed with favor.

It must be made clear the State Department argument in these cases did not rest upon non-recognition of the U.S.S.R., but upon the fact that the benefits of the loan would accrue to German rather than United States manufacturers. The State Department had not interposed, for example, when Chase National in 1925 arranged a short-term credit for cotton shipments destined for the U.S.S.R., nor in the provision of loans by the International Harvester Company.

Their position was reviewed in the case of the American Locomotive proposal in October 1927 and weakened to the extent that no objection was raised to American manufacturers of railway equipment granting long-term credit to the Soviets for the purchase of locomotives, cars, and other railroad materials from the United States.[40]

The only position not breached in late 1927 was that on long-term *loans* to the Soviet government. The Harriman concession was utilized by the Soviets to give the coup de grace to what was left of American trade policy with Russia. Harriman was induced to accept long-term bonds as compensation for expropriation.

Discussion between the Harriman interests and Soviet representatives in July and August 1928 led to an agreement to cancel the concession, and the Soviets agreed to repay Harriman the estimated $3,500,000 investment. However, Harriman was 'to arrange a commercial loan for the Soviet authorities to develop the manganese industry.' The acceptance by Harriman of a

[40] This was apparently decided at the Presidential level. There is the following handwritten notation by RFK (Kelley of Division of Eastern European Affairs) on the file copy of the letter to American Locomotive: 'Drafted after discussion of the matter by Secretary with Mr. Mellon, Mr. Hoover and the President.'

long-term credit arrangement and position as Soviet fund-raiser as compensation for expropriation was the final breach in the American policy of restriction on trade with the U.S.S.R.[41]

According to the United States Commercial Attaché in Prague, after the Harriman collapse the Soviets went about Europe bragging they could borrow money from Harriman at 7 percent; therefore their credit must be good.[42]

With the departure of Harriman, the Soviets had two sizeable manganese deposits, both with up-to-date mining and loading equipment supplied on credit terms. In addition, they had Rawack and Grunfeld to continue operating the Nikopol deposits, take over operation of the Chiaturi deposits, and continue as exclusive sales agent for the U.S.S.R. on the world market. As Rawack and Grunfeld now controlled output from both deposits, they were no longer in the position of duopolists competing price down to zero, although they still had to face competition from newly opened deposits in Brazil and West Africa. It is also very interesting to note that *one-half* of the 1927–8 output of Chiaturi was from the Perevessi Hill deposit,[43] the high-grade area which had been left out of the Harriman concession. In other words, Harriman had been induced (on top of all else) to mechanize production of the *low-grade* deposits and install loading facilities so that the Soviets could take advantage of these low-cost loading facilities to ship high-grade, almost surely low-cost, ore.

Sales of manganese ore were further facilitated in 1929 by the negotiation of a five-year contract with United States Steel Corporation for an annual supply of between 80,000 and 150,000 tons.[44]

[41] This was the State Dept. assessment (316–124–45). Harriman's recollection is subtly different: 'In 1926 I was back there on business, representing a group that was mining manganese in the Caucasus. I found Stalin and Trotsky in disagreement about foreign concessions like ours. I talked to Trotsky for four hours, concluded that we should give up the concession and got our money out—paid in full with interest and with a small profit.' ('How Harriman "Earned a Dinner" from Khruschev', *Life*, August 9, 1963, p. 29.)

[42] The interested reader is directed to the four-page report from the attaché, which summarizes very well the impossibility of normal commercial dealings with the Communists, although, as the attaché pointed out, 'Harriman and Company are not saying very much.' (316–138–332/5.)

[43] Kruglyakova, *op. cit.*, p. 100.

[44] *Ekonomicheskaya Zhizn*, No. 182, August 10, 1929.

CHAPTER SIX

Gold Mining, Platinum, Asbestos, and Minor Mineral Concessions

GOLD MINING AND FOREIGN CONCESSIONS

RUSSIA has excellent gold ore reserves. In tsarist times the Lena River gold mining area in Siberia, reputedly one of the richest in the world, measured by both extent of reserves and metal content of the ore, was operated by concessionaires. In 1913 there were 39 foreign and Russian companies operating 770 mines in the Lena River area; of these 121 were actually producing gold and employed over 10,000 workers. 'These mines had excellent equipment, full electrification and large hydroelectric installations. . . .'[1]

British companies held several concessions from the tsarist government, including some for development of the Siberian gold and platinum mines in the Lena River region. These were developed as self-supporting industrial entities complete with iron and steel plants, smelters, and agricultural and small-consumer goods manufacturing works. The departure of the Western owners with the Revolution significantly reduced Russian gold production.

There was a catastrophic decline in the condition of the Siberian gold fields, of which Lena-Vitim was the most important, from about 1921 onward. The Urals' 1913 gold production of 25,700 pounds dropped to just over 8 pounds in 1921, the West Siberian output from 7,200 pounds in 1913 to 33 pounds in 1921, the East Siberian output from 103,000 pounds in 1913 to 8 pounds in 1921, and the Yenessei output from 5,000 pounds in 1913 to 140 pounds in 1922.[2]

The Siberian Revolutionary Council suspended operations in the Lena-Vitim area in early 1921, with the arguments that the labor force of 9,000 was producing significantly less than before the war and that it was costing

[1] *Ekonomicheskaya Zhizn*, No. 196, September 2, 1922.

[2] *Izvestia*, No. 213, September 22, 1922.

two zolotniks of gold to produce one zolotnik. However, the Council was overruled by the Soviet of Labor and Defense, and the fields were ordered to continue working. Shortly thereafter, the 1920 decree which had forbidden private interests from mining gold was replaced by a decree authorizing special concessions for gold and platinum operations. This was followed by the organization of the Lenzoloto trust in December 1921. This trust had the exclusive right to mine gold on the right bank of the Lena River, although individual prospectors continued working both elsewhere and for Lenzoloto itself on a contract basis.

It was argued in *Ekonomicheskaya Zhizn* that the mines had suffered from two years of civil war in the Urals, were badly equipped, and were exhausted by 200 years of continual mining.[3] However, the report which formed the basis for the foundation of Lenzoloto gives a more detailed and substantially different picture. In substance, the gold mining equipment was in good operating condition.[4] However, the reasons for conversion into a trust are obvious from the catastrophic decline in output.

> Mining of gold by prospectors almost ceased in 1921, as it was impossible to send supplies to the prospectors and also there were persistent attempts on the part of local organs to turn prospectors into ordinary State workmen, who receive payment in money and goods regardless of the amount of gold they find.[5]

Conditions did not improve much in 1922–3. Employment dropped to just under 5,000 men because of lack of food and supplies; there were financial difficulties and equipment needed repair. It was believed that the richer gold areas would only last another seven to eight years. Dredges, not manufactured in Soviet Russia, were required to develop the low-grade areas on a profitable basis. The average gold content was 65 zolotniks per cubic sazhen, while the average of the extensive poorer area was in the neighborhood of 44 zolotniks per cubic sazhen. An article in *Ekonomicheskaya Zhizn* recommended turning part of the Lena fields over to private enterprise in accordance with the 1921 decree and also recommended the purchase of foreign dredges to operate poorer areas.[6]

Conditions apparently had not improved much one year later. Only the Feodosyer placer among the hydraulic operations was working, and underground production was curtailed. There were the perennial financial problems, and no move had been made to obtain the 17-foot Bucyrus dredge, ordered from the United States in 1916 and stored at San Francisco. It was estimated

[3] *Ekonomicheskaya Zhizn*, No. 172, August 4, 1922.
[4] *Ekonomicheskaya Zhizn*, No. 196, September 2, 1922.
[5] *Ekonomicheskaya Zhizn*, No. 172, August 4, 1922.
[6] *Ekonomicheskaya Zhizn*, No. 196, September 2, 1922.

it would take two years and another \$1.5 million to move it to Siberia. Later in the year the government speeded up payments to Lenzoloto to relieve the financial crisis but refused to import the dredge, as low gold reserves would not warrant the expenditure.[7] However, dredging was the only solution to the long term Siberian gold problem.

The situation was so abysmally bad that in a 1923 report on Soviet gold mines in *Ekonomicheskaya Zhizn*, it was seriously suggested that it was no longer worthwhile to continue working the deposits. Production was too small and the costs too high to justify the expenditures of materials and labor. An almost unbelievable cost-revenue ratio of 25:1 was quoted. A dredge was considered to be the only solution.[8]

In mid-1923, a French mining expert, Professor E. N. Barbot-de-Marni, was hired by the Soviets to make a report on the Siberian mines, including those in the prewar Lena group. The report stated that there had been no illicit digging of gold, but that work had been concentrated in high-grade mines, while low-grade mines were ignored. The equipment was prewar and utilized in an inefficient manner. Barbot-de-Marni pointed out that, although the Lena mines possessed the most advanced drilling equipment in Russia (forty steam drills of the Keystone type), no exploration and development work was in progress. In brief, the higher-grade properties were working and so could work at a profit, whereas lower-grade properties and exploration work required for future development were ignored. Barbot-de-Marni's recommendation was for state assistance to get development under way.

In mid-1923, thirty-four leasing contracts were made with private individuals and enterprises in the Lena-Vitim area. There were seventeen contracts in the platinum mining areas of Semipalatinsk. Nine mines were leased in the Northern Yenessei and five in the Southern Yenessei district, together with eleven gold mines in the Altai Mountains.[9]

After 1925, gold began to assume its key role in Soviet development as a major earner of the foreign exchange required to pay for imports of foreign equipment and technology utilized in the industrialization program. Gold mining was, consequently, put in the vanguard of the Soviet mineral exploitation program: an effort characterized by Shimkin as 'the merciless and insatiable Soviet quest for gold.'[10]

[7] *Ekonomicheskaya Zhizn*, January 16, 1923. The original cost of the dredge was \$495,367, of which \$432,135 was paid before the Revolution. However, spares, freight, customs, and assembly required an estimated total expenditure of \$1,532,836.

[8] *Ekonomicheskaya Zhizn*, February 20, 1923.

[9] *Ekonomicheskaya Zhizn*, No. 143, June 29, 1923.

[10] Demitri B. Shimkin, *Minerals: A Key to Soviet Power* (Cambridge: Harvard, 1953), p. 172.

The Lena Goldfields, Ltd. (United Kingdom), concession was concluded on April 30, 1925. It was to extend for a period of thirty years in the Lena gold mines and for fifty years in the Ural and Altai Mountain districts. The area included in the concession was that previously leased from the tsarist government and operated by a Russian subsidiary, the Lensky Zolotopromishlennoie Tovarichestvo. In the 1925 agreement the properties of the former Sissert copper mines and the Altai District Mining Company were also operated by Lena Goldfields.

The Lena concession therefore, covered the following properties:[11]

1. The Sissert copper mines (described in chapter 5).
2. The Nikolopavdinsky platinum mines, reportedly. However, nothing has been traced of any post-revolutionary development of this property by Lena Goldfields.
3. The copper, lead, and zinc deposits on the Irtish River (discussed in chapter 5).
4. The north Kuznetsk (Kiselov) coal mines (discussed in chapter 3).
5. The anthracite mines at Yegoshin in the Urals (discussed in chapter 3).
6. Gold mines on the Lena-Vitim Rivers in Siberia. This is the only development covered in this chapter, and a major part of the Lena complex.
7. The Zirianovsky, Zmeynogorsky, and Pryirtishky districts (discussed in chapter 5).
8. The copper and iron smelters at Sissert and Revdinsky (discussed in chapters 4 and 5).
9. The Degtiarinsky copper mines (discussed in chapter 5.)
10. The Gumeshevsky copper smelter (discussed in chapter 5).
11. Wire- and nail-making factories in the Urals (discussed in chapter 13).
12. The Bodaibo railroad in the Lena-Vitim area, the Degtiarinsk railroad in the Urals, and the shipping system on the River Lena, under a separate agreement with the People's Commissariat of Ways and Communications.

The concession did not include Soviet participation in either operations or management, but the Soviet government received a royalty equal to 7 percent of the total output of gold, and the concessionaire received the right to export any surplus duty-free.

The company was granted unrestricted freedom of hiring and firing labor, and, in regard to social insurance and railroad rates, treatment equal to that afforded government trusts.

[11] Based on an interview with Lyman Brown by the United States Consulate at Riga, Latvia in May 1925 (316–136–419). There is some doubt whether the Nikolopavdinsky platinum mines were operated by the Lena concession, but they were part of the tsarist-granted prerevolutionary concession.

Arbitration of disputes was to be by an arbitration court composed of an equal number of representatives from both sides, with an umpire selected from either the faculty of the Freiburg Mining School, in Saxony or the King's Mining School, in Stockholm.

The agreement was a departure from previous agreements in that it permitted extensive industrial and commercial operations without the joint management of the Soviet government, and in addition gave the concessionaire practically unlimited control of real property (at least on paper), although title was not established, together with control of labor and the right of unrestricted export.[12]

In 1928 the Lena Goldfields Company was producing 35 percent of all the gold mined in the Soviet Union.[13] It was also by far the most efficient producer.[14]

Table 6-1 SOURCES OF GOLD PRODUCED IN THE SOVIET UNION, 1913–28

Year	*Kilograms of Gold Produced By:* *U.S.S.R.*	*Lena Concession*	*% Produced by Lena Concession*
1913	—	11,728	—
1921	—	966*	—
1922–3	11,179	2,588*	—
1923–4	20,000	4,734*	—
1924–5	25,258	6,749*	—
1925–6	25,149	8,364**	33
1926–7	23,152	8,552**	37
1928	27,965	7,953**	28

Sources: 1913–24: B. P. Torgashev, *The Mineral Industry of the Far East* (Shanghai: Chali, 1930), p. 102.
1925–28: Amtorg, *Economic Review of the Soviet Union*, III, 34.

* Operated by Soyuszoloto.

** Operated by Lena Goldfields Co. This production is in excess of the 6,500 kg. annual production required by the concession agreement.

[12] Based on interview between Lyman Brown, representing the concession, and F. W. B. Coleman, the United States Consul at Riga, Latvia, printed in Report No. 2838, May 12, 1925. Coleman makes pointed comment on the value of the concession, and history was to bear him out almost exactly: 'While my opinion may be a passing one and gratuitous, I think that Mr. Brown is too optimistic and that nothing will come out of the agreement in the shape of profits. Asked what security he had that the party of the first part would fulfill the terms of their contract, Mr. Brown said that they 'could not afford to do otherwise; which, in view of the past records, is adjudged very slim security.' (316–136–426.)

[13] *Times* (London), September 3, 1930, p. 13. The Soviet estimate is also 35 precent. (Amtorg, *op. cit.*, III, 116.)

[14] The Lena Co. employed 8,000 workers and was producing 2.73 kgs of gold per worker per year. The Soviet national average was between 0.44 and 0.59 kgs of gold per worker per year. (Amtorg, *op. cit.*, III, 285.)

Lena Goldfields fulfilled its agreement to produce more than 6,500 kilograms of gold per year. Both Soviet and Western sources agree on this point. Reference to table 6–1 indicates that, during the life of the concession, Lena consistently exceeded the agreed gold output, and averaged more than one-third of Soviet gold production between 1925 and 1928.

According to Soviet sources, Lena also fulfilled the other requirements of the concession.[15] A summary of the first three years of operations (1925–8) stated that Lena had installed a 17-foot dredge in the Bodaibo section of the Lena-Vitim fields 'before the time set in the agreement.' This in itself was a massive undertaking, as a large, complex piece of equipment had to be moved from the United States to the far interior of Siberia, installed, and put into operation. Special roads and equipment were built, and the dredge was put into operation in July 1928. A yearly average 8,000 kilograms of gold was produced between 1925 and 1928, with a slight drop at the end of 1928 because of the changeover from hand to machine methods. It was estimated that the dredge alone, apart from re-equipment of the underground mines operated by Lena, would double Soviet gold production almost immediately.[16]

By March 1929, Lena had invested, according to *Izvestia*,[17] over eighteen million rubles in new equipment, and in addition had restored old plants to operation. However, the Lena Goldfields honeymoon was not to last for long. In April 1928, just as the dredge was being finally readied for production, an article by I. Maisel in *Ekonomicheskaya Zhizn* entitled 'It must be ended' began the harassment which was to culminate in the expulsion of Lena in 1930. Maisel argued that Lena had turned exploitation over to starateli (private prospectors) and to artels comprised of former hired laborers. That this was the arrangement also used by the Aldenzoloto trust was not mentioned. The article cataloged alleged complaints against the operation and specifically stated that the company was 'manifesting a quite unjustified and inadmissible intolerance and stubborness' in relation to the miners' economic provisions: i.e., social insurance payments and allotments for cultural needs. The crux of the argument was, however, the organization of artels, the company preferring a

15 Amtorg, *op. cit.*, IV (February 1929), 33.

16 The dredge was one of four placer dredges built for Russia by the Bucyrus Co. (United States) in 1916–7. Of these, two were delivered and one canceled. The fourth was the Lena dredge, a massive piece of equipment, as high as a six-story building. It was delivered to Lena in 1927 after being moved from South Milwaukee to Baltimore on seventy-five flat cars, to Murmansk by steamer and to Irkutsk by rail, then 200 miles on a mountain trail by wagon and sledge, and then to Kachuca by barge on the River Lena. At Kachuca it was reloaded on small boats for a 700-mile trip up the River Vitim to Bodaibo, just 11 miles short of its final destination. Delivery and assembly took 18 months. [*Designed for Digging: The First 75 Years of Bucyrus-Erie Company* (Evanston: Northwestern University Press, 1955), p. 156.]

17 *Izvestia*, March 26, 1929.

simple association of miners while the Miners' Union wanted an organization similar to labor artels under which the artel also became a contractor. The time was picked well—the start of the gold-mining season—and the union called for a revision of company policy, irrespective of a concession agreement which clearly gave the Lena company a clear option in this aspect of labor relations.

This article was followed eighteen months later by one in *Izvestia* of October 22, 1929, which made a derisive attack on the profits being made by Lena: 'The profits of the concessionaire are growing—what a victory.' As the Lena concession got into full operation, it was attacked as a 'weed in the socialist system' which required attention. Two months later the GPU searched the company offices and arrested several Lena employees.

Continual Soviet interference with production by labor strikes, management fines, and similar harassment slowed output after 1928.[18] The Soviets then claimed that the reduced output was non-fulfillment of paragraph 39 of the concession agreement, *ergo* the agreement 'has lost its validity owing to the one-sided and unlawful action of the Lena Goldfields. . . .'[19] Liubimov was thus enabled to make the statement that gold production was 'below agreement,'[20] although previously published Soviet figures (table 6–1) had indicated a production well in excess of the agreement.

In February 1930 it was reported that the Soviet government had given notice of its intention to annul the Lena concession in the first week of April 1930. Lena denied the validity of this report on the basis that the Soviet government had no authority under the concession agreement to give any such notice or to annul the concession.

The labor disturbances had started in earnest in January, and on January 30 the Soviet courts sentenced the Lena manager to eight months' forced labor and a fine of $62,500 for alleged late payment of wages.

On February 12, 1930, Lena sent the Soviet government a telegram asking for arbitration and nominated Sir Leslie Scott as its representative. There was no direct reply to the telegram, but on February 28 the Soviets agreed to arbitration via *Izvestia*, which published a long indictment of the Lena Company alleging that:

(a) The company had insufficient capital to undertake the program.
(b) It had failed to reach its production and construction program in the last year.
(c) It had failed to utilize the latest technical methods.[21]

18 *Times* (London), September 3, 1930, p. 13.

19 *Documents Concerning the Competence of the Arbitration Court Set Up in Connection with the Questions Outstanding Between the Lena Goldfields Company Limited and the U.S.S.R.* (Moscow: Glavnyi kontsessionnyi komitet, 1930), p. 32.

20 Liubimov, *op. cit.*, p. 139.

21 *Izvestia*, March 6, 1930.

The article alleged failure to meet foreign obligations and breakdowns in the dredge and the Urals copper smelter as evidence of the validity of these charges.

Three weeks later, four Russian employees of the concession were placed on trial on charges of espionage and sabotage, and on May 9 all four were jailed.

In the meantime, the Arbitration Court had been established in Berlin with Professor Stutzer as Chairman. On May 10, Moscow recalled its delegate to the Court. Stutzer decided to continue hearings and stated that the concession could be abrogated only by a decision of the Court. At the end of May, the Soviet government instructed the Commissariat of Transportation to take over the steamships and other transportation property of the Lena concession.

On August 7 the Special Court of Arbitration opened its hearing with the Soviets absent. It was established without question that Lena had fulfilled the terms of the agreement. Whereas the agreement called for an expenditure of $11 million in seven years, Lena had actually spent $17.5 million in four and a half years. Evidence of adequate financing was presented. On the other hand, extensive evidence was presented that after 1929 the Soviets had started to use physical pressure against Lena, first by cutting off supplies, and then by ejecting the company from the Sissertsky limestone deposits by armed force. (Limestone was essential as a flux in the Lena smelter operations.) An independent arbitrator valued the Lena property at more than $89 million.

The Soviets did not put in an appearance; the Court found for Lena, but the concession passed into the pages of history. A booklet was published by the U.S.S.R. in both German and English, as a rather superficial attempt to explain what was clearly completely unjustifiable expropriation.[22]

In retrospect, there can be no other conclusion than that the Soviets deliberately enticed Lena into the U.S.S.R. to get the massive dredge installed and also as much else as they could along the way. It is, in the light of history, a clear case of premeditated industrial theft on a massive scale.

Before Lena Goldfields entered the Siberian gold fields, some 75 percent of all Russian gold output was being produced by hand methods, and there was no mechanical equipment. Consequently, output per worker was both very low and fluctuating: '. . . even the record of the most efficient producer, the foreign concession at the Lena Goldfields, was unimpressive.'[23] With the

[22] *Materialien zur Frage der Zustaendigkeit des Schiedsgerichts in Sachen 'Lena Goldfields'—Union d.S.S.R.* (Moscow: Glavnyi kontsessionnyi komitet, 1930), published in English as *Documents Concerning the Competence of the Arbitration Court Set Up in Connection with the Questions Outstanding Between the Lena Goldfields Company Limited and the U.S.S.R.* Also see, for the Soviet side, S. A. Bernstein, *The Financial and Economic Results of the Working of the Lena Goldfields Limited* (London: Blackfriars, n.d.). This title must be a classic among misnomers. The booklet contains not a single statistic concerning 'results.'

[23] Shimkin, *op. cit.*, p. 168.

introduction of the Lena dredge, however, the stage was set for a massive increase in production at a much lower production cost, and the field of operations could be extended into the low-grade-ore-bearing areas. By 1928 Herbert Guedella (Chairman of Lena) in his annual report to shareholders reported that the results of capital expenditures were beginning to show. There had been an intense reorganization of production during the previous three years; large orders for plant equipment had been placed (in addition to the dredge), and these had been financed with the aid of the Deutsche Bank in Germany.[24] In brief, by 1930 the technical reorganization was almost complete. In addition, the Soviets decided to utilize American technology. Consequently, Lena, held predominantly by British interests, could be expropriated without fear that political repercussions would affect further technical acquisitions.

THE LESSER GOLD CONCESSIONS

Smaller gold-mining and exploration concessions were located in the Far East, in the Amur River basin, Okhotsk, and Northwest Siberia.

Table 6–2 LESSER SOVIET GOLD MINING CONCESSIONS LEASED TO FOREIGN OPERATORS, 1921–8

Concessionaire	*Country of Origin*	*Location*	*Years*	*Investment*	*Work*
Vint concession	United States	Amur Basin	1921–8	N.A.*	Mining
Far Eastern Prospecting Co. Inc. (formerly Smith concession)	United States	Amur Basin	1923–4	125,000 rubles	Prospecting
Ayan Corporation, Ltd.	United Kingdom	Okhotsk	1925–7	400,000 rubles	Prospecting
Yotara Tanaka	Japan	Kamchatka	1925–?	N.A.	Mining
Shova Kiuka Kabushiki Kaisia	Japan	Far East	1925–?	N.A.	Mining
D.A. Hammerschmidt	United States	Amur Basin	1926–8	$375,000	Prospecting

Source: U.S. State Dept. Decimal File, see text.
* Not available.

The first such concession was granted to J. C. Vint in 1921 and was followed by at least five others. Apart from direct concessions, there were also attempts by the Soviets to get Chinese capital and labor for the Okhotsk and Amur fields.[25] As late as 1928, when the trust Dalzol (Far East Gold Trust) had been

[24] *Times* (London), November 20, 1928.
[25] *Harbin Daily News*, May 27, 1924.

organized to operate the Amur River mines, the Soviets had agents in Harbin, China, to recruit 3,000 coolies and were also utilizing United States gold mining machinery and mining specialists.[26]

The Vint gold mining concession, granted in December 1921 for 20 years, covered 1,600 dessiatins along the River Smirtak, in the Amur Region of the Far East, and gave Vint the right to exploit prerevolutionary mines at Ftoroi, Blagovestchensky, Petrovsky, Zaharievsky, Novopoktovsky, Beregovi, Evdokievsky, and Codachny, and the placer deposits in the Smirtak River valley for two versts upstream from the Codachny gold mine. As late as 1923 this concession represented 'practically the only organized effort either in Russia or Siberia to produce gold.'[27] Vint was required to install a dredge, with a capacity of not less than 2 cubic feet, not later than June 1, 1922. Extra dredges had to be installed before July 15, 1925 to excavate not less than 50 cubic sazhens per day.[28]

In lieu of the deposit of 35,000 gold rubles required in the concession agreement, Vint was allowed to purchase a dredge already on the Smirtak River.

Vint had both British and American partners and raised capital in the United States, Britain, Belgium, and China at various times during the life of the concession, which lasted at least until 1927.

The Vint concession is especially interesting from the viewpoint of the heavy tax burden placed upon more successful concessionaires. According to information given in an interview with the U.S. State Department, Vint was subjected to the following taxes:

1. A 'dessiatin tax' of one gold ruble per year for each of the 1,600 dessiatins in the concession.
2. A land tax of 0.75 ruble per dessiatin.
3. A workmen's insurance tax equal to 10 percent of the wages paid.
4. A workmen's association tax equal to 2 percent of wages paid.
5. An assessment of 10 gold kopecks per dessiatin for the 'gold miners' association.'
6. A 6-percent tax on turnover in the general merchandise store which Vint was required to operate as part of the concession.
7. A local tax not in excess of 30 percent of the total state tax (items 1 through 4 above).
8. The cost of providing a school for the miners' children.

[26] 'The Soviet mining officials are unable to work these mines without foreign mining experts and without the labor of Chinese coolies who work more efficiently and with less wages than do Russian laborers.' [U.S. Consulate in Harbin, China, Report, July 23, 1928 (316–136–675).]

[27] U.S. Consulate in Riga, Report 1480, November 20, 1923.

[28] There is a copy of the Vint agreement in the U.S. State Dept. Decimal File, 316–136–348, with other data scattered throughout 136.

9. A 5-percent royalty on gross output to the government, which in any event reserved the right to fix the price of gold and required all production to be delivered to government laboratories.

Vint held that he was unable to make the proposition pay and that taxes were continually raised—eventually to the point of eliminating profits. Apart from that, he argued that locally concluded agreements were not always honored in Moscow, and that on taking a local agreement to Moscow for ratification he would be 'chipped down' even further. Although the concession may have been profitable from Vint's viewpoint in 1923, continuing tax pressure made it unprofitable from about 1924 until its demise some time after 1927.

C. Smith, a mining engineer and former employee of the Inter-Allied Railway Commission, in Siberia, was the operator of a gold mining concession in the River Karga area of the Amur Basin. The concession, granted in November 1923, was for the exploration and production of gold. One year was allowed for initial prospecting, during which all gold had to be turned over 'without payment,' and a further twenty-three years was allowed to mine any prospects discovered in the initial prospecting period. The agreement contained the usual terms: customs-free import of machinery and equipment, a land rental fee and 5–8 percent output tax, together with state and local taxes. At the end of the concession period, all equipment and properties were to be turned over to the Soviet government in good condition.

It is certain that Smith did some work. He brought in a mining engineer, three American drilling specialists, and fifty Russian laborers. The concession was transferred to a United States registered company, the Far Eastern Exploration Company.[29] Drills and supplies ordered through this company were shipped to the Drazhud gold fields. At this point the history of the concession becomes vague. It was reported that more than $125,000 was spent in the first nine weeks of exploration, but that the expenditure was made in looking at oil-well borings and that the imported drills were not used. It can reasonably be assumed that the concession lasted only a short while—probably less than one year—and that it made an insignificant contribution to Soviet gold fields development in the Far East.[30]

[29] *New York Times*, October 30, 1923, p. 8, col. 2, reported that the Far Eastern Exploration Company, headed by Henry T. Hunt, had received concession prospecting rights to 3,500 square miles of placer fields in the Amur Basin; there was no mention of C. Smith.

[30] U.S. State Dept. Decimal File, 316–131–147. The Smith concession is more interesting in relation to the 'arm's length hypothesis' discussed in chap. 17. Smith was suspected by the U.S. State Dept. of being in the pay of the Soviet Union, was a member of the Peasant International, and later, in 1926, became Moscow representative for the American-Russian Chamber of Commerce, which had such prestigous members as Westinghouse, International General Electric, and Deere.

In early 1925, a gold prospecting and mining concession was granted to the Ayan Corporation, Ltd., of the United Kingdom. The company acquired the right to prospect for, and mine, gold in the Okhotsk uyezd, Kamchatka. The concession had a nominal life of thirty-six years; during the first four years the company was required to expend 600,000 rubles in prospecting work, deposit 100,000 rubles as security, and purchase all buildings and existing physical property at market value. Modern prospecting and mining techniques were to be imported by the concessionaire, who was also required to build roads and communications, with the right to run aerial communications if desired.

The entire gold output was to be delivered to government laboratories for purchase by the Soviet government. A rental was paid on land explored, a 5-percent royalty on the total output of gold, and an overall 5-percent tax. The company organized food stores and was required to abide by the labor laws and to hand over all buildings and property intact at the end of the thirty-six years.[31]

After two years the concession was cancelled at the request of the Ayan Company, in the light of unpromising prospecting results.[32]

A protocol of the 1925 Treaty of Friendship and Recognition between Japan and the U.S.S.R. made provision for gold concessions in Kamchatka and Okhotsk. The Kamchatka concession was taken up by two Japanese firms, Yotara Tanaka and Shova Kiuka Kabushiki Kaisia.

The D. A. Hammerschmidt concession to prospect and mine gold in the Amur Basin was signed on November 12, 1926. The American concessionaires were required to transfer not less than $375,000 capital to a joint-stock company, and the founder members were to be subject to the approval of the Soviet government. The initial prospecting period was to expire on March 31, 1928 and the mining period on March 21, 1948. During the initial period, Hammerschmidt and his associates were required to undertake 2,000 meters of drilling and do trenching on an exploratory basis. Any gold mined was to be deposited with the Soviet government, and the concession was to be voided if mining did not commence before March 31, 1928. A royalty of 3 percent was to be paid to the U.S.S.R., in addition to an annual land rent, plus 4 percent of the gold mined, in lieu of national and local taxes. The mine was to be turned over to the U.S.S.R. at the end of the concession period.

The concession was subject to the Labor Code, and the lessee 'agreed to admit . . . for purposes of study, Soviet geologists, engineers and technical personnel.'[33]

[31] *Izvestia*, No. 103, May 8, 1925.
[32] U.S. State Dept. Decimal File, 316–136–667.
[33] *Ekonomicheskaya Zhizn*, No. 275, November 27, 1926.

These smaller concessions did not have the same magnitude of capital investment as Lena Goldfields, but they were required to introduce modern mining and exploration equipment and techniques.

Those gold mines that did not come within the sphere of concessionary activity were equipped with modern equipment, and Western mining engineers were hired to establish and plan future production. The Kockar gold mine, in the Southern Urals, previously a French concession, was the first to be equipped in this manner, in 1928. According to Littlepage, who was in a position to have accurate data, by the end of the 1920s *each* gold mine, outside the concessions, had four or five United States mining engineers and employed 'thousands of foreign workers.'[34]

It is estimated, therefore, that in 1928 about 40 percent of Soviet gold was being produced directly by foreign concessions utilizing modern dredges and ore-crushing and sorting plants. This estimate is indirectly confirmed by other data from Soviet sources. It was reported in 1928, for example, that 56 percent of gold was being produced by 'individual prospectors and purchased from them by the large companies'—presumably Soyuszoloto and the other gold trusts. The balance of 44 percent was being produced by 'organizations using hired labor'—presumably Lena and the smaller concessions.[35]

DISCOVERY AND DEVELOPMENT OF THE ALDEN GOLD FIELDS

In 1924 a rich gold field was discovered and exploited in Northwest Siberia: the Alden. There are two features worth noting about this discovery: first, this was the initial gold discovery under Soviet rule and the only major discovery in the 1920s, and second, it was not opened up to foreign concessions for development. The question then logically arises: how is such a development, remote from Western influence, consistent with the hypothesis of this study?

Under the 1922 decree, private leasing and exploration had been restored in gold and platinum mining. The Alden discovery was made in 1923 by Kuzmin, a private digger working on his own account and not employed by a State organization.[36] The report of the discovery spread rapidly, and the response was a typical Western-style gold rush. Thousands of prospectors flocked into the Alden area, under the inducements offered in newspaper

[34] J. D. Littlepage and D. Bess, *In Search of Soviet Gold* (New York: Harcourt Brace & Co., 1937), pp. 68, 87–8. Littlepage was chief production inspector for the Soviet Gold Trust at this time; he later became deputy chief engineer of the same trust.

[35] The heavy reliance on individual prospectors or 'Russian concessionaires' is confirmed by Littlepage and Bess, *op. cit.*, p. 121.

[36] *Izvestia*, No. 1, January 1, 1927

publicity.[37] The result was a decrease in the working force of the Far Eastern province mines from 12,238 in 1923 to 8,222 in 1924, as workers moved to the Northwest.[38] The field was then closed to private claims, and in mid-1925 the 12,000 or so workers who had moved to Alden were organized into artels. A trust, Aldenzoloto, was then created and a few months later the Yakut Autonomous Socialist Soviet Republic was closed to outsiders.[39]

In brief, this remarkably rich deposit was prospected and initially developed by individual 'Russian concessionaires,' as Littlepage calls them, rather than foreign concessionaires. The state trust was formed three years after the initial discovery and development.

The extraordinary inefficiency of the state trust (even the best-run) has been described by Littlepage, who was in a position to observe. The Soviet Gold Trust was run by Serebrovsky, the best of the trust directors in the 1920s. Serebrovsky hired Littlepage as his technical administrator, but the difficulty of efficient administration is seen in the examples given by Littlepage. The Alaska Juneau gold mine, one of the largest in the world, had five people in the office and could provide figures promptly. Littlepage describes the typical trust gold mine with 150 in the mine office, and a fraction of the United States output. It could take weeks or months to get comparable figures.[40]

PLATINUM EXPORTS

Before World War I, the Urals provided almost all the world's supply of the platinum group metals. Production of platinum in 1901 was 14,000 pounds and in 1914 10,700 pounds. In general, the platinum producing areas escaped the ravages of war and revolution, and demand was certainly stimulated between 1917 and 1919 by vigorous pre-emptive buying on the part of the Allies to prevent platinum from falling into German hands. The provisional Omsk government required sale to government sources but little else of a restrictive nature. The area was occupied by the Soviets in 1919 and within two years production dropped to between 700 and 1,000 pounds per year.

> The condition of the platinum industry appears to be no better than that of the gold industry. All the events which caused the collapse of the gold industry . . . refer as well to the platinum industry.[41]

By 1921, production had fallen to 360 pounds, concentrated in three areas along the River Isse. Apparently some production was on an 'irregular' basis,

[37] *Harbin Daily News*, December 7, 1924.
[38] *Ekonomicheskaya Zhizn*, No. 355, December 9, 1924.
[39] *Izvestia*, No. 23, January 29, 1926.
[40] Littlepage and Bess, *op. cit.*, p. 216.
[41] *Ekonomicheskaya Zhizn*, No. 173, August 4, 1922.

and platinum was exported to the West through Latvia in substantial quantities until choked off by more effective Soviet border patrols in 1925.[42]

From about 1923 to 1926, Rusplatina used the London chemical firm of Johnson, Mathey and Company as a world distributing agent, although at rare intervals platinum was also shipped via the Compagnie de la Platine, in Paris. This trade was on the basis of a yearly renewable contract. In 1926 Johnson, Mathey and Company became a little high-handed and the Soviets established Edelmetall Verwertungs Gesellschaft in Berlin, which apparently had the effect of bringing the London firm back into line.

This was followed by an active campaign of price cutting to regain the prewar share of the market. In order to accomplish this, the industry had been reorganized and equipped with imported modern electric shovels. This meant that platinum could be mined profitably where the ore content was as low as 1/30 pennyweight platinum content per ton, in contrast to the requirement for 1/10-pennyweight per ton under earlier conditions. By 1926, production was restored to 5,800 pounds per year, all of which was exported. However, this was hardly a major contribution to foreign exchange earnings, as the price of platinum had been forced down from $112–$120 in 1925 to $62 per ounce in 1927.

Two platinum-refining works had been started by the Russian government in 1914 under the pressure of changing wartime conditions. These plants were started again in the early 1920s, with the assistance of Professor L. Duparc (France), described as 'the greatest platinum expert in Europe.'[43]

BAUXITE AND THE ALUMINUM COMPANY OF AMERICA

A Type I concession agreement was signed in April 1926 between the U.S.S.R. and the Aluminum Company of America (ALCOA) which gave the latter the right to explore for bauxite, the raw material for aluminum, throughout Russia during a period of two years. Although no details were published concerning this agreement, representatives of ALCOA were interviewed from time to time by U.S. State Department officers, and it appears that nine ALCOA engineers prospected for bauxite in several locations—mainly south of Tikhvin.

The Tikhvin area blocked out by ALCOA contained four deposits of Grade I bauxite, estimated to contain 2.8 million tons of 'probable' ore, together with additional tonnages of 'possible' ore. The ore had a high silica content,

[42] The figures for 'irregular exports' are available, as Latvia produces no platinum and Latvian platinum exports for this period are all of 'irregular' Russian platinum. Export figures for 'regular' platinum are not available, but these were approximately 40,000 oz. per year, compared to just under 10,000 oz. for 'irregular' exports.

[43] *Annuaire*, *op. cit.*, page XI.

together with iron oxide (an impurity), and the project was abandoned at the end of 1927, as the engineers considered the deposits not of commercial value and unworthy of further development.[44]

The Soviets did not give up. Tikhvin was their best bauxite deposit, and they were determined to build an aluminum industry. In 1929 the German firm Vereinigte Aluminumwerke A-G., which had perfected a reduction process applicable to the Russian bauxite grades, reported that the Soviets had been attempting '. . . for some time to secure the patent rights for Russia or at least operating rights to this process, but the negotiations have remained negative due to the failure of the Soviets to furnish certain guarantees.'[45]

Nevertheless, by 1930 technical-assistance agreements had been made to cover most aspects of aluminum manufacture. An agreement in 1930 with Compagnie de Produits Chimiques et Electrométallurgiques S.A. (France) covered the reduction of aluminum; and another contract, with Dr. Ing Straube of Karlsruhe, covered the manufacture of aluminum hydroxide, synthetic cryolite, and aluminum electrodes. A third agreement, with the Société du Duralumin S.A. (France), covered the manufacture of duraluminum.[46] A fourth agreement with Frank E. Dickie, an independent American engineer, provided technical assistance to Aluminstroi, the Construction Bureau for Aluminum Plants.[47]

MICA MINING AND THE INTERNATIONAL MICA COMPANY, INC.

The largest mica deposits in the U.S.S.R. were included in a Type I concession agreement in 1924 with the Russian-American Mining and Engineering Corporation, a subsidiary of the International Mica Company, Inc., of the United States. The concessionaire agreed to produce 35 tons of mica in the first year, increasing quantities gradually to 175 tons in the fifth year. A 5-percent royalty was paid on all production, and export was allowed by the operator. Modern mining equipment was imported and installed by the company.

[44] U.S. State Dept. Decimal File, 316–136–363 and 1230; 316–131–388 and 316–108–2008. The analyses of Tikhvin ore are in Geologicheskii komitet, *Godovoi Obzor Mineral'nykh Resursov SSSR za 1925/6* (Leningrad: 1927), pp. 47–8.

[45] *Vossische Zeitung*, November 18, 1929.

[46] Vneshtorgizdat, *op. cit.*, pp. 228 and 230. By 1930 Soviet aluminum production was on a pilot basis. The problems of development and the partially successful transfer of Western technology will be covered in Vol. II.

[47] A. A. Santalov and L. Segal, *Soviet Union Yearbook, 1930* (London: Allen and and Unwin) p. 358.

ASBESTOS PRODUCTION IN THE URALS

The Urals' asbestos deposits have been mined since the 1880s. The most important group of mines was at Baskenovo, about 90 miles northeast of Sverdlovsk; this group produced 96 percent of the 24,000 metric tons asbestos produced in Russia in 1914. Just before the Revolution, mines at Alapaievsk and Iltchirsk (in Irkutsk Province) were equipped and brought into production. The Neviask and Ostanino deposits were known but not exploited. In 1912 Russia exported 13,260 metric tons of asbestos, but exports ceased completely during the Revolution.

The impact of the Revolution was significant. No maintenance was done for several years, many of the mine buildings fell into disrepair, and the open-cut workings became watered. The essential problem, however, between 1917 and 1920 was to organize production and transport the mined asbestos to foreign markets.

Table 6–3 ASBESTOS PRODUCTION IN RUSSIA, 1913 AND 1923

Mines	*1913*		*1923*
	All grades, in metric tons		
Baskenovo Group:			
Grasmuchka River	1,300		None
Korevo	11,500	22,350	7,850
Reftinsk	8,000		
Mukhanovsk	1,400		
Okunevsk	150		
Alapaievsk	N.A.		350
Neviask	1,000		None
Ostanino	170		None
Iltchirsk (Irkutsk Province)	N.A.		None

Source: L. Berlinraut, 'Russian Asbestos Mining Reviving,' *Engineering and Mining Journal-Press*, CXXI, No. 4 (January 23, 1926), 164.

In 1920 only 1,300 tons of asbestos were produced (all from the Baskenovo group of mines), and of this more than 75 percent was of inferior grades.

The Alapaievsky, Neviask, Ostanino, and Iltchirsk mines were closed because of the lack of engineering and managerial skills.

In November 1921 a Type I concession was granted to the Allied Chemical and Dye Corporation of the United States, whose subsidiary, the Allied American Corporation, owned by the Hammers, had been operating under license in the U.S.S.R. since 1918. The concession was to restore and operate the Alapaievsky asbestos mines. The concessionaire repaired the buildings and organized production, and by 1922 had more than 1,000 men employed, or 44 percent of all asbestos mine workers in the U.S.S.R., as shown in table 6–4.

The agreement was made with the Ural Industrial Bureau for twenty years, and Allied was required to start work within four months. A sliding scale of required output was established, progressing from 1,200 tons in the first year to 2,580 tons in the fifth and subsequent years. The government had the right to purchase the concession after five years, and was to receive 10 percent of all production.[48]

Table 6–4 WORKERS EMPLOYED BY URALASBEST AND HAMMER CONCESSION, 1921–4

Producer/Year	*1921–2*	*1922–3*	*1923–4*
Uralasbest	1,385	2,487	3,067
Hammer	1,100	1,617	1,227
Total	2,485	4,104	4,294
% Employed by Hammer	44.30	39.40	28.60

Source: Annuaire Politique et Economique, p. 161.

Hammer has described the pitiful conditions of the workings when operations began.[49]

Six months after the concession agreement was signed, the company received 'one very deteriorated asbestos mine.' Piles of asbestos blocked the passages; there was a heap of 1,200 cubic sazhens of waste ore. There were no communications and no housing for workers or management. The company built 4,800 feet of mine passages and repaired shafts, workers' barracks, houses and schools. Within a year 1,200 poods of high grade material had already been shipped, 20,000 poods of ore were ready for shipment, and 1,100 workers were employed during the summer mining season. To achieve this, the concession imported modern mining and transportation equipment and built a sawmill and a 2½ verst narrow-gauge railroad.[50]

By 1925 the concession began to show a profit.

Uralasbest was created in 1921 to operate the Baskenovo group of mines, but it took many years and many major setbacks before Ruykeyser, an American asbestos mining engineer and consultant to Uralasbest, was able to perform his 'brilliant construction feat . . . in creating the Ural Asbestos Works.'[51] All the problems of Soviet development during the 1920s seem to be found in this trust: lack of working capital, personal jealousies, sabotage, inefficient foreign contracts, fire—but through sheer persistence, and at tremendous cost, a workable enterprise was finally built up.

48 *Krasnaya Gazeta*, January 4, 1922.

49 Armand Hammer, *The Quest of the Romanoff Treasure* (New York: Payson, 1932).

50 *Ekonomicheskaya Zhizn*, No. 280, December 10, 1922.

51 Shimkin, *op. cit.*, p. 226.

The Baskenovo open-pit mines are by far the most important asbestos deposits in Russia. In the early 1920s, production was primitive and without facilities for upgrading.[52] However, some asbestos was produced, despite the shortage of working capital, under the technical direction of Svedberg, who had been the prewar director and was retained by the Soviets as consulting director. The limitations on output were the extremely primitive mining methods and the absence of a mill to upgrade the mined chrysotile asbestos ore.

The first major step was taken by Uralasbest in 1928, when it concluded a Type III concession agreement with the Humboldt Company (Germany) to build a mill for upgrading the asbestos fiber and to reorganize mining methods.[53] Ruykeyser's description of the circumstances surrounding the mill contract is quoted in full:

> In 1928 I had fulfilled a contract with Amtorg in New York to lay out the preliminary designs, along generalized lines, for the proposed asbestos mill. The plans were accompanied by an extensive report covering all phases of the processes involved. I had pointed out wherein my ideas, based on actual experience with the subject, were at variance with the technical norms sent me as a basis for the drawing, ideas from which I could not depart. But disregarding such advice, without heed of consequence, a contract had been given a large German firm to build the plant. The flowsheet, or schematic arrangement of machines and processes, had been made by the engineers of the Trust under the direct supervision and approval of the technical director. This flowsheet was also contributed to by the Germans, a paltry five-ton sample of the ore being worked on laboratory scale in the preliminary testing. I was told that none of the Russian or German personnel had ever seen a chrysotile asbestos mill in operation; and yet, they had attempted to build what was to be one of the largest mills of its kind in the world.[54]

Not surprisingly, this mill failed to produce the desired results, although there is some evidence that sabotage was at least partly responsible for its failure. There are reports, for example, that wood chips, fatal to asbestos quality, were found along the production line. The mill was destroyed by fire in May 1929, and, as a result of the subsequent investigation, three Russian civil engineers were shot by the GPU and two sentenced to twenty years' hard labor. Svedberg, the technical director, was arrested for negligence.[55] The Soviet response was to order another mill—a copy of the first; this also failed

[52] Photographs in W. A. Ruykeyser, *Working for the Soviets* (New York: Covici-Friede, 1932) indicate quite clearly the hand methods in use before Ruykeyser reorganized production in 1929.

[53] U.S. State Dept. Dispatch No. 1528, Finland, Dec. 7, 1929. (Decimal File, 361.60d21/1.)

[54] Ruykeyser, *op. cit.*, p. 60.

[55] U.S. State Dept. Dispatch No. 1528, Finland, December 7, 1929. (Decimal File, 361.60d21/1.)

Table 6–5 ACQUISITION OF ASBESTOS MINING AND MILLING TECHNOLOGY BY URALASBEST, 1921 TO 1930

Year	*Mines* *Technology*	*Mines* *Railroad*	*Design*	*Mill Construction (Stroiuralasbest)*	*Power Station*	*Final Products (Spinning and Manufacture)*
1917	Hand methods	Prewar equipment	—	—	—	Exported only
1926	Hand methods					Hammer* Moscow plant concession with Czechoslovak management[1, 2]
1928	Ruykeyser Reorganization and mechanization.[1]	Purchased from Austria (1927)	I—Humboldt*** Svedberg[1] II—Humboldt[1]***	Humboldt[1]*** Krupp**	Swedish General Electric	Multibestos Company (United States)[1] and equipment purchased in United States[3]
1930			III—Smith** Ruykeyser[1]	Smith** (Canada)[2]		

Sources: 1 Ruykeyser, *op. cit.*
2 Berlinraut, *op. cit.*
3 U.S. State Dept. Decimal File.

Notes: * Type I pure concession.
** Type III technical assistance agreement.
*** Maschinenbau-Anstalt Humboldt of Cologne.

to perform. The consequence was the contract with Ruykeyser, and later with the C. V. Smith Company, of Thetford, Canada, to design a mill suitable for milling chrysotile asbestos fiber using Canadian experience. This was done, and finally, on the third attempt, the Soviets acquired a mill which would perform adequately. As late as 1939, this third mill was producing 95 percent of Russian asbestos fiber.

ASBESTOS ROOF SHINGLES MANUFACTURE

Asbestos products were manufactured in prewar Russia at the Red Triangle Works in Moscow. This works continued producing at about 25 percent of capacity (see table 6–6) for a few years after the Revolution, and closed in 1923.[56] In 1926, Hammer (Allied American) started to build a factory in Moscow, under a concessionary agreement, to manufacture asbestos roof shingles utilizing raw material from the Alapaievsky asbestos deposits, which had been operated by Allied since 1921. The plant utilized imported modern equipment and was managed by Dr. G. L. Rosenbaum, formerly head of a similar plant in Czechoslovakia.[57]

Table 6–6 MANUFACTURE OF ASBESTOS SHINGLES BY FOREIGN COMPANIES

Year	*Output (Millions of Shingles)*
1921–2	2.17
1922–3	2.75
1923–4	3.92
1924–5	11.9
1925–6	16.6
1926–7	21.6
1927–8	38.5
1928–9	51.3
1929–30	65.9

Source: G. Warren Nutter, *The Growth of Industrial Production in the Soviet Union* (Princeton, N.J.: Princeton University Press, 1962), p. 429.

Production of shingles accordingly doubled in a brief period; but this was apparently insufficient, as a Type III technical-assistance agreement was signed in 1928 with the Multibestos Company of the United States for the construction and equipping of another asbestos products plant.[58]

[56] *Ekonomicheskaya Zhizn*, No. 14, October 17, 1923.

[57] *Ekonomicheskaya Zhizn*, No. 124, June 1, 1926.

[58] Another technical-assistance agreement between E. Waite and the Rubber Trust, is listed for asbestos products in American-Russian Chamber of Commerce, *op. cit.*, p. 101. E. Waite however, probably represented Multibestos Company in the U.S.S.R., so that this may not have been a separate contract.

CHAPTER SEVEN

The Industrialization of Agriculture

THE transfer of Western technology and labor skills in agriculture was attempted along five channels. Each was part of a complex set of aims; enlarging the scale of farming, substituting machinery for labor, converting the farming sector into an industry, and removing the class enemy—the *kulak.* The five transfer channels were: the large farming concessions, communes manned by foreign sympathizers, model seed and breeding farms, the modernization of the agricultural implement industry (particularly the tractor, which had a place of honor equivalent to electrification in the industrial sector), and the technical-assistance programs.

Bolshevik interest in large-scale agriculture began in 1924 and has been viewed as an anti-*kulak* measure, but it was equally a method of industrializing the farm sector. The *kulak* was the ideological enemy, but his ability to outproduce the *bedniak* and the *serednia*k made him, at least up to 1928–9, indispensable. There was a basic, naïve assumption (which saturated the thinking of the planners) that a large scale of operations would effect infinite economies in agriculture.[1] The large farms of the American and Canadian prairies attracted the attention of Gosplan and the Commissariat of Agriculture, not because their yields were significantly greater than those in the U.S.S.R., but because the sheer scale of operations and the massive substitution of capital for labor promised a simultaneous solution for two basic problems in the Russian economy: the technical backwardness and hostility of the peasant, the latter stemming from the policy of *prodrazverstka* (forced requisition of grain) and the growing demand for agricultural products from cities and planned industrial complexes. Perhaps a more obvious pressure was Russia's complete failure to regain her prewar position as a major grain exporter or even to reduce the grain imports necessary in 1928–9. The grave decline

[1] The Gigant, largest of the State farms (500,000 acres), had higher costs than less favored and smaller state farms, however.

in Soviet grain procurements in 1929 (down 23 percent from the previous year) was an immediate incentive to action.[2]

In 1928 the People's Commissariat for Agriculture drafted a proposal for the establishment of very large grain farms, and thirty experts were sent to the United States, Canada, and Australia to study large-scale foreign agriculture.[3] Zernotrust (the grain trust), which had been organized to develop large-scale farms, sent two further groups.[4] The Zernotrust program for 1928–9 provided for establishment of fifteen large grain farms with a total area of 150,000 hectares in the Northern Caucasus and Volga regions, to be cultivated by 635 tractors.[5]

THE KRUPP AGRICULTURAL CONCESSIONS

The first attempt to introduce large-scale farming was made with the aid of Krupp in 1924, after an announcement by the Commissariat of Agriculture that it considered agricultural concessions necessary to the development of livestock breeding, sugar beets, and silk worms. Processing and equipment enterprises were thought to be in particular need of foreign help.[6] However, the Krupp agreement, after two major changes, ended in failure. The new Zernotrust farms were consequently modeled on American and Canadian practice.[7]

The Krupp agricultural concessions were an ambitious attempt on the part of the Soviets to introduce modern agricultural large-scale methods into the U.S.S.R., but for Krupp the objective was to develop a market for German agricultural implements and equipment. The concession was also designed to revive Russian agriculture, eliminate the possibility of famine, and turn the U.S.S.R. once again into a grain-exporting country. Krupp'sche Land-concession Manytsch G.m.B.H. was partly financed by a United Kingdom company, Russian Land Concession Manytsch, Ltd., registered in London. The function of the latter was to finance the German company to the extent of 75 percent of the funds required for exploitation of the concession. The United Kingdom company had a basic capital of £40,000, of which £30,000

[2] *Ekonomicheskaya Zhizn*, No. 187, August 16, 1929. See map of crop conditions on p. 2.

[3] *Izvestia*, No. 114, May 18, 1928.

[4] *Izvestia*, No. 92, April 21, 1929.

[5] *Pravda* (Moscow), No. 168, July 21, 1928.

[6] *Ekonomicheskaya Zhizn*, No. 331, November 11, 1924.

[7] M. Farbman comments, 'The big American and Canadian farms served as a model for the new experiment and American agronomical engineers and experts were engaged to start it, while the great virgin plains in the southeast of Russia, where the meteorological and soil conditions resembled those of the wheat belt in America, were chosen as the scene of operations.' [*Piatiletka: Russia's Five Year Plan* (New York: New Republic, 1931), p. 130.]

was subscribed by the English group and £10,000 by Krupp. There was an obligation to raise a further £80,000 if required.

A model farm was established in the Don district of the Ukraine, equipped with the most modern equipment and operated according to the latest methods. The final agreement, signed on April 3, 1922, covered an area of 162,000 acres. In a further agreement later in the same year, this area was reduced to 67,500 acres in the Saal section of the Don district. The concession company was obligated to place 3,780 acres under cultivation annually until a total of 63,450 acres was under cultivation at the end of the sixth year.

The Soviet government had an option to buy the whole output at world market prices. At the end of the twelve years the Soviets might purchase the entire concession settlement, and either party would have the absolute right to cancel the agreement in any sixth year. The period of the concession was set at thirty-six years, at the end of which time the concession, with all its equipment, would revert to the U.S.S.R. in good condition; the government would reimburse Krupp for all improvements that had not been amortized.

A special tax was imposed, equal to 17.5 percent of the total annual crop yields, calculated at world market prices on the basis of Rotterdam Grain Exchange quotations; this was in addition to the usual taxes. Krupp was authorized to employ foreign labor to 50 percent of the total labor force and foreign administrative workers to 75 percent. There was a board of arbitration; books and administrative procedures by the company were under the supervision of a government inspection board. Workshops were established to repair, assemble, and improve agricultural machinery.[8]

A new concession agreement for farming in the North Caucasus area was signed by Krupp with the Concessions Committee in 1927. The purpose was changed from grain-growing to sheep-raising. Apparently substantial quantities of the land originally granted in 1923 could grow grain only at a considerable loss.[9] Liquidation was first considered but then replaced by the new agreement. Under the new agreement, 12,000 acres were to be used for grain and the balance of 66,000 acres for sheep-raising. Two thousand sheep were to be imported immediately, and 36,000 to be grazed within eight years.[10] Ten percent of gross receipts were paid to the U.S.S.R., which also had the right to buy the wool at world prices. The wages paid by the concessionaire were 30–40 percent higher than average Russian wages.[11]

[8] U.S. Consulate in Konigsberg (Germany) Report No. 2110, February 17, 1923, and *Ekonomicheskaya Zhizn*, No. 13, January 19, 1923.

[9] U.S. Embassy in Berlin, Report 2561, August 9, 1927. (316–133–626.)

[10] Amtorg, *op. cit.*, II, No. 18 (September 15, 1927), 2.

[11] U.S. Embassy in Berlin, Report 2561, August 9, 1927. (316–133–626.)

A significant change was that the Soviets now agreed to participate in losses (previously they had only participated in profits) and in the burden of financing and management on an equal basis. A mixed enterprise (Type II), the German-Russian Krupp Manushka Company was formed. Krupp's share of the capital was 3 million rubles and the Soviets' 1.5 million rubles. The capital invested by the Krupp concern was 'guaranteed,' and in the event that the undertaking was not successful, it was repayable in 1937.[12]

The soil was too salt, and tractors were more expensive to use than animals. Buildings were built and experiments conducted, but when things went wrong the bureaucratic process was slow and corrections could not readily be made. Grain raising failed, so cattle raising was substituted, and, when this failed, sheep raising—but too long a period elapsed between the substitutions.[13]

OTHER 'PURE' FARMING CONCESSIONS

An agreement between the U.S.S.R., the Volga-Deutsch Bank in the Volga region, and the Berlin firm Deutsch-Russische Agrar A-G (Druag) in late 1923 covered an agricultural concession on 67,000 acres of land in the Volga region. The land was to be used for any purpose seen fit by the German concessionaires. The Soviet government had an option on any products, although any portion not so taken might be exported. A tax equal to 14.5 percent of the total output was paid during the first two years of the life of the concession, but increased to 17.5 percent during the next two years and to 19.5 percent during the remaining years. Rent was equal to 10 percent of gross revenue and additional taxes equalled a further 10 percent.[14]

An extensive agricultural concession was also granted to the German Volga Bank, a Soviet joint-stock company, despite its name. This concession covered 270,000 acres in the German Volga and in the cantons of Federov, Krasnokutsk, and Palassov near the German Autonomous Commune. The concession was then broken up and sublet to German sub-concessionaires in areas of about 50,000 acres each. One such sub-concession was made to the German-Russian Agrarian Association. The company was required to cultivate the land according to an approved plan: 10 percent in the first year, 30 percent in the second, 80 percent in the third, and 100 percent in the fourth. The concession was set up to last for thirty-six years. The company paid to the bank a percentage of total production: 14.5 percent in the first year, 17.5 percent in the next two years, and 19.5 percent thereafter—an arrangement somewhat more liberal than in the Krupp concession. All state and local taxes had to be paid,

12 U.S. Embassy in Berlin, Report 3923, September 18, 1928. (316–133–823.)
13 *Berliner Tageblatt*, October 6, 1928.
14 U.S. Embassy in Berlin, Report No. 2110, November 19, 1923. (316–131–140.)

and upkeep of the roads in the area was a concession responsibility. The bank had the right to buy out the concession after twenty-five years.[15]

An Italian-Russian concession for agricultural and mineral development in the Kuban district was ratified in September 1922. One of the signatories, Commendatore Ferdianando Bussetti, discussed the matter with the U.S. Embassy in Rome shortly after signing the agreement. He indicated that the operation of the 100,000-hectare concession would be under the supervision of the Italian Agricultural Confederation, and that the objective was to grow wheat for export to Italy. Under the contract, 15 percent of production was to be paid to the Soviet government, a further 35 percent was to be sold locally, and the balance was to be exported. It was suggested that 30,000 Italians were to be transported to work the concession, and that they were to be free from Soviet law and under Italian jurisdiction.[16]

An agricultural concession was granted to Harold M. Ware of the United States in 1924. Ware formed the Prikumskaya Russo-American Association and established farms on several thousand acres near Piatigorsk, in the North Caucasus. His main objectives were to train Russian agriculturists in American methods and organize model agricultural enterprises in the U.S.S.R.[17] Ware brought a number of tractors and fifteen American specialists with him.[18]

Another concession agreement signed in 1923 transferred 15,000 dessiatins to the Nansen Mission for the organization of model and demonstration farms. The objective of the concession was to produce high-quality seeds and high-grade animals, together with the organization of model seed-cleaning stations and cooperative butter and cheese factories.[19] A much larger seed-growing concession, however, was Deutsche-Russische Saatbau A-G (Drusag).

15 *Pravda* (Moscow), No. 244, October 27, 1923.

16 U.S. Embassy in Rome, Report No. 456, October 2, 1922 (316–130–1242). This is a little far-fetched. There is no evidence that such a large number of Italians ever went to work in the U.S.S.R.

17 U.S. State Dept. Decimal File, 316–136–1241.

18 *Pravda* (Moscow), No. 198, September 2, 1924. Previously Ware had organized the export of tractors to the U.S.S.R. through the Society of Friends of Russia. The Ford Delegation of 1926 met Ware on several occasions and made unfavorable comments on his personal operations and ethics. For example, 'He intimated that provided we could arrange to give him a complete repair outfit (practically everything on his farm had been a gift) much good would result on both sides. . . .' (Presumably Ware was going to use his 'influence' with the Soviets on behalf of Ford.) Later, with reference to some tractors which Sherwood Eddy had prevailed upon the Ford Motor Co. to give to Ware, he commented to the Delegation that the tractors did good work, 'but that the Company failed to send along the tractors equipped with fenders, pulleys and assorted spares. We thought this a somewhat curious statement from one who had received the tractors as a gift.' [*Report of the Ford Delegation to Russia and the U.S.S.R. April-August 1926* (Detroit: 1926), Ford Motor Company Archives Accession No. 49, p. 145–6.]

19 *Izvestia*, No. 166, July 26, 1923.

GERMAN-RUSSIAN SEED CULTIVATION COMPANY[20]

Drusag was founded in 1923 by Stinnes, the City of Königsberg, and a group of German agricultural implement firms including Sack, Kemna, and Lanz, together with the Soviet Commissariat of Agriculture. The concession was granted two properties: one in the Kuban area, suitable for seed growing, and the other near Rostov, used as a cattle-breeding station. Substantial investments were made in buildings and machinery, and within two years a greater area was under cultivation than that called for under the agreement.

In 1925 a new agreement replaced the old contract. The main alteration was that the rental fee, based on gross profits, was decreased. Further relaxations were granted in order to allow the concession to export from the Soviet Union so as to purchase foreign machinery and to pay interest on loans raised in Germany. The concession apparently operated well for a year after the reorganization, and in 1926–7 a profit of 450,000 rubles was reported. Then difficulties developed, so that further German and Russian investment was required. By 1927 a debt of more than 300,000 rubles was owed to Gostorg, in addition to the unamortized part of the original German loan. A further 600,000 rubles was borrowed: 450,000 from the German government and the balance from the City of Königsberg and German implement-manufacturing companies. Of this sum, 150,000 rubles was used to repay the balance of the German debt, 300,000 rubles was used to settle various Russian claims, and the balance was used as working capital to carry the enterprise over until the 1927 harvest. However, in 1927 the German obligation had grown to some one million marks, and the Soviets began to move the enterprise toward compulsory liquidation. Further negotiation kept the enterprise alive until 1932.

The existence of the Drusag concession from 1923 to 1932 enables us to make a brief comparison between 'tractorization' undertaken in the late 1920s and the experience of the concession—an island of private enterprise in a sea of collectivization.

The mass introduction of the tractor, the high cost of depreciation, the cost of fuel, the almost total lack of repair facilities, and the rough treatment the machine received in the hands of the peasant made it an extremely wasteful method of farming. The Drusag concession, farming land of good quality in a large plot of 27,000 acres, found animal power was often more economical than mechanical power. Animals, especially oxen, were cheap: a unit consisting of eight yoke oxen, a four furrow plow, and two men did the job as efficiently as, and at less cost than, a tractor. The tractor only came into its own when speed was a factor.

[20] The information in this section is based on the German Foreign Ministry Archives.

> The Russian however is inclined to think that, because the tractor turns over the soil at a prodigious rate and with lots of cheerful noise and bustle it is doing it more economically and efficiently than any other method.[21]

The contribution of Drusag was not, therefore, to a more efficient allocation of agricultural resources. For a period of ten years the enterprise contributed seed and pedigreed cattle to the state and collective farms, and although Gostorg made sizable investments from time to time, these were repaid, while the innovations developed by the concessions were contributed free of charge.

TECHNICAL ASSISTANCE IN AGRICULTURE

An early form of technical assistance was given by the International Agrarian Institute, established in 1923 by the International Peasant Soviet.[22] The institute consisted of five departments, for the study of peasant agriculture, agrarian legislation, agricultural practices and methods of work, the attitude of local Communist parties to this work, and the contribution made by peasant economies in the world toward the achievement of a higher standard of living. The institute established a library and published a monthly, *The Agrarian Question.*

The main objective of the institute was the world-wide collection of information concerning the peasant and his relation to agricultural technique and economics.[23] In 1924 the institute established an agricultural bureau in New York to study the theory and practice of agriculture in the United States, Canada, and the Latin American countries.[24] In the same year an American citizen, Coleman, founded an agricultural school in the U.S.S.R. with an American staff.[25]

The acquisition of agricultural technology increased as delegations went from and visited the U.S.S.R. A Soviet Agricultural Commission of twelve experts, headed by P. B. Asaultschenko, visited Denmark in June 1926 to study Danish agricultural methods. The commission purchased some animals for breeding purposes, although fewer than had been expected in Danish trade circles.[26] A Swedish model farm was established and stocked with

21 L. E. Hubbard, *Economics of Soviet Agriculture* (London: Macmillan, 1939), pp. 260–1. Hubbard points out that the consumption of fuel alone by a tractor would in 1935 be 63 litres, or the equivalent of 630 kilos of grain—very nearly the whole yield.

22 Charles H. Smith, of the American-Russian Chamber of Commerce, formerly with the U.S. State Dept., was also a member of the International Peasant Soviet.

23 *Izvestia*, No. 3, January 4, 1924.

24 *Pravda* (Moscow), No. 116, May 24, 1924.

25 *Pravda* (Moscow), No. 198, September 2, 1924.

26 U.S. Legation in Copenhagen, Report 216, July 25, 1927. (316–133–622.)

Swedish pedigreed animals. Nineteen Ardenne horses were delivered personally by the Director of Sweden's General Agricultural Service, who commented on the model farm being established:

> The Swedish model farm will be of a very great service for the demonstration of Swedish products and the use of Swedish agricultural machinery as well as for instruction in Swedish agricultural methods.[27]

A group of American specialists was induced to go to the U.S.S.R. One of them, Professor A. A. Johnson, was 'unduly enthusiastic' and voiced his 'unstinted praise' of Soviet development to the U.S. Consul at Berlin in September 1928 after a three-month visit to the U.S.S.R., where he had received an offer to act as agricultural adviser.[28]

This search for specialists extended throughout the range of agriculture. The grain elevators at Vladivostok and at Harbin, first operated by the Chinese Eastern Railway, were later operated on a concession basis when the area came under the control of the Soviet authorities. A group of Russian businessmen in the Far East joined with the railway administration and formed a joint-stock company to operate existing elevators and construct new ones. Such a move suggests the inability of the Soviet authorities to either operate or construct such units. As the elevators were handling nearly 100 million poods of grain a year, this was no small operation.[29] Attempts to make a similar agreement with a group of Italian grain importers for operation of Black Sea elevators was not successful; after extensive negotiations, the Italian group refused to participate without a Soviet guarantee of investment protection.[30]

Thomas Campbell,[31] according to *Izvestia* 'the biggest American farmer and one of the most prominent experts on the organization of grain production,' was invited to the U.S.S.R. by Zernotrust in 1929. The organization of Campbell's Montana farm had been noted by Soviet experts and the processes 'reproduced on a film 2,000 feet long which he has brought to the U.S.S.R. with him.' Campbell farmed 95,000 acres in Montana with 109 tractors and only 200 workers. The object of his visit was to advise in development of ten million acres for wheat growing. The scheme envisaged expenditure of $100 million on agricultural machinery and another $50 million on trucks and road-making equipment. Campbell was reported to have been interviewed

[27] U.S. State Dept. Decimal File, 316–133–631.

[28] U.S. Embassy in Berlin, Report No. 3924, September 15, 1928. (316–134–255.)

[29] A translation of the extensive agreement is in U.S. State Dept. Decimal File, 316–134–860 to 891.

[30] Several detailed reports on the negotiations are in U.S. State Dept. Decimal File, 316–134–782 and 316–134–791.

[31] Thomas D. Campbell, *Russia: Market or Menace?* (New York: Longmans Green, 1932). Campbell's book is of the 'I'm not a Communist but. . .' genre and contains nothing specific concerning his work in the U.S.S.R.

and approved by both President Coolidge and Mr. Herbert Hoover before his 1929 visit.[32]

While these ingredients for agricultural improvements became part of Soviet agriculture, the *kolkhoz* yield was less at the end of the decade than the yield on private estates had been during the first ten years of the century, although it represented a marginal improvement over the yield of prewar peasant farms.[33] The uneconomic replacement of the horse by the tractor and the persecution of the more effective peasants were disastrous to Soviet agriculture, and incipient transfer of advanced Western agricultural techniques was drowned by an intemperate ideology.

COTTON IRRIGATION

In July 1923 it was reported by the American consul in Riga that a group of German financiers, including Krupp and Stinnes, had formed an organization with the objective of reviving and enlarging the cotton industry of Turkestan. The Turkestan cotton crop had received numerous setbacks from drought, hot winds and marauding bands of *basmachi* who had succeeded in extensively damaging the Fergana irrigation system, essentially devoted to cotton. The population had fled to the towns as a result of the disturbances, so that the cotton fields remained uncultivated. Production had consequently declined heavily. In Bokhara, 1921 production of cotton fiber was less than 100,000 poods compared with 2.5 million before 1917. Between 1909 and 1914, the total Russian production of cotton had averaged 13 million poods per year; this declined to less than 2 million by 1922.[34]

In 1911 a mixed group of American and Russian engineers had visited the Karakouma Steppe in Transcaucasia to determine its suitability for growing cotton. The expedition, financed by John Hays Hammond, confirmed the prevailing opinion in Moscow that the steppes were not suitable for irrigation or cotton growing.[35] The 1911 expedition was led by Arthur P. Davis, a well-known American irrigation engineer. In 1929 the Soviets invited Davis to undertake complete supervision of the operation and extension of the irrigation system of central Asia, Sredazvodkhoz.[36]

[32] *Bank for Russian Trade Review*, I, No. 2 (February 1929), p. 16. This claim was marked with a marginal question mark in Decimal File 316–133–1167.

[33] L. E. Hubbard, *op. cit.*, Chap. XXII, 'Effects of Mechanization on Production.'

[34] U.S. Consulate in Riga, Report No. 1337, October 6, 1923. (316–139–361.)

[35] U.S. State Dept. Decimal File, 316–134–410/429.

[36] *Ekonomicheskaya Zhizn*, No. 133, June 13, 1929. By extraordinary good fortune, extensive documentation exists for the work of one of the consulting engineers to *Sredazvodkhoz*. This collection, now at the Hoover Institution, Stanford University, forms the basis of a chapter in Vol. II.

One unusual—and successful—experiment was the establishment of a Russian experimental station for cotton growing *in Persia*. This was established in 1926 in Mazanderan Province, the country's largest cotton-growing district. The station consisted at 222 acres with a large Soviet and Persian staff. Experimental work was done with all varieties of cottonseed, including the American types Weber and Acala, which did well, and Pima, which did less well. By improving seed quality and making cash advances to the planters in the surrounding areas, the Soviets came to dominate the area. The cotton was exported to Russia. Records of the experiment were transferred to the cotton-growing areas of Turkestan.[37]

Later in the decade the Chief Cotton Committee sent a delegation to the United States to study latest American achievements in cotton growing and cotton ginning; the ten specialists remained in the United States about six months. Particular attention was given to organization and mechanization problems. An agreement was also negotiated with a 'large cotton growing firm' for the establishment of a seed farm in the U.S.S.R. and for the mechanization of Soviet cotton gins. The Committee argued that the contract would 'permit the Commission to successfully bring the experience of American cotton cultivation to the Soviet Union.'[38]

MERINO WOOLS AND AN AUSTRALIAN EMBARGO

A decline in the breeding of sheep had become catastrophic by 1923. Said the President of the Wool Syndicate, 'The breeding of Merino sheep must be considered as completely ruined.'[39] As a result of the Revolution only 98,000–110,000 head of Merinos were left, compared to the more than two million head in 1912. Commercial sheep farming had almost ceased, as sheep farmers had left Russia and their flocks had dispersed. In 1923, only

Table 7-1 PRODUCTION AND IMPORTS OF MERINO WOOL IN U.S.S.R., 1923–6

Year	*Clipped in U.S.S.R.*	*Imports*
1923–4	20,000 poods	480,000 poods
1924–5	28,000 poods	350,000 poods
1925–6	30,000 poods	None

Source: *Possibilities of British-Russian Trade* (London: Anglo-Russian Parliamentary Committee, 1926), p. 50.

[37] U.S. Consulate in Teheran, Report, August 6, 1926. (316–135–275.)
[38] *Ekonomicheskaya Zhizn*, No. 171, July 28, 1929.
[39] *Ekonomicheskaya Zhizn*, December 9 and 12, 1922.

20,000 poods of Merino wool was clipped, and less than half of all available supplies was collected. There was a parallel decline in the wool manufacturing industry.[40]

The solution came in two stages. Large quantities of Merino wool were imported in 1923–5, followed by heavy imports of Merino and other stud sheep for breeding. The latter created sufficient concern in Australia to cause the imposition of a ban on the export of Merinos, still effective in 1962. Between 1919 and 1927, Soviet purchases of Merinos for breeding were not too great: about 2,000 head during the whole period. In 1928–9 the Soviets stepped up buying far beyond normal and on one order purchased 30,000 stud Merinos. The subsequent outcry led to the embargo on stud Merinos on November 28, 1929.[41]

Supplementing the import of sheep, a group of Australian sheep breeders with capital and a flock of 1,500 Merinos settled in the southeast portion of the R.S.F.S.R., under an agreement with the People's Commissariat of Agriculture.[42]

Large purchases of high-grade pedigreed sheep were also made in the United States to improve and build up Russian stocks. In 1924, 2,766 sheep were purchased; in 1925, 1,621; in 1926, 2,628; and in 1927, 8,414.[43] They were shipped in groups of 1,000 to 3,000. For example, in 1927 four Russian peasants arrived in the United States to escort 2,700 pedigreed animals purchased in Utah, Montana, Oregon, and Ohio. This group included 1,550 prize stock Rambouillets, 1,000 prize Hampshires, and 150 Shropshires, purchased for a total of $160,000.[44]

REPLENISHMENT OF LIVESTOCK HERDS

The 1922 famine left the Soviet Union, particularly the southeast, with a much-depleted livestock population; most of the animals had been killed and marketed. The restocking project was offered for concession. In the Volga A.S.S.R., it was indicated that there were forty-five large cattle ranches, each of which could be put in order for £50 sterling, although livestock and supplementary equipment would cost a total of more than £1 million. It was suggested that the enterprise would be profitable; but there were no takers.[45]

[40] U.S. Consulate in Helsingfors, Report No. R-2100, February 28, 1923.
[41] Commonwealth of Australia, *Parliamentary Debates*, '12th Parliament, 1st Session,' p. 358.
[42] *Izvestia*, No. 35, February 12, 1924.
[43] Amtorg, *op. cit.*, II, No. 24 (1927).
[44] Amtorg, *op. cit.*, II, No. 19 (1927).
[45] *Russian Information and Review*, I, No. 20 (July 15, 1922), 462.

Breeding herds, as well as herds for sale, had been reduced to minute proportions. In July 1921, just after the establishment of a commission to reorganize and improve the livestock-breeding industry, it was found that, although breeding establishments occupied more than 35,000 acres, they contained very few breeding stock. Only 1,000 pedigreed horses, 114 bulls, 1,700 cows, and a few pigs, sheep, and goats remained in the breeding farms. Some improvement was made the following year by purchasing small herds from peasant farmers, but a decline of this magnitude required replenishment from outside.[46]

The failure of tractor production, a 175,000-head shortage of horses, the lag in agriculture, and possibly a military demand produced an unusual transaction in halter-broken wild horses in 1927–8. Britain had broken with the U.S.S.R. over the Arcos affair and Canada had immediately followed suit, so that officially there were no diplomatic relations between Canada and the U.S.S.R. However, the Canadian Department of Agriculture made four shipments, totaling 8,000 horses, from the western Canadian ranges to Leningrad, under official auspices. Canadian officials rounded up the horses and made the purchases, and two Canadian officers escorted them to Leningrad. Further, the price was only $30 per head! The horses were taken to a military camp outside Leningrad, inspected by General Budenny and cavalry officers, and then shipped down to the Ukraine.[47]

LIVESTOCK AND DAIRY INDUSTRY CONCESSIONS; UNION COLD STORAGE, LTD.

The Union Cold Storage Company, of the United Kingdom, had several concessionary arrangements with the U.S.S.R. The first was signed in May 1923 with the North Western Trade Department. The Trade Department assembled animal products in the R.S.F.S.R., with the technical and financial assistance of Union Cold Storage, who then exported and sold them abroad guaranteeing a minimum profit of 10 percent. This profit was then split: 67 percent to the Department and 33 percent to Union Cold Storage.[48]

G. H. Truss and Company, also of the United Kingdom, had a similar agreement with Khelboprodukt, concerning bacon exports, and provided equipment and technical assistance to build two bacon factories to produce for export. These were supplied on a credit basis.[49]

[46] *Ibid.*, pp. 461–2.

[47] *Ekonomicheskaya Zhizn*, No. 193, May 27, 1924.

[48] *Ekonomicheskaya Zhizn*, No. 102, May 11, 1923.

[49] A. Troyanovsky, *Eksport, import i kontsessii soyuz S.S.S.R.* (Moscow: Dvigatel, 1926) Troyanovsky adds the comment that ' . . . the Soviet purchasing-export organizations have conducted their eggs-exporting business mainly with the use of foreign capital.' P. 145.

Khleboprodukt concluded two further concession agreements in 1924 with Union Cold Storage. The first was a concession for the export of woodcocks, hazen-cocks, and partridges. Combined with this was a technical-assistance agreement in poultry-farming development with a view to the subsequent export of poultry. Union Cold Storage advanced credit, and the initial agreement lasted until September 15, 1927. The second concession agreement covered pig breeding. In 1922 there were only twenty pig-breeding farms left in the Soviet Union, with a total of 843 pedigree animals, compared to a total pig population of over 21 million animals in 1916.[50] [51] Union Cold Storage agreed to facilitate the export of pork to England through company distribution channels on credit, and also to provide technical assistance in Soviet pork production until September 15, 1929.

The Gostorg butter-export office in Leningrad also concluded an agreement with Union Cold Storage, in August 1924 for export of butter to the United Kingdom, the latter granting financial and machinery credits to facilitate the contract.[52]

The 'Arcos break' interrupted Union Cold Storage concessions, but, upon resumption of trade relations in 1928, they were the first United Kingdom concessions to be renewed. Under the 1928 agreement, the Union Company agreed to advance a credit of $2.5 million in exchange for the right to handle all Soviet imports and dairy produce for United Kingdom market. The credits, utilized for the purchase of machinery in the United Kingdom for the Soviet dairy industry, were spread over three years and were granted in addition to a credit of 80 percent of the value of dairy goods shipped. The dairy produce was sold by Union Cold Storage on a commission basis and credit was made available upon receipt of the produce in London.[53]

Butter production and export in 1924 were also facilitated by a concession agreement forming the Danish-Siberian Company (Sibiko), under which a Danish company obtained for five years the right to produce and export butter from Siberia. First-year production was set at a minimum of 200,000 poods, with 300,000 poods as the minimum annual quantity thereafter. This con-

[50] *Pravda* (Moscow), No. 182, August 13, 1924.

[51] Henry Wallace noted that the Siberian pigs were Yorkshires descended from 800 imported from the United Kingdom in the early 1920s. [*Soviet Asia Mission* (New York: Regnal & Hitchcock, 1946), p. 222.]

[52] *Izvestia* (Moscow), No. 189, August 21, 1924. Union Cold Storage was handling almost all Russian exports of butter and eggs in the middle of the decade (including exports to Latvia, reexported to the United Kingdom) except for a small quantity handled by Truss, another Type II United Kingdom concession, and IVA, a German concession. [L. Segal and A. A. Santalov, *Soviet Union Yearbook, 1925*, (London: Allen and Unwin, 1925), p. 243.]

[53] *New York Times*, March 16, 1928, p. 5, col. 3. Sir Edmund Vestey, who controlled Union Cold Storage, was quoted: 'We have been doing business with Soviet Russia for some time, and have found it quite satisfactory.'

stituted a considerable portion of Russian butter production at the time. The Danish company received half the profits made by Sibiko.[54]

A report from the Danish Legation in Moscow to the Danish Foreign Office in early 1925 suggests that the Soviets had problems even in butter production. The butter trust, Maslocentr, operated some 5,820 dairies and 680 cheese factories (about 80 percent of the prewar total), but production was only about 31 percent of the 1913 total. There were problems with 'irregularities' in distribution; by keeping producer prices low, regional dairy associations were able to make substantial profits for their own organizations which were not passed on to producers. A certain amount of Danish capital was involved in the regional associations. It was indicated that future attention would be concentrated on product standardization, training, and improved techniques.

These butter and egg exports were of major importance as, together with lumber, they replaced the lost grain exports on which the Soviets had placed major reliance for foreign exchange.[55] Hens had been nationalized soon after the Revolution, and eggs were nationalized under a decree signed by Lenin on March 3, 1920. A quota was allotted each farm to be delivered to government collecting points.[56]

FOREIGN AGRICULTURAL COMMUNES IN RUSSIA

The Ira commune was established in April 1922 in Tambov Province, on the estate of Prince Obolensky. Another commune, the Seyatel, was established on an estate requiring considerable repair, by about 1924. Local peasants and the Communists were reportedly friendly, and the former were reportedly impressed by such novelties as the welding of broken farm implements and the artificial hatching of eggs.[57]

In 1923 some 200 returned emigrants arrived in the U.S.S.R. from the United States and were organized by the Society for Technical Aid to Russia (which had about thirty branches in the United States) into five communes: the New World, the John Reed, the Red Banner, the Labor Field, and the Estonian. They were settled in the Ukraine and the Don Basin with $130,000 worth of equipment brought from the United States. About 20 percent were party members and the rest were sympathizers.[58]

[54] *Ekonomicheskaya Zhizn*, January 11, 1922.
[55] U.S. State Dept. Report No. 3945, September 25, 1928.
[56] U.S. Consulate in Vibourg, Finland, Report No. 69, April 8, 1920. (316–125–713.)
[57] *Izvestia*, No. 124, January 7, 1923.
[58] 'Longing for Home' *Izvestia*, No. 82, April 15, 1923. The Society for Technical Aid to Russia, located in New York, was performing the functions of a consulate (supposedly denied to the U.S.S.R., as there was no diplomatic recognition at the

Another group of repatriated emigrants, mostly metal and textile workers, arrived later in the year and also settled in South Russia. Their communes were organized according to city of origin in the United States. The Trud Commune had members predominantly from Boston; Harold (a dairy farming commune), from Chicago; Proletarian Life, from Cleveland; Krasny Loutch, an agricultural commune in Nikolaev, from Chicago; and so on.[59]

At Perm a group of returned agricultural laborers was given 10,000 dessiatins (27,000 acres) to farm.[60]

The California commune was established by an agreement between the Soviet of People's Commissars and a group of American agricultural workers largely from the western United States. The commune was granted 2,700 acres in Don *oblast* to establish various agricultural enterprises on a lease basis for twenty-four years. A fee equal to 5 percent of all crops grown was to be paid the Soviet government, with the first payment falling due after the third harvest. On expiration of the contract, the commune was to hand over all equipment and livestock.[61]

This commune was not destined for success; it was near bankruptcy within nine months. The major blow was the loss of three railroad cars containing the equipment and possessions of the settlers. These cars wandered about Russia for six months despite '348 inquiries to the railroads.' Two were permanently lost, and the commune had to pay the freight charges for the wanderings of the third, placing an impossible burden on their finances.[62]

Lenin had the announced aim of settling one model American group in each *uyezd*, which would have required about 250–300 such groups, a long way from the 25–30 that actually were settled.[63]

The communes, particularly the American communes, appear to have been utilized in an attempt to transfer more advanced agricultural practices into the surrounding areas. For example in the village of Posovka, Americans founded a commune in 1920 which created for a period of at least three years a series of 'circles' devoted to various problems: seed selection, agricultural exhibition, horticulture, and similar activities.

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time). See, for example, the document issued to L. F. Rautanen in New York which is, in essence, a visa. (316–110–719.)

The Society for Technical Help to Armenia was also organized in the United States to return qualified Armenian laborers from the United States, to establish trade schools in Canada and Armenia for training specialists, and to maintain relations. (*Pravda*, No. 210, September 18, 1923.)

59 *Pravda* (Moscow), No. 232, October 13, 1923.

60 *Pravda* (Moscow), No. 246, October 31, 1922.

61 *Ekonomicheskaya Zhizn*, No. 19, January 28, 1923.

62 'Now the Agricultural Communes Are Perishing,' *Pravda*, No. 260, November 16, 1923.

63 *Pravda* No. 246, October 31, 1922.

> The young Americans are continuing their efforts quietly, without noise. Their example was not fruitless. In various neighboring villages similar circles with agricultural purposes have been formed.[64]

The Finnish commune comprised a group of Finns and a few Americans on about 100 dessiatins of land fifteen miles from Leningrad, farmed on a cooperative basis. The commune failed because local peasants stole the equipment, there was lack of harmony in the group itself, and finally, taxes, at 5,000 rubles per year, proved to be too much of a burden.[65]

Another Finnish settlement was the Seattle Commune, started by Finns deported from the United States in 1921. This was more successful. The commune was visited in 1930 by M. Farbman, who reported that its wheat fetched higher prices than neighboring state farms.[66]

Gigant State Farm	128 kopecks/pood
State Farm No. 2	175 ,, ,,
Seattle Commune	193 ,, ,,
Average all peasants	120 ,, ,,

An agricultural union of Dutch descendants in the Ukraine concluded a foreign loan of $1 million for purchase of foreign equipment.[67]

Communes were supported by the Czechoslovakian government to the extent of fifteen million crowns in agricultural equipment, but, as this was distributed to all communes regardless of nationality, it is impossible to assess how much of this sum went directly to the aid of Czechoslovakian communes. The Czech Mission in the U.S.S.R. was also (in 1923) given the right to rent and organize shops for the assembly and repair of agricultural machinery.[68]

An Australian commune was established with help from the Society for Technical Help to the U.S.S.R. in Australia. Mainly from North Queensland, the group settled in 1921 in the Ukraine (with equipment brought from home) as the Australian Commune.[69]

There was a Canadian Dukhorbor commune with some 2,500 members—but this sect and the Mennonites tended to leave Russia, near the end of the decade when anti-religious pressures were applied.[70] There was also a

[64] *Pravda* (Moscow), No. 276 (December 5, 1923).

[65] U.S. Consulate in Helsingfors, Report, October 8, 1928 (316–133–843). This report is based on the experience of Lauri Rautanen, a United States citizen of Finnish descent; it is useful as being among the most balanced and objective of the excommunard reports. Although he had lost $1,500 and wanted to return to the United States, Rautanen did not regret his experience; '. . . he wanted to see how it worked in Russia. He would advise nobody to go to Russia.'

[66] Farbman, *op. cit.*, p. 148.

[67] *Izvestia*, No. 246, October 27, 1923.

[68] *Pravda* (Moscow), No. 279, December 8, 1923.

[69] *Pravda* (Moscow), No. 247, October 31, 1923.

[70] U.S. State Dept. Decimal File, 316–135–251.

'Canadian commune' near Odessa formed by the Canadian Society for Technical Aid to Soviet Russia. They were allotted 1,500 dessiatins and employed several hundred Canadians and a few Russians. They brought equipment for their workshops from the United States.[71]

The Austrian commune, Imkommune Uhlfeld, was supported by both the Austrian government and the City of Vienna. The former contributed 800 schillings ($125) for each immigrant (the investment required by the U.S.S.R.). The City of Vienna gave a similar amount to commune members from Vienna. There were about 600 members in the commune, which settled in the Kirghiz Republic with the intent of founding an Austrian city based on regional agricultural development.[72]

JEWISH LAND SETTLEMENT PROGRAMS

With financial support from the Jewish community in the United States, Jewish settlers were encouraged to settle on various parts of the U.S.S.R. and particularly to undertake farming.[73] The act organizing the Committee for Settling Jewish Toilers on the Land was published in *Izvestia* on October 13, 1926, which outlines the land distribution and budgetary considerations in the program. Quite unknowingly, this organization aided the Bolshevik drive on private trade, renewed in 1924.

American assistance was organized under the Jewish Joint Distribution Committee, which had cooperated with American Relief in Russia and maintained a representative in the U.S.S.R. In 1925 land was set aside for these settlers, and the Joint Committee supplied tractors and other equipment, dug wells, provided cattle, gave loans for housing and farm building, and gave instruction in farming. By October 1925, the committee had settled 6,000 families on 500,000 acres in the Ukraine and Crimea.

Apparently the land settled could be used only with foreign assistance, as it was arid and water wells had to be drilled to a depth of 300–400 feet: hence the comment that 'this is why the country can be settled only by Jews who receive money from abroad'.[74]

71 *Pravda* (Moscow), No. 47, March 2, 1923.

72 The commune had a 12-page agreement with the Soviets. A translation is in the U.S. State Dept. Archives at 316–131–343.

73 It should be noted that Jewish leaders in the United States, unlike many business men, took precise care to discuss their plans and actions with the State Department and ascertain the government viewpoint on such financial support, in order to avoid any possible misunderstanding. (See U.S. State Dept. Archives, 316–127–304.) There were similar organizations in other countries, but little is known of their activities. For example, Verein ORT, Gesellschaft zur Forderung des Handwerke und der Landwirtschaft unter den Juden, a German organization, registered to undertake operations in the U.S.S.R. *Ekonomicheskaya Zhizn*, No. 248, October 25, 1928.

74 *Izvestia*, No. 157, July 11, 1926.

The Joint Committee also provided American plants and administrators for distribution and cultivation.[75]

Another 4,000 Jews settled by mid-1926. This number was held to be 'more than in the preceding 100 years, from the foundation of Jewish colonies during the reign of Nicholas I.'[76] Early in 1928, the Soviet government set aside for colonization by Agro-Joint some ten million acres in Eastern Siberia, between the Ussuri Railway on the north and the Amur River on the south. The administrative office was established in the spring at Khabarovsk and soon after, tractors, buses, automobiles, and settlers began to arrive. Adverse conditions forced half the settlers back to their homes in the first year, but very gradually a settlement was carved out of this previously unsettled land.[77]

Ikor, another United States Jewish organization interested in colonization, sent Dr. Charles Kanz to Siberia in 1928 to investigate conditions at first hand. Some 32,000 people, including the 1,000 immigrants who had arrived the previous year, lived in a total area of 42,000 square kilometers. Through Ikor and Ozet (a Soviet organization for establishing Jewish workers' settlements), quantities of equipment were shipped to the settlers during the 1929–30 season. A commission sent by Ikor to render technical assistance to the colony arrived in the U.S.S.R. in July 1929.[78]

The Joint Tractor Commission (1924) was an American-Jewish organization with the objective of generally developing Russian agriculture. At this time the commission had 135 tractors, which it rented out to peasants on condition that they create artels in groups farming not less than 20 dessiatins of adjoining land. Payment ranged from one to five poods of wheat per dessiatin.[79]

In 1923 the Jewish-American Committee imported 200 tractors, of which 75 were Waterloo Boy (make unknown) and the rest were Fordson. These were put to work in the Ukraine, generally at the disposal of collectives lacking horses.[80]

A joint-stock company, Akotprom, was formed in June 1923 to undertake commercial and industrial business in order to aid the Jewish Committee for Relief.[81] French Jewish circles also aided agricultural colonization. In 1923

[75] *Izvestia*, No. 64, March 10, 1923.

[76] *Izvestia*, No. 140, June 20, 1926.

[77] U.S. Consulate in Harbin, Report January 22, 1929. However, there are two sides to this story. Reports indicate that the Soviets had great difficulty after the first year in getting anyone to go to Biro-Bidjan, in Siberia, and gave each village and town a quota to fill for settlers to populate this 'God forsaken [sic] country.' [Report May 26, 1929, (316–108–529).]

[78] *Pravda* (Moscow), July 6, 1929.

[79] *Izvestia*, No. 140, June 20, 1926.

[80] *Pravda*, No. 166, July 26, 1923.

[81] *Ekonomicheskaya Zhizn*, No. 142, June 26, 1923.

some three million French francs were sent under an agreement, renewable annually, to Jewish families settling on the land.[82] In retrospect, one can only conclude that these settlements were little more than attempts on the part of the Soviet Union to extract foreign Jewish assistance. None of the settlements have survived.

THE FATE OF THE AGRICULTURAL COMMUNES

In early 1923 reports began to filter out of the U.S.S.R. concerning the desperate state of foreign communes. Many settlers were left without land allotments; others were in need of assistance, and some were caught in the squeeze between rising costs and low prices for grain and dairy produce.[83]

The commune was a failure, and its fate is well described in a *Pravda* article of late 1923. The author pointed out that incoming communes should have had every chance to become models of efficient agronomy. They brought in modern equipment, totaling to that time some $600,000 in value, and the membership, skilled and efficient, contained a large percentage of Party members. 'In general they are energetic, businesslike, Americanized people.'[84]

It was pointed out that in areas where land was lying idle, the commune Echo was given 'wild prairie' without a single building, with two of the sections connected by a narrow corridor 1 kilometer wide and 15 kilometers long. The Canadian commune in Odessa lost five baggage cars for six months; finally only three of the cars arrived.[85] The John Reed Commune in Podol Province did not obtain land for nine months, and then received a ruined estate. The Red Banner Commune waited seven months for land; and after working it for a while was expelled and force to sell its equipment to pay moving costs. The Novy Mir Commune received buildings infected with foot and mouth disease. The communes, it was stated, were breaking up. Some members were going back to the United States, and some were wandering all over Russia. Said the Soviets, ' . . . we are losing very precious and important breeding stations of agricultural knowledge; we are killing the cause with our own hands.'[86]

On the other hand, some communes must have survived for several years, as they were still importing American equipment in 1926. The Ira imported $35,000 worth of agricultural equipment in early 1926, the Agro-Joint

[82] *Ekonomicheskaya Zhizn*, No. 18, January 27, 1923.

[83] IS Report, December 8, 1923. (316–133–339.)

[84] *Pravda* (Moscow), No. 260, November 16, 1923.

[85] *Pravda* (Moscow), No. 260, November 16, 1923. Elsewhere it is stated that two cars out of three were lost.

[86] *Ibid.*

commune just over $39,000 worth of equipment, and AIK, in the Kuzbas, $4,345.[87]

In the end, however, they all perished.

THE AGRICULTURAL EQUIPMENT MANUFACTURING INDUSTRY

Toward the end of the nineteenth century, Russian farming, as a result of the introduction of modern agricultural machinery and implements, underwent extensive technical improvement. Peasant credit associations, funded by government banks and the zemstvos (district councils) encouraged this trend. Spurred by these changes, the manufacture of agricultural implements expanded rapidly; by 1908 there were over 500 plants, not including peasant industries, also of considerable importance. In 1908 the plants produced more than 390,000 ploughs, 8,800 seeders, 61,000 reapers and mowers, 22,000 threshers, and 31,000 winnowers.[88] By 1913 the number of establishments increased to more than 800, employing 39,000 workers and including very large plants funded with Western capital. By far the largest was the International Harvester plant, covering sixty-two acres at Lyubertsy, near Moscow. This plant, opened in 1911, provided employment for 2,000. The company had an extensive and well organized service network in Russia; the Omsk (Siberia) branch of International Harvester was the largest overseas branch operated by the company.[89]

Agricultural exhibitions, credit associations, and other forms of government aid enabled Russia to develop a relatively advanced agricultural economy before World War I. Agricultural products were exported on a large scale; at the turn of the century Russia had become the world's largest exporter of wheat.

The equipment plants survived the Revolution; exactly the same number (825) were reported available for use in 1923 as in 1913, but their output had declined catastrophically. In 1923, the Soviets produced only 12 percent of the ploughs, 70 percent of the scythes, 26 percent of the sickles, and between 1 and 8 percent of other implements which had been produced in 1913.[90]

The early 1920s were characterized by continuing crises in the industry. The 1921–2 plan for agricultural machinery was less than 50-percent fulfilled,

[87] *Amerikanskiai torgovlia i promyshlennost'* (New York: Amtorg Trading Company, June 1926), p. 40.

[88] *Russian Yearbook: 1912* (New York: Macmillan, 1912), pp. 157–61. This evidence appears to refute the numerous statements that agricultural machinery output in prewar Russia was negligible. For an example, see Friedman, *op. cit.*, p. 81.

[89] *World Harvester*, November–December 1953.

[90] *Biednota*, No. 1427, January 26, 1923.

and productivity per worker only 43 percent of prewar.[91] *Kooperativnoe Delo* for June 1922 describes the chaos into which the industry had descended. Of the 825 enterprises working in 1913, only 73, or 9 percent, were working at all, and most of these in a half-hearted manner.

To overcome production difficulties, the industry was consolidated. Prerevolutionary works in the Ukraine were now grouped into two trusts: Ukrselmashtrest and Zaporozhtrest. In October 1923, eleven of the twenty-one plants in these two trusts were combined in the Vseukrainsky Selmashintrest, and the remaining ten were closed down. Specialization of output was increased. Drill seeders were now produced at Elvorty, Helferlich-Sade (in Kharkhov), and Kiranon-Fuks. Reapers were produced by the Donsky (Nikolaev) and Kopp (Zaporozhia) works. Threshing machines were produced at Elvorty, Helferlich-Sade, and Lepp-Valman. However, major deficiencies reported for 1925–6 suggest that concentration did not get to the root of the problem.[92]

Selmashstroi reported in 1923 that the decline was due to the high cost of production and inadequate financing. The deficiencies had now become monumental. Production and imports together failed even to offset normal wear and tear, and peasants were reverting to the use of primitive, hand-made wooden equipment.

ATTEMPTS TO DEVELOP A SOVIET TRACTOR, 1922 TO 1926

The Soviets made numerous unsuccessful attempts to produce a workable tractor in the early years of the 1920s. These ended in failure, and the Soviet Union then turned to the United States for assistance in constructing the massive tractor plants of the Five-Year Plan.

Two designs were completed in the Soviet Union about 1923, both by I. B. Mamin. The 'Gnom' design was selected as being suitable for Russian agricultural conditions, and Mamin was sent to Germany (with 130,000 rubles) to purchase the necessary production equipment. The Balakov factory in Samara was turned over to 'Gnom' mass production. It was anticipated that 150 of these small, 16-horsepower, oil-driven tractors would be built in the first year and 250 to 300 per year thereafter. No complete units were produced, although some engines were used for a while as stationary power units.

The other Mamin design was the crude oil tractor, 'Karlick,' with a one-cylinder 12-horsepower engine. This was built at the Old Neurepublik works at Marmstadt on the Volga. Some were produced, but, like the 'Gnom', they

[91] *Pravda* (Moscow), No. 279, December 8, 1923.
[92] U.S. State Dept. Decimal File, 316–129–969.

were too heavy, too clumsy, and insufficiently powered for field use, and were used only as stationary power units.[93] Another tractor, the 'Bolshevik', a 4-cylinder, 20-horsepower machine was also attempted at the Bolshevik Works in Leningrad. Only a small number were produced, in 1923–4, and production ceased entirely before 1926. The Ford Delegation suspected it was for military transport work, as it was too large and clumsy to perform as a tractor.[94]

The 'K.P.Z.' tractor was a 4-cylinder, 50-horsepower machine built at the Kharkov Locomotive Works. This was a copy of the German tractor, 'W.D.' It was expensive (15,000 rubles) and much too clumsy for field use. Production stopped before 1926.[95]

Several hundred of the 'Zaporojetz' were built at the Ukraine Agricultural Machinery Trust. This was a 3-wheeled, 1-cylinder, 12-horsepower machine, very heavy (2 ton) and useful only as a stationary power unit. It was priced at 5,000 rubles, expensive when compared to the imported Fordson (1,800 rubles).[96]

Two additional tractor models were attempted at the Kolomensky Machine Works at Golutviko near Moscow. One was the 'Mogul', a 4-cylinder, 12–25-horsepower machine: an 'exact copy of an American tractor by the same name.'[97] The other was a 2-cylinder, crude-oil copy of the Swedish tractor, 'Avance,' but with transmission and gears as in the 'Mogul', built in the same plant. Production of both was very small and ceased by 1925–6.[98]

Work was also started on an experimental electric plow: an example of Lenin's preoccupation with electrification. A contract was issued in 1923 to plow 16,000 dessiatins with 16 electric plows. When the season was over, only one had worked any length of time, and only 477 dessiatins had been plowed. In the following year, 5 plows undertook 4,000 dessiatins, but actually plowed only 300. The trailer was found to be 'extremely heavy and constantly buried in the ground.'[99] It was expensive and impractical; the experiment was discontinued in 1926, although it has been revived at intervals since that time.

Work also started on several models of oil-fueled tractors. 'An exact copy of an American tractor built in 1922'[100] (100 'Holt') was placed in production at the Bolshevik plant, near Leningrad. The carburetors, ignition system, and other parts were imported from the United States. Work continued for one

[93] *Report of the Ford Delegation to Russia and the U.S.S.R. April–August 1926* (Detroit: 1926), Ford Motor Company Archives Accession No. 49, p. 42.
[94] *Ibid.*, p. 41, The report has photographs of these Russian models.
[95] *Ibid.*
[96] *Ibid.*
[97] *Ibid.*, p. 40.
[98] *Ibid.*, p. 46.
[99] *Ibid.*, p. 102.
[100] *Ibid.*, p. 103.

year. Between 1924 and 1926 the plant only made spare parts, but this also ceased in 1926. The Ford Delegation (1926) reported the 'Russian Holt' to be a product of extremely high cost and poor quality.

INTERNATIONAL HARVESTER COMPANY AND NATIONALIZATION

According to Keeley,[101] the International Harvester plant at Lyubertsy, just outside Moscow, continued operation through both revolutions and the winter of 1919–20 with only a single three-day strike. Cromming, the German manager, produced equipment for the Bolsheviks on a cost-plus-10-percent basis, the percentage to cover the living expenses of the chief executives and himself. Cromming agreed with the Workmen's Committee to supply food (no small promise), in return for complete authority over technical operations of the plant. Cromming apparently acted on his own initiative; he was reported as not knowing whether the parent United States company had even wanted to continue operations after the Revolution.

In 1921 the Soviets offered an agricultural equipment manufacturing concession to an unknown United Kingdom tractor manufacturer. The offer was passed along to International Harvester, who in turn passed it on to the State Department with a notation that the company was cool to the proposition but worried lest British and German interests accept a concession to manufacture tractors and freeze out International.[102]

It is clear that, although Cromming operated the Moscow plant and International Harvester was concerned for the welfare of employees inside the U.S.S.R., including several engineers sent in 1921, the company did not press for modification of United States policy. Mr. Legge of International is quoted as saying, 'Nothing has occurred up to the present which would justify considerations of change in policy of this Government.'[103] In 1924 rumors circulated about an impending takeover of the Moscow plant[104] which was, in part, accomplished before the end of 1924. The enterprise immediately slumped into substantial deficit, a subsidy of 1.8 million rubles and a credit of 466,000 rubles being required on expenses of 3.49 million rubles. Even more catastrophic was the effect of the August decree of the Council of Labor and Defense equalizing prices for domestic and imported tractors. In February 1925,

[101] U.S. State Dept. Decimal File, 316–107–97.

[102] A copy of the proposed concession agreement is in U.S. State Dept. Decimal File, 316–130–1162. There is a marginal notation, marked HH (Herbert Hoover), that great importance was attached to this offer—presumably on the part of the Administration.

[103] U.S. State Dept. Decimal File, 316–108–23.

[104] Rumors noted in 361.115 of the Decimal File, 316–108–1279.

Glavmetal confirmed the first year's program of 1,000 hay harvesters and 600 reapers planned for Lyubertsy. The hay harvesters were estimated to cost 130 rubles apiece, against 190 rubles for imported harvesters. Glavmetal then reversed itself and requested Vesenkha to dismiss the 'acceptance committee' which had been taking over the factory from the International Harvester Company.[105]

A rapprochement took place in 1925. In August, International Harvester was granted permission to conduct trading operations within the U.S.S.R. and supply spare parts for agricultural machinery.[106] The company then began to advance substantial credits for the purchase of American-made equipment.[107] At the end of 1925, all International plants were denationalized; according to the German Embassy, they were found too complex to operate and International Harvester temporarily re-entered its own factories.[108]

The Bolsheviks had the last word. The Selmash trust was liquidated November 16, 1926 and a committee established to wind up business, including the claims of the Lyubertsy works of International. On March 7, 1927, the trust was placed under moratorium, and all claims against it suspended. The United States Riga consul comments:

> Thus the legal guarantees which existed at the time when the creditors entered into business with the syndicate [i.e., trust] were suddenly withdrawn, leaving the creditors of a Government organization at the mercy of a Government commission and depriving them of a part of the lawful interest on their money. It will be noted that the moratorium is entirely one sided and does not suspend the obligations of the syndicates debtors . . .[109]

As late as 1929, International was still trying. It negotiated a contract for the sale of 5,900 International tractors on three-year credit terms, including clauses which allowed the U.S.S.R. to send technicians to the United States for training and required International engineers to give consulting services on the establishment of a network of tractor-repair shops.[110]

The contribution of Lyubertsy and the International Harvester Company to Soviet industrialization is best summed by a Soviet publication:

> The Lyubertsy enterprise is a shining example of the good sense of 'Nep.' The Harvester Company rendered the hated Bolsheviks the same service that Harriman performed in Chiatury and Krupp in the Ukraine.

[105] *Ekonomicheskaya Zhizn*, No. 29, February 5, 1925.

[106] *Torgovo-Promyshlennaya Gazeta*, No. 185, August 15, 1925.

[107] German Foreign Ministry Archives, T120–3033–H10945. The company advanced $2.5 million on 18-month terms.

[108] *Ibid.*

[109] U.S. Consulate at Riga, Report 4449, April 12, 1927. (316–111–924.)

[110] *Izvestia*, No. 149, July 3, 1929.

> These firms helped them to train a nucleus of skilled workers in these enterprises and to learn the process of production which soon enabled them to continue production without the capitalists. Today there are few concessions left in Soviet Russia and not even the Vorwaerts dares to assert any longer that the Bolsheviks have introduced capitalism. . . .[111]

At the same time, 1,300 60-horsepower Caterpillar tractors were purchased for delivery in November–December 1929, with similar clauses for technical assistance. Caterpillar sent engineers and technicians to the U.S.S.R. to instruct in the operation of tractors, and Russian engineers went to Caterpillar plants in the United States for further instruction on maintenance. The company opened a permanent office in Moscow to solve problems arising in the utilization of their tractors.[112]

POSITION AT MID-DECADE

The 1924–5 plan for tractor manufacture concentrated production in larger prewar plants taken over by Glavmetal; Krasnyi Putilovets was planned to produce 500 tractors, Gomza 500, and the Kharkhov plant 120.

These targets were not achieved, and attempts to create a tractor industry were described by Dr. G. Schlesinger, a German tractor expert, as 'creating a laughable impression and extremely amateurish.' In an effort to induce the peasant to buy the miserable product of the Soviet tractor factories, a decree was published in August 1925 equalizing prices for Soviet-made and the much cheaper and better-quality imported tractors. In effect, the prices for imported tractors were raised.

Table 7–2 PRICE SCHEDULE FOR SOVIET AND FOREIGN TRACTORS (DECREE OF AUGUST 1925)

Russian		*Rubles*
Krasnyi Putilovets (copy of Fordson)	(with plow and spares)	1,800 (cost 4,000 rubles)
Kolomenets	(with plow and spares)	2,500
H.P.Z.	(without plow)	8,000
Zaporozhets	(with plow and spares)	2,000
Karlik	(with plow and spares)	2,000
Bolshevik (planned)	(with plow and spares)	8,000
American		
Fordson	(with plow and spares)	1,800 } (now including 165 rubles tractor subsidy tax)
International (30 h.p.)	(with plow and spares)	4,000 }

Source: *Ekonomicheskaya Zhizn*, August 18, 1925.

An implementing decree of the Council of Labor and Defense had the stated objective of providing the largest possible distribution of tractor power

[111] Theodor Neubauer, *Lyubertsy; a Cross Section of the Five Year Plan* (Moscow: Co-operative Publishing Society of Foreign Workers in the U.S.S.R., 1932), p. 17.

[112] *Ekonomicheskaya Zhizn*, No. 160, July 16, 1929.

for the improvement of land cultivation.[113] Imported Fordsons and Internationals normally sold well below the prices of the few domestic tractors; after the 1925 decree the imported Fordson and the Krasnyi Putilovets copy of the Fordson both sold at 1,800 rubles, as indicated in table 7–2. The stated objective, of course, was not fulfilled: the domestic product was far below the imported quality. The peasant preferred the imported tractor, but surplus accruing from taxation of the imported tractor was used to offset the deficit in domestic production, and in effect subsidize domestic tractors.[114] Agricultural productivity suffered while industry tried to overcome production problems.

Russian tractor works in this period were chronically inefficient. The Putilovets required 350 man-days per tractor produced, and at the Kharkov Works the assembly of a tractor motor required eight man-months.[115] In 1926 an inspection of the agricultural machinery factories of Riazan, Tula, Orel, and Belokhuminsky revealed that the raw-material supply, particularly that of iron and steel, was hopelessly deficient. Tula, for example, received only 8 percent of its iron and steel requirements in 1925–6. In addition, equipment was out of repair and in need of replacement.[116]

The dismal plight of the tractor-building industry was investigated in June 1925 by the above-mentioned Dr. Schlesinger, at the invitation of Orgametal. Conditions must have been pretty miserable; *Ekonomicheskaya Zhizn* made the point that 'one must not become downhearted.'[117]

Schlesinger's specific recommendation was a plant to built 10,000 tractors a year 'with the special machine tools that are being built by American factories for Ford,' to replace the outmoded tractor works.

The 1925–6 plan for domestic tractor-building allowed for only 1,800 tractors:[118]

Type 'FP' (Fordson-Putilovets)	900 tractors
'Kolomenets'	250 tractors
'Zaporozhets'	300 tractors
'Karlik'	100 tractors
'Bolshevik'	100 tractors
'Comintern'	150 tractors
	1,800 tractors

113 Decree is reprinted in *Ekonomicheskaya Zhizn*, No. 186, August 18, 1925.

114 This was almost the supreme insult so far as the Ford Motor Company is concerned: the unauthorized Soviet copy of the Fordson was subsidized at the expense of the imported Fordson. The 'subsidy tax for Russian tractor industry' was 165 rubles on a Fordson—about 8 percent of cost.

115 U.S. Consulate at Riga, Report No. 3237, September 28, 1924. (316–133–516.)

116 *Ekonomicheskaya Zhizn*, No. 87, April 16, 1926.

117 *Ekonomicheskaya Zhizn*, No. 130, June 11, 1925.

118 *Ekonomicheskaya Zhizn*, No. 290, December 19, 1925.

The intent in 1925–6 had been to supply 16,750 tractors, of which 1,800 were to have been made in the U.S.S.R. The balance of 14,950 tractors (89.2 percent) were planned as imports.[119] Actually, less than 900 tractors were produced, and most fell to pieces after a few weeks or months in operation; in effect, almost all usable tractors were imported.

KRASNYI PUTILOVETS AND THE FORD MOTOR COMPANY

Although the International Harvester plant had been the largest in tsarist Russia, the oldest and most famous undoubtedly was the Putilovets in St. Petersburg, which was founded in 1801, and 100 years later was claimed as the largest manufacturing plant in Russia and also the largest in Europe, apart from Krupp in Germany and Armstrong in the United Kingdom.[120] The firm had licensing agreements with Western companies; one with the Bucyrus Company (United States) dated from the early 1900s and covered the manufacture of placer dredges and steam shovels.[121] The Revolution dispersed its skilled workers and managers, and it was not until January 1922 that some sections began operating again, with German engineering assistance. We do know something of the mechanical condition of the plant during the period 1917 to 1922 (the five years of 'technical preservation'). A report exists which indicates that equipment was intact, although '60 percent worn out'; blame for non-operation was placed on the enemies of the people:

> It was at that moment impossible without any prepared plan to put all in order, because of the opposition (not shown openly) of the different specialists towards the Working Peasant Power.[122]

Later some émigrés from Detroit were sent to Putilovets, and the 1926 Ford Delegation reported that the works was well equipped with United Kingdom, German, and American machine tools, and that it was

> . . . not at all badly arranged, with machines in progressive order, and it was the only shop visited that was provided with special tools and fixtures to any extent. The manufacturing methods, jigs and fixtures strongly reflected Ford practice at the old Dearborn plant.[123]

The plant had then been reopened about a year before, and employed some 800 workers. The delegation estimated production at three tractors per month.

119 U.S. Consulate at Riga, Report 3529, January 18, 1926. (316–133–559.)

120 *The Works 'Red Putilovez': A Short Historical Description.* Typewritten ms, undated, origin unknown. Hoover Institution, Stanford University.

121 *Designed for Digging: The First 75 years of Bucyrus-Erie Company* (Evanston: Northwestern; 1955), p. 85.

122 *The Works 'Red Putilovez': A Short Historical Description*, p. 15.

123 *Ford Delegation Report (1926)*, pp. 48–9.

There was a sprinkling of ex-Ford Motor Company employees throughout the plant, including the final inspection area.

Ford, the arch-capitalist, then attracted the envious attention of the Communists. *Fordismus* and *Fordizatsia* as work methods became bywords; if Ford methods would work in a capitalist country then they must surely work in a socialist country.[124] The initial relationship between the Ford Motor Company and the Soviets was purely one of trade. Between 1922 and 1926, Ford sold 20,000 tractors to the U.S.S.R., each with its own set of replacement parts. By 1927, more than 85 percent of all trucks and tractors used in the U.S.S.R. were Ford-built from Detroit. The balance was a mixture of imported Fiats, Case, Internationals, and some United Kingdom models, together with the scrambled output of the A.M.O. plant in Moscow (attempting to reproduce Fiat trucks and repair White trucks), the ex-International Harvester plant, and the decrepit prerevolutionary tractor plants in Moscow and Kharkov.

The 1926 Ford Delegation to the U.S.S.R. found Ford products everywhere. The Ukrainian government owned 5,700 tractors, of which 5,520 were genuine Fordsons. Azneft had 700 automobiles, of which 420 were Fords. The major problem facing Soviet organizations was servicing, and this was also the primary interest of the five-man Ford team. The delegation traveled throughout the U.S.S.R. giving lectures and lessons on servicing and cost reduction, and setting up training schools and service organizations along Ford lines elsewhere in the world. The existing servicing was found to be 'wretched.' Charts and diagrams produced in abundance on request meant nothing: in practice, little in the way of either maintenance or repair was being done:

> Our surprise can be imagined when we arrived in the Ukraine, the richest tractor district in Russia, and were unable to find a single Fordson repair shop worthy of the name. No special repair equipment existed anywhere, although fourteen full sets of Fordson (repair) equipment had lately been received for Ukraine alone. . . .[125]

In 1923 the State Trade Commission had been given the responsibility of developing a network of sale and repair shops to be tied in with the major repair points established by the Fordson sales organization in the U.S.S.R. Apparently the trade commission had not established its repair shops, and the Fordson shops had been neglected.[126]

The 1928 Sorensen mission to Russia inspected the Krasnyi Putilovets plant, and, as Sorensen relates it:

[124] 'Fordismus,' *Bolshaya Sovetskaya Entsiklopediya* (1933).
[125] *Ford Delegation Report (1926)*, p. 49.
[126] *Ekonomicheskaya Zhizn*, No. 48, March 3, 1923.

> We came into . . . the assembly room and I stopped in astonishment. There on the floor lines they were building the Fordson tractor. . . . What the Russians had done was to dismantle one of our tractors in the Putilov Works, and their own people made drawings of all the disassembled parts.[127]

However, as Sorensen pointed out, it was a long way from pulling a machine to pieces to building workable copies, and the Russians had neither the specifications nor the skills to turn out good copies. The Fordson-Putilovets tractor experiment provided little more than technical education.

In brief, at the mid-point of the 1920s, the Soviets had five prewar agricultural machinery plants, suitable for small-scale tractor construction. However these plants were costly to operate and technically backward. They made a hopelessly insufficient and inefficient contribution to agricultural development.

The solution was to turn to American technology. The poor Krasnyi Putilovets works was therefore completely re-equipped with American equipment[128] and, by technical-assistance arrangement, placed under the management of the engineering consultants Frank Smith, Inc.[129] A series of large-scale tractor building plants was then envisaged, utilizing the latest American mass production methods. The first of these was the Stalingrad (followed by the Chelyabinsk and Kharkov), designed by Albert Kahn, a United States construction design firm, and built by McClintock and Marshall, also of the United States.[130]

Albert Kahn had been the builder of the large mass-production plants of the American automobile manufacturers, and he incorporated the skills and ideas of American experience in mass production. The Stalingrad tractor plant was designed to produce 40,000 tractors a year in two shifts. With United States assistance, the Soviets produced similar tractor and automobile plants in the 1930s.

The Soviets had a clear concept of the advantages to be gained from importing this technology *in toto*, and the contribution it would make to the achievement of the first Five Year Plan:

> The utilization of its [i.e., Kahn's] technical assistance assures the execution of the construction work of the Traktorstroi within the specified time and guarantees the employment of all the achievements of modern American technique.[131]

[127] Charles E. Sorensen, *My Forty Years with Ford* (New York: Norton, 1956), p. 202. The plant certainly did not impress Sorensen, who suggested they take some sticks of dynamite and 'blow it out of its misery.'

[128] Friedman, *op. cit.*, p. 238.

[129] U.S. State Dept. Decimal File, 316-131-654.

[130] *Ibid.*

[131] The agreement between Albert Kahn and Glavmashinostroi is reported in *Torgovo-Promyshlennaya Gazeta*, No. 109, May 16, 1929.

The Kahn company prepared construction plans in the United States while at the same time instructing a group of engineers from Traktorstroi. The company then hired American engineers to handle the erection of the buildings, worth about 8 million rubles ($3 million). The production equipment was purchased in the United States.[132]

Table 7–3 TECHNICAL-ASSISTANCE AGREEMENTS (TYPE III) WITH THE POST-REVOLUTIONARY TRACTOR CONSTRUCTION INDUSTRY TO 1930

Technical Process	*Western Partner*
Preliminary consulting	Dr. Ing. G. Schlesinger (Germany)
Gear-cutting technology	Brown Lipe Gear Co. (Syracuse)
Electrical-equipment manufacturing	The Electric Auto-Lite Co. (Toledo)
Axle-manufacturing	Timken-Detroit Axle Company (Detroit)
Engine technology	Deutz A-G, Hercules Motor Company (U.S.)
Plant design	Albert Kahn, Inc. (Detroit)
Plant steel structure erection (Stalingrad)	McClintock and Marshall (U.S.)

Source: American-Russian Chamber of Commerce, *Economic Handbook of the Soviet Union*, pp. 97–101.

Although the tractor industry, heralded as the basis for socialist agriculture in the same manner that electrification had been associated with industrialization, was a major problem for much of the decade, the gravest shortages occurred in production of the simpler kind of equipment. Scythes, sickles, pitchforks, plows, harrows, and winnows were prohibited from import, as it was planned to supply all internal demand from Russian factories. The simpler kinds of agricultural equipment were subject to a heavy duty of 4.5 rubles per 100 kilograms, whereas the more complicated mechanical equipment was allowed in duty-free; reapers, binders, disc harrows, and all newly invented or improved equipment required by model farms were allowed in without duty. However, the massive shortages of simple equipment reduced the ability of the peasant to work his land, and in some areas the peasant actually returned to the use of wooden implements.[133]

We may conclude therefore, that in agriculture the transfer of Western technology was not notably successful. The hostility of the peasant, the collectivization of agriculture, the undue attachment to imaginary massive

[132] *Bank for Russian Trade Review*, II, No. 7 (July 1929), 4; and U.S. State Dept. Decimal File, 316–132–28/44.

[133] U.S. Consulate at Riga, Report 3481, December 5, 1925. (316–133–540.) The deficiency in 1925 amounted to 140,000 plows, 614,000 harrows, and 17,000 winnows.

economies of scale, and the misunderstanding of the factors making for success in Western large-scale agriculture made for ineffective transfer.

Kuibyshev's lengthy report of April 1927 suggests the great gap between the Soviets' achievement and their fantastic claims. While Krasnyi Putilovets was struggling to make a few ersatz copies of the Fordson tractor, the effort was thus described by Kuibyshev:

> . . . a mass of difficulties has been solved brilliantly, the production of tractors is getting cheaper and cheaper and the quantities produced by the Red Putilovets are ever increasing. . . .[134]

In the agricultural equipment industry, nothing of substance was achieved in tractor production until the very end of the decade, and implement manufacture was unfortunately ignored in favor of the tractor—the favored Bolshevik symbol of industrialization. The failure of adapted prerevolutionary plants to make tractors, whether of native design (the Gnom) or stolen design (the Fordson) forced the Soviets to arrange for Western tractor manufacturers to install packaged 'knocked-down' plants in the U.S.S.R.[135]

CREDITS GRANTED BY AGRICULTURAL MACHINERY PRODUCERS TO THE SOVIET UNION, 1925

The Soviet Union had no trouble purchasing agricultural machinery on credit terms. The *Ford Delegation Report (1926)*, for example, notes:

> International Harvester, which lost huge sums of money in Russia through nationalization of its property and equipment, are now extending two years credit to the Soviet Government.

An International Harvester invoice dated August 18, 1925, indicates that the cost of the International 15–30 tractor to the Soviet government was $1,150 and the 10–20 tractor $775 (both f.o.b. New York). Terms were as follows:

50 percent three months after purchase
16.6 percent August 15, 1926
16.6 percent November 15, 1926
16.6 percent May 15, 1927

Interest was charged at 8 percent in the first year and 6 percent in the second.

Case Machinery was granting about the same terms. Advance-Rumley, which had about 600 to 800 of its 'Old Pull' tractors in the Soviet Union, was offering less favorable terms, and this limited its sales. An invoice dated August 12, 1925, places cost to the Soviet government at $1,000, and offers terms at 10 percent with order, 40 percent against documents in New York, and 25 percent in each of two payments, to be made November 1, 1926, and November

[134] *Izvestia*, No. 94, April 27, 1927.

[135] Construction of the Stalingrad and other tractor plants is covered in Vol. II.

1, 1927. Dodge Brothers was offering nine-month terms with only 6-percent interest for lots of more than 50 tractors, but required 50-percent payment against documents for any size of purchase. Massey-Harris, in Canada, sold 300 binders in August 1926 on terms of 10 percent with order, 20 percent against documents, 10 percent three months from date of delivery, and the balance in August 1927. Fordson, who sold the bulk of the tractors in the U.S.S.R., required 25 percent down and the balance over nine months or one year. These terms were not, however, as favorable as those obtained by the Soviets for automobiles and trucks. Steyer in Austria and Mercedes in Germany both gave three-year credits, and Renault in France two years.

Of a total 24,000 tractors in Russia in August 1926, 20,000 were Fordsons, 2,400 were International Harvesters, 700 were Advance-Rumley, and 900 were miscellaneous (including Soviet makes).

In the light of these statistics, statements that the Soviet Union developed without foreign financial assistance are seen to be manifestly untrue.

CHAPTER EIGHT

Fishing, Hunting, and Canning Concessions

THE small group of fishing, hunting, and canning concessions was more important as a contributor to foreign exchange earnings than as a channel for the direct transfer of technology. Furs, for example, were the second most important Soviet export and indirectly, by generating foreign exchange, aided the technological transfer process.

NORWEGIAN FISHING CONCESSIONS

In early 1923, an agreement was made between the Norwegian firm Vinge and Company and the People's Commissariat of Supplies, under which the Norwegians were given the privilege of hunting 'sea animals' within the territorial waters of North Russia. The company equipped fifty-six ships for this purpose. Vinge and Company paid 200,000 Norwegian crowns for this right.[1]

For the second year of operations the Soviets demanded negotiation with the ships' owners who had been organized with Vinge as their bargaining agent in the first year. In the second year, rental was set at $10 per ton for ships employed hunting seals, with a minimum payment of $40,000. Provision was also made for Russian scientists to study fishing methods and fishing locations, on board the 'best' of the ships in the fleet.[2]

An additional contract was also concluded for the 1924 season, under which Vinge was granted the right to fish for white sturgeon along the Russian Arctic coast.[3]

A concession was granted to the Norwegian citizen Christensen in May 1923 to hunt whales and reduce these to food products within a zone extending along the Arctic coast of Russia. It was granted for a period of fifteen years, and the

[1] *Russian Economic Review*, III, No. 8 (June 10, 1923), 12.

[2] *Ekonomicheskaya Zhizn*, No. 71, December 23, 1923.

[3] *Ekonomicheskaya Zhizn*, No. 303, October 7, 1924.

Soviet government received a portion of the profits unstated but not less than £2,000 sterling per year. Each ship manned by Christensen was required to have at least six Russian seamen, and shore enterprises operated by the concession were required to employ not less than 25 percent Russian workmen.[4]

A group of German fishing firms working in the Murmansk area was granted a concession in 1924 to fish in certain northern waters disputed by the U.S.S.R. and Germany. The group holding the concession was known as Wirtschafteliche Verband der Deutschen Hochseefischerein and was based in Bremen.[5]

FUR AND SKIN CONCESSIONS

The Hudson's Bay Company of the United Kingdom and Canada concluded a concessions agreement with Vneshtorg in April 1923, under which the company agreed to export to Kamchatka, in the Far East, goods to the value of $350,000, at prices not exceeding the London market price plus 20 percent. The company could also purchase furs on the peninsula in cooperation with Vneshtorg. The furs were to be exported to London, where 10 percent of the value was payable to Vneshtorg, and any profit resulting from the ultimate sale of the furs was to be divided equally between Hudson's Bay and Vneshtorg. A similar agreement was reported with Glavconcern for smoked fish and furs.[6] The company was required to pay all state and local taxes, license fees, and export and import taxes.

The winter buying season did not go untroubled for Hudson's Bay. There were petitions from Kamchatka in which hunters requested the government

> . . . to free them from the criminal activities of the Hudson's Bay firm . . . agents of the firm deliberately value furs at 50 percent below last year, and sables of the highest quality are valued at the same price as skins of the lowest quality. . . . The firm has double income whereas the population suffers treble losses.[7]

The Persian lamb fur market in the United States was dominated by Brenner Brothers, of New York. In the fall of 1922, Kalman and Feival Brenner made a buying trip into Russia and purchased 'a considerable quantity of furs,' for delivery to Paris and New York. They considered uncertainty too great to warrant more extensive dealing, although they were offered an 'attractive proposition.'[8]

[4] *Izvestia*, No. 113, May 24, 1923.

[5] U.S. State Dept. Decimal File, 340–5–806.

[6] *Rigasche Nachrichten* (Riga, Latvia), April 14, 1923.

[7] *Pravda* (Moscow), No. 40, February 19, 1924.

[8] U.S. Consulate at Riga, Report 2729, September 25, 1922. (316–107–1034). This deal apparently went through because Brenner's Siberian representative had a brother who was a 'high government official in Moscow.'

Karl Brenner, a partner of the firm, was approached by Arcos agents in 1924 with another $1 million proposal. In return for the exclusive right to purchase furs within the U.S.S.R., they could buy at 15 percent under the market price or be repaid at an interest rate of 10 percent. Brenner pointed out that Arcos had overheads of 35 percent in handling furs while Brenner had a 50 percent markup. They considered the U.S.S.R. had reached the end of its financial resources and refused to deal.[9] The company registered for business and purchased 500,000 rubles of furs in the 1924–5 season.[10]

In the same season, J. Wiener, of New York, was registered for operations in the U.S.S.R. and purchased 400,000 rubles worth of furs.[11]

Probably the largest of the fur concessions was that of Eitingon-Schild, which in 1924–5 handled 4 percent of the total trade turnover between the United States and the U.S.S.R.[12]

A dispute between the Eitingon-Schild concession partners in United States courts revealed the substantial profits made by a few successful concessions. Representing Eitingon-Schild, Otto B. Shulhof, of New York City, went to London and then to Moscow in 1922 to negotiate a contract for the marketing of Russian skins and furs. Eitingon himself was a Russian émigré and had considered himself persona non grata so far as the Soviets were concerned. Shulhof held that when the concession was about to be signed (he had all required signatures except those of Krassin and Bogdanov) he found that Eitingon had signed a fur concession directly with Arcos, Soviet trade representatives in London. Shulhof sued for $1 million damages for breach of contract, in lieu of the 10-percent commission. Just before going into court, he raised the damage claim to $2 million. Examination of Eitingon-Schild accounting records indicated that the concession profits for two years were over $1.5 million. Net sales of the concession had been $7,340,178, which after deduction of cost and 7 percent royalty, left a net profit of $1,846,759.[13] The contract had run initially for one year, during which Eitingon-Schild advanced the Soviets 50 percent of the value of the skins and furs and split profits equally with them. During the second year, the concessionaire was required to make more substantial advances, and his profit was limited to 15 percent of the selling price of the furs.[14] Apart from the Hammer operations, no other case is known where large profits were made from concessions.

[9] U.S. Consulate at Riga, Report 2550, December 8, 1924. (316–108–1277.)
[10] U.S. Consulate at Riga, Report 927, January 17, 1925. (316–111–915.)
[11] *Ekonomicheskaya Zhizn*, No. 192, August 25, 1925.
[12] U.S. State Dept. Decimal File, 316–108–1543.
[13] An independent accountant in later evidence held that profits were only $1,079,973 over two years.
[14] *New York Times*, various issues, November 1927.

SIBERIAN FISH CANNERIES

In the Soviet Union the only variety of fish canned in 1923 was salmon, of which about 30 million pounds were canned annually and almost all exported. Of the twenty canneries in Siberian waters, fifteen were owned and operated by Japanese, two by Russians, two by Americans, and one by the British. There were also eighteen crab canneries, of which fifteen were Japanese-owned and operated and three were Russian. The entire Siberian fishing industry in 1923 employed about 34,000 persons, of whom 29,000 were Japanese. The Japanese also leased 62 percent of the fishing stations.[15]

AMERICAN CONSTRUCTION OF SALMON CANNERIES IN KAMCHATKA

In 1927–8, two large salmon canneries, one with five canning lines and one with three canning lines, were built to can salmon for export. The construction of these new canneries indicates a complete dependence on the most advanced Western engineering achievements. Nearly all the firms involved in construction came from the Pacific coast of the United States.

Table 8–1 CONSTRUCTION AND EQUIPMENT OF KAMCHATKA SALMON CANNERIES, 1928

Structural Equipment Supplied	*Company*
Coolers	Isaacson Iron Works, Seattle
Steam engines	Nagle Engine and Boiler Works
Steel barges	Wallace Bridge and Structural Co.
Conveyers	International B.F. Goodrich Co.
Boilers	Pennsylvania Boiler Works
Diesel engines	Fairbanks Morse
Transmission equipment	Link Belt
Canning Equipment Supplied	
Electric strapping equipment	EBY Co.
Lift trucks	Parker
Cannery equipment	Seattle-Astoria Iron Works
Canning equipment	Smith Canning Machine Co.
Pumps	Worthington Pump Co.
Tinplate	Bethlehem Steel and United States Steel
Fish cutters	Wright and Smith
Fillers, retorts	Troyer-Fox
Lacquering machines	Seeley
Nailing machines	Morgan

Source: Amtorg, *op. cit.*, III, No. 7 (1928).

[15] U.S. Embassy at Tokyo, Report 13, January 29, 1925. (316–108–1310.)

A floating crab cannery with a capacity of 500 48-pound cases a day was manufactured for the U.S.S.R. by the International Packing Company in Seattle, in 1928.[16]

After a Russian fishing industry delegation had visited the United States, the equipping of nearly all Siberian and Far Eastern canneries was given over to American firms.[17] Similarly, an Odessa fish cannery with a capacity of 10 million cans of fish a year was equipped with Western canning machinery.[18]

In brief, fur concessions enabled the Soviets to enter the foreign market and, with the help of Western partners, build this into their second largest generator of foreign exchange. The canneries, also a significant exchange generator, were equipped completely by Western manufacturers, primarily from the United States.

[16] Amtorg, *op. cit.*, III, No. 7 (1928).
[17] Amtorg, *op. cit.*, III, No. 2 (1928).
[18] Amtorg, *op. cit.*, III, No. 12 (1928).

CHAPTER NINE

Restoration of the Russian Lumber Industry 1921-30

SEVEROLES TRUST AND FOREIGN LUMBER COMPANIES

Russia has extensive forestry resources—probably the finest in the world. Under the tsars, lumber trade possibilities were not fully recognized and the industry developed slowly in the years immediately preceding World War I. In 1913 Russia had exported 10 million cubic meters of sawed timber; by 1929 this volume of exports had been almost regained.

There were no Soviet exports of lumber in 1919–20. In 1921 the industry recovered slightly and exported 35,000 standards, or about 3 percent of the average yearly prewar shipment. Reorganization in 1922–3 created four trusts: Severoles in the northern forest area, Sapodles in the western forest area, Dvinoles in the Dvina forest area, and Exploles in the Far East.

The trusts, however, were incapable of increasing production. Penetration of prewar markets was impossible, owing to their inability to organize production; shortages of equipment, tools, provisions, and labor made sizable production impossible.

Negotiations for assistance were opened with foreign lumber companies in 1921 and resulted in the formation of four mixed companies (Type II concession agreements, with some elements of the Type I and Type III), which took over the operation of the greater part of the northern forests in the Severoles trust. The foreign companies were predominantly British and German and held 49 percent of the shares, 51 percent being held by the Soviet government. The Soviets also had the right to grant further concessions to build sawmills and woodworking mills in the trust areas. The foreign companies were entrusted with entire management of forests and mills and had the obligation to supply machinery, tools, housing, and food for those workmen supplied by the Soviet government. The poor state of the railroad system meant that only areas close to rivers and ports could be exploited.

For timber in the Luga and Pliussa forests, near the Estonian border, the Soviets made an agreement with the Estonian companies Arbor and Narova. These companies were entrusted with the operation of the sawmills, but export arrangements were left in the hands of the Soviet government.

In the Dvina forests, the Dvinoles trust owned shares in a mixed Russo-Latvian company organized along lines similar to those of the Severoles agreement.

Sapodoles was dependent on Polish and Lithuanian technical assistance.[1]

Table 9–1 THE SOVIET LUMBER TRUSTS AND FOREIGN CONCESSIONS

Trust	*Foreign Operator of the Trust Area*
Severoles	Russangloles, Ltd. (United Kingdom)
Onega	Russnorvegloles, Ltd. (Norway, United Kingdom)
North Dvina-Vichegoda	Russhollandoles, Ltd. (Holland, United Kingdom)
Sapodoles	Polish and Lithuanian lumber companies
Dvinoles	Russo-Latvian Company (Latvia)
Exploles	Rorio Rengio Rumian (Japan)
	Raby-Khiki Kansha (Japan)
	Rorio Rengio Kumai (Japan)
Non-Trust Area	
Mga-Rybinsk	Holz Industrie Aktien Gesellschaft Mologa (Germany)

Sources: 1. U.S. State Dept. Decimal File, 316–135–479.
2. Troyanovsky, *Eksport, import i kontsessii soyuz S.S.S.R.*, p. 16.

RUSSANGLOLES, LTD.

Russangloles, Ltd. was a stock company organized under British law, and the most important of the lumber joint-stock or mixed companies. It was registered on February 7, 1922 with a nominal capital of £150,000. Its objective, noted in a Memorandum of Association, was to develop timber properties, sawmills, and transportation (including docks, railroads, roads, etc.) in order to merchandise timber products. The company could borrow money to achieve this objective.[2] Of the six company directors, three were Russian, two were British, and one was Latvian. The foreigners had all been in the lumber business.

Russangloles was the operating arm of an earlier concession agreement made between Severoles and the London and Northern Trading Company, Ltd., on December 31, 1921. This company had been organized in the United Kingdom

[1] *Timber News and Sawmill Worker* (London), June 10, 1922.

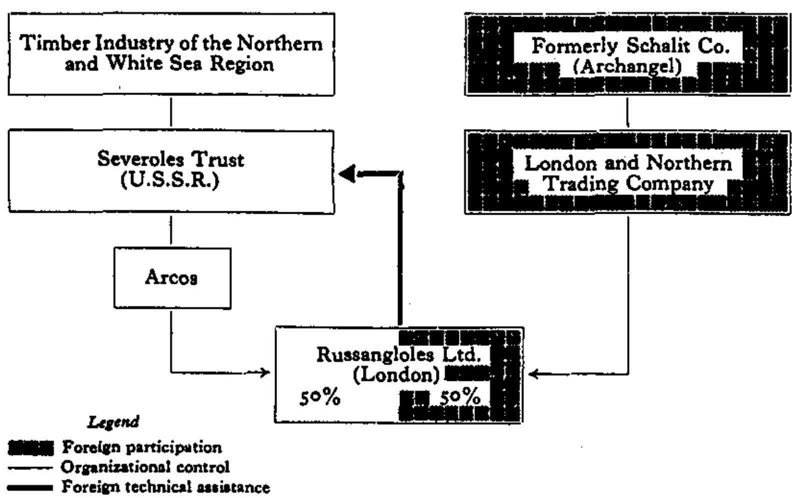
[2] The complete Memorandum of Association is available in a dispatch, dated February 16, 1922, from the American Vice Consul in London (316–135–479).

on September 20, 1919 with a nominal capital of £1 million to operate sawmills in the Archangel area and merchandise substantial quantities of lumber already stored there. Four of the directors of the London and Northern Trading Company were British and one Russian—Morduch Schalit, earlier a timber merchant in Archangel and the former owner of the property taken over by the company.

It was not unusual for concessions to be in operation before official announcement, and this was the case with Russangloles. There is in the State Department files an agent's report, dated August 1921, describing a stormy meeting held at the town of Petrozavodsk, in Olonetz Province, concerning 'the question of handing over to the English the working of woodlands and forests in the province.' This concession was submitted to the regional committees and commissariats to enlist local support, as local peasants objected to losing their timberlands.[3]

Russangloles was given the right to exploit timber lots in the Pomozdinsky and Kontzegorsky areas for a term of twelve years. The rental consisted of a gross income percentage, a stumpage fee, and a separate fee for sawmills and

Chart 9-1 ACQUISITION OF FOREIGN LUMBER MARKETS: PHASE I (1922–4)



[3] The agent reported that the 'meeting was so stormy . . . it was almost necessary to have recourse to troops but they also voted for a second discussion refusing to attack the people.' (316–135–477.) It has been noted elsewhere that concession operations often caused local trouble (apart from the Party-inspired 'strikes'), and a case could be made that the concessions were seen locally as a means of perpetuating an unwanted Bolshevik rule.

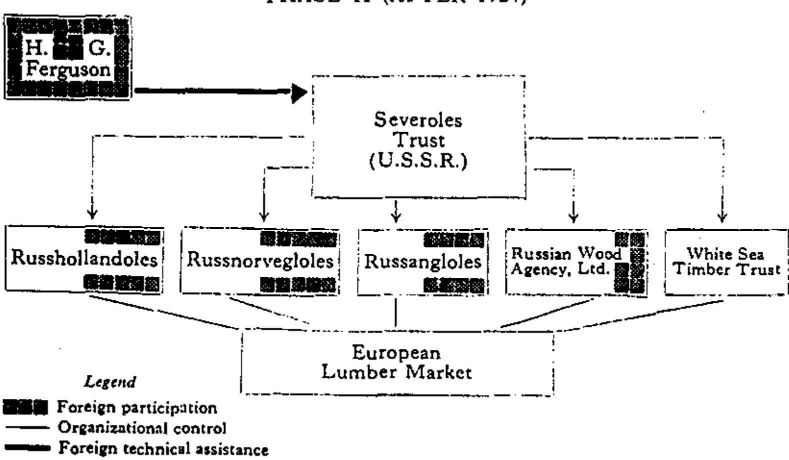
building and transportation facilities. In addition, taxes were levied by the central and local governments. Export duty was payable, and the Soviet government reserved the right to purchase any timber prepared for export.[4]

Severoles was the largest of the Soviet timber trusts, covering the whole of the gigantic white wood resources of the Russian northland. It was this enormous area that was taken over, developed, and operated by Russangloles. The other two trusts in the western area, Sapadoles and Dvinoles, were considerably smaller and were operated by Estonian and Latvian companies in mixed company arrangements with the U.S.S.R.

Severoles was also the principal shareholder, along with British lumber companies, in the White Sea Timber Trust, Ltd. (organized in the United Kingdom to sell sawed lumber on the European market), and its auxiliary concerns: the Russian Wood Agency, Ltd. (a timber brokerage firm), the Russ-Norwegian Navigation Company, Ltd., and the Norway-Russian Navigation Company, Ltd., which used leased Norwegian ships to transport timber materials and products to foreign markets.[5]

In each of these trusts, and in the Far East trust discussed later, timber development, construction of sawmills, transportation, and ancillary operations were undertaken by foreign companies. In effect they transferred their skills to Russian operations, and in each area created extensive and successful timber operations.

Chart 9-2 ACQUISITION OF FOREIGN LUMBER MARKETS: PHASE II (AFTER 1924)



[4] *Ekonomicheskaya Zhizn*, No. 60, March 17, 1923.

[5] Troyanovsky, *op. cit.*, p. 16.

Sales were made through a wholly Russian-owned trust. As the original agreement has never been published, it is impossible to determine precisely the part played by Western firms. Severoles acted as a broker, obtaining sawed lumber from concessions and selling it to Western timber merchants for advance royalties. This operation generated scarce foreign exchange.

Lumber sales to Germany, however, did not go through the trusts. The German Mologa concession output was substantial and financed on credit by Deruwa (the German-Russian Merchandise Exchange Society) and the Berlin branch of the Russian Bank of Commerce (the Aschberg concession). Advance payments were made through Deruwa beginning in 1923 for all lumber sold through the organization in Germany.[6]

RUSSHOLLANDOLES, LTD. (RUSSIAN-DUTCH TIMBER COMPANY)

Russhollandoles, Ltd. was a mixed company similar to Russangloles formed in the spring of 1922 by Severoles and a Dutch timber firm, Altius and Company, with some British financial participation. The objective was to develop for a period of twenty years the forest resources of the North Dvina and Vichegoda River area in the Archangel region. The area covered over 400,000 dessiatins and included property formerly belonging to the Altius company. Half the shares were owned by the Soviets and the other half by the Dutch and United Kingdom concessionaires. Operations began in August 1922, and in the first three months a quarter million railroad sleepers and the stock of 2,500 standards of lumber had been exported to the United Kingdom and Holland.[7]

Another very large timber concession, Russnorvegloles, was concluded in July 1923 with a group of Norwegian firms and a Dutch company (Backe and Wigg, of Dramman; Backe and Wagner, Prytz and Company, and Altius and Company). The capital stock was set at £300,000 divided equally. The Soviets were granted the right to contribute their share in timber instead of cash. The company was registered in the United Kingdom. The area covered was about 2.9 million dessiatins, of which about two million was forest land in the Onega River area. The term of agreement was twenty years, after which all equipment and buildings became the property of the U.S.S.R.[8] The capital stock was divided proportionately between Severoles and the Dutch and Norwegian companies.

[6] U.S. Consulate in Königsberg, Report, March 6, 1923. (316–135–501.)

[7] *Ekonomicheskaya Zhizn*, No. 53, March 9, 1923.

[8] *Ekonomicheskaya Zhizn*, July 6, 1923; and U.S. Consulate in Christiania, Norway, Report, July 19, 1923. (316–135–531.)

The three mixed companies—Russangloles, Norvegloles, and Hollandoles—organized by Severoles advanced 15 million rubles credit in the first year of operation, as well as providing necessary working capital and technical assistance to get the northern timber areas back into operation.

British lumber companies also had an arrangement with Dvinoles known as Dvinoles Export, Ltd. There was in addition an agreement between Finnish companies and Dvinoles called Repola Wood, Ltd. Both companies exported unsawed timber. The cutting operations were financed by the foreign partners; the wood was exported and cut by foreign mills.[9]

In brief, to restore timber cutting operations and renew contact with Western markets, the Soviets used the good offices of the former owners, although a superficial examination of the organizational structure of the Soviet trusts and the mixed companies does not indicate the full extent of these arrangements.

EX-CHANCELLOR WIRTH AND THE MOLOGA CONCESSION

An important Type I concession was the 'Society for Economic Relations with the East' (Gesellschaft fur Wirtschaftliche Beziehungen mit den Osten), headed by ex-Chancellor Wirth and ex-Reichstag Deputy Haas, and including the German firms Himmelsbach, Dortmund Association, Bop und Reiter, Schuckart und Schuette, Voegele, and others—and signed in October 1923. It included timber production and export, and the construction of a railroad in Northwest Russia. By the end of 1923, the Mga-Rybinsk railroad alone had received an investment of almost 25 million rubles.

Under the agreement, which created an operating company, Holz Industrie A-G Mologa, one million dessiatins of forest land was granted to the concession and 5,000 dessiatins was required to be cut annually. In addition, the concessionaire built a wood sleeper-treating plant for 1,000,000 sleepers annually, together with a pulp and chemical works, including ten plants for the chemical treatment of tree stumps. The Soviets received a royalty which varied between 2.5 and 22 rubles per cubic sazhen marketed by the Mologa concession. The railroad construction had to be completed within three years. The life of the concession was twenty-five years, with provision for an extension to thirty-five years upon mutual agreement. At this time properties would revert to the Soviet state.[10]

The concession got under way in 1924; seven ships of timber were loaded in the first nine months, and the Mga-Rybinsk Railroad was started. There was a report of a labor disagreement on the railroad construction in September

[9] Troyanovsky, *loc. cit.*

[10] U.S. Embassy in Berlin, Report 135, October 12, 1923. (316–135–545).

1924, but this was settled and the threatened strike collapsed when Mologa submitted to the demands of the workers.

By 1926 Mologa work was not going well, and Dr. Wirth visited Leningrad in April to renegotiate the concession. The proposals made by Wirth were briefly as follows:

1. That the royalty payable to the Soviet government be reduced by 30 percent. (A 15 percent reduction was granted.)
2. That machinery for use in the concession enter the Soviet Union duty-free instead of at the previously agreed preferential tariff. (This was granted.)
3. That railroad freight charges be reduced to 50 percent of those normally paid. (This was not granted.)
4. That permission be granted to bring in timber specialists from Germany. (This was granted.)
5. That labor hours be increased by 20 percent. (This was not granted by the Soviets, but it was agreed that overtime be paid at 40 percent above the regular wage rates.)

In addition, Dr. Wirth agreed to build a cellulose factory, two additional sawmills, and an electric power station on the Mologa River to serve the concession area. At this time, between 25,000 and 32,000 men were employed by the concession in cutting and shipping lumber to Germany.[11]

In early 1927, the Mologa representatives in Moscow (Levin and Berdichevsky) were alleged to have bribed Soviet officials, specifically those employed by Mostroi (the Moscow Construction Trust), the Lyubertsy Agricultural Machinery Works (formerly the International Harvester Plant in Moscow), and officials of Grozneft. The trial opened in 1927. The Soviet officials were sentenced to death and Levin, the Mologa representative, to five years' imprisonment.

By mid-1927 Mologa was again in a very precarious position, and the Germans decided to withdraw and allow the Soviets to take over.

Mologa was exceptional in that it received preferential treatment. The renegotiation of 1926, for example, was clearly favorable to German interests. The accusation of bribery was a characteristic move to force expulsion of the concession as soon as production was organized and sufficient equipment introduced into the concession areas.[12]

[11] U.S. State Dept. Decimal File, 316–135–595.

[12] Coleman, U.S. Consulate at Riga, Report 4516, May 19, 1927. (316–135–615.) Coleman's conclusion reads: 'Ksandrov's assurances of friendliness to the Mologoles merely confirms the long known fact that this concession has been particularly favored by the Soviet Government who saw in it one of the concrete manifestations of a Soviet-German rapprochement. But incidentally they also reveal that in spite of

In an interview published in *Ekonomicheskaya Zhizn*, No. 85, March 22, 1927, Ksandrov, deputy chairman of the Chief Concessions Committee, argued that the real reasons for the Mologa financial difficulties lay outside both the concession agreement and the attitude of the U.S.S.R. toward the agreement. He stated that the Society for Trade with the East had been formed in Berlin in 1923 and this company formed also the Holz Industrie Aktien Gesellschaft Mologa with an initial capital of 300,000 marks, increased in 1926 to 3 million marks. During the first year, the company erected ten frame saws instead of the stipulated six, and a major part of the investment—about 2.35 million rubles—was made in the first year, resulting in an operating loss of 576,000 rubles. This induced Mologa to request changes in the agreement. Ksandrov pointed out that the changes were made; consequently the 1925–6 production was 1 million rubles, compared to 4.5 million rubles in 1924–5. Also the concession was granted a two-year extension on the railroad construction program, a postponement of stumpage payments, and a grant of Soviet financial support. Up to March 4, 1927, credits from Gosbank amounted to 4.5 million rubles, in addition to 420,000 rubles loaned by the Bank of Trade and Industry, a revolving credit of 3 million rubles, and a government subsidy of 2.2 million rubles granted in January 1926 and repayable in March 1927. Ksandrov then concluded that 'the main reason for the financial difficulties of the Mologoles is a lack of a solid financial basis.' The initial capital of 300,000 marks was used during the initial organizing period; the concessions then had to borrow capital at high interest rates (15 to 16 percent in the first year, 13 percent interest in the second year, and 7 to 8 percent in the third year), and Anglo-American capital, which was anticipated at lower rates of interest, was not forthcoming.

Therefore, Ksandrov said:

> In view of the economic and political importance of this concession, the Soviet Government granted considerable privileges already at the conclusion of the agreement, that assured large profits from the concession to German capitalists.

A rather different explanation of the decline and liquidation of the Mologa concession is given by M. Klemmer in his 1927 report to Western Electric Co. and is the basis for his advice that pure concessions, as distinct from technical-assistance agreements, were not suitable objects for investment. Klemmer reported that the Mologa concession developed normally in its first years, but

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the exceptionally friendly attention shown to Herr Wirth's concession, the prominent German interests backing the latter proved unable to overcome the reluctance of the international money market to make investments in the Soviet Union. . . . It is a striking coincidence, characteristic of the Soviet regime, that the failure of the concessionaires *(sic)* to obtain new investments was immediately followed by sentences in a Soviet criminal court of several officers of the Mologoles to prison for alleged bribing of employees of Soviet commercial institutions. . . .'

then 'the cost of labor and all the prices went so high up' that export did not pay; the concession then acquired permission to sell on the internal Soviet market. This appeared profitable, as lumber prices were two to three times higher than in the previous years. However, Soviet organizations paid only after long delays, and, coupled with rising prices for materials and labor, this put Mologa in another difficult financial position. Klemmer points out that Gosbank loans were insufficient to meet commitments, and Mologa was forced to go abroad for financial assistance.[13]

It would appear, then, that credits were advanced by the U.S.S.R. to Mologa, but that these were insufficient to offset the disadvantages of selling on the internal market. Any foreign enterprise operating within the U.S.S.R. and this certainly applied also to Harriman and Lena—faced insurmountable difficulties in an environment where normal business facilities, such as credit and terms of trade, were controlled by an arbitrary organization whose interests were not coincident with those of the Western organization.

In conclusion, the Mologa 1925–6 balance sheet indicated a profit. This profit did not satisfy the Concessions Committee, and in February 1927 Ksandrov proposed reorganization of the concession:

> It is obvious . . . that the fate of the concession enterprise depends entirely on a thorough solution of the financial problem, and that the failure of the concessionaire to solve this problem in a satisfactory manner will make the liquidation of the concession inevitable.[14]

Two months later, according to *Ekonomicheskaya Zhizn*, the Soviets liquidated Mologa.

The German government, it was argued, had refused to continue financing Mologa; therefore the concession was unable to establish a stable financial basis and 'a friendly agreement was reached by both parties to liquidate the concession.'[15] It was also stated that Mologa would be reimbursed the fair value of the concession property and a committee was appointed to appraise its value. Operations were then transferred to the Northwestern Lumber Trust (Severoles).

The only reimbursement was a payment for raw materials taken over. In the final analysis, the reimbursement for the 20 million marks invested by German firms was about 5.7 million marks, or 25 percent of the investment. Nevertheless, this was a considerably more favorable settlement than any other concession received. The creditors received 27 percent of their debts; the stockholders lost their investment.[16]

[13] Klemmer Report (1927), pp. 22–3 (316-60-95).
[14] *Ekonomicheskaya Zhizn*, No. 85, March 22, 1927.
[15] *Ekonomicheskaya Zhizn*, No. 120, May 29, 1927.
[16] *New York Times*, September 29, 1928, p. 21, col. 2.

THE EXPLOLES TRUST IN THE FAR EAST

In early 1923, the Soviet government completely reorganized the timber industry in the Far East. All timber resources east of Lake Baikal, except those areas under concession or reserved for concessions, were grouped into the Exploles trust. This included timber lands and wood product factories, including sawmills and veneer plants. Plants within the trust were not immediately nationalized; there were eight private sawmills and six nationalized mills. The veneer factory was privately owned—an essential feature, as the trust was in its early years financed by private capital from émigré Russians in Harbin. The trust then negotiated concessions with foreign capital.[17] An agreement was concluded in early 1923 between the Far Eastern Revolutionary Committee, the forerunner of the Far Eastern Soviet Government, and the Japanese syndicate, Ookura Gumei.[18] The grant was six million acres covering seven forest districts in Maritime Province, six for a period of twenty-four years and one for one year.[19]

The 1925 Treaty of Friendship and Recognition between Japan and the U.S.S.R. contained several protocols concerning concessions. Protocol 'B' led the way to more timber concessions in the Far East. The Far Eastern Timber Industry syndicate and Rorio Rengio Rumian were later relinquished because of difficulties imposed by the Soviets concerning the erection of sawmill and paper factories and the application of labor regulations.[20]

In 1927 a third timber concession was granted to a group of Japanese lumber companies in the Primorsky District.[21] The Raby-Khiki-Kansha concession was formed to exploit some 5,400,000 acres of forest and to ship the timber to Japan. The period of the concession was six years (until 1933), and renewal could be discussed during the sixth year. At least 7.5 million board feet of lumber had to be removed annually. Twenty-three dwellings were erected for Soviet lumber inspectors; and 350,000 rubles (a special fee), a royalty, and stumpage fees were paid after sale on the Japanese market. Sawmills and pulp mills were erected. Foreigners were employed but could not comprise more than 25 percent of total employment except in sawmills. There was a requirement to employ Soviet technical students in all operations.[22]

Another agreement was signed in April 1927. The Rorio Rengio Kumai, which employed 2,000 men, consisted of 2.7 million acres near the Tartar Straits, with an annual output of 7.5 million cubic feet.[23]

17 U.S. Consulate in Vladivostok, Report, March 1, 1923. (316–135–502.)
18 U.S. Embassy in Tokyo, Report 579, April 30, 1923. (316–108–455.)
19 *Russian Daily News* (Harbin), May 13, 1923.
20 C. Conolly, *op. cit.*, p. 45.
21 Amtorg, *op. cit.*, II, No. 7 (April 1, 1927), 1.
22 U.S. Embassy in Tokyo, Report 399, January 11, 1927. (316–135–435.)
23 Amtorg, *op. cit.*, IV, No. 8 (April 15, 1929).

Later in 1927 an effort was made to attract foreign timber concessionaires on a much larger scale. It was announced, for example, that large unexploited timber regions of the Far East, extending for some 62,000,000 acres, had been divided into fifty-one blocks and that concessions could be obtained for these regions.[24]

ACTIVITIES AFTER THE DEPARTURE OF THE CONCESSIONS

Exit of Western companies and their concession operations was followed by the operation of the same northern lumber areas by prison labor: specifically political prisoners and *kulaki* under the management control of the OGPU. Although this proposition will not be examined in depth, there is considerable evidence that those lumber stands developed by the concessions (Dvina, Onega, and Komi in the northern forest areas) were precisely those areas turned over to OGPU prison camp operations. The loading of foreign ships with the sawed lumber was also undertaken by forced labor.[25]

New sawmills constructed were, however, still built by Western companies and with Western equipment after the departure of the concessionaires. The Dubrovsk sawmill, with a capacity of 5 million cubic feet of lumber a year, was built by the Bolinder Company in 1928 and 'largely' utilized Swedish equipment.[26] Another large sawmill, built in 1928 at Volinkinsky, near Leningrad, with a capacity of 2.5 million cubic feet per year, utilized equipment from both the United States and Sweden.[27]

The technical backwardness of the Russian lumber-processing industry, even as late as 1929, is suggested by the admission by Lobov that only 1 percent of Russian lumber was kiln-dried, compared to more than 60 percent in the United States.[28]

PULP AND PAPER MILLS

All pulp and paper mill technology was imported from Western countries. The Kondopozh (Lake Onega) paper mill, built in 1928, with an annual capacity of 25,000 tons of newsprint, had two turbo-generators built in Sweden and a 3,000 kilowatt steam plant and paper-making machine from

[24] Amtorg, *op. cit.*, II, No. 20–1 (November 1, 1927), 10.

[25] A. Pim and E. Bateson, *Report on Russian Timber Camps* (London: Benn, 1931). Swianiewicz, who had personal experience of the Soviet prison system, makes the point that lumber had to take the place of grain in generation of foreign exchange. In 1920–30 an acute manpower shortage developed; this led to OGPU operation of the northern forest areas. (S. Swianiewicz, *Forced Labour and Economic Development*, London: Oxford University Press, 1965, pp. 113–4.)

[26] Amtorg, *op. cit.*, III, No. 2 (1928), 23.

[27] Amtorg, *op. cit.*, III, No. 3 (1928), 41.

[28] Amtorg, *op. cit.*, IV, No. 4 (1929), 77.

Germany. Nine Soviet paper technicians studied paper-making in Canada before returning to operate the plant.[29]

In 1926–7 the total Russian output of paper was 267,000 tons. A single plant, the Balakhna paper mill on the Volga River in Nijnhi-Novgorod Province, with a capacity of 105,000 tons, raised this overall capacity in 1928–31 by just under 50 percent. The Balakhna mill had three paper-making units: one bought in Germany and two in the United States. The larger of the two United States units had a bed width of 234 inches and, at the time of installation, was the fastest American sectional-drive paper machine in the world. Its finishing delivery speed was 1,200 feet per minute. The complete electrical installation for the mill was supplied by General Electric, whose engineers supervised installation and initial mill operations. The final unit was not completed before 1931.[30]

TECHNICAL ASSISTANCE IN THE LUMBER INDUSTRY

The mixed trading company agreements of 1923–4 contained technical-assistance clauses. The British, Norwegian, German, and Dutch lumber companies were required to cut and transport the lumber. In undertaking these operations, they entered the timber areas of the U.S.S.R. to organize production and shipping. There is little doubt that these concessions granted in the timber and sawmill industry between 1922–27 worked closely with the Soviet government on the technical sphere and furnished considerable capital for lumber operations.[31]

In every case, operations ultimately proved unprofitable, and by 1928 the last foreign operations in the lumber industry had closed, except for the Japanese concessions in the Far East. The technical-assistance components, however, persisted. Harry Ferguson, Ltd., provided technical assistance under the Russangloles, Ltd. agreement, and his contract for assistance was still in operation in 1929, several years after the ejection of the British concessionaires.[32]

After closing the concessions, the Soviets purchased technical assistance in the form of Type III agreements. For example, in September 1928 the Stebbins Engineering and Manufacturing Company, a firm of architects and engineers of Watertown, New York, was approached by Amtorg with a request for a consultant to make a report on Soviet pulp operations.[33]

[29] Amtorg, *op. cit.*, III, No. 8 (1928), 195.

[30] *Monogram*, November 1943.

[31] See, for example, the United States Consulate Report from Helsingfors dated December 24, 1929. (316–135–663.)

[32] U.S. State Dept. Decimal File, 316–131–642.

[33] The Amtorg letter reads in part, 'We wish your representative to come to the U.S.S.R. in a consultant capacity on organization and production problems.'

In 1929 the British-European Timber Company, a United Kingdom firm, sent a group of engineers to forested areas in Mezen, Pechora, and Siberia.[34]

SOVIET LUMBER TRADE FROM 1921 TO 1928

As a result of these transfers of foreign skills and technology, Soviet exports of sawed lumber grew from a mere 48,000 standards in 1921 to 569,000 standards in 1928—an increase greater than tenfold. However, 569,000 standards was still less than one-half of 1913 Russian export of sawed lumber.

The destination of these exports was significantly oriented to the operation of the mixed trading companies. In 1913 about half of sawed lumber exports went to the United Kingdom. The most important of the Type II agreements (made in the 1920s) was made with United Kingdom lumber merchants and lumber importers. In 1928 some 389,000 standards went to the United Kingdom—about 60 percent of the amount exported to Britain in 1913. However, the total 1928 Soviet lumber exports were only 46.7 percent of those in 1913. In other words, the relative proportion of lumber going to the United Kingdom was considerably greater in 1928. Holland and Germany, who possessed concession arrangements in lumber, show a similar increased importance as importers of Soviet lumber, whereas France and Belgium, with no concession arrangements, took an insignificant proportion of their 1913 imports of Russian lumber (13.9 and 20.1 percent, respectively).

Table 9–2 EXPORTS OF SAWED LUMBER FROM THE U.S.S.R., 1913–28, BY DESTINATION

Destination	*1913*	*1926*	*1927*	*1928*	*1928 as percent of 1913 exports*
		(Export in Standards)			
United Kingdom	642,800	217,542	332,597	389,610	60.0%
Germany	194,100	15,634	41,607	48,318	24.9
France	83,700	16,406	2,116	11,666	13.9
Holland	161,200	41,720	40,334	66,292	41.1
Belgium	70,000	6,114	6,099	14,095	20.1
Others	65,800	15,908	14,799	39,257	49.5
Total	1,217,600	313,324	437,552	569,238	46.7%

Source: U.S. Consulate at Helsingfors, Dispatch Number 1370, July 10, 1929.

An examination of lumber exports by type of lumber suggests a similar orientation toward countries with concessionary arrangements. Almost all sawed lumber (87 percent) was marketed by means of the United Kingdom

[34] Amtorg, *op. cit.*, IV, No. 6 (1929), 117.

Type II concessions, using the maiket knowledge and skills of the private concessionaires. Part of the balance was shipped through the German Mologa concession. Beams, alder veneer, and pit props also show a strong orientation toward the United Kingdom market.

Companies underwriting timber contracts with the U.S.S.R. had complaints about Soviet trading practices, as the Soviets entered the market on their own account after 1924–5. The Soviets had a practice of appearing in the lumber market at the last minute and underselling not only Swedish and Finnish timber but also their own earlier contracts, and thus 'disturbing' the market, from the veiwpoint of the British trade. Twenty leading United Kingdom timber merchants formed a coalition on 1929 and made arrangements to purchase all Russian timber in specific grades forthcoming in a particular year at agreed prices.[35]

More than 90 percent of all Soviet timber exports during the 1920s was going to countries with mixed company arrangements. In brief, all Soviet timber was produced and most marketed with foreign capital and technical assistance.

[35] U.S. Embassy in London, Report 3342, February 7, 1929. (316–135–647.)

CHAPTER TEN

'Sovietization' of the Tsarist Machine-Building Industry[1]

THE LENINGRAD MACHINE-BUILDING TRUST (LENMASHSTROI)

THERE was a well-established general and precision machine-building industry in Russia before the Revolution. This was located primarily in Petrograd and Moscow and included the locomotive construction plants in the Ukraine. After the Revolution, the industry went through a chaotic transformation.

Table 10–1 PLANTS COMPRISING THE LENINGRAD MACHINE-BUILDING TRUST IN 1923

Prerevolutionary Name	*Soviet Name*	*Position in 1923*
Putilovets	Krasnyi Putilovets	Open, under War Commissariat
Aivaz	Engels	Working intermittently
Atlas	Economizer	Under War Commissariat
Pneumatic	Pneumatic	Under War Commissariat
Truba	Krasnaya Truba	Not known
Metal Petrograds	Metallic (Stalin)	Under War Commissariat
Nobel	Russky Diesel	Under War Commissariat
Lessner	Karl Marx	Closed
Arthur Koppel	International	Closed
Struk-Ekval	Ilytch	Closed
Phoenix	Sverdlov	Closed
Tilimans	Northern Mechanical and Boiler Works	Closed
Vulcan Pipe Works	Vulcan	Closed

Sources: 1. *Ekonomicheskaya Zhizn*, No. 10, October 12, 1923.
2. *Spravochnyi katalog rossiskoi promyshlennosti* (VSNKh, Moscow: 1923).
3. U.S. State Dept. Archives.

[1] Agricultural machinery is covered in chap. 7 and transportation equipment in chap. 14, except for aircraft manufacture, which is covered in chap. 15.

In Petrograd, half the machine-building plants were closed in 1923, and those open were working on an intermittent part-time basis and were later trustified.[2]

The Putilovets in Petrograd employed more than 6,000 before the Revolution. In 1920, renamed the Krasnyi Putilovets, the works employed 1,000 but produced almost nothing. Continual strife between the technical executive staff and the workmen's committee was aggravated by the fact that unskilled workers received higher pay and more food than skilled technicians and managers. The plant remained more or less in this condition through the early 1920s. In 1929 the Putilovets arranged a technical-assistance contract with Frank Smith Co., Inc., of the United States.[3] The Ford production chief, Sorensen, also visited the plant in 1929 and, when asked by a Soviet official what he thought of it, suggested they put a few sticks of dynamite in the middle of the shop floor and blow it out of its misery.[4]

Other operating plants were in little better condition. The Nobel Gas Engine Works (renamed Russky Diesel) was well equipped in 1921, but produced only a few repair jobs. The Arthur Koppel works, formerly a producer of fire escapes and light structural steel work for the city of Petrograd, was completely at a standstill. Keeley reported that they were trying to build a couple of peat excavators.[5] The Lessner, renamed the Karl Marx, reopened with 100 skilled workers imported from Finland in late 1921 or early 1922.[6]

Lenmashstroi concluded a technical-assistance agreement with the Metropolitan Vickers Company of the United Kingdom in March 1927. For a period of five years the trust used the patents and manufacturing rights for Vickers turbines, paying to the company a royalty dependent on the number of turbines produced. Russian engineers were sent to the Vickers' plants in England for study, and a large crew of English engineers went to the trust's plants in the Soviet Union.[7] Vickers' assistance was concentrated in the old Petrograd Metal Works, renamed the Stalin. The assistance concerned turbine design and construction problems. The Stalin plant was the only producer of turbines until 1930; they were all produced with Vickers' assistance and

[1] This information is based on report by Royal Keeley in U.S. State Dept. Decimal File, 316–107–99/100. Keeley, an American, was in Russia from September 1919 to August 1921. He investigated, at the invitation of Lomonosov, industrial and economic conditions in various plants in Moscow and Petrograd. These visits received support from Lenin and Rykov. Keeley reported personally to Lenin on several occasions. He was imprisoned from May 1920 to August 1921 'because he knew too much about Russian conditions.' (U.S. State Dept., Division of Russian Affairs, memorandum to Secretary of State, October 18, 1921. 316–107–106/12.)

[2] U.S. State Dept. Decimal File, 316–131–642.

[4] Sorensen, *op. cit.*, p. 202.

[5] Keeley, *op. cit.*

[6] *Makhovik* (Petrograd), December 13, 1921.

[7] *Torgovo-Promyshlennaya Gazeta*, No. 60, March 15, 1927; and Allan Monkhouse, *Moscow 1911–1933* (Boston: Little Brown, 1934), pp. 185–6.

comprised the total Soviet output. Other plants in the trust were reestablished with German technical assistance.

MOSMASH AND GERMAN TECHNICAL ASSISTANCE

The tsarist-era machine-building plants in Moscow were grouped after the Revolution into Mosmash. Their names were changed and most were restarted with German technical assistance.

Table 10–2 PLANTS COMPRISING MOSMASH IN 1923

Prerevolutionary Name	*Soviet Name*
Bary Engineers	Parostroi
Bromley Brothers	Krasnyi Proletariat
Gratcheff	Krasnya Presnia
Singer Goujon	Serp i molot
Danhauer and Kaiser	Kotloapparat
Dobroff and Nabholz	Melnitchno-Tkatskoie Oborudovanie
Jaquot	Press
List-Butirsky	Boretz
List-Sofisky	Hydrophil
Kramer	Krasnyi Stampovstchik

Source: *Annuaire, op. cit.*, p. 84 rear.

The Bromley Brothers Works in Moscow kept running throughout the Revolution under its English manager and was nationalized in 1918. This was one of the better-organized plants in the Soviet Union, but it ran into the same difficulties as others, and by 1921 its production was negligible.[8] It was renamed the Red Proletariat and brought into the trust. Moscow's oldest and largest semi-fabricated metal materials plant was the Singer Goujon. It produced structural shapes, steel sheet and plate, wire, rope, and similar products. The plant was nationalized in 1918 and a former English foreman made manager. In 1920 the plant was at a complete standstill; official records indicated an output of only 2 percent of 1913. After being renamed the Serp i molot and absorbed into the trust, the works made a good recovery with German technical assistance. By 1923 the plant was producing 80 percent (by weight) of the Mosmash output.[9] The trust was also interested in producing steam and diesel engines, turbines, and pumps, as well as fabricated metalwork.[10] A technical-assistance agreement was made in 1926 with Gasmotoren-Fabrik Deutz A-G, of Germany, which gave the trust the right to construct

[8] Keeley, *op. cit.*,
[9] *Ibid.*
[10] *Annuaire*, rear p. 84.

and assemble all types of Deutz motors (with and without compressors), stationary engines, and main and secondary engines for river and marine craft. All patents, designs, experimental data, and other information generated in the German plants passed from Deutz A-G to Mosmash. There was the usual exchange of engineers, Deutz engineers going to the plants of the trust and trust engineers going to Deutz plants in Germany for training. Royalties were paid on all production.[11] Further, there was probably an implied reciprocity clause of some type in the agreement. In mid-1927, the Soviets ordered two freight-passenger ships from the Janssen and Schnilinsky A-G shipyards of Hamburg and specified Deutz diesel engines.[12]

GOMZA AND THE WESTINGHOUSE BRAKE WORKS

Gomza was the largest of the machine-building trusts, and in 1924 consisted of eighteen units, including iron ore mines, smelting plants, and works producing machinery, tools, locomotives, wagons, and agricultural machinery. In 1925, the Westinghouse Air Brake Works was nationalized and added to this trust. Of the eighteen units, only fourteen were operating. Of the remaining units, two were in a state of 'technical preservation' and two in liquidation. The trust was notoriously inefficient, accumulating a loss of 3.7 million rubles in 1922–3, 7 million rubles in 1923–4 and over 4 million rubles in 1924–5 and in 1925–6.

The Westinghouse Air Brake plant in Moscow (moved by the company to Yaroslavl in the early 1920s) was not nationalized until after the Soviets had assured themselves of its facilities and were confident of having enough skilled engineers and workers available. It is noteworthy that any activities connected with transportation—and particularly railroads—were handled with great care by the Soviets.

There is little question that Westinghouse also played a cautious game in an attempt to evade the nationalization decree. The manager of the Yaroslavl plant, when interviewed in 1922 by officials of the U.S. State Department, reported that relations between management and labor were excellent, that the company did not import raw materials, that the Soviet government owed the company half a million rubles, and that he felt the time was ripe for a further investment by the parent company. He claimed that profits could be transferred out of the Soviet Union with only a 3-percent penalty, while the fee for imported funds was only 10 percent. Westinghouse did not bite.[13]

[11] *Torgovo-Promyshlennaya Gazeta*, No. 279, December 3, 1926.
[12] U.S. State Dept. Decimal File, 316–130–605.
[13] U.S. State Dept. Decimal File, 316–139–31.

During the Civil War and famine, the company supplied its Russian workers with flour and clothing. Consequently, the Party had trouble stirring up Westinghouse workers when the time came to demand nationalization. The end was foreshadowed in a *Pravda* article on January 18, 1924, under the title, 'With the Lackeys of American Capital.' The article complained about conditions in the Westinghouse plant. The company was accused of using the Taylor system to carry out twelve months' work in six months and bribing the factory committee by supplying food and clothing. The essence of the complaint was:

> . . . at the present time they are paying only 25 percent more than other factories. The cells have now opened the eyes of the workmen. At present the workers not only distrust but even hate the administration.

This was followed by a demand that the secretary of the cell should be present at collective bargaining meetings—presumably to 'protect' the interests of the workers.[14] The company was nationalized in 1925 and the works absorbed into Gomza.[15]

GOMZA AND THE GERMAN AND SWEDISH LOCOMOTIVE PROGRAM

In August 1920, Professor Lomonosov, formerly director of traffic on the tsarist railroads and in 1920 director of all railways in the Soviet Union, went to Germany and later to Sweden to negotiate for railway supplies, the Soviets' most urgent requirement.[16]

The locomotive stock at this time was about 16,000 of which only about 6,000 were able to operate at all. The position was so critical that workers were released from the Red Army transportation corps to help repair locomotives.[17] The Sormovo locomotive works was able to make capital repairs to thirty-six locomotives in the last half of 1920 but only to nine in the first half of 1921. Sormovo repaired 246 cars in the second half of 1920 but only 31 in the first half of 1921.[18] The Tver wagon construction works made 100 new freight trucks and repaired 603 in the last half of 1920, and then closed down. At this time more than 10,000 locomotives and many more wagons were awaiting or undergoing repair.[19] In August 1921, of a listed rolling stock of 437,152 cars, only 20,000 were in first-class condition, and fewer than 200,000 were able to run

[14] The complaint was phrased, 'The Americans have played a dirty game with us but they are called a cultured and liberal nation.' (*Trud*, No. 42, February 24, 1923.)

[15] *Pravda* (Moscow), No. 15, January 18, 1924.

[16] U.S. State Dept. Decimal File, 316–163–721.

[17] U.S. State Dept. Decimal File, 316–163–724.

[18] In 1890 the Sormovo Works was making complex rolling-mill equipment and was able to machine one-piece 20-ton forgings. See Foss Special Collection, Hoover Institution Library.

[19] U.S. State Dept. Decimal File, 316–163–849.

at all.[20] The equipment and locomotive problem was solved by purchasing European and American locomotives; sending defective locomotives to Latvia, Estonia, and Berlin for repair; and importing German technicians and railway materials for wagon repair.

In July 1920 the U.S.S.R. made an agreement with the Nyquist and Holm A/B locomotive construction company at Trollhatten in Southern Sweden. The agreement has been variously described. The Stockholm Consulate, in an interview with C. W. Beckmann, chief engineer at the plant, reported that Gunnar W. Andersson had purchased controlling interest för Kr 7 million. In addition, he had a contract from the Soviets for 1,000 locomotives. Andersson, who knew nothing about locomotives, became president and director general; Lomonosov assumed technical direction.[21]

The Berlin Embassy reported the Soviets had advanced a loan of $1.5 million to the company to extend the locomotive construction plant at Trollhatten.[22] The Soviets themselves stated the arrangement was no more than a credit. In view of the special 'arm's length' relationship with Andersson, the latter explanation is unlikely.[23] What is quite clear is that the Soviets financed locomotive construction in Sweden at a time *when they had five locomotive construction plants in 'technical preservation,' one with completely new equipment*,[24] and notwithstanding a precarious financial and foreign exchange position. Later the following month about 1,500 'high-grade' locomotives were purchased from Germany, delivery beginning early 1922.[25] These were of basic American decapod design adapted to Russian conditions.[26]

The imported Swedish and German locomotives were sent to the Putilovets in Petrograd for assembly under the supervision of Waldemar Sommermeyer, representing the German builders, and Karl Kainer, representing Nyquist and Holm. The status of locomotives in January 25, 1922 was as follows:

Locomotives	*On Order*	*Delivered*	*Assembled*
From Germany	1,350	220	
From Sweden	600	12	53
From United States	250	24*	
Total	2,200	256	53

Source: U.S. State Dept. Decimal File, 316–163–890.
* These were probably Baldwin Locomotive units. The Russian Ambassador in Washington reported on September 1920 that Baldwin Locomotive had sold 50 locomotives 'indirectly' to the Soviet Union with payment through a Spanish account (316–163–836).

[20] *Ekonomicheskaya Zhizn*, No. 210, September 21, 1921.
[21] U.S. State Dept. Decimal File, 316–163–731.
[22] U.S. Embassy in Berlin, Report 53, December 8, 1921. (316–130–1174.)
[23] See page 269.
[24] See page 269.
[25] U.S. State Dept. Decimal File, 316–163–739.
[26] *Trud*, No. 104, May 14, 1922.

Locomotives were assembled at Putilovets as a temporary measure, and some 2,000 extra workers were engaged under supervision of Swedish and German engineers. Between November 1921 and January 1922 about 53 locomotives were assembled and sent to Nikolaev and Northern Railways. During January, twelve were returned as defective due to 'systematic damage' by railway workers. As the locomotives were driven under the supervision of German instructors, 160 of whom had been sent from Germany, this was presumably sabotage.[27]

In addition to outright purchase of locomotives in Sweden, Germany, and the United States, the Soviet Union contracted for large-scale repairs in Estonia and Germany. The first Estonian contract was with locomotive-building plants in Reval for repair of 2,000 'sick' locomotives. Payment under this and similar contracts was in damaged locomotives; i.e., a percentage of the delivered units was retained by the Estonian firms as payment in kind.[28] The second Estonian contract, valued at over $2 million, was signed on December 21, 1921 with the Dvigatel plant (representing a group of Estonian and English builders), the Russo-Baltic works, the Peter shipyard, the Fr. Krull, and the Ilmarine, all in Reval. This contract covered an initial 200 freight units of the 0-8-0 type and extended later to 1,000. The repairs were classified into three categories, and a fixed price was paid for each class of repairs with additions for missing parts according to a fixed scale. Cash advances were made and 40 percent paid on delivery of the repaired locomotives at the Russian-Estonian frontier. Payment was in American dollars. All steel and parts, except copper fire-boxes, were the subject of a separate agreement between the Estonian companies and Krupp of Germany. The latter also arranged financing of the program with the Deutsche Bank. The British Vickers-Armstrong Company participated in the repair contract by leasing the Russo-Baltic works through a specially formed subsidiary, the Anglo-Baltic Shipbuilding and Engineering Company. The major portion of the order was divided between Anglo-Baltic, the Dvigatel, and the Peter shipyard. The plants were kept busy for about one-and-a-half to two years.[29]

The Soviet Union made numerous attempts to acquire American locomotives. On April 22, 1919, Martens, operating as the 'representative of the U.S.S.R. in the United States,' claimed 200 locomotives ordered by the Kerensky government as the property of the Soviet Union. His letter was left unanswered.[30] The next recorded attempt was in February 1920, when Mayor

[27] U.S. State Dept. Decimal File, 316–163–836.
[28] U.S. State Dept. Decimal File, 316–163–856.
[29] U.S. State Dept. Decimal File, 316–163–881 *et. seq.*
[30] U.S. State Dept. Decimal File, 316–163–453.

Friedenberg (of Riga), who had just returned from Moscow, announced that he had been commissioned to enter into negotiations for purchase of 600 American locomotives and 'large quantities' of machines, tools, and rails. Payment was proposed in gold and platinum.[31] Ten days later the Riga Consulate reported that Friedenberg was going to attempt to order directly from Baldwin Locomotive or American Locomotive for delivery to Latvia, and then turn the locomotives over to the U.S.S.R.[32] It was reported via Finland two months later that representatives of 'American firms' had accepted a Soviet order for 400 locomotives at Reval, Estonia.[33] Purchase of American locomotives was also attempted through Latvia.[34]

In the main, however, the bulk of the locomotives purchased were either Swedish or German and were classified 'Eg' (German-built) or 'Esh' (Swedish-built). The basic design was the Vladikavkaz Railroad 0-10-0, introduced in 1912 and built after 1926 at all five Russian locomotive construction works. The only difference was a larger superheater in front of the engine. More powerful variants were introduced in the 1930s, but this basic type was still being produced after World War II and is still the basic steam freight-hauler in use on Soviet railroads today. For passenger locomotives the Soviets inherited a mixed group of pre-revolutionary makes and selected the Vladikavkaz Railroad type S 2-6-2, known as the 'Sv', built originally for use on

Table 10-3 LOCOMOTIVE CONSTRUCTION BY GOMZA WORKS, 1921-3

Prerevolutionary Name	*Soviet Name*	*Position, 1921-3*
Sormovo	Krasnoye Sormovo	Closed, then opened with German technical assistance
Kolomna	Kolomna	Partly open, for wagon repair
Bryansk	Profintern	Closed 1922-3
Hartmann (Lugansk)	Lugansk	Closed 1922-3
Kharkov	Kharkov Locomotive	Closed 1922-3

Source: German Foreign Ministry Archives, T120-4249-L092272.

[31] U.S. State Dept. Decimal File, 316-163-678.

[32] U.S. State Dept. Decimal File, 316-163-680. The State Dept. reply (marked 'not sent') suggested that the Friedenberg matter be allowed to develop along these lines. It was drafted by Poole of Russian Affairs but killed by the Second Assistant Secretary.

[33] U.S. State Dept. Decimal File, 316-163-703. An intercepted radio message to Martens in the U.S. directed him to purchase 100 locomotives directly from Baldwin Locomotive.

[34] U.S. State Dept. Decimal File, 316-163-705.

the Warsaw-Vienna railroad. This locomotive was redesigned to carry a larger firebox and superheater and was put into production after 1925 with the designation 'Su'. Several hundred were built in this basic design.[35]

The decline in repairs continued throughout 1921 and 1922, and the position was stabilized only by this flow of new locomotives from abroad.

This decline continued; Russian locomotive shops were idle although in good mechanical condition. They had lost many skilled workers but had enough to turn out some new locomotives. The orders, however, were going abroad, not even the newly equipped Murom plant outside Moscow could get locomotive orders. Pressure built up to halt the export of 'sick' locomotives to Estonia for repairs and place orders in the idle Russian plants. In June 1922, Glavmetal refused to sanction a shipment of 200 'sick' locomotives to Estonia. The trade union organizations added to the pressure by accusing Lomonosov of selling out the proletariat to Estonian capitalists.[36] As a result of this pressure, deliveries under both the Estonian and German contracts slowed after 1922, and the idle Russian plants were restarted, with German assistance, by about 1924-5.

Table 10-4 CONSTRUCTION OF STEAM LOCOMOTIVES IN RUSSIA AND THE U.S.S.R., 1906 TO 1929

Year	*No. Built*	*Year*	*No. Built*	*Technical Assistance*
1906	1,270	1921-2	115*	
1913	609	1922-3	96*	
1914	762	1923-4	169*	
1915	883	1924-5	148*	
1916	616	1925-6	302	German post-Rapallo technical assistance
1917	410	1926-7	359	
1918	200	1927-8	479	
1919	74*	1928-9	575	Baldwin Locomotive technical agreement
1920	90*	1929-30	625	

Sources: 1. U.S. State Dept. Archives.
2. German Foreign Ministry Archives.
3. G. W. Nutter, *op. cit.*, p. 432.

* These figures, from Nutter and originating in Soviet sources, are doubtful. They are probably major or capital repairs counted as new locomotives; the Archival sources support this argument.

Productivity in the Gomza trust was about 20 percent of that of 1913. The State Railroad system—the major customer—calculated it was paying

[35] J. N. Westwood, *A History of Russian Railways* (London: George Allen & Unwin, 1964), pp. 86-93.

[36] U.S. State Dept. Decimal File, 316-163-913.

prices six times greater than prewar for Gomza products, and smaller articles made by the trust were being sold on the open market at half price in order to sell at all. Consequently, it is not surprizing that the trust was covering only 7 percent of *direct* costs (i.e., it was making no contribution to fixed costs). The statement was made that, ' . . . we cannot close down as this would throw 80,000 men out of employment and the railways would suffer.'[37] The problem, of course, was lack of orders. While German, Swedish, and American locomotives were being imported in quantity, Gomza was largely idle. On the other hand, there was ample evidence that the skills to manufacture locomotives were lacking. The engineers had fled, and those locomotives that were being repaired broke down after a few days back in service.[38]

THE BALDWIN LOCOMOTIVE TECHNICAL-ASSISTANCE AGREEMENT OF 1929[39]

The Baldwin Locomotive Works Company, with a group of fifteen manufacturers of input parts and supplies for locomotives, made a sales-cum-technical agreement with the Soviet Union on April 12, 1929. Baldwin agreed to sell its products and those of the allied companies to Amtorg on a revolving credit basis. A total of $5 million was made available ($2 million within eighteen months of date of signature). Separate technical-assistance agreements (not available from the State Department files) were also signed to assist Gomza in the development of locomotive production. The credit terms were:

20 percent payable 24 months from date of dock receipt
20 percent payable 36 months from date of dock receipt
20 percent payable 48 months from date of dock receipt
20 percent payable 60 months from date of dock receipt.[40]

These advances carried a 6-percent interest rate. Baldwin and the associated companies agreed to send their engineers into the Soviet Union for locomotive erection and engineering work, and, as the contract reads:

> . . . agrees to receive at its works and assist in placing at the works of such firms whose products will be supplied under this agreement, and will also assist in placing in shops and on railroads in the United States a reasonable number of workers, foremen and engineers sent from the U.S.S.R. for a period of time provided in each case separately, so as to enable these workers, foremen and engineers to get fully acquainted with American practice.[41]

[37] U.S. State Dept. Decimal File, 316–107–1044.
[38] U.S. State Dept. Decimal File, 316–163.
[39] A copy of the agreement is in the U.S. State Dept. Decimal File, 316–163–1301.
[40] Clause 9 of the agreement.
[41] Associated companies were American Steel Foundries, Athey Truss Wheel, Brill Car Company, Electric Controller and Manufacturing, Fairmont Railway Motors,

The agreement was signed by A. A. Zakoshansky for the Soviet Union and Charles M. Muchnic, Vice President for the Baldwin Locomotive Works Company.

GENERAL ELECTRIC DIESEL-ELECTRIC 'SURAM' LOCOMOTIVE

Russia had been a pioneer in diesel traction. Prerevolutionary shipbuilding yards and locomotive construction plants in Petrograd and Kharkov had undertaken a great deal of innovatory work in the direction of diesel-electric and diesel-mechanical propulsion. There were diesel electric ships in tsarist times built in Russian shipyards. The Tashkent railroad had been an early innovator in diesel traction and had actually built a gas turbine locomotive.[42] This promising start came to a complete halt in the 1920s. Efforts to continue diesel locomotive construction were halting and unsuccessful. They culminated in the import of the General-Electric-designed 'Suram' locomotive, named after the mountain pass in the Caucasus, in 1932.

In 1922 an experimental power plant was built, using the Tashkent railway turbine and a compressor system designed and built by Armstrong-Whitworth in the United Kingdom. The claims were great but nothing more was heard of it.[43] Two years later a locomotive design competition was announced for a 16-ton, 930-mile-radius locomotive with a tractive effort of 26,000 pounds at 9 m.p.h. The sole entrant was a design by Professor Gakkel, which was subsequently built at the Putilovets and Baltic plants under German supervision. The locomotive was powered by a Vickers 1,030 h.p. diesel engine reclaimed from a submarine, coupled with some Italian generators. This was the Lenin Memorial Locomotive, presently preserved in Moscow. Westwood says it was withdrawn from service in 1927 after running only 25,000 miles and spending much of its active life out of service. It spent many years as a mobile generator.[44]

Russian designs were not forthcoming; it was obvious that the designers had fled with the Revolution. Prototype locomotives were then ordered in Western countries. These used both diesel-electric and diesel-mechanical systems. The most successful under Russian conditions was a Krupp 1-E-1 diesel electric, and in 1927 a trial order was placed with Krupp for an improved

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Locomotive Terminal Improvement, Southwark Foundry and Machine, Standard Steel Car, Superheater Company, Sunbeam Electric, Westinghouse Air Brake (expropriated without compensation in 1925), Wilson Welder, G. D. Whitcomb, Locomotive Firebox, and Nathan Manufacturing.

[42] Westwood, *op. cit.*, p. 67.

[43] *Ibid.*

[44] *Ibid.*

version of this prototype with a Mann-type four-stroke six-cylinder engine which enabled the Soviets to make use of their technical-assistance agreement with the Mann company. Brown-Boveri traction engines of 140-kw hourly rating were also ordered. These prototypes were not built in the Soviet Union, however, until 1932, when production started at Kolomna. The design produced was identical to the German E-e 15. This decision ended an unsuccessful prototype development program which had been continued for some years at the Kolomensky works. It had produced some prototypes for secondary lines in the late 1920s, but Westwood indicates these had not been successful, owing to frequent burnouts.[45] Future locomotive construction was based on foreign design and particularly on the General Electric design for the 'Suram' model; indeed some elements of the current (1966) VL 23 design are the same as those in the original 'Suram' delivered about thirty-four years ago. Diesel-electric traction is an area where the Soviets have shown neither innovatory nor construction ability.[46]

Apart from purchasing prototypes, the Soviets induced Western companies to undertake the solution of specific mechanical problems. In the development of industrial locomotives using gasoline engines, the technical problems were solved by an American company hoping to sell such locomotives to the U.S.S.R. In 1926–7 the Koehring Company sold several four-cylinder industrial locomotives to the Soviet Union and in the following year received an inquiry about six-cylinder units. The company pointed out that ordinary Russian grade kerosene would not be sufficiently volatile, although the 'export' grade produced by the Standard Oil refinery at Batum would be suitable. With the assistance of the Department of Commerce, which canvassed American oil companies for Koehring, data was developed on the characteristics of Russian kerosenes, and engineers from 'one of Koehring subsidiary companies' developed an engine suitable for efficient operation on this grade of fuel.[47]

TECHNICAL ASSISTANCE TO GOMZA REFRIGERATION EQUIPMENT PLANTS

Gomza's efforts in refrigerator and cold-storage plant construction received technical assistance from German and United Kingdom firms from about 1926 until well into the 1930s. In late 1926 an agreement was signed between Gomza and A. Borsig G.m.b.H., of Berlin, for assistance in construction of refrigerators utilizing the Borsig system. The German firm prepared construc-

[45] *Ibid.*, pp. 67–9.

[46] *Ibid.*

[47] Records of the U.S. Bureau of Foreign and Domestic Commerce, File 312 (1927).

tion designs and working plans for the trust, utilizing its own patents and experience. There was an exchange of refrigeration engineers between Gomza and Borsig plants. Further such technical-assistance contracts were signed with Maschinenfabrik Augsburg-Nurnburg A-G and L. A. Reidinger A-G, also of Augsburg, for construction of cold-storage facilities.[48]

Dairy produce agreements with the Union Cold Storage Company, Ltd. (of the United Kingdom), allowed the company to establish cold-storage facilities in the U.S.S.R. to handle food products being exported under the trading agreement.[49]

GENERAL TECHNICAL ASSISTANCE FOR ORGAMETAL

The first *overall* technical guidance for the reconstruction of the heavy-machine industry came under a three-year agreement signed in later 1926 between Orgametal (the heavy industry syndicate) and the German company, Verein Deutscher Werkzeugmaschinen Fabriken Ausfuhr Gemeinschaft (known as Faudewag). This company set up a joint technical bureau in Berlin to design new plants and re-equip the tsarist heavy-machine industry. The company supplied engineers, technicians, and skilled workers; superintended construction and reconstruction; and supplied machinery, raw materials, working supplies, and design services.[50] The agreement was renewed in 1929, and Faudewag added more functions. It was still in force in the early 1930s.[51]

The Faudewag project, which supervised all Orgametal work, was followed by an extensive technical-assistance agreement with the Frank Chase Company, of the United States.[52] The most significant agreement was made at the end of the decade, in connection with the large-scale construction projected under the first Five-Year Plan. Almost all major projects under the Plan were designed by American companies.[53] Albert Kahn Company of Detroit had the basic task of supplying technical advice to the Building Committee of Vesenkha, in addition to contracts with Glavmashstroi for construction of new machine-building plants and with Traktorstroi in Stalingrad for construction of tractor

[48] Vneshtorgizdat, *op. cit.*, p. 227.

[49] See chap. 7.

[50] *Torgovo-Promyshlennaya Gazeta*, No. 279, December 3, 1926.

[51] Vneshtorgizdat, *op. cit.*, p. 228. This expanded Faudewag agreement supervised all Orgametal projects. The company office in Berlin replaced the Russian-operated and staffed Buiro Inostrannoi Nauki i Tekhniki (BINT), organized in Berlin in 1920 to collect foreign technical data. BINT employed 100 Russians in 1921 but the staff was reduced to 5 by Ipatieff, who considered the cost too great in light of the returns. (Ipatieff, *op. cit.*, p. 330.)

[52] U.S. State Dept. Decimal File, 316-131-642.

[53] This is covered in detail in Vol. II.

plants.[54] The Five-Year Plan as a concept is almost completely a myth of the propaganda mills. First, there were no hard and fast dates for beginning and ending specific projects in sequence. Each contract had its own time sequence and was not always well integrated with other construction projects. A set of dates was necessary, however, for the propaganda image of 'scientific socialism at work.' Second, the complete design work, supervision of construction, provision of equipment, and, in many cases, actual factory construction were done by Western companies under contract. They were kept to the all-important dates by heavy penalty-bonus clauses. The fact that some large plants were finished ahead of the planned date had nothing to do with 'socialist construction.' It was quite simply that the Western firms responded to the substantial bonuses payable for completion ahead of the contracted date. When the Soviets attempted to repeat the feat of Western private enterprise later in the 1930s, they were totally unsuccessful and became very secretive about new projects.[55]

SKF (SWEDEN) AND THE MANUFACTURE OF BALL BEARINGS[56]

Prior to the Great War in 1915, the Swedish company Aktiebolaget Svenska Kullagerfabriken (SKF), an internationally known manufacturer of ball bearings and transmissions, established an extensive and well equipped plant in Moscow. This plant was nationalized in 1918 but continued to work at full speed under its Swedish engineers through the Revolution. Sometime in 1920, negotiations started between SKF and the Soviets for a concession arrangement. Agreement was reported by the *Chicago Tribune* in October 1921, but not by the Soviets for another eighteen months. The details are fairly clear, but the exact date of signature remains unknown.

The SKF company was given the right to produce balls, bearings, and transmissions and to export up to 15 percent of these products. Complete supply to Soviet industry was anticipated. The company was guaranteed a 15-percent profit. In return, the company was allowed to purchase its own prewar property (two plants and the remaining stock of raw materials) for a payment of 200,000 gold rubles. The plants were then re-equipped by SKF,

[54] *Torgovo-promyshlennaya Gazeta*, May 16, 1929; and U.S. State Dept. Decimal File, 316-131-674.

[55] Vol. II uses data from the German Archives and suggests that the construction under the second and third Five-Year Plans, in which the Soviets relied much more on their own resources, was almost catastrophically below projected targets. At least part of this problem was caused by diversion of the finest of available skills and equipment into military production.

[56] Sources for this section are the *Chicago Tribune* (Paris edition), October 3, 1921; *Izvestia*, No. 63, March 22, 1923; and the U.S. Consulate in Stockholm, Report, April 4, 1923.

who supplied all patents and management, the Soviets supplied raw materials. Some 400 workers were employed, with Swedish engineer Wilhelm Adrian as manager. Three-quarters of the workers were Russian and the balance Swedish ' . . . paid in Swedish money and fed on imported Swedish food.' The intent, according to Adrian, was to raise the standard of Russian labor by mixing skilled Swedish workers with the Russians.

A completely new SKF plant was built under the agreement and produced, with the re-equipped tsarist-era plants, about 2–3 million rubles' worth of bearings per year, and the company paid a rental based on this annual volume at a progressive rate. Previous to the Revolution, only bearings had been produced in Russia; the steel balls were imported from Sweden. The Soviets required the steel balls to be manufactured in the U.S.S.R., and up to that time the company was required to keep on hand in its Moscow warehouses a stock of balls equal to three times the quantity of bearings.

The Soviets were represented by two members on the Board of Directors, although nominally and probably in practice the plant was run by a Swedish management. Provision for arbitration was made with a board comprising two members from each side and a president appointed by the Moscow High Technical School; i.e., the Soviets had a say in management and a majority in arbitration. All former SKF claims were cancelled by the concession. The agreement was viewed by the United States consul at Riga with some distaste:

> The Soviets having forced the owners to pay for the use of their own property over a long period of years, will probably hold the transaction out to the world as evidence that property once nationalized by them has actually been bought back by the original owners.[57]

The company was required to buy back its own plant and also required to amortize its new equipment over twenty-five years, a lengthy period when compared to a more normal requirement of five years. As the hidden intent of the Soviets was to nationalize once again after the new plant and techniques had been assimilated, the 'guaranteed 15-percent profit' was meaningless. The concession was expropriated long before the expiration of the amortization period. One has to examine Soviet attitudes to Western business to appreciate the overriding importance of good faith in enterprise societies. Company after company went into the U.S.S.R. with an agreement based on good faith, and all eventually learned the meaning of the 'dictatorship of the proletariat.' SKF had to buy back its own property for cash, make a second investment from its own capital stock, and amortize that for the purpose of estimating its 'guaranteed profit' on the basis of a twenty-five year stay. Finally, however, the whole investment was re-expropriated under conditions which effectively

[57] U.S. State Dept. Decimal File, 316–131–721.

precluded anything but a purely arbitrary Soviet settlement. One can understand why details of these investments are difficult to come by. The picture of the capitalist entrepreneur as a hardnosed calculating machine is shattered by the story of his dealings with the Soviets.

One by-product of the SKF agreement was technical assistance in the production of high-quality steel. Under the SKF concession, the Soviets were required to supply steel for the bearings. This posed a problem, as all high-grade steel had previously been imported and there were no facilities for production of this type of steel. The problem was solved in a characteristic manner: the Soviets asked for technical assistance and the SKF Company installed Swedish steel men in the Zlatoust steel plant in the Urals.

The transfer of Western ball-bearing technology was not completed by the time of the second expropriation of SKF. Two further agreements were made in 1930: one with Vereinigte Kugellager Fabriken A-G, of Berlin, and the other with S. A. Officine Villar Perosa (RIV), of Turin, Italy.[58]

STEAM BOILERS AND MECHANICAL STOKERS

Steam boilers are essential for industrial production operations where coal is a useful fuel. The relative decline of the economy under the Soviets may be well illustrated by the increasing age of steam boilers between 1914 and 1924.

Table 10–5 AGE OF STEAM BOILERS IN RUSSIAN PLANTS, 1914 AND 1924

Age	*1914*	*1924*
Under 10 years	35.5 percent	4.8 percent
Under 25 years	49.0 percent	53.0 percent
Under 35 years	11.5 percent	31.0 percent
Over 35 years	4.0 percent	11.2 percent
	100.0 percent	100.0 percent

Source: Troyanovsky, *op. cit.*, p. 383.

In 1914, 35 percent of boilers were less than ten years old but in 1924 less than 5 percent fell into this category. This suggests negligible replacement. Even more important, in 1914 only 15 percent of boilers were more than twenty-five years old; by 1924 the figure had increased to 42 percent. There were 138 boilers in Briansk and Dnieper factories in 1923; of these, 111 had been built before 1900.[59] Imports of boilers immediately after the Revolution

[58] Vneshtorgizdat, *op. cit.*, pp. 228–9. Barmine, *op. cit.*, p. 210, testifies to the low quality of Russian ball bearings in this period. See Vol. II for further information.

[59] *Izvestia*, No. 278, December 5, 1923.

sank to zero. Importation began again in 1921, rose to almost one-third of the prewar level, and then declined after 1924. Steam boiler accessories followed a similar pattern. The decline after 1924 was due to local production by a concession.

In 1922 a concession was granted to Richard Kablitz, a Latvian firm, which took back its old prewar Petrograd factory and started again to produce steam boilers, mechanical stokers, fuel economizers, and similar equipment. This was by far the largest such plant in the U.S.S.R. Production expanded rapidly, and by the end of the decade Kablitz had equipped over 400 Russian factories with boilers and stoking equipment.[60] In the last two years of the decade, Kablitz turnover was substantial: more than 900,000 rubles in 1925–6, 1.4 million in 1926–7 and more than 1.6 million in 1927–8.

In brief, the Kablitz concession, operating from 1922 to 1930, enabled the Soviets to eliminate importation of boilers almost completely since the firm organized production and trained Russian workers in boiler production. It made a very significant contribution to the re-equipment of Soviet industry. The success may be established by the decline of boiler imports in the face of increasing boiler age. By 1929, Kablitz had served its purpose. Taxation was increased to the point where production was no longer profitable, and the Soviets took over the Kablitz operation.[61]

PRECISION ENGINEERING TECHNOLOGY AND ITS ACQUISITION

Many skilled instrument-makers fled Russia during the Revolution, but in 1918 a group of these returned from the United States with a group of American deportees and formed the Russian-American Instrument Company in Moscow. They brought their own machinery from the United States, employed about 300 unskilled Russian workmen, and ran what was considered to be 'one of the best factories in Russia. Members of the Third International were taken to see it as an example of the finest conditions.' As the government was unable to supply food, the enterprise broke up.[62]

In 1921, the pre-Revolutionary plants producing instruments, watches, and precision equipment were grouped into *Techmekh* (the Precision Engineer-

[60] *Bank for Russian Trade Review*, II, No. 2 (February 1929), 10; and *Izvestia*, No. 223, October 2, 1923.

[61] U.S. Consulate in Riga, Report 5997, March 25, 1929 (316–110–1014). In the view of the Latvian Foreign Office, it was impossible to establish Latvian firms in the U.S.S.R., as the Soviets 'would force them out of business either through taxation, labor legislation, charges of economic espionage or some other method of persecution if the enterprise should become too prosperous or compete with a Soviet industry.'

[62] Keeley, *op. cit.* The trade unions also protested this plant.

ing Trust). These comprised the former Duber plant (renamed the Geophysika), the former Tryndin (renamed the Metron), and the Unified Watch Works, formed from smaller pre-Revolution plants.[63] The process of trustification did not appear to achieve very much, and the next few years saw a succession of concession agreements with foreign companies. These were of all three types and were allocated one to each branch of precision engineering. Calculating machines, typewriters, sewing machines, clocks and watches, razor blades, drawing instruments, and similar items were all subject to agreements. The Soviet Union took the opportunity to change over to the metric system. This problem was tackled by yet another concession, the Franco-Russian Association for the Study of the Metric System (SOVMETR) a French-Soviet mixed Type II company which undertook the changeover and the production of the necessary weights and measures. The difficulties of changeover varied by industry and were dependent to a great extent on conditions during the prerevolutionary period. In the electrical industry, there was no difficulty, as the industry had been developed on the basis of the metric system; but textiles, equipped extensively with British equipment, posed considerable difficulties which Gosmetr (State Office for Metric Weights and Measures) was unable to solve for some years.

The Singer Sewing Machine Company operated numerous plants, warehouses, and retail units in prerevolutionary Russia, including manufacturing units in Moscow, Leningrad, and Vladivostok. These plants, producing one quarter of a million household sewing machines, were valued by Singer at $75 million.[64] In addition, the wholesale and retail Singer network in tsarist Russia included 50 central agencies and warehouses and more than 3,000 individual outlets for the sale and servicing of sewing machines. The Singer sales force alone employed 27,500 in 1914.

Nationalization of the Moscow and Petrograd Singer plants in 1917 and the Vladivostok plant in 1923 was completely unsuccessful. The equipment was found to be much too complex to operate on the basis of shock tactics and revolutionary slogans. The factories were denationalized and returned to the Singer Sewing Machine Company in 1925.[65] This company, like many others, assumed incorrectly that this admission of inability implied that the Soviets did not wish to renationalize. No sewing machine output figures have been recorded for the period 1917 to 1926–7; technical problems probably

[63] *Annuaire*, p. 29; and Troyanovsky, *op. cit.*, p. 385.

[64] Based on claims filed with the U.S. State Dept. in 1922 (Decimal File, 316–109–1330). Including Russian government treasury bills and accounts in Russian banks, the Singer claim was over $100 million. (Foreign Claims Settlement Commission of the United States, Claim No. SOV-40,920.)

[65] Denationalization, and the reasons for it, are noted in the German Foreign Ministry Archives, T120–3033–H109454.

inhibited production.[66] In 1926–7, the first full year after denationalization and restoration of operations to the Singer Sewing Machine Company, the plants produced 200,000 machines, a figure which rose to 500,000 by the end of the decade.

In the early years of the New Economic Policy the Miemza concession was granted for the operation of a clock manufacturing plant in Moscow. After expropriation this became the Second State Clock Factory and was supplied with additional equipment from the Ansonia Clock Company in New York.[67]

The clock and watch industry production problems were overcome in a manner more suggestive of the massive 'turn-key' acquisitions of the 1950s. In June 1929 Techmekh negotiated a contract with two United States firms when Swiss firms refused to sell equipment necessary for watch plants. This contract called for establishment of two complete watch and clock factories. The first contract, with Dubert, was for a plant to produce 200,000 pocket and wrist watches a year to sell at retail prices between 20 and 40 rubles. The Soviets obtained five-year credit terms, and the plant was built in the early 1930s. This became the First State Watch Factory. The other plant was supplied by Ansonia for the production of one million alarm clocks and 500,000 large clocks for public squares, railroad stations, and public institutions. This plant was also supplied on five-year credit terms and was named the Second State Watch Factory. In both contracts, provision was made for the supply of manufactured and semi-manufactured parts until such time as the plants were able to develop their own input from internal Russian sources. About twenty-five specialists were sent from the United States to establish the plants and supervise production for the breaking-in period.[68]

Typewriters were not produced in the Soviet Union until after 1930. In 1929, the Moscow Soviet decided to build a typewriter factory and instructed Techmekh to negotiate with foreign firms for construction. An agreement was made with the Underwood Company for technical assistance to manufacture typewriters and calculating machines and for the intermediate-term sale of machine parts for assembly in Russian plants. During the first two years, the new factory only assembled machines. In the first year, 5,000 machines were planned for production, and in the second, 10,000. This figure was scheduled to rise to 218,000 annually after ten years. Typewriter

[66] The U.S. State Dept. has a report (origin unknown) to the IX Congress of Soviets noting that the figure for sewing-machine production was 318 in the first half of 1920 and 187 in the first half of 1921. Even this miserable contribution has the air of 'something is better than nothing' and is dubious.

[67] S. Weinberg, *An American Worker in a Moscow Factory* (Moscow: 1933), p. 18–19.

[68] *Torgovo-Promyshlennaya Gazeta*, No. 147, June 30, 1929; and *Ekonomicheskaya Zhizn*, No. 191, August 21, 1929.

ribbons and supplies were produced by the Alftan concession after about 1924.[69] Pencils and stationery items were made by the Hammer (American Industrial) concession. These companies were the only producers of these items in the Soviet Union.

In the case of precision equipment, we can trace the start of a process of acquisition which was to be developed more extensively from the late 1930s to the 1950s. This was the purchase of single items or prototypes which were examined, broken down, and then used as the basis for Soviet production. The Fordson (Putilovets) tractor was probably the first effort in this direction. Purchases of small lots of Western machines began about 1927. For example, in September of that year, a number of calculating machines were bought in the United States, but only one or two each of a large number of makes and models.[70] Burroughs, Monroe, Marchant, and Hollerith were represented in the purchase. In more difficult areas, such as marine instruments, technical-assistance agreements were made: in the case of marine instruments, with Sperry Gyroscope Company of the United States.[71]

CONCLUSIONS

The process by which the tsarist machine-building industry was restarted and modernized is quite obvious. A great number of the plants were physically intact after the Revolution; skilled labor and engineering personnel were missing. Both had been dispersed by the political upheaval.[72]

[69] *Ekonomicheskaya Zhizn*, No. 346, November 28, 1924.

[70] Amtorg, *op. cit.*, II, No. 18, September 15, 1927, 5.

[71] A. A. Santalov and Louis Segal (eds.), *Soviet Union Year Book, 1930* (London: George Allen & Unwin, n.d.), p. 359.

[72] The Foss Special Collection at the Hoover Institution illustrates the comparatively advanced technology of tsarist industry. Foss, graduate of the St. Petersburg School of Mines, was variously builder and manager of the Briansky Works, the Kolomna Locomotive Works, the Sormovo Works, and the Alexandrovsky plant between 1890 and 1917. The collection comprises eighteen large folders of high-quality photographs stressing the technical side of these plants.

The photographs emphasize particularly the size of these prerevolutionary enterprises; some shops at the Alexandrovsky and Sormovo were very large by contemporary world standards. General neatness and order, uncharacteristic of post-revolutionary plants, is very noticeable (see the 'General view of blast furnaces and coke ovens' in the Alexandrovsky folder). A high degree of Russian craftsmanship is demonstrated in photographs of the erection of the manual training school at the Kolomna Locomotive Plant, particularly in the stone and brick work. This craftsmanship is conspicuously missing in post-revolutionary buildings.

Complex machinery was made in these plants. The Briansky Works folder has photographs of intricate steel castings, stampings, bevel gears, helical screws, locomotive parts, small tools, and armaments, as well as complete locomotives and wagons. Kolomna Service Locomotive No. T1027 (dated 1897) is an impressive piece of equipment. Of particular interest (in the Sormovo Works folder) is a photograph of a large planer under construction (dated 1887) and an almost complete 3-high plate-rolling mill. The latter is complete with run-out tables, cast rolls, and screw-down mechanism. The rolls are about 84 or 96 inches wide and of great

Several of the more complex machine-building plants were allowed to continue unmolested (e.g., Westinghouse Air Brake and Citroen). The alternative was to see the plants at a complete standstill. The foreign owner viewed the situation with a measure of hope. In some cases (Singer and International Harvester) the plants were nationalized and then denationalized. This was also seen as a sign of a genuine return to capitalism. Others were restarted with German technical assistance forthcoming under the Rapallo economic protocols. At the end of the decade, after a decision had been made to orient to American technology, a series of agreements were made with American companies: Baldwin Locomotive, Frank Chase, Albert Kahn, Sperry Gyroscope, and Underwood, for example. In diesel and engine building, the decision was to continue with German (Deutz and Faudewag) technical assistance.

In sum, the restored tsarist machine-building industry was on the way to modernization at the end of the decade. Construction of new plants was on the drawing boards of top American and German companies.

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interest in the light of Soviet assertions that this equipment was not built in Russia until after 1930. In the Alexandrovsky folder there are photographs illustrating forging and machining a one-piece 20-ton steel ingot into a connecting rod for the cruiser *Bogatyr* (about 1890). Other features are the racks in Pickling Shop No. 1 at the Kolomna Works. These are the same model in use in Welsh tinplate mills in the early 1950s. The worker's dress is decidedly better than that of the post-revolutionary period.

The reader who is interested in pursuing this comparison further should compare the complete Foss collection with examples of the *same* plants in the Soviet period. One source for Soviet data is the booklets published by the Chief Concessions Committee describing plants offered as concessions to foreign entrepreneurs. For example, see I. N. Kostrow, *The Nadedjinsky and Taganrog Metallurgical Works* (Moscow: 1929). The plants were in a pitiful state, having been allowed to run down during twelve years of Bolshevik rule. There is a photograph of the open-hearth shop of the Nadedjinsky Works, which indicates that the shut-down plants only needed *work* to get them into operation. Nadedjinsky appears partially in operation, but one furnace is obviously 'cold,' with debris and trash heaped around the furnace doors.

CHAPTER ELEVEN

Electrical Equipment Manufacturing Industry and Goelro[1]

THE FORMATION OF TRUSTS

A RUSSIAN electrical equipment industry was established in the decade before the Revolution. In 1917 the industry was concentrated in Petrograd (about 75 percent) and Moscow, and employed some 60,000 workers. The Soviets nationalized the industry, which came through the Revolution with its equipment substantially intact.

From 1921 onward, the government invited a series of foreign experts and companies into the U.S.S.R. to make recommendations for modernization. The first known report by a Western engineer painted a chaotic picture. Some plants were closed; in those that remained open, employment was 5 to 10 percent of the prewar level (about 4,000 in 1920) and production even less. Many skilled Soviet workers had entered military service to get food and shelter; the more skilled foreign workers had returned home; and those domestic workers that remained were largely inefficient. Wages did not correspond to ability. Bench workers often earned more than skilled technicians. Communists possessing little or no technical ability served as technical directors, and 'white' skilled engineers were serving in minor posts. Stocks of raw materials ran out; no means existed for importation or domestic supply.

On the other hand, the industry was in relatively good shape technically; only a few plants required re-equipment.[2]

[1] This chapter is based on Soviet sources published inside and outside the U.S.S.R., on reports submitted to the U.S. State Dept. by representatives of American companies invited to examine the condition of the electrical industry, and on material on Allgemeine Elektrizitäts Gesellschaft (A.E.G.) from the German Foreign Ministry Archives.

[2] See the Report by B. W. Bary, electrical engineer, to the U.S. Consulate at Vibourg, October 1921. The covering letter describes the report as 'competent,' 'comprehensive,' and 'a measure of the true conditions.' (316–139–11.)

Confirmation of the excellent technical state of the industry comes from a surprising source—Charles P. Steinmetz, the inventive genius of General Electric Company, who was certainly not unsympathetic to the Bolshevik Revolution:

> It is interesting to note that Russia had a considerable electrical industry before the war, so that in 1913 more than half the electrical machinery used in Russia was built in Russia . . . (but) in 1920 the output of the electric factories in Russia was very low. It is stated however that their equipment including tools, etc., was perfectly intact and ready to resume large scale operation.[3]

The first step in reconstruction was to organize the industry into four trusts. The total industry contained thirty-two plants, of which twenty-six were in operating condition and six completely idle, or, as the Soviets expressed it, 'in a state of technical preservation': i.e., in working condition but not operating. The twenty-six were working very intermittently. The four trusts formed were: (1) the Electro-Technical Trust for the Central District (or GET), to manufacture high tension equipment, (2) a trust for manufacture of electrical high-tension equipment (Elmashstroi), (3) the low-tension equipment trust, for telephones and radio apparatus, and (4) the accumulator-manufacturing trust.

The formation of the trusts brought prerevolutionary managers back to positions of authority; although usually these were technical men, one at least had been a company director. Lew Zausmer, a former officer of the Russian General Electric Company, became one of the trio of directors controlling the Electro-Technical Trust.

Concurrently with this reorganization and the return of former managerial and technical personnel, invitations were sent to foreign electrical equipment manufacturers to participate in the development of the industry. On March 29, 1922, Maurice A. Oudin, President of the General Electric Company, informed the U.S. State Department that 'his company feels that the time is possibly approaching to begin conversations with Krassin relative to the resumption of business in Russia.' The State Department told Oudin that this was a question of 'business judgment.' Oudin then added that negotiations

[3] Charles P. Steinmetz, 'The Electrification of Russia,' p. 3 of typescript supplied to the writer by the Schenectady Historical Society, New York.

The reports of Western company representatives are of particular interest and agree with Steinmetz on this point. These engineering reports were to form the basis of managerial decisions to enter or not to enter into agreements with the U.S.S.R. As the reports were made by engineers, they are important for their estimates of the technical state of the electrical plants. These engineers had unrestricted access granted by the Soviet authorities and collected detailed data. The writer gives this data greater weight than that from any other source, including the intelligence reports found scattered throughout the U.S. State Dept. Archives. These engineers (Bary, Reinke, Keeley, Klemmer, and others) were skilled observers, knew the Russian language and also many of the engineers in the plants they visited.

were currently under way between General Electric and A.E.G. (German General Electric):

> . . . for resumption of the working agreement which they had before the War. He expects that the agreement to be made will include a provision for cooperation of Russia.[4]

Within four weeks an offer was made to International General Electric Company to participate in a joint mixed-capital company:

> We believe that the low rate of wages as well as the excellent conditions of the outfit (equipment) of the works will give you sufficient economic grounds for taking part in our business, either in the way of supplying us with certain materials, or by a partial finance in exchange for the products worked out by our factories.[5]

Table 11-1 AGREEMENTS BETWEEN FOREIGN COMPANIES AND THE ELECTRICAL EQUIPMENT TRUSTS, 1922–30

Trusts formed from prerevolutionary plants	*Affiliated foreign firm*	*Type of concession**
Electro-Technical Trust (GET)	International General Electric	III
	Allmanna Svenska Elektriska A/B (A.S.E.A.)	I and III
	Allgemeine Elektrizitäts A-G (German General Electric)	III
	Metropolitan-Vickers, Ltd.	III
	Radio Corporation of America	III
Elmashstroi	Allgemeine Elektrizitäts A-G	III
	Metropolitan-Vickers, Ltd.	III
	John J. Higgins (U.S.)	III
Low-Tension Trust	Ericsson (Sweden)	I
	Radio Corporation of America	III
	Compagnie Générale de TSF (France)	III
Accumulator Trust	Gaso-Accumulator A/B (AGA) (Sweden)	I and III
New Soviet undertakings		
Electroselstroi	Allmanna Svenska Elektriska A/B	II and III
Electroexploatsia	International General Electric Co.	II and III

Sources: 1. U.S. and German Archives.
2. *Annuaire, 1925–26.*
3. Troyanovsk, *op. cit.*
4. Klemmer Reports to Western Electric Co., 1926 (U.S. State Dept. Decimal File, 316–141–630) and 1927 (U.S. State Dept. Decimal File, 316–60–95).

* See chap. 1 for definition of concession types.

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[4] U.S. State Dept. Decimal File, 661.1115/402. Memorandum from D. C. Poole to Secretary of State, March 29, 1922.

[5] U.S. State Dept. Decimal File, 316–139–58. Letter from the Electro-Technical Trust to the International General Electric Company, Schenectady, May 2, 1922.

Two points are notable: first, the statement that the equipment in the plants was in good working order, and second, the timing of the letter from the Electro-Technical Trust to General Electric. It arrived just four weeks after the State Department conversation.[6]

After 1922 a series of similar invitations was sent, and agreements were concluded between all four trusts, individual plants within each trust, and most major Western electrical equipment manufacturers, including International General Electric, A.E.G., A.S.E.A. (Sweden), Westinghouse (through its U.K. subsidiary, Metropolitan-Vickers), Ericsson of Sweden, Brown-Boveri (Switzerland), Western Electric, and Siemens, as well as numerous smaller companies.

These agreements were made at two organizational levels: the trust and the individual plant. At the trust level they provided technical assistance, patents, drawings, and exchange of personnel (Type III agreement). At the plant level the contracts provided for technical assistance and also, in some cases for plant operation as a pure Type I concession by the Western entrepreneur. Table 11–1 lists the four trusts formed by the Soviets from prerevolutionary factories together with the affiliated foreign partner, and the Soviet enterprises Electroselstroi and Electroexploatsia which were developed by the Soviets and did not incorporate prerevolutionary plants. They had affiliated foreign partners and operated in the form of 'mixed' companies, or Type II concessions with technical assistance features.[7] One Western company managed to evade nationalization after the Revolution. A.S.E.A. (Swedish General Electric) operated its Leningrad plant from the time of the Revolution throughout the 1920s and even managed to get its Yaroslavl plant, built in 1916, denationalized and converted into a Type I pure concession in 1924. There was also an independent factory, the Carbolite, operating outside the control of the trusts and coming directly under Glavelectro until it was abolished.[8]

The four trusts will now be considered in more detail.

THE ELECTRO-TECHNICAL TRUST (GET)

GET was responsible for manufacture of high-tension equipment and was formed by grouping together the major prerevolutionary dynamo and electric motor works located in Moscow and the Ukraine, including the

[6] It may be that Zausmer, the ex-officer of General Electric and a director of the Electro-Technical Trust, had some influence on this decision. He is quoted by a Berlin newspaper as follows: ' . . . the Russian electrical industry cannot develop without the support of the highly developed electrical industries of Germany and America.' (*Boerson Courier*, September 25, 1922.)

[7] *Annuaire, op. cit.* (rear page 24).

[8] The German Foreign Ministry Archives refer to a 'Carbo project'; otherwise nothing is known of this operation. (T120–4247.)

Kharkov works of the General Electric Company and its twelve assembly divisions in major industrial centers throughout the Soviet Union. All types of heavy electrical machinery, including generators, motors, transformers and turbines, were produced.

Table 11–2 PLANTS COMPRISING THE ELECTRO-TECHNICAL TRUST

Prerevolutionary Name	*Soviet Name*	*Production*
Russian General Electric	Dynamo A-G (Moscow and Petrograd)	Electric motors
Allgemeine Elektrizitäts A-G	Electrosila (Kharkov)	Electrical equipment
Allmanna Svenska Elektriska A/B	(A.S.E.A. concession)	A.C. electric motors

A.S.E.A. obtained its prerevolutionary plant as a Type I concession and in 1927 received another Type I concession to build and operate a plant at Yaroslavl for production of alternating current electric motors.[9] By 1928 the company was producing 500 motors a month at Yaroslavl, 'the output sold on partial credit terms mainly to state-owned enterprises.'[10] The construction involved an outlay on buildings and equipment of between 15 and 18 million rubles. The new plant had 28,000 square meters of floor space and 1,500 employees, and in 1929 produced at the rate of 30,000 electric motors per year. In weight this was 48,000 tons of equipment, valued at 14 million rubles. Production included alternating current motors ranging from 1/4 to 700 h.p. Equipment for the Yaroslavl factory came from the Swedish General Electric factory at Stockholm. A royalty was payable by the Soviets on all production during the life of the concession, agreed upon at thirty-five years but expropriated long before the final date.

The widest impact of G.E. technology came, however, from agreements made after the Swedish General Electric concessions. There had been negotiations between A.E.G. in 1922 and 1923 following the letter sent by GET to International General Electric. These negotiations were not immediately successful. Their failure probably placed G.E. at a competitive disadvantage; Siemens-Schukert Werke A-G, for example, had granted credits as early as 1922. Metropolitan-Vickers (the Westinghouse subsidiary) had been in the U.S.S.R. from about 1922 onwards. The G.E. company therefore continued negotiations through its German subsidiary.[11]

The first technical-assistance agreement was concluded between Uchanov, Chairman of the Electro-Technical Trust, and A.E.G. in October 1925. This

[9] Amtorg, *op. cit.*, III, 374.

[10] *Ibid.*, E. P. Lindgren, Director of A.S.E.A. (Swedish General Electric).

[11] U.S. State Dept. Decimal File, 316–139–41.

agreement included the manufacture of General Electric generators, electric motors, and transformers of high-voltage types. The trust was given the right to produce A.E.G. products and use 'all patents, protective certificates, inventions, construction and experiments belonging to A.E.G. in the field of high-voltage currents.'[12] General Electric was required to furnish data on request and to accept and train Russian engineers in German plants for a period of five years. The agreement was supplemented and continued by other agreements which continued the technical-assistance program until 1938. A royalty was payable on all production of high-voltage electrical products for which A.E.G. held manufacturing rights from the parent company in the United States.[13] As a *quid pro quo* for technical assistance, substantial quantities of equipment were purchased on credit terms for the plants comprising the trust.

Table 11–3 PRODUCTION OF HEAVY ELECTRICAL EQUIPMENT IN RUSSIA AND THE U.S.S.R., 1913 TO 1929–30

Year	*Power transformers (thousand kva)*	*Electric motors (A.C.) (thousand kw)*	*Turbo-generators (thousand kw)*
1913	96.3	N.A.	N.A.
1918 to 1922–3	None	N.A.	N.A.
1923–4	76.5	N.A.	N.A.
1924–5	196.0	104.4	10.3
1925–6	127.4	N.A.	16.3
1926–7	291.7	N.A.	51.8
1927–8	403.2	258.6	75.0
1928–9	791.1	321.7	136.5
1929–30	1525.0	632.6	186.0

Source: Nutter, *op. cit.*, p. 441.

Table 11–3 indicates production of transformers, electric motors, and turbo-generators from 1913 to 1929/30. There was no Soviet production of these items in the years before 1924. Their production coincided with the technical-assistance agreements and the operation of the A.S.E.A. Type I concession. The recovery and development of the Soviet electrical equipment industry in these fields was almost entirely dependent on General Electric technology transferred to the Soviet Union through A.E.G.

In addition to the agreements outlined in this chapter, there was a technical-assistance agreement between the United States firm of John J. Higgins and GET in 1929 and an important Radio Corporation of America agreement,

[12] U.S. Consulate in Hamburg, Reports No. 149, December 13, 1925 (316–108–1543); and No. 360, October 12, 1925 (316–130–552).

[13] *Ibid.* See also International General Electric section, p. 198.

which included General Electric and Westinghouse patents in the field of communications, concluded in 1929 and discussed at length in chapter 14.

Even while this technical transfusion was in progress, the Party propagandists were unable to restrain themselves from 'agitprop.' A challenge was issued 'from the workers' of the ex-A.E.G. plant in Kharkov to the A.E.G. plant in Berlin to engage in 'revolutionary emulation,' and a delegation of working men from Berlin was invited to the Kharkov plant 'all expenses paid.' The benefits of 'revolutionary emulation' to the General Electric Company were not spelled out.[14]

THE ELECTRICAL MACHINE TRUST (ELMASHSTROI)

This trust grouped high-tension equipment plants in Petrograd, including the Siemens A-G plant (renamed the Electrosila), with the Volta factories in the Urals. Elmashstroi negotiated an agreement with A.E.G. in late 1923 for technical assistance. A.E.G. was required to supply drawings, machines, and apparatus for the production of high-tension equipment, together with aid in construction of electrical manufacturing plants within the U.S.S.R. Russian engineers were sent to Germany for training and German engineers were sent to the trust offices and plants in Leningrad. The agreement ran initially for five years, and a percentage of all production was paid to A.E.G. as a royalty.[15]

The most important plant in the trust was the Electrosila, originally built in 1893. This trust had a chaotic history of technical assistance under the Soviets. In tsarist times the plant had produced steam turbines and generator equipment. In 1923 Electrosila adopted the designs forthcoming under the A.E.G. agreement. Then came four management changes in rapid succession,

Table 11–4 THE ELECTRICAL MACHINE TRUST (ELMASHSTROI)

Prerevolutionary Name	*Soviet Name*	*Production*
Siemens-Schukert A-G	Electrosila	Electrical machinery
Nordische Kabel Werke A-G	Sovkabel	Electric wire and cable
Koltschugin	Sovkabel	Electric wire and cable
Svetlana Gluklampenfabrik	Svetlana	Electric light bulbs
Druzniai Gorka*	—	Porcelain insulators
Kernilov*	Proletarii	Porcelain insulators
Petrograd Armaturfabrik A-G	—	Armatures

Source: U.S. State Dept. Archives.

* Transferred in 1923 from the Glass and Porcelain Trust, and later transferred back to the same trust. (U.S. State Dept. Decimal File, 316–111–957.)

14 'Challenge to the Proletarians of Berlin from the Workers of the Electro-Technical Factory of Kharkov,' *Trud*, No. 244, October 23, 1929.

15 *Izvestia*, No. 7, January 9, 1924.

and by 1925–6, turbines were being built under a ten-year agreement with Metropolitan-Vickers. This was apparently not too successful, because one year later a further change occurred. As A. Monkhouse, the Metropolitan-Vickers chief engineer in the Soviet Union, puts it, 'a great American company contracted to render technical assistance to this and other factories and thus American designs were introduced.'[16]

The 'great American company' was International General Electric. Russian engineers were then sent to the United States for training, whereas previously they had gone to the United Kingdom. In 1931 the Metropolitan-Vickers company again obtained the technical-assistance contract, and this heralded yet another series of management changes.

In the tsarist era, electric light bulb production was concentrated at Svetlana Gluklampenfabrik in Petrograd. In 1913 the plant produced 2.85 million electric light bulbs, and in 1916 over 4.58 million (a good example, incidentally, to show the fallacy of using 1913 as a comparative base). Production in 1920 fell to about one-quarter million, but later recovered (with the use of imported wire), reaching a level between the 1913 and 1916 outputs (3.82 million in 1922–3).[17] In May 1923, *Ekonomicheskaya Zhizn* published an interview with the chief of Glavelectro, A. G. Holtzman, who had just returned from negotiating with Osram in Germany, Phillips in Holland, and General Electric in the United States for the introduction of the latest in Western techniques in the manufacture of electric light bulbs. A joint-stock company was proposed, in which the Soviets would provide the plant (the tsarist Svetlana plant) and the foreign partners would introduce modern equipment.

The objective was as follows:

> . . . Russia would develop within two years to the same extent as now exists in Western Europe and America. The Russian bulbs must not be worse nor more expensive than those produced by the aforementioned firms.[18]

In the following months, agreement was also reached with the International Electric Light Cartel. With the aid of Western technical experience, production was increased from 1,500 to 7,500 bulbs per day. At first, tungsten wire was purchased abroad, and later Russian tungsten wire was used. From an output just under four million in 1922–3, there was a significant increase to thirty-three million bulbs in 1929–30.[19]

[16] A. Monkhouse, *Moscow 1911–1933* (Boston: Little, Brown and Co., 1934), pp. 194–5.

[17] Nutter, *op. cit.*, p. 458.

[18] *Ekonomicheskaya Zhizn*, No. 96, May 3, 1923.

[19] Nutter, *loc. cit.* It is known that a Polish Type I concession, Yan Serkovsky, operated an electric lamp plant in Moscow. As the Svetlana was the only plant able to produce electric light bulbs the plant was possibly leased to this group. (U.S. State Dept. Decimal File, 861.602/211.)

THE LOW-TENSION TRUST

The Low-Tension Trust was comprised of the tsarist-era plants in Leningrad, Moscow, and Nizhni-Novgorod which had made telephone and telegraph apparatus. In 1923 this was probably the most efficiently operated Soviet trust. The trust president, Joukoff, was a party member but, unlike most of his confrères, who were long on talk and short on management ability, Joukoff had excellent management abilities, was entirely responsible for financial matters, and was directly supported by a team of 'white' technical experts who managed internal operations of the plants.

The 'white' technical directors were hold-overs (former engineers, not former directors) from the prerevolutionary electrical industry. They included Mochkovitch, formerly chief engineer of the Heisler Company (owned by Western Electric) and Kolotchevsky, formerly of the B.T.M. company. These technical directors functioned alongside 'red' directors. The latter were party members who nominally directed the plant but in practice left the 'white' technical men to operate independently in the technical sphere. The equipment in all the plants in the trust was intact and maintained in good order. Each plant operated as an independent profit-making unit.

The ex-Western Electric Heisler plant employed some 850 men: slightly less than its 1917 employment level of 1,100. In mid-1923, the plant was busy on an order for 900 train-dispatching sets for the Railway Administration, its only major customer.

Table 11–5 PLANTS COMPRISING THE LOW-TENSION TRUST

Tsarist name	*Number of workers* 1913[1]	1916[1]	1923[2]	1926[1]	*Production*
Ericsson (Red Dawn)	1275	2700	900	2800	Automatic telephone equipment and switchboards
Heisler A-G	845	900	850	1200	Telegraph equipment and loudspeakers
Siemens Halske A-G	750	2200	600	1300	Radios, R.R.-signaling meters
Electro-vacuum plant (new)	—	—	—	250	Radio and roentgen tubes
Marconi plant	—	—	—	250	Military radios
Telephone plant	—	1200	—	1000	Radio receiving equipment
Siemens	—	1200	—	700	Telephone sets

Sources: [1] Klemmer report to Western Electric Company, 1927 (U.S. State Dept. Decimal File, 316–141–630).
[2] Reinke report (U.S. State Dept. Decimal File, 316–108–672).

The Ericsson plant employed 900 (considerably fewer than the 3,500 employed just before the Revolution) and was making Ericsson-type telephones—the only producer of telephones in the U.S.S.R. It was operated as a concession and was able to produce all types of telephone equipment except lamps (which were imported from Germany or Sweden), and cords and cables, (which were bought from the Cable Trust). Troubles were reported in 1923; Soviet raw materials were of poor quality, and some items, such as enameled wire and magnet steel, were either in short supply or unobtainable. Production, therefore, averaged only about 7,000 sets per year, although capacity was 12,000 telephone sets annually. Nutter[20] gives the telephone output as rising from 13,300 in 1923/4 to 117,000 in 1929/30. As Ericsson was still the sole producer, this was also the measure of Ericsson's ability to increase production during the decade.

The Siemens Halske works in Petrograd, previously a manufacturer of telephone equipment, employed some 600 and was preparing to change over to the manufacture of radio equipment under technical direction of Compagnie Générale de TSF (which Reinke erroneously calls French General Electric).[21] Since the Revolution, this plant had been at a standstill except for a little repair work.[22] Reinke, the Western Electric engineer who visited the plant, concluded that the chance of a mixed company or pure concession for Western Electric, the previous owner, was remote. Reinke concluded that the U.S.S.R. was 'encouraging only badly run factory trusts to get into mixed companies.' However, he did comment that the trust was anxious to associate itself with a large foreign firm. He explained this on the basis that although the plants were operating efficiently, they lacked the ability to progress.[23] This observation is confirmed by the subsequent agreement between the Low-Tension Trust and Compagnie Générale in June 1923 and Ericsson in 1924. Even a well-run trust required foreign technology to make technical progress. In the 1920s this could be explained on the basis of a negligible research and development investment. More recently the notable absence of Soviet innovation which can compete in the Western marketplace has had to be explained on quite different grounds.[24]

[20] *Ibid.*, p. 448.

[21] Based on the Reinke Report (mid-1923) (State Dept. Decimal File, 316–108–672). This was supplemented by two later reports in 1926 and 1927.

[22] Keeley Report (316–107–100).

[23] 'The present technical men are those formerly in control, and they are doing practically as good a job as in 1917. They can get on very comfortably without us. But what they lack is the ability to go ahead. The same difficulty existed in 1917 when the factories depended on the foreign mother companies to lead the way.' (Reinke, *op. cit.*)

[24] Klemmer lists electrical products not produced in the Soviet Union in 1927, four years after the Reinke Report. These were: generators above 5,000 kw, all types of high-tension equipment and transformers, fine insulated wires, special lamps (including all over 200w), high-tension insulators, carbon brushes and carbon materials (including telephone carbons), heating appliances, nickel steel accumulators, measuring instruments, automatic telephone equipment (including pneumatic tubes), condensers, all types of electrical consumer equipment (including vacuum

TECHNICAL ASSISTANCE TO THE LOW-TENSION TRUST

In June 1923 the Compagnie Générale de TSF of France signed a technical-assistance agreement with the Low-Tension Trust to re-equip its plants with modern machinery and processes, to supply technical assistance, and to build electrical substations in the Moscow area. A new electro-vacuum plant was established by the Compagnie Générale, using French methods of producing cathode ray tubes and radio tubes. The old Petrograd plant of Siemens was equipped to manufacture radio transmission equipment for radio stations. Other plants of the trust were similarly modernized, 'after which Russian radio technique (will be) on the same level as the French,' as Klemmer says in his report. The trust sent its engineers to France for training, and French engineers went to the trust plants to provide the engineering and operational assistance required. Equipment was supplied on five-year credit terms.[25] Patents were transferred from France and, unlike other contractors, the French were able to negotiate a payment (the amount unknown) for the technical-assistance features. The very extensive nature of the Compagnie Générale agreement is suggested by the transfer of over 38,000 drawings and 3,000 technical specifications in the first two years of the cooperation.[26]

The Compagnie Générale agreement was followed by another with Ericsson of Sweden, which took over its old plant in Petrograd for the manufacture of telephones. This was, in effect, a formality, as Ericsson engineers had been working in Petrograd almost continuously since the Revolution. Modern machinery, imported from Germany and Sweden, included automatic screw machines and automatic punching, milling, and tooth-cutting equipment from the United Kingdom and the United States. Inspection and test equipment was installed. This re-equipped plant started production in 1926, at first with Swedish raw materials and later with Soviet-produced raw materials. Ericsson had four engineers in the plant with complete authority to control and approve every step of the production of automatic telephone equipment. All drawings

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cleaners), electrical medical apparatus (including roentgen tubes), and special electrical apparatus. (Klemmer, *op. cit.*, p. 42.)

Some of these items were the subject of technical-assistance agreements apparently not known to Klemmer (for instance, medical apparatus, nickel accumulators, high-tension equipment, high-tension insulators, and transformers). Most came within the scope of technical-assistance agreements by 1930.

25 The Soviets erected 43 internal radio stations between January 1923 and January 1927; all except the experimental models were with French technical assistance. Klemmer states the manufacturer in 22 cases; 16 were built by the Low-Tension Trust-Compagnie Générale operation, 4 were built by local laboratories on an experimental basis, and 2 radio stations were imported. Later, more powerful stations were built either in the U.S. by RCA or in the Soviet Union with RCA technical assistance after assurances by the State Dept. to RCA that they would not be used for propaganda (see chaps. 14 and 18). (316-141-712 *et seq.*)

26 *Izvestia*, No. 15, January 18, 1924; and No. 35, February 12, 1924. See also *Soviet Union Yearbook 1927*, p. 169.

and technical information were supplied by Ericsson. Locally made Russian drawings and technical instructions had to receive approval of an Ericsson engineer before use. Between ten and twelve Russian engineers were trained in the Ericsson Stockholm plant for periods ranging from three to six months and then returned to Leningrad, ultimately to take over production control.[27] Credit for the arrangement was supplied by a consortium of Swedish banks.

The technical contribution of the foreign electrical companies enabled the trust to increase its output from two million rubles in 1922 to more than thirteen million rubles in the year 1924–5. According to Klemmer, this increase was mainly due to the work of Ericsson.

The 1927 Klemmer Report[28] indicated that 1926 output in the electrical equipment industry was 20 percent greater than the previous year, with Ericsson showing the most progress. Several new shops had been opened and about one-third of the plant had received new equipment. At this point about one-third of the employees of the Low-Tension Trust were working for the Ericsson Company.

There was a less significant agreement for the manufacture of long-distance receiving sets, including the transfer of patents, with the German company Telefunken Gesellschaft für Drahtlose Telegraphie.[29]

In 1926–7 all Low-Tension Trust products were copies of Western equipment. Klemmer noted that the trust microphones were an 'exact copy' of the Western Electric Model 373-W, the loudspeakers were the balanced armature accord type (Western Electric Model 4002) and the amplifiers and public address systems had been copied from Western Electric systems. The Russians had produced domestically designed radio valves, but according to Klemmer these would not work. In 1926 they were producing, and attempting to export to Latvia, the Western Electric Models 216-D, 102-D, 205-B, and 211-D.[30] Klemmer should have known; he was an engineer with Western Electric.

The trust teletype machines were allegedly designed by A. F. Shorin, but Klemmer points out that the design was no more than a Morcum printer combined with the Murrey keyboard. Further, although the Kaupush distributor (of which the trust manufactured about 20 in 1926–7) was claimed as a Soviet design, it was actually based on the Baudot repeater. Quite clearly these manufacturing efforts were part of a learning process, although the products manufactured were in many cases useless.

The electrical industry was the advanced sector of the economy, and the Low-Tension Trust just described was the most advanced trust within the

[27] Klemmer, *op. cit.*, p. 27.
[28] U.S. State Dept. Decimal File, 316-60-124.
[29] Vneshtorgizdat, *op. cit.*, p. 228.
[30] Klemmer, *op. cit.*, p. 28.

electrical industry. Other branches were using 40–50 percent imported materials and more extensive foreign technical assistance.[31]

THE ACCUMULATOR TRUST

The Accumulator Trust employed about 250 in 1923. Combined within it were the prerevolutionary accumulator, lighting, and illuminating fixture firms in Moscow and Petrograd. In 1912 the value of product for this sector was 2.4 million rubles; in 1922/3, the value was only 0.6 million rubles. In December 1924 an agreement was made by the trust with the Swedish company Gaso-Accumulator A/B (AGA) whereby the Moscow Lukes (or Lux) plant was leased under a concession agreement. The company was required to produce equipment valued at 210,000 rubles in the first year (one-third of the current Soviet output), rising to 470,000 rubles in 1926–7. AGA paid 75,000 rubles to the trust for the stock of raw materials and unfinished work in the plant. The company was required to re-equip the plant and after twenty-five years turn the plant over to the government. A royalty of 3 percent was paid on gross turnover.[32]

Insulating materials were the subject of an agreement between Centroprobizol and the Swedish Company Vakander in 1927. This was a Type III agreement which ran for five years and included supply of the complete equipment for a plant to produce all types of insulating materials. The agreement included construction, start-up assistance, training of engineers, and the supply of production and technical data. Russian engineers were allowed to make 'a thorough study of the Swedish production methods.'[33] This agreement was followed by a General Electric technical agreement with the Izolit insulation materials plant in 1930.[34]

The Soviets formed two trusts which did not include major prerevolutionary institutions and indeed had had no exact equivalent in tsarist times. One was Electroselstroi, a joint-stock company founded in June 1924 with the same objective as the United States Rural Electrification Authority: to expand the use of electricity in rural areas. Electroselstroi undertook construction of district electric generating stations of a standard type and sold electric motors, generators, and allied equipment to state farms and collectives. The Swedish General Electric Company was a shareholder (with a participation of 250,000 rubles purchased for cash) along with the People's Commissariat for Agriculture, Gosstrakh, Gosspirt, and Sakharotrust. The Swedish company

[31] Klemmer, *loc. cit.*
[32] U.S. State Dept. Decimal File, 316–139–554.
[33] Amtorg, *op. cit.*, II, 14.
[34] *Ibid.*

had the function of organizing and supplying equipment for sale by the trust and no doubt its share subscription was 'a fee' for this privilege.[35] The General Electric Company was also one of the 'main shareholders' in Electroexploatsia, the second of these trusts, specifically designed to promote the use of electrical systems, in accordance with Lenin's dictum that 'socialism is electrification.'[36]

THE INTERNATIONAL GENERAL ELECTRIC COMPANY CONTRACTS OF 1928 AND 1930

A contract of fundamental importance was signed in 1928 by the Soviet Union and the International General Electric Company. Under this contract the company supplied to the Soviet Union $26 million worth of electrical equipment on six-year credit terms. The Soviets claim that G.E. agreed to consider all prewar claims against the U.S.S.R. as settled.[37] Technical assistance was an integral part of the agreement. This began what General Electric has described as 'a continuous uninterrupted record of close technical collaboration and harmonious commercial association.'[38]

The 1928 agreement was followed by a long-term technical-assistance agreement signed in 1930, under which 'vast amounts' of technical, design, and manufacturing information flowed from General Electric in Schenectady to the Soviet Union. The Soviet Union established an office at Schenectady and G.E. a parallel office in Moscow.

There was the usual exchange of personnel, training of Soviet engineers in the U.S., and dispatch of American engineers to the U.S.S.R. to implement the agreement. The Electrozavod transformer plants, the Izolit insulation material plant, the Dynamo locomotive plants, the Electrosila plants, Electroapparat and Electric works in Leningrad, and the turbine plant in Kharkov received groups of G.E. engineers. In general, however, the great impact of *direct* General Electric technological assistance was not in the period 1917 to 1930. Development before 1930 was dependent on Metropolitan-Vickers and A.E.G. (i.e., *indirect* G.E. technical assistance). The General Electric era was after 1930.[39]

35 U.S. State Dept. Decimal File, 316–139–56. *Annuaire, op. cit.*, rear p. 24.

36 Troyanovsky, *op. cit.*, p. 791.

37 *Izvestia*, No. 247, October 23, 1928.

38 *Monogram*, November 1943.

39 The 1928 General Electric contract was closely examined in Germany. The Rapallo Treaty contained a clause that compensation would be relinquished only for German claims against the U.S.S.R. so long as the Soviets did not make payments to any other power. The Soviets argued that G.E. was a private company, not a power, and that therefore the Rapallo clause did not apply. The Germans considered the G.E. agreement a violation of the Rapallo Treaty, as the company received a payment of

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY—MASHINOSTROI TECHNICAL ASSISTANCE AGREEMENT

In addition to German assistance in the electrical industry, two other European manufacturers rendered substantial assistance and equipment. In 1927 the Brown-Boveri Company of Switzerland opened an office in Moscow to implement the installation and erection of equipment supplied under a number of contracts with the U.S.S.R. Little is known of the content of these agreements.[40]

Far more important was Metropolitan-Vickers, a United Kingdom subsidiary of Westinghouse. The company has operated in Russia since the turn of the century, installing several large electricity-generating plants and the electrification of the Moscow tramway system in 1906. Just before World War I, the company became associated with Russian General Electric (the Dynamo works) which then took over the Metropolitan-Vickers plants in Moscow.[41]

After the Bolshevik Revolution, Metropolitan-Vickers returned to Russia and by 1924 had several large contracts in progress. Each major technical advance made by the company in its U.K. plants was transferred to the Soviet Union. In the early 1920s significant advances were made in the operating speed of generators. A world record was set by a Metropolitan-Vickers generator of 38,500 Kva (3,000 rpm.) installed in a Soviet power station in 1926. Similarly, in the same period there was an increase in transmission voltages; Metropolitan-Vickers manufactured transformers for Soviet 110-kV and 115-kV systems were installed in 1923, some five years before the start of the British grid system utilizing similar transmission voltages. In 1922 the company developed outdoor switchgear for 132-kV systems. Several 1500-MVA 132-kV circuit breakers were installed in the U.S.S.R. within two years of initial development. These sales of the latest products of the Metropolitan-Vickers laboratories were followed in 1927 and 1931 by long-term technical-assistance agreements. The 1927 agreement was initially signed with Mashinostroi for six years at £30,000 ($150,000) per year and covered that turbine construction which formed the basis of the Soviet turbine industry.[42] The company maintained extensive erection and technical facilities in the Soviet

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$575,202 as compensation for its claims on the U.S.S.R. G.E. claims this was only a partial settlement. The Foreign Claims Settlement Commission (Decision No. SOV-3119) made an award of $1,157,407.26 plus interest to G.E. This dispute, of course, has not been settled. (340-6-517.)

40 U.S. State Dept. Decimal File, 316-131-1010.

41 Westinghouse left Russia in 1913 except for a bank account. This was expropriated, and Westinghouse has received $5,703.44 from a claim amounting to $49,400 plus interest. Letter from Westinghouse to writer, March 4, 1966.

42 J. Dummerlow, *1899-1949* (Metropolitan-Vickers Electrical Company, 1949).

Union, an office at Electroimport, a company office at Leningrad and a 'compound' with several buildings at Perlovka, just outside Moscow.[43] Company engineers established the manufacture of turbines according to company plans on 'a large scale' under R. Cox, its chief mechanical engineer, in the U.S.S.R. Soviet engineers and foremen were sent to the United Kingdom for training. In 1931 another agreement with GET expanded the scope of the transfer of turbine technology. These agreements endured both the Arcos break of 1927 and the notoriety surrounding the arrest and expulsion of six Metropolitan-Vickers engineers in 1933 on grounds of economic espionage and sabotage.

Steam turbines had been made in the Petrograd Metal Plant (later renamed the Stalin) early in 1906. By 1914 there were seven plants in Russia manufacturing naval turbines and one manufacturing stationary steam turbines; after 1917 the Petrograd plant alone continued working, but only on repairs to existing turbines and the manufacture of spare parts. Neither this nor any other Soviet plant had experience with high-power hydraulic turbines.

To summarize, by the end of the decade the Soviet electrical industry had undergone a complete overhauling in methods of production, variety of goods produced, and quantity produced. This had been achieved in the face of disaster by restoring the prerevolutionary technical personnel, injecting foreign managerial and engineering personnel and foreign-developed technology into the most important of the prerevolutionary plants. Whereas in 1913 the industry value of output was 45 million rubles, in 1924–5, one year after the introduction of foreign technology, it was 75 million (1913) rubles, and by the end of the decade more than 200 million (1913) rubles. Imports of electrical equipment increased from 7,592 tons (valued at 14 million rubles) in 1925–6 to 26,465 tons (valued at 45 million rubles) in 1927–8. Eighty percent of these imports were electrical machinery and high-tension apparatus (i.e., capital goods).

The variety of goods also expanded under foreign guidance. Steam turbine generators of up to 10,000 kw, hydro-turbine generators of up to 8,750 kw, transformers of up to 38,000 volts, high-voltage armatures, oil switches, and mercury rectifiers were being produced by the Electro-Technical Trust and Elmashstroi by the end of the decade. Production of electric light bulbs was modernized and arrangements had been made with foreign firms to introduce the manufacture of mercury lamps, automatic car headlights, and pocket lights. The Low-Tension Trust was now producing radio transmitters and receivers, although large stations for international communications and

[43] *Correspondence Relating to the Arrest of Employees of the Metropolitan-Vickers Company at Moscow*, Command Paper 4286 (London: H.M.S.O., 1933) pp. 2–3.

propaganda were built by RCA in the United States.[44] Watt meters, X-ray apparatus, automatic telephones, and exchanges were being built in the U.S.S.R.

Research establishments, including the State Electrical Engineering Experimental Institute, were also established, complete with 'unique' equipment manufactured by the General Electric company.[45]

All trusts and plants within the trusts received foreign technical assistance. All technological progress resulted from a transfer from West to East. Further, rather than just restoring and modernizing the prerevolutionary plants, the foreign associates introduced the latest innovations from Western laboratories —sometimes before they had been utilized in the Western country of origin.

SOCIALISM IS ELECTRIFICATION; THE GOELRO PROGRAM

The most important customers for electrical machinery are power stations, utilizing hydro, peat, and coal fuel methods of energy conversion.

The original Goelro program outlined by Lenin demanded 100 power stations as the basis for a socialist economy. This was revised downwards in the Zinoviev speech of January 1921 to 27 stations, and followed by ample discussion but little concrete action.[46] Two years later only three projects were receiving any attention, and that was rather desultory. Studies inherited from the tsarist period included one which had been expanded into the Dniepr project, but a few scattered site borings comprised the total achievement. The general feeling was that Dniepr should be offered as a concession. Volkhov, Svir, and Nizhni-Novgorod were at various points of early construction, but three years after the announcement of Goelro, the program had hardly moved.

The Svir hydroelectric project, north of Leningrad, ran into almost innumerable difficulties, which stretched its construction period from 1920 well into the 1930s. The fifteen-month preliminary investigations of the project were handled by an American engineer, Emegess, employed by the

[44] It should be clearly noted that RCA pointed out the propaganda possibilities to the State Dept. The latter described these warnings as 'theoretical' (316–141–714 *et seq.*). See also chap. 18.

[45] *Monogram*, November 9, 1943; and *Bank for Russian Trade Review* (January 1929), pp. 8–9.

[46] Telegram Quarton, Vibourg to U.S. State Dept., April 11, 1921: 'Confidental. Although Soviet papers contain little on electrification accomplishments and only reiterate bombastic plans the truth is that slight progress has been made due to the lack of electrical goods, technical supplies and skilled labor. To date most energy has been devoted to collecting material and making paper plans. The colossal Svir electric station has not materialized, and is no further advanced than six months ago except that a small and inadequate quantity of building materials has been collected. . . .'

Cooper Company, also working on the Dniepr project.[47] Various other American (J. G. White Company) and Swedish (Karlsrads Mechaniska A/B and Vattenbyggnadsbyran A/B) construction companies were involved in various aspects of the Svir dam and site construction. The generators were supplied by Metropolitan-Vickers and the turbines by Werkstaden Kristinegamm A/B of Sweden. The project was finally completed in 1933 at an estimated cost of $500 per horsepower compared to an average cost of approximately $100 per horsepower in the United States.[48]

At Volkhov the construction process was also extremely slow. Graftio, the engineer in charge, used Swedish engineers to implement Swedish construction methods.[49] The 10,000 h.p. turbines from Sweden arrived at the end of 1923, and date of completion was set at 1926. By April 1927, despite extensive foreign assistance from A.S.E.A. and Metropolitan-Vickers, the Volkhov station was still not fulfilling expectations. It was described as 'irregular, capricious and unreliable.'[50] The problem was in the use of generators from two sources: four from A.S.E.A. and made in Stockholm, and four made at the Electrosila works in Leningrad with its mixed history of technical assistance. The Electrosila generators contained materials of different specification from those in the Swedish generators, and problems arose when the eight generators were operated simultaneously.[51]

The high-tension insulators (Hewlitt type) for the 130 kilometers of transmission lines to Leningrad were manufactured by the General Electric Company and the Thomas Company in the United States. The total cost of the project was estimated by Klemmer at 90 million rubles, of which 6 million was spent on imported equipment and technical assistance. In return for this substantial investment, the plant did not generate more than 20,000 kw in 1927[52] or about seven times the cost per kilowatt of capacity constructed at the Zages project.[53]

The world-famous 650,000 h.p. Dniepr project, supervised by Col. Cooper, builder of Muscle Shoals in the United States, used four 80,000 h.p. turbines manufactured by the Newport News Shipbuilding and Drydock Company, linked with vertical 77,500 kw. General Electric design generators. The total

[47] Emegess made a report to the U.S. State Dept. concerning the methods used by the Soviets to keep Col. Cooper in ignorance of the true conditions in Soviet Russia. (316-139-131.)

[48] Emegess Report. (316-139-128.)

[49] *Ibid.*

[50] *Ekonomicheskaya Zhizn*, No. 85, April 1927.

[51] *Ibid.*

[52] Klemmer, *op. cit.*, pp. 16–7.

[53] See table, p. 205.

value of $2.5 million was granted by G.E. on five-year credit terms. Cooper Company engineers were sent to Russia in the summer of 1926 to make a feasibility study for this project. They examined the prerevolutionary construction plans and the structural and geological problems of the site. In particular, they raised questions concerning labor supply, raw materials and transportation, all of which were considered inadequate for the size of the proposed project.[54]

The initial study was followed in October 1927 by the visit of Professor E. G. Alexandrov, Chairman of the Technical Council and Vice-President of Dnieprstroi, to the United States, where he visited construction machinery plants and raw material supply and water power projects. He especially noted operating principles and types of materials used. Alexandrov expressed the hope that the 'best methods' could be applied at Dnieprstroi. By this time some $1.5 million in equipment orders had been placed in the United States for Dniepr. This equipment included dump trucks, steam shovels, pneumatic drills, forges, and similar construction items. Credit terms obtained varied between one to one and a half years.[55]

A construction agreement was then made with both the Cooper Company and Siemens A-G of Germany to undertake supervision of the dam construction. Cooper reported on the project to the American section of the All Union Western Chamber of Commerce which was a Soviet institution with functions rather different from those of Western chambers of commerce. The dam was to be considerably larger than any existing dam in the world, exceeding in volume the Nile Dam by 18 percent and the Wilson (Hoover) Dam by 10 percent. The electric power station was designed to yield 2.5 billion kwh at a cost equivalent to this supply of electrical energy in the United States. As *Ekonomicheskaya Zhizn* phrased the goal, 'The United States is a country in which electrical energy is used wherever possible. The U.S.S.R. must also become such a country.'[56] The ultimate capacity was designed to be 650,000 h.p. The dam itself was 51 meters high and 720 meters across. The first five generating sets, each with Francis-type turbines and 77,500 kw. generators as well as the outdoor equipment (transformers, oil circuit breakers, switchboards, etc.) were manufactured and installed by General Electric. Equipment used in construction was imported from the United States and Germany. Two massive stonecrushers were specially made in Germany. Even the equipment for the dining halls, to seat 2,000 workers at one time, was imported. The only purely Soviet work traced was the longer of the two bridges which were built

[54] *Pravda* (Moscow), No. 171, July 28, 1926.
[55] *Ekonomicheskaya Zhizn*, No. 237, October 16, 1927.
[56] *Ekonomicheskaya Zhizn*, No. 215, September 15, 1928.

Table 11-6 TECHNICAL ASSISTANCE AND EQUIPMENT SUPPLY IN THE GOELRO PROGRAM, 1920–30

Project	*Consultants/Supervisors on Dam/Plant Construction*	*Equipment Supply Generators and Transformers*	*Turbines/Boilers*
Svir	J.G. White Engineering Co. J. Cooper Inc. Karlsrads Mechaniska A/B Vattenbyggnadsbyran A/B	Metropolitan-Vickers Electrosila (with General Electric assistance)	Werkstaden-Kristinegamm A/B
Volkhov	A.S.E.A.	4 A.S.E.A. 4 Electrosila	A.S.E.A. Metropolitan-Vickers
Nizhni-Novgorod	Thomson-Houston (U.K.)	Metropolitan-Vickers	*
Dniepr	H. Cooper Company Siemens A-G	5 General Electric 4 Electrosila (General Electric assistance)	9 Newport News
Shatura	Metropolitan-Vickers	Brown-Boveri Erste Brun. Maschinen Fabrik (Czechoslovakia)	Brown-Boveri
Shterovka	(under construction 1930)	Metropolitan-Vickers	Metropolitan-Vickers
Zages	**	Electrosila (General Electric assistance)	—
Ivanovo-Voznessensk (Ivgres)	Krupp	Metropolitan-Vickers	Metropolitan-Vickers
Moges		Metropolitan-Vickers, General Electric	Metropolitan-Vickers
Chelyabinsk		Metropolitan-Vickers, General Electric	Metropolitan-Vickers
Zuevka	(under construction 1930)	Metropolitan-Vickers	Metropolitan-Vickers
Zlatoust		Metropolitan-Vickers, Westinghouse, General Electric	Metropolitan-Vickers
Nigres (Gorki)		Metropolitan-Vickers, General Electric	Metropolitan-Vickers
Baku (Krassnya Zveska)		Metropolitan-Vickers	Metropolitan-Vickers
Belovo		Unknown	Metropolitan-Vickers
Orekhovo		Metropolitan-Vickers	Metropolitan-Vickers
Saratov		Unknown	Rateau(France)

Sources: 1. 'A Portfolio of Russian Progress,' *Monogram*, November 1943.
2. INRA, *op. cit.*
3. A. Monkhouse, *Moscow 1911–1933* (Boston: Little, Brown and Co. 1934).
4. J. Dummerlee, *op. cit.*
5. *Wrecking Activities at Power Stations in the Soviet Union* (Moscow: State Law Publishing House, 1933).
6. Klemmer Reports, U.S. State Dept., Archives.

* A German firm, name unknown.

** 'Foreign consultants,' INRA, *op. cit.*, p. 276.

over the Dniepr; this was of short-span construction and, according to Scheffer, 'entirely Russian work.'[57]

The Zemo-Avtchalin hydroelectric development (Zages) at Tiflis, in the Caucasus, was begun in 1922 and completed in 1927. The project engineer was Russian (Melik-Pashaev) and the supervising engineer Armenian (Chichinadze), but 'foreign consultants' were used in some stages.[58] The station developed a useful capacity of 40,000 kw, compared to 60,000 kw at Volkhov, and an annual output of 150 million kw hours, compared to 225 million kw hours at Volkhov.[59] Four turbo-generators were manufactured at the Stalin plant (formerly Petrograd Metal) with German assistance and by Electrosila with assistance from A.S.E.A. Cost of construction was 21 million rubles: well in excess of the original estimate of 6.9 million rubles but substantially cheaper than Volkhov both in terms of cost of construction per kw of capacity and per kw hour of electricity produced. (See table 11–7.)

Table 11–7 COMPARATIVE CONSTRUCTION COST AND ENERGY COST AT THE VOLKHOV AND ZAGES PROJECTS, 1927

	Volkhov	*Zages*
Comparative cost per kw of capacity	1,250 rubles*	500 rubles
Cost per kw hour	3.5 kopecks	1.3 kopecks

Source: Ekonomicheskaya Zhizn, No. 143, July 1927.

* Klemmer put the Volkhov capacity at 20,000 kw (useful) in 1927; on this assumption construction cost would be 3,750 rubles per kw capacity.

The textile complex at Ivanovo-Voznessensk, claimed as the largest in the world, had a peat-burning power station erected by Krupp.[60] The status of the other projects is listed in table 11–6.

A few large foreign companies undertook the greater part of the construction, installation, and equipment of these power stations. Metropolitan-Vickers obtained the lion's share of the work. A list of the most important orders received by the company in this period includes three turbo-alternator sets for Krasny Oktiabr (Leningrad), two of which were 45,000 kw units; all the switchgear and transformers for Shatura and Nizhni-Novgorod; large-capacity

[57] P. Scheffer, *op. cit.*, p. 99. Foreign assistance and equipment were so commonplace that any purely Russian project at this time was usually noted as being exceptional and therefore worthy of recording.

[58] *INRA*, p. 276.

[59] *Ekonomicheskaya Zhizn*, No. 143, July 1927. Another Soviet source suggests this station had a smaller capacity and was started before the Soviet occupation of the Caucasus and completed in 1925. (*Annuaire*, p. 255.)

[60] P. Scheffer, 'Aus dem Textilbezirk von Ivanovo-Voznessensk,' *Berliner Tageblatt*, June 22, 1929.

turbo-generators for Moges (Moscow), Baku, Chelyabinsk, and Ivanovo-Voznessensk; medium-capacity generators for Shterovka and the Third Cotton Trust; smaller-capacity turbo-generators for Irkutsk, Novo-Sibirsk, and others; and all the switchgear equipment for Volkhov, the oil-well electrification program for the Baku area, and the Moscow-Mytishe electric railway.[61] To give a comparative estimate of the importance of the Metropolitan-Vickers contribution, the turbo-generators supplied for the Krasny Oktiabr plant, in themselves only part of the generating equipment, equaled the total generator capacity already produced in the U.S.S.R. at the time (90,000 kw versus 92,600 kw); and Metropolitan-Vickers was only one of a number of foreign firms supplying similar equipment. Further the existing generator capacity of the U.S.S.R. was all being produced with foreign technical assistance.

In brief, all electric energy stations built in this period, whether coal, peat or hydroelectric, were based on Western technology. Station equipment was either supplied directly from abroad or, if of Soviet construction, was built in a plant with Type III technical assistance. The Svir, Shatora, Shterovka, and Ivanovo plants, for example, utilized generators built abroad and installed by Western engineers in the Soviet Union. Volkhov and Dniepr used generators made abroad and in the U.S.S.R. Similarly, turbines were either manufactured abroad or in Soviet plants with Type III technical-assistance agreements. A larger selection of foreign companies was utilized in this area of technology: Werkstaden-Kristinegamm and A.S.E.A. of Sweden, Newport News and General Electric of the United States, Krupp of Germany, Metropolitan-Vickers of the United Kingdom and Brown-Boveri Company of Switzerland.

THE PROCESS OF HYDROELECTRIC TECHNOLOGY ACQUISITION

In 1925 the Leningrad Metal Plant manufactured a 4,500 h.p. hydraulic turbine for the Zages project. This was the first turbine produced after the Bolshevik Revolution, and a copy of three turbines imported for the purpose from Germany.[62] In the following year the plant produced a second turbine: a 1,500 h.p. unit for the Leninaken hydro project in Armenia. These were produced with A.E.G. technical assistance. In 1927 an agreement was made to construct Metropolitan-Vickers turbines under license and with United Kingdom technical assistance; thus 'the manufacture of big Francis turbines (for the Dzoraget and Rion stations) was mastered in the course of 1927–30.'[63]

[61] *Bank for Russian Trade Review*, March 1929, p. 15.
[62] *INRA*, p. 276.
[63] *Ibid.*

In 1927 the Electrosila plant in Leningrad (formerly Siemens A-G) manufactured four vertical generators for the Zages project: the first ever produced in the Soviet Union. This was followed by an order for four generators for the Volkhov project. These to be coupled with four Swedish made A.S.E.A. generators. There was a further order for four generators for the Dniepr project, to be coupled with five General Electric generators. Electrosila had assistance agreements with A.S.E.A. and the International General Electric.

The acquisition process is now clear. There was a primary stage when generators and turbines were both imported and installed by foreign engineers. This was succeeded by the acquisition of foreign technical assistance and by the use of plants inherited from the tsarist era. A specific technology was established with imported equipment and technical designing, supervisory, and engineering skills. Orders for capital equipment to modernize the plants of the electrical trusts were dependent upon the granting of technical-assistance contracts. Normally the Western company was glad to donate the technical-assistance aspects to acquire the order for the major installation.

Substitution of domestically produced machinery for imported machinery then followed. In hydroelectric projects, several installations utilized both equipment manufactured abroad and equipment domestically produced with foreign assistance. The technical advantages were dubious, but the educational aspects were undeniable. Comparative data on operating performance was generated and found useful as a check on the efficiency of domestic production. The final stage was reached when only domestically produced equipment was used, with or without foreign assistance. In hydroelectric projects this did not occur in the 1920s.

Concurrent with the progress of import substitution, there was increasing technical sophistication. Manufacture shifted from the small and simple to the complex and large. The 'gigantomania' of the 1930s was an uncontrolled technical escalation of this nature. There is nothing in Marxist theory, in the absence of the discipline of the market place or a theory of production and diminishing returns, which dictates a cut-off point for either complexity or size. By definition, the largest and the most complex is always the most efficient, and only in the last few years has the assumption been challenged in Soviet technico-economic literature. By the same measure we would expect to see a degree of over-engineering in Soviet design. In the 1920s it was much too early to see the flowering of this phenomenon, but the politico-economic structure established in this period was destined to move Soviet industry along this road. Volumes II and III will pick up and trace the threads from this inauspicious starting point.

It is also interesting to note that many of the associations described here for the 1920s have continued uninterrupted to the present date. Karlsrads Mechaniska Werkstad A/B had a contract for the Svir project in 1923. In 1963 the same company completed a paper mill, and in 1964 a pulp mill. This long-term association is not at all uncommon. The transfer process is still underway.

CHAPTER TWELVE

The Chemical, Compressed Gas, and Dye Industries

NITROGEN FIXATION: BASIS OF A CHEMICAL INDUSTRY

THE immediate chemical industry problem in 1921 was synthesis of ammonia from the elements: i.e., nitrogen fixation. This would eliminate use of Chilean saltpeter and facilitate production of calcium cyanamide needed for the manufacture of ammonia and cyano compounds.[1]

In 1921 V. I. Ipatieff, Chairman of the Chemical Committee of Vesenkha, made an extended trip through Europe to investigate purchase of these processes for use in the U.S.S.R. He found the best available process was owned by I. G. Farben of Germany, who would not sell or grant a license to manufacture in the Soviet Union. The remaining alternative was to install plants for production of calcium cyanamide to produce fertilizer in peacetime and ammonia and nitric acid in wartime. Ipatieff investigated several processes, including those of Bayerische Stickstoff Werke in Germany, but was denied access to the best-known plant, the nitrogen fixation plant at Oslo, Norway.[2]

A Commission on Fixation of Nitrogen was then organized and all available foreign literature acquired. Research was started, not to develop a nitrogen fixation process, but to determine which of the foreign processes was the best. Domestic production of ammonia was recognized as the key problem, with special significance for military purposes, and this was taken up by both the War Technical Administration of Vesenkha and the Chemical Branch of Gosplan.

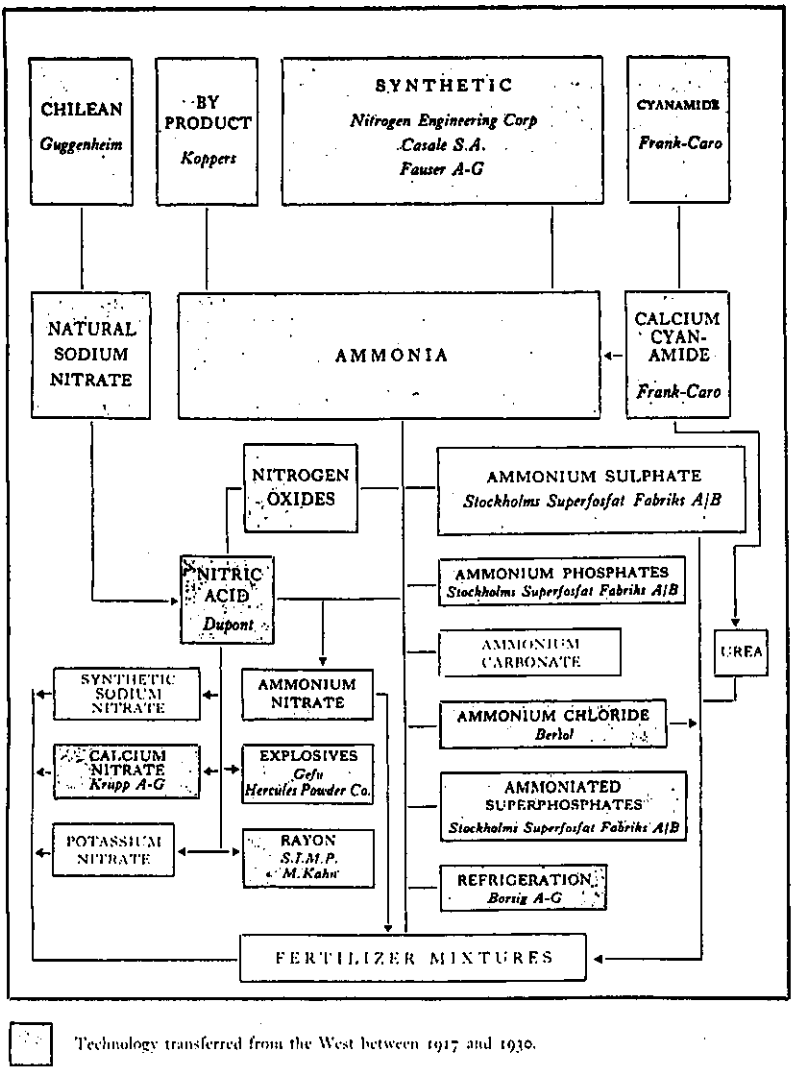
The manufacture of nitric acid, also dependent on ammonia technology, had also been ignored. This was a major gap in Soviet industry—particularly

[1] V. I. Ipatieff, *Life of a Chemist* (Stanford: Stanford University Press, 1946), pp. 327–8. Ipatieff fled Soviet Russia and left us a first-hand account of the chemical industry in tsarist and Soviet Russia. The Gumberg Papers at the State Historical Society in Madison, Wisconsin, also contain data on Chemstroi.

[2] *Ibid.*, p. 379.

Chart 12-1 THE TRANSFER OF NITROGEN INDUSTRY TECHNOLOGY TO THE U.S.S.R.

PROCESSES



Source: Based on United States Tariff Commission, Report No. 114, Second Series. *Chemical Nitrogen* (Washington D.C. 1937). With data from text of chapter added.

in the military sector (nitric acid is an essential ingredient in explosives manufacture). The three available synthetic ammonia processes available were the Cloudt in France and the Casale and Fauser in Italy. Ipatieff selected the Casale process as the most suitable; it was not too expensive and a small plant (20,000 tons per year) could be readily installed. A Soviet commission was dispatched to Italy; the final arrangement was for a 16,000-ton-capacity plant built by the Italian company at Dzerdjinsky in 1927. Russian engineers were trained at Casale Ammonia S-A in Italy, and Italian engineers built and initially operated the Dzerdjinsky plant. Essentially the only differences from the I. G. Farben process, which had been refused, were in the type of catalyst and the operating pressures used.

For a solution to the calcium cyanamide problem, Ipatieff visited Bayerische Stickstoff Werke and Borsig A-G in Germany and the Superfosfat A/B in Sweden. The Swedish method, obtainable on more advantageous terms, was adopted, and several plants were ordered from Sweden. This was the basis of the Soviet superphosphate industry.[3]

SYNTHETIC PRODUCTION OF AMMONIA IN THE UNITED STATES[4]

The technical revolution brought about by synthetic ammonia was felt throughout the heavy chemical and allied industries, from agriculture to explosives. The opening of a single synthetic ammonia plant in Niagara Falls utilizing an atmospheric nitrogen process cut the price of ammonia by 50 percent in one week. Cheaper ammonia stimulated development of refrigeration, established effective competition against the Chilean saltpeter monopoly, replaced sodium nitrate in the chamber process for the manufacture of sulphuric acid, and introduced an entirely new method of nitric acid production.

Several synthetic ammonia processes were developed simultaneously in Europe and the United States. General Chemical, a subsidiary of Allied Chemical and Dye, spent between $4.5 and $5 million on research and development of the Haber process, followed by an investment of $125 million in the Hopewell plant, opened in 1928. The Mathieson plant, using the Nitrogen Engineering process, was built in 1921 and followed by another in Niagara Falls using the Casale process, built by Ammonia Corporation of New York. In 1924 Dupont acquired American rights to the Claude process and in 1927 acquired American rights to the Casale process and then proceeded to improve both processes. At the end of the decade the effectively competing

[3] *Ibid.*, p. 426–8.

[4] Based on W. Haynes, *American Chemical Industry* (New York: Van Nostrand, 1948), IV, 85.

processes in the United States were those of the Dupont Company (Claude-Casale) and the Nitrogen Engineering Corporation (Haber-Bosch). It was not until 1936, after the expenditure of more than $24 million on development of synthetic ammonia, that net operating results began to show a profit.

It was American technical ingenuity and originality in developing techniques for handling very great pressures and temperatures which enabled successful replacement of early methods of ammonia manufacture and introduction of a much cheaper method. Research was partly financed by the Army Ordnance Department, the Department of Agriculture, and a special Congressional appropriation of $185,000.[5] The value of the developed technology is suggested by the payment of $1.25 million for Japanese and Chinese rights to the Claude process. The reader may compare this figure to the $150,000 received from the Soviet Union for similar rights.[6]

MANUFACTURE OF NITRIC ACID AND THE DUPONT COMPANY

There was a small production of nitric acid in tsarist Russia. In 1920 eight small plants produced 360 tons per year. During the 1920s major technical advances were made in the West, and by the end of the decade three companies were offering nitrogen fixation processes for the manufacture of nitric acid. The Soviets found themselves in an excellent bargaining position. Dupont, Nitrogen Engineering, and the Casale Company were competing suppliers with more or less equivalent processes. The Soviets used their monopsonistic power to drive prices down from opportunity costs (probably well in excess of $100 million when one considers the absence of input suppliers in the U.S.S.R.) to a mere $150,000—the price ultimately paid to the Dupont Company after a number of such plants had been erected. Only if the three Western owners of fixation processes had merged into a joint bargaining unit could the price extracted from the U.S.S.R. have approached Soviet opportunity costs. It appears that from the strictly technical viewpoint the Dupont process had a slight competitive product edge by virtue of the 120 lb.-per-square-inch pressure used, but this was insufficient to offset Soviet buying power.[7]

In early 1929, negotiations began between Chemstroi and Dupont concerning the sale of their ammonia oxidation process and nitric acid technology. Dupont had expended over $27 million developing the process.[8] This was in addition to the substantial investment made by the earlier French and Italian

[5] *Ibid.*, p. 90.

[6] See page 213.

[7] F. D. Miles, *Nitric Acid; Manufacture and Uses* (London: Oxford University Press, 1961), p. 34.

[8] *Dupont: The Autobiography of an American Enterprise* (Wilmington: Dupont, 1952), p. 95.

owners of the process. To attempt to recoup anything like this amount from the Soviets would have been naïve; there were other processes available and the alternative always existed that the Soviets could develop the process themselves. For Dupont, any return over marginal cost of supplying the process was advantageous. However, marginal costs were zero as, according to the agreement, the U.S.S.R. paid the expenses of both the Soviet and the Dupont engineers. Consequently the $150,000 fee to Dupont was a return on research and development investment and a 'windfall' gain to the Dupont Company.

In requesting advice from the State Department, the Dupont concern argued that the process was neither secret nor covered by patents, that the end use of nitric acid is the manufacture of fertilizer, although it is the basic fundamental raw material for dyes, celluloid, photographic materials, medicine and artificial silk.[9] Dupont argued that if they did not supply the process it could be bought elsewhere, and that several plants had already been erected in the U.S.S.R. by Casale and Nitrogen Engineering of New York. Further, the company argued that there was nothing exclusive about the Dupont process: 'Our superiority . . . is based entirely upon the economic advantages of our engineering design.'[10]

The copy of the agreement from the State Department files indicates that Chemstroi

> . . . (wishes) to use in Russia the Dupont process for the oxidation of ammonia and to place at its disposal sufficient data with respect to the design, construction and general information as to permit the satisfactory operation of such plants . . . the Company shall serve the Russian Corporation in an advisory capacity and furnish upon request services of engineers and chemists so as to accomplish the purpose of the contract.

The agreement further stipulated that Chemstroi might use the Dupont processes for the oxidation of ammonia to manufacture 50–65 percent nitric acid and that Dupont agrees

> . . . to place at the disposal of Chemstroi sufficient data, information and facts with respect to the design, construction and operation of such plants as will enable Chemstroi to design, construct and operate ammonia oxidation plants. . . .

[9] In 1927 more than two-thirds of U.S. nitric acid was being used for explosives. Dupont said the acid was 'too weak' for explosives manufacture. However, the State Dept. appears to have accepted this rather surprising statement.

[10] Letter from Dupont to U.S. State Dept. (316–139–572). The Dupont-Chemstroi agreement is in the U.S. State Dept. Decimal File, 316–139–570. This agreement is well worth reading from one viewpoint alone: the remarkable two-facedness of the Soviets. They can call themselves a 'Russian Corporation,' etc., to give the Western company the impression it is dealing with fellow businessmen, and then present the Dupont work as a 'feat of socialist construction.'

Dupont was therefore to act in an advisory capacity in the construction and initial operation of all such plants. The fee for the use of the process was $10 per metric ton of yearly rated capacity for the first plant and $10 per ton on subsequent plants, until the total fee was $50,000. In addition, a flat fee of $25,000 per plant was payable until the total fees paid amounted to $150,000. As has been pointed out, this was rational profit-maximizing action for Dupont, but hardly for the Western world.

Chemstroi was allowed to request reasonable services of Dupont engineers and chemists, their salaries and expenses to be paid by Chemstroi. In the case of the first plant Dupont provided construction engineers and chemical engineers to build and start up the plant and train sufficient local personnel to continue operations. In all, five such plants were built. Permission was granted by Dupont to enable Chemstroi to pass on the technical information to other state organizations (a similar request caused R.C.A. some amusement; their patents and processes were being sequestered either way).[11] In addition, Dupont agreed to accept Chemstroi engineers and technicians in their United States plants for training.

Table 12–1 SOVIET ACQUISITION OF BASIC CHEMICAL TECHNOLOGIES, 1925–30

Technology	*Western Process*	*Soviet Plant*
Nitrogen fixation	Nitrogen Engineering Corp (modified Haber-Bosch)	Berezniki (1929–1932)
	Nitrogen Engineering Corp (modified Haber-Bosch)	Bobriki (1929–1932)
	Casale Ammonia S-A. (Italy)	Dzerdjinski (1927)
	Fauser (Italy)	Gorlovka (1930)
Calcium cynamide	Stockholms Superfosfat Fabriks A/B (Sweden)	Karakliss
Nitric acid	Dupont Company	Five plants (one erected before 1930)
Sulphuric acid	Bersol (Russo-German Company)	Samara
	Hugo Petersen (Berlin)	N.A. Technical assistance
	Lurgie Gesellschaft fur Chemie und Hüttenwesen m.b.H.	N.A. Technical assistance

Sources: 1. V. I. Ipatieff, *op. cit.*
2. U.S. State Dept. Archives.
3. German Foreign Ministry Archives.

The first Dupont plant for nitric acid was built at Chernorechenski, near Gorky. The capacity of the combine was 115,000 tons of superphosphates a year and included plants for the manufacture of ammono-phosphates, calcium carbide, cynamide, and nitric and sulphuric acids. Alcan Hirsch, a New York

[11] See below, page 300, n. 18.

consultant, was chief engineer for Chemstroi and supervised construction of the combine by Western companies. Hirsch comments that the nitric acid plant was built according to the Dupont specifications and 'incorporates apparatus made of nickel-chromium steel and all the equipment is of American manufacture throughout.'[12]

As has been pointed out, 'turn-key' purchases were also made from Dupont's competitors, so that the Soviets ended up in a better position than any of their suppliers independently. They had the sum of Western technical experience within two to three years of perfection of that process. In other words, the Soviet Union was able to acquire a greater knowledge of the processes involved in nitrogen fixation, nitric acid production, and other areas by expending a microscopic amount of money. An agreement covering the production of ammonia from coke was made with Nitrogen Engineering of New York, and another contract with the same company covered construction of a $10 million synthetic ammonia plant. Yet another contract with NEC established a ten-year technical-assistance agreement for all NEC-Haber-Bosch technology.[13]

SOLIKAMSK POTASH DEPOSITS

Phosphatic fertilizers, either from bones or from phosphate rock, were not produced in any quantity in prerevolutionary Russia. Nutter gives a total of only 55,000 tons for 1913. Toward the end of the 1920s, production of both natural and rock phosphate fertilizer jumped substantially to a total of 484,000 tons.

The substantial increase in natural phosphate output in 1929–30 may well be associated with the kulak extermination program and massive slaughter of cattle. Natural phosphate is bone meal.

Increase in rock phosphate output stems partly from development of the Khibini apatite deposits on the Kola peninsula. These deposits of apatite-nepheline contain about 28–32 percent phosphoric acid. One of the major

[12] Alcan Hirsch, *Industrialized Russia* (New York: Chemical Catalog Company 1934), p. 83. This phrase has a much deeper implication than first reading might convey. Let the reader ask the question, which plants in the U.S.S.R. were able to produce stainless (i.e., nickel-chrome) steels in 1927? There was one, and that used the old hand-mill process and was unable to turn out the larger sheets of very different quality used in chemical engineering. In other words, if the apparatus had been denied, the Soviets would first have had to acquire a stainless steel production unit.
Alcan Hirsch was a most effective agent for the transfer of chemical engineering technology. He was quite sympathetic to the aims of the Bolshevik Revolution. After the extermination of the kulaks, the show trials, and the forced labor construction of industry (all of which he witnessed) he could still write in 1934: 'Soviet Russia has not as yet reached unprecedented eminence in the arts, science or industry although I believe that sociologically it is far ahead of the rest of the world.' (P. 273.)

[13] Vneshtorgizdat, *op. cit.*, p. 226; and Hirsch, *op. cit.*, p. 78.

technical difficulties in initial development was presence of nepheline, which had to be separated out. A concentrating and refining plant was built, with a capacity of 250,000 tons of apatite concentrates per year (more than the increase in output from 1928–9 to 1929–30). The presence of nepheline was overcome by a flotation process, utilized by the first such nepheline treatment plant in the world, designed and built by General Engineering Company of Denver and utilizing all United States equipment. The by-product nepheline was used in the manufacture of glass, ceramic wares, pottery, porcelain, and electrical insulators. In brief, the by-product became useful in many other industries, all with their own technical-assistance agreements with foreign firms.[14]

In 1924 there was a production crisis in the largest potash production operation, Kubtrestpotash, which badly missed its production targets although the 'mixed' trading company Wostwag had an agreement to take its complete output for export.[15] Two years later, prospectors found extensive deposits of potash (sylvanite and carnallite) in the Solikamsk district while drilling for oil.[16] It was decided by Vesenkha to favor development of Solikamsk over Kuban. The report of the prospecting expedition found its way from the Geological Committee of Vesenkha to the State Department in Washington, D.C.[17] The deposit was offered as a concession to Lyman Brown, previously American Relief Administrator in Russia. He operated on the fringes of concession-promotion of Soviet opportunities. By August 1927, Dillon, Read and Company was in process of raising $30 million to finance the development of Solikamsk and an associated chemical combine and oil pipe line. The fund-raising was killed by unilateral action on the part of the State Department; the Soviets then decided to start development with their own resources, utilizing Western skills under Type III assistance agreements.

A potash trust was formed and an agreement concluded with the German company, Deilmann Bergbau und Tiefbau Gesellschaft, of Dortmund, to design the mine and plant at Solikamsk.[18] The resultant Berezniki-Solikamsk complex included a salt refinery to produce 160,000 tons of stone salt annually,

[14] Amtorg, *op. cit.*, IV, No. 6, p. 110.

[15] *Ekonomicheskaya Zhizn*, No. 115, February 19, 1924.

[16] Much was made in the Soviet press about this oil-potash discovery (see *Torgovo-Promyshlennaya Gazeta*, No. 99, pp. 107–9 and 118, for 1929). This was, however, an extension of a field developed before 1917 (See A. A. Trofimuk, *Uralo-Povolzhenovaya neftiania baza S.S.S.R.* (Moscow: Gostoptekhizdat, 1957), pp. 144–5.

[17] The 31-page Provisional Report includes the drill core logs. These suggest a very substantial deposit of potash salt (316–138–352). The Soviets must have needed Western technology badly in this area, to allow out the drill logs. At about the same time they sentenced the representatives of a Swedish company to eight years in jail just for making a market survey of dairy equipment requirements.

[18] Vneshtorgizdat, *op. cit.*, p. 22.

a plant to procure 1.2 million tons of potash, chemical plants to utilize the potash, a brick plant, and other industries. Two shafts were planned for the mine: one was sunk by the trust to a shaft depth of 35 meters, and the main shaft was sunk to 260 meters by the German company, Gefrierschachbau, using freezing methods of sinking. The nature of the overburden required use of methods beyond Soviet capabilities at the time.[19] The degree of technical uncertainty felt by the Soviets is probably indicated by the fact that one year after development was started the project was still being offered as a concession. The program finally involved some thirty German engineers. The first mine, with a capacity of 1.5 million tons of ore, and the first concentrator, with a capacity of 1.2 million tons, were completed in 1933.

MANUFACTURE OF SULPHURIC ACID

Sulphuric acid capacity was modernized with the help of German firms. Lurgie Gesellschaft für Chemie und Hüttenwersen m.b., of Frankfurt, provided assistance for construction of a sulphuric acid plant with a daily capacity of 80 tons of monohydrate. The company also provided equipment and started operations for the Soviets. General technical assistance for sulphuric acid production was provided under another agreement, with Hugo Petersen, of Berlin.[20]

Bersol (the Russo-German company) was primarily interested in development of poison gas facilities, but was also instrumental in establishing factories for production of potassium chloride, sulphuric acid, superphosphates, and other chemicals.[21]

Development of an acids capacity is an essential prerequisite to plastics production. While nitric and sulphuric acid production was under development, moves were being made to acquire a plastics base. *Ekonomicheskaya Zhizn* of November 30, 1926, reported that a concession agreement had been signed with Société Industrielle de Matières Plastiques (S.I.M.P.) for production of cinema and photographic film and articles made from celluloid. S.I.M.P. was granted a factory at Podmoskovnia, just outside Moscow. The French company repaired this facility and started production in 1927. This was followed by a joint American-German concession in early 1928, under which a plant was built to produce noninflammable film, artificial silk, and also paper, utilizing a patented process based on the use of corn stalks. The German participant was Deutsche-Russische Film Allianz A-G (Derufa), and the American was the Euroamerican Cellulose Products Corporation of New

19 *Ekonomicheskaya Zhizn*, No. 86, April 11, 1928; and A. Hirsch, *op. cit.*, p. 64.
20 Vneshtorgizdat, *op. cit.*, p. 228.
21 Troyanovsky, *op. cit.*, p. 836.

York, represented by Montifiore Kahn (not the Albert Kahn firm with Vesenkha agreements).[22] The patents were held by the New York firm which 'thought it best' not to enter directly, but through German intermediaries. Investment amounted to $1.5 million, but little is known of the process itself.[23]

COKE OVEN BY-PRODUCTS

The Russian chemical industry was not insignificant in size before the Revolution. The production of coke oven by-products, an important source of chemicals, was well developed in tsarist times. Table 12–2 compares 1914 production of by-products with 1915 and 1926.

Table 12–2 COKE OVEN BY-PRODUCTS, 1914, 1915, AND 1926

	1914	*1915* (*Metric tons*)	*1926*
Tar	486,700	529,000	645
Ammonia water	197,300	209,800	0
Ammonium sulphate	169,000	117,230	0
Sal ammonia	64	196	0
Benzol	767	49,230	145
Oils	145,640	200,300	0
Goudron	201,700	248,300	0

Source: Quoted by J. Douillet, *Moscow Unmasked* (London: Pilot, 1930), pp. 47–8. Douillet had been Belgian Consul in Moscow and obtained the data from a Belgian engineer with personal working knowledge of the Russian coke by-product industry before and after the Revolution.

In 1914 production was substantial in both tar and ammonium sulphate. The war affected different branches of the industry differently. Tar output increased, while that of fertilizers decreased. The industry completely collapsed in the early 1920s and the Soviets were unable to restore production even by 1926. The only plant operating in the first few years of the decade was the Enakievo Coke Benzol Works, formerly owned by the Russo-Belgian Company. In 1921 John Reed, the noted American Communist, organized 300 unskilled American workers, to whom Lenin donated a coke benzene plant to operate:

> A year afterward the Chemical Administration sent a Commission of engineers to report on the coke-benzene plant. Atrocious conditions were uncovered, and the ovens were found to be badly damaged. The workers were soon returned to the United States. . . .[24]

[22] U.S. State Dept. Decimal File, 316–139–562.

[23] *Berliner Tageblatt*, April 28, 1928. It may be noted that the use of German intermediaries was a common practice among American firms at this time, no doubt to avoid adverse publicity in the United States.

[24] V. N. Ipatieff, *op. cit.*, p. 322.

Then for a period of some years no attempt was made to utilize coke by-products, officially because Koksobenzol and Ukrchim questioned the right of the Central Coal Industry management to concern itself with these products. Nothing was done while the dispute was in progress.[25] The coke-benzol industry was finally grouped under Koksobenzol. Of the twenty-two by-products plants incorporated into the trust, fifteen were fully equipped and had an annual aggregate capacity of 16,000 tons of benzol. Output in 1926 was a mere 145 metric tons. Before the Revolution, Russian coking had been dependent on foreign coke-oven technology. The Donbas ovens installed before World War I consisted only of Coppe and Piette systems.[26] Although about 800 ovens were available, output of coke was only 9,800 metric tons for 1920, compared to 4.3 million metric tons in 1913. By 1922 output recovered slightly to 110,000 and in 1923 to 130,000 metric tons. This enabled some attention to be placed on by-product recovery.[27] This recovery was brought about as coal supplies found their way once again to the ovens, but still only 4 percent of ovens were in production.[28]

THE RUSSIAN-AMERICAN COMPRESSED GAS COMPANY (RAGAZ)

Ragaz was a joint-stock company organized in January 1926 by the International Oxygen Company of New Jersey and the Soviet Metalosindikat for development of industrial gases in the U.S.S.R. Both parties held an equal share, and it was agreed that the concession would last until 1941. It was taken over by the Soviets in 1932.

Seven plants were established by Ragaz for manufacture of oxygen and acetylene for industrial uses. This included locations in Moscow (Rostokin), Sverdlovsk, Rostov on Don, and Baku. In addition, some seventeen welding plants, three acetylene gas generating plants, and two special schools for training welders were established at various points throughout the U.S.S.R.

The Moscow plant was opened in April 1927 and combined a special school with facilities for production of oxygen and acetylene. The second plant, which manufactured oxygen only, opened at Rostov in April 1928. The others followed. The Ragaz company also held the contract for the welding the Baku-Batoum and Grozny-Tuapse pipelines built between 1926 and 1929—the only pipelines built in the U.S.S.R. in this period.

25 *Ibid.*, p. 288.

26 Coppe ovens were at Petrovsky, Mariupol, Donetz-Urevsky, Taganrog, and Stalino. Piette ovens were at the Providence works. (316-131-949.)

27 *Coal Age*, January 8, 1925, p. 47.

28 Polish Foreign Ministry Report. (316-107-1262.)

In 1928 Ragaz produced 345,000 cubic meters of oxygen and 66,500 cubic meters of acetylene, and one year later 500,000 cubic meters of oxygen and 77,000 cubic meters of acetylene—the total Russian production. After the manufacture of industrial gases and the establishment of welding schools, the next problem was manufacture of welding equipment to replace imports. This was done under a technical-assistance agreement in 1929 with a German company, Messer A-G, of Frankfurt, specialists in the development of automatic welding equipment.[29] and later with technical assistance from General Electric for more advanced forms of welding equipment.[30]

BASIC AND INTERMEDIATE DYES

Imported dyes came exclusively from I. G. Farben, under an arrangement made in 1922 by a joint German-Russian commission containing I. G. Farben representatives. The latter agreed to maintain a warehouse in the U.S.S.R. and to import dyestuffs through Russgertorg (the mixed trading company). The commission also undertook to arrange for production of dyes through a jointly owned subsidiary—Igerussko. In return, the Soviets agreed to buy I. G. Farben products up to 70 percent of requirements of all coal tar dyes and medicines. The arrangement lasted until 1929. It was hardly profitable for the Soviets—only four intermediate dyes were manufactured by Igerussko, and the impression is gained that I. G. Farben was rather uncooperative. In return for a guarantee of gross sales, I. G. Farben was supposed to provide technical assistance also to the chemical and pharmaceutical industries. The agreement was not renewed. The Soviets complained they had not received any technical assistance, and the Farben company charged it had not received the agreed share of the Russian market.[31] There is a distinct possibility that I. G. Farben was shortchanged, as the Soviets made another dye agreement in 1924, a couple of years after the I. G. Farben agreement.

Before the Revolution, the German firm of Berger and Wirth A-G operated a large dye, ink, and paint manufacturing plant in Petrograd. This plant remained closed until 1924, although it was largely undamaged and nominally part of the Chemical Trust.[32] In February 1924, Berger and Wirth received a Type I concession agreement to reopen and modernize its old plant. The company was required to install new equipment. During the second year, a production level of 390 tons of dyestuffs was required, and in the third year 30,000 poods of printing inks, dyes, varnish, and paint. All technical advances

[29] Vneshtorgizdat, *op. cit.*, p. 228.

[30] *Monogram*, November 1943, p. 18.

[31] *Bank for Russian Trade Review*, II, No. 1 (January 1929); and U.S. State Dept. Decimal File, 316–136–1421.

[32] Report, April 13, 1923, U.S. State Dept. Decimal File, 316–108–362.

made by the company in Germany were required to be incorporated into the Russian plant. The agreement was to last for twenty-four years, at which time the plant was to revert to the Soviets in good condition. A royalty of 15,000 rubles per year plus 10 percent of sales was paid to the Soviets. Foreign workers were not allowed to exceed 20 percent of the labor force. In 1929 the company employed about 120 with an annual output of two million rubles in a new and completely mechanized plant.[33]

In 1924, when Berger and Wirth started work, the State Aniline Trust, which grouped together the prewar dye industry plants, was not in good shape. Of eight plants forming the trust, two (the Derbenevsky in Moscow and the Vladimirsky) were closed, two (the Butinsky and the Kinkshensky) were about to be closed, and four others (the Experimentaly, the Trigor, the Krasny Lutch, and the Central Laboratory) were on a heavily reduced schedule and working for the Military Trust. In 1923, just before the Berger and Wirth agreement, the trust sustained an overall loss of 876,451 rubles on a minute output. In 1913 the industry had produced 4,000 metric tons of synthetic dyes; in 1920–1 no output has been reported. There was then pressure on the Soviets to conclude a concession agreement in this sector. The opening of the Berger and Wirth plant and the implementation of the I. G. Farben technical agreement through Igerussko had an immediate impact on production.

Table 12–3 DYE PRODUCTION IN THE SOVIET UNION

Year	*Production (metric tons)*
1913	4,290
1920	170
1921	none
1922	none
1923/4	1,800
1924/5	n.a.
1925/6	8,290
1926/7	7,370
1927/8	10,250
1928/9	13,300
1929/30	16,790

Source: Nutter, *op. cit.*, p. 425.

By the end of the decade, the Soviets were able, with the help of I. G. Farben and Berger and Wirth, to claim legitimately a production of dyestuffs four times greater than prewar—wholly due to foreign efforts.

[33] U.S. State Dept. Decimal File, 316–139–549; and Haynes, *op. cit.*, p. 59.

Smaller concessions in this and allied fields were negotiated with the Leo Brand Company for production of cosmetics and with H. Brock for production of laboratory drying and desiccating equipment.

GLASS MANUFACTURING INDUSTRY

The earliest technical assistance in glass-making came under the Rapallo Treaty protocols involving a German group in the Kuban for production of Glauber's salts, and the processing of these sulphates for use in glass manufacture. Arsky said, ' . . . we must admit that we are quite incapable of doing this ourselves just now or even in the next ten-fifteen years,' and then realistically he added that, ' . . . the concessionaires will profit but it will bring wealth to us and we must pay for that.'[34]

The only completely modern glass-making plant built in the decade of the 1920s was the Bely Bychok plate glass works, built in 1927 and equipped with two ovens and twenty imported Fourcault-type furnaces and glass machines; the complete plant cost $3.6 million.[35] Later, in 1927, four American glass-machinery operators were hired and spent between one and two years in the U.S.S.R. They toured Soviet glass-making plants and introduced Russian workers to new American equipment as it was imported to replace the pre-revolutionary machinery.[36]

Simultaneously, a Ukrainian delegation arrived in the United States to study American glass factories. The delegation was sent by the Porcelain and Glass Trust of the Ukraine to study the application of American glass-making machines and methods to the Ukrainian industry. The delegation visited Pittsburgh, the Ohio River glass plants, Detroit, Buffalo, and Trenton, New Jersey. The delegation then announced that a large-scale plan of expansion had been worked out which involved purchase of 'considerable machinery abroad.'[37]

RESINOTREST

There was a rubber goods manufacturing industry in tsarist Russia. The important components were the Treugolnik (Triangle) plants in Moscow and Petrograd, combined by the Soviets into Resinotrest. Progress at these works and the tsarist Bogatyr, Caoutchouc, and Provodnik factories (also incorporated into Resinotrest as Rubber Manufacturing Plants Number 1, 2, and 3) went very slowly. The latter three plants employed about 10,000 in 1923,

[34] *Krasnya Gazeta*, September 3, 1921.
[35] Amtorg, *op. cit.*, II, No. 14, 5.
[36] *Ibid.*, No. 15, 5.
[37] Amtorg, *op. cit.*, II, No. 8, 2.

but were only partly in operation, producing rubber galoshes and tire canvas. The Petrograd Treugolnik plant employed about 10,000 and also produced galoshes. The essential problems were those of raw materials, skilled labor, and equipment.[38]

The Petrograd Treugolnik plant was selected for improvement and completely modernized in the mid-1920s. New activities were added, including asbestos spinning and manufacture of brake linings, yarns, packings and similar products. Its employment was boosted to 22,000 by 1928, and the company was placed under management supervision of two American consultants.[39]

The establishment of a rubber-reclaiming industry was initiated by a technical-assistance agreement between Resinotrest and the Akron Rubber Reclaiming Company in 1930.[40] The manufacture of rubber tires was initiated with the aid of the Seiberling Rubber Company, which completely outfitted a tire manufacturing plant at Yaroslavl and provided technical assistance in operations.[41]

CONCLUSIONS ON THE CHEMICAL INDUSTRY

During the decade the tsarist plants were restored and modernized and the Soviets added a new dye-manufacturing plant (built by Berger and Wirth under their concession agreement) and glass-manufacturing plant (from the United States), expanded a Treugolnik rubber plant (with American assistance), and obtained, through concession agreements, two foreign plastics operations.

The most significant items were the transfer of technology for the manufacture of synthetic ammonia, and nitric and sulphuric acids, and the creation of a compressed gas industry. The Dupont, Casale, and Nitrogen Engineering processes were transferred to the Soviet Union and formed the basis for development of chemical complexes under the so-called Five-Year Plan. These complexes were the Berezniki-Solikamsk, where the NEC synthetic ammonia plant was backed up by a Westvaco chlorine plant, and the Chernorechensky complex designed on the basis of the Dupont synthetic ammonia and nitric acid plants. A third complex was started at Bobriki (later Stalinogorsk) based on a second NEC synthetic ammonia plant.[42] Modernization of the basic chemical

[38] IS reported that Treugolnik 'refused' to join Resinotrest and had 'suffered accordingly' but gave no details. (316-108-408.)

[39] Ruykeyser, *op. cit.*, pp. 209-10. The engineering section was run by a German engineer, Hertwig. (316-108-415.)

[40] A. A. Santalov and L. Segal, *Soviet Union Year Book, 1930* (London: Allen and Unwin, 1930), p. 357.

[41] *Ibid.*, p. 359.

[42] Hirsch, *op. cit.*, pp. 73-85.

capacity, vital for industrialization, was essentially an achievement of foreign enterprise; once again, indigenous Soviet technology is notable for its absence. There is no trace in the engineering literature, Western or Soviet, or in archival material, of any Soviet contribution, unless the 35-meter Solikamsk shaft (which *may* have been a Soviet project) is counted as a technological contribution.

CHAPTER THIRTEEN

Clothing, Housing, and Food Concessions

THE FORMATION OF TRUSTS IN THE TEXTILE INDUSTRY

ALL large textile firms were nationalized by the decree of 1918 and management placed in the hands of a Chief Committee of the Textile Industry. The home textile industry, based on hand work but without hired labor, remained in private hands.

Available cotton spindles in 1920 totaled about seven million, but only a little more than ten percent of these were working. In the flax industry, only one quarter of 400,000 available spindles were working. Thus, although spindle capacity was about the same in 1920 as in 1912, output was very much less. This decline was the result of poor administration. Substitution of 'ignorant, sometimes unscrupulous Soviet officials' for the former owners, a labor and fuel shortage, and inability to provide food for the workers were the main causes. Rations were small and in irregular supply, and output was largely restricted by time wasted in foraging expeditions.[1]

In late 1921, the textile industry was organized in a number of trusts. These were the Tambov, comprising five factories producing coarse cloth; the Simbirsk, comprising six factories producing coarse cloth; the Moscow Trust, combining thirty-two plants in the Moscow industrial district and called also the Worsted and Finishing Trust; the Silk Knitting Trust, comprising fifteen factories; the Bogorodsk-Glukov Trust, with ten factories; the Orechovo, with ten factories; the Ivanovo-Voznessensk, with twenty-seven factories, and the Vladimir with ten cotton-spinning plants. Later the Petrograd district was organized as was the Linen Administration, comprising seven factories in the Vladimir-Kostroma provinces. Altogether, the Linen Trust comprised seventeen factories, including the large Kostroma plant.[2]

[1] *Wool and Textile World*, July 7, 1921.

[2] *Krasnya Gazeta*, August 2[illegible], 1921. These figures are somewhat different from those

Trustification was accompanied by the return of emigrants from the United States: usually deportees with ideological sympathies with the Revolution. In the summer of 1922, Petrograd *Pravda* reported that an 'American Department' had been organized in the Thirteenth State Clothing Factory by a group of deportees led by Comrade Summer and using methods described as the last word in efficiency, in an effort to create 'a genuinely American attitude to work.'[3] Another group of thirty-six American tailors joined the Moscow Tailoring Combine. It is interesting to note how a comparatively small group can affect a major organization:

> [they] have raised its work to such a level of efficiency that the Combine has become a model establishment . . . there are now six cutters to 150 machines, whereas formerly there were fifty cutters when hand machines were used.[4]

Demand for textiles was intensified by good harvests in the middle 1920s, but the cotton crop was insufficient to meet the demand, so that imports were necessary. In 1923–4, some 10 million poods of cotton was produced and another 8–9 million, valued at $75 million, was imported from the United States. The Chase National Bank advanced credits to the Textile Syndicate for the purchase of this cotton, payment being collected against documents in Moscow. In 1925, negotiations between Chase and Prombank extended beyond the finance of raw materials and mapped out a complete program for financing Soviet raw material exports to the U.S. and imports of U.S. cotton and machinery.

Imports were still insufficient to meet demand, and in March 1926 most cotton mills suspended work during Easter for an extended summer vacation. Wool factories closed for most of the summer discharging half of their workers and paying the rest at half rates.[5] The crisis recurred in 1927. Again numerous factories were closed. These supply problems were compounded by technical problems. In the Kostroma plant, some 45,000 spindles were crowded into a space designed for 20,000. These were of widely varying types, and about three quarters were from thirty-five to sixty years old. Few repairs had been undertaken since the Revolution, and spare parts were removed from machines already in operation. The steam engines providing power dated back to 1880.

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given by M. Dobb. In particular, Dobb places only 7 plants in the Moscow Trust instead of 32, and quotes his source as Y. S. Rozenfeld, *Promishlennaia Politika S.S.S.R.* (1926). (Dobb, *op. cit.*, p. 134.) The propaganda image of a 'destroyed industrial structure' is hardly consistent with this comparatively large number of plants ready for trustification.

3 *Pravda* (Petrograd), No. 175, August 6, 1922.

4 'Emigrants Returning from North America,' *Pravda* (Moscow), No. 246, October 31, 1922.

5 *Izvestia*, No. 191, August 23, 1925.

As a result of this technical backwardness, substantial orders were placed abroad for textile machinery, particularly in the United Kingdom and Germany. In 1927–8, the U.S.S.R. purchased 11,471 tons of 'machines for spinning and twisting cotton, wool, flax, silk and bast fibres' from the United Kingdom alone. This may be compared with purchases of only 3,896 tons of cars, trucks, and fire engines from the same source. Textile machinery was the largest single category of exports from the U.K. to the Soviet Union in the years 1926 to 1928.[6]

THE RUSSIAN-AMERICAN INDUSTRIAL CORPORATION (RAIC) AND SIDNEY HILLMAN[7]

Several small groups of American emigrants arrived in the early 1920s. One, as already mentioned, joined the Moscow Tailoring Combine. Another, comprising 120 deportees with 200 sewing machines and other equipment, arrived a few months later. They took over an old sewing factory and established the Third International Clothing Works.[8]

In 1922 a much more ambitious project, of major significance in modernizing the textile and clothing industries, was begun. The project was initiated by Sidney Hillman and the Amalgamated Clothing Workers of America, whose official position was as follows:

> Russia has been pleading in vain with the rulers of the world for industrial credit. It is the duty of labor to give Russia the credit denied her by the ruling class. The Amalgamated has made the beginning with the clothing industry. Let us be big enough to perform our duty fully and quickly.[9]

In an *Izvestia* article, Hillman pointed out that the aim of the union was not solely to establish a clothing industry in the Soviet Union: 'our aims are much higher, we will begin with this industry and then grant credits to the other clothing trusts.'[10]

[6] A. A. Santalov and L. Segal, *Soviet Union Year Book, 1930* (London: Allen and Unwin, 1930), p. 331.

[7] Board of Amalgamated Clothing Workers of America, *Bibliography of the Amalgamated Clothing Workers of America* (New York, 1939). Section IV is a list of references to the Russian-American Industrial Corp.

[8] *Pravda*, No. 225, October 6, 1922.

[9] Amalgamated Clothing Workers of America, Sixth Bienniel Convention, *Report of the General Executive Board* (Philadelphia, May 1924), p. 90. Hillman was not typical of American unionists. Samuel Gompers thundered long and loud against Soviet treachery and brutality. He was wholly opposed to any form of economic or trade links with the Soviet Union. [See S. Gompers and W. E. Walling, *Out of Their Own Mouths: A Revelation and Indictment of Sovietism* (New York, 1921).] Most present-day American unionists follow in the Gompers tradition. (See the speeches of Meany, *et al.*) Comparison with the record of American businessmen (both then and now) is revealing: see chaps. 17 and 18.

[10] *Izvestia*, No. 252, November 10, 1921.

An agreement was drawn up between Vesenkha and a company formed by Hillman and Amalgamated Workers called American-Russian Industrial Workers Association (Artina) later changed to Russian-American Industrial Corporation (known as RAIC or RAIK). The full text of the agreement was given in the *Nation* and was intended to act as a model agreement for a series of such worker enterprises, which were conceived as the equivalent of the foreign commune in agriculture.[11] RAIC made three contracts with the Soviet Union. The first was a general contract (November 1921) authorizing the company to do business and to underwrite contracts made by the union treasury. The underwriting included a minimum dividend and repayment of principal if the corporation should be liquidated. The second agreement was with Vesenkha and similar to the first. The third and most important was with the All-Russian Clothing Syndicate and covered the first project: that of operating the prerevolutionary clothing and textile plants.

RAIC was capitalized at $1 million, and stock was sold to union members at $10 per share. The union appropriated $10,000 from the union treasury to defray initial organization expenses and also bought $50,000 worth of stock. RAIC was linked also to the all-Russian syndicate of the Sewing Industry, which was founded in 1923 with a capital of 900,000 rubles. Sixty percent of the syndicate was owned by various Soviet state institutions (Vesenkha held eighty shares; Moscow Sewing Industry, twenty shares; Petrograd Sewing Industry, 600 shares; Tartar Clothing Industry, twenty-five shares; Nijhny-Novgorod Sewing Trust, five shares; Experimental Factory twenty shares; and the Kharkow Sewing Trust, twelve shares). *The balance of 40 percent was owned by RAIC.* This was an arrangement similar to the General Electric ownership of shares in Electroexploatsia and Electroselstroi. The syndicate opened fifteen branches across Russia. This provided a channel for the transfer of capital, equipment, management techniques, and skilled labor from RAIC to the textile and clothing industries.[12]

In June 1922, six clothing factories in Petrograd and three in Moscow were turned over to the control of the joint board. It was then announced that the new capital would go mainly for new and improved equipment, and in August RAIC announced that the first shipment of spares for American machines currently in use in the U.S.S.R. had been made. By late 1923 RAIC was

[11] 'Contract with Soviets', *Nation*, CXIV (June 1922), p. 728. The *Nation* was a very useful vehicle for spreading news of the aims and work of these enterprises and communes and in denying rumors (true *or* false). For example, when Americans were trying to leave the Kuzbas Commune (American Industrial Corp.), the *Nation* vehemently denied any such pressure existed or that any exodus was under way.

[12] *Izvestia*, No. 207, September 14, 1923. It is likely, although no evidence can be presented, that the syndicate utilized the 3,000 outlets, 50 agencies, and 50 warehouses and manufacturing plants built by the Singer Sewing Machine Co. (Foreign Claims Settlement Commission of the United States, Claim No. SOV-40, 920.)

operating nine clothing plants in Moscow as well as plants in seven other Russian cities. This was independent of the arrangement to aid, technically and financially, the clothing syndicate.[13] By late 1923 RAIC was operating twenty-five clothing plants in Moscow alone and employed 15,000 workers.[14] The union also supplied skilled personnel to aid plants operating outside the syndicate, and provided specialized personnel for research and other operations. (For example, the Moscow experimental factory had a manager supplied by the union in the United States.)[15]

The capital and technical skills were supplied by the union, and the workers and raw materials were provided by the U.S.S.R. Both sides were equally represented on the board of control, and the enterprise run on a cooperative basis.

The books had opened for subscription in June 1922; by August more than $100,000 had been subscribed, and by September more than $300,000. It was announced on September 15, just three months after formation of the company, that a dividend of 8 percent would be paid. There were immediate protests in the current news media that this was a payment from capital and not earnings. Hillman denied this claim:

> So far as our information goes we expect the dividend to come out of the earnings of the Syndicate. Under our contract with the Soviet government, if these earnings are insufficient the Soviet makes the dividend good on our filing a claim. We have filed no claim, and reports that the Soviet has sent money here for this specific purpose are incorrect.[16]

In April 1924 the Amalgamated Clothing Workers of America opened two banks: the Amalgamated Bank of New York and the Amalgamated Trust and Savings Bank of Chicago. These banks called their 'most important function' the transmission of dollars to Russia. By 1927 some $20 million had been sent, in addition to $200,000 in food gifts and another $300,000 in cash gifts. The money was 'largely used for the purchase of machinery and raw materials for the clothing trusts of Russia.'[17] RAIC also interested itself in Syndchveiprom, the syndicate for the united confectionery trusts, but, apart from a financial investment, the degree of participation is not known.[18]

[13] *New York Times*, October 31, 1923, p. 17, col. 6.

[14] *Nation*, January 19, 1924, letter from S. H. Walker.

[15] *Nation*, November 7, 1923, p. 524.

[16] *New York Times*, September 2, 1923, Sec. II, p. 11, col. 1. Payment out of capital would, of course, be an offense against the 'blue sky' laws.

[17] *Nation*, May 25, 1927, pp. 569–70.

[18] *Annuaire*, p. 133.

THE TRILLING, NOVIK, AND ALTMAN CLOTHING CONCESSIONS

In September 1926, a Type I concession agreement was concluded with O. Trilling, of Poland—the former owner of the Spartak factory in Moscow. The concession produced woolen goods, including blankets, thread, and carpets. The plant had been part of the Mossukno and was in a very run-down condition, producing only 2 percent of the trust's output, although reportedly working at capacity. Trilling was required to re-equip the plant completely so that by the second year of operations it would produce not less than 200,000 meters of cloth, and by the end of the third year 300,000 meters. In addition, Trilling was required to produce 150,000 meters of blanket cloth a year. The necessary equipment was to cost not less than $80,000 and had to be imported.

Trilling was employing 230 workers by 1929 and had introduced

> considerable alterations and improvements in the factory, which was obsolete. . . . the whole plant was electrified and much new equipment introduced. The daily output of the spinning department was increased from 400 to 2,500 kilograms of wool yarn. In the weaving department twenty-seven new looms were installed and automatic drying machines were purchased for the washing department. . . . Additional equipment will be imported to produce Jacquard blankets, an article which is not manufactured at the present time in the Soviet Union.[19]

Upon expiration of the concession, the enterprise was to be turned over to the Soviets without compensation, free from debt, and in a technical condition not less favorable than that for the final two years of operations. In the meantime a yearly payment was to be made to the Soviet government. This was to be not less than 40,000 rubles per year and equal to 6 percent of the sales volume of the factory. The concessionaire was given the right to establish a share company either abroad or in the U.S.S.R., with a capital of not less than 400,000 rubles, and with all members to be approved by the Soviet government. The term of the concession was to be fifteen years, although the concession was actually expropriated long before this date.[20]

The second clothing concession was granted to Novik and Sons to operate the Baranov factory for manufacture of caps and hats. They were required to equip the plant and start operations within nine months of date of signature. Production was to be not less than 20,000 dozen caps and hats per year, in addition to 13,000 dozen felt snow shoes and 20,000 meters of felt cloth per year. Novik paid an annual rent of 32,000 rubles and from the end of the second year onward an additional annual royalty of 50,000 rubles per year. At the end of the agreed term of twelve years, the factory was to be turned over to the Soviet government in good condition and without charge.

19 *Bank for Russian Trade Review*, II, No. 2 (February 1929), 10.

20 *Ekonomicheskaya Zhizn*, No. 237, October 14, 1926.

A third concession was granted to the Austrian citizen, Altman, who took over the former Gorbachev plant to produce knitted goods. The concession was required, within fourteen months from date of signature, to produce annually 25,000 kilograms of cotton and 50,000 kilograms of woolen yarn, of which not less than 30 percent was to be used for the manufacture of stockings and gloves. Altman was required to import equipment for production of knitted goods. The equipment was to be valued at not less than 120,000 rubles, in addition to equipment for wool-spinning valued at not less than 60,000 rubles. A royalty of 8 percent was payable on knitted goods turnover and 5 percent on woolen goods turnover.

Turnover was required to be not less than 400,000 rubles in the first, 800,000 rubles in the second, and one million rubles in the third year. Annual rent was set at 8,000 rubles. The factory was to revert to the state at the end of eighteen years with complete equipment and in good working order.[21] The concession was later taken over by Tiefenbacher and expropriated before the eighteen years had expired.

There had been numerous small shoe-manufacturing concerns in tsarist Russia. Aktieselskabet United Shoe Machinery Company of Copenhagen (the Danish subsidiary of United Shoe Machinery Corporation of the United States) had leased shoe machinery to over sixty-two plants before 1914. This equipment was valued at five million rubles. In addition equipment was stored in Petrograd warehouses. These factories and their equipment were confiscated in 1918.[22] In the 1920s a concession was negotiated with the Union Shoe Company of Vienna for technical assistance and the use of imported Austrian equipment.[23]

TECHNICAL ASSISTANCE TO THE TEXTILE INDUSTRIES

In July 1929 an agreement was concluded with the U.S. firm, Lockwood, Green and Company, under which four American textile machine-building specialists were sent to the Soviet Union 'for technical aid in the reorganization of Soviet textile mills as well as drafting projects for new textile mills.' The agreement included 'material responsibility' by the American company for the rationalization proposals of its engineers and was coincident with an increase in the purchase of American textile machinery.[24] Another contract aimed at rationalizing the accounting system in Russian textile mills; this contract was made with the New York firm of management consultants, Eugin

[21] *Ibid.*

[22] Foreign Claims Settlement Commission of the United States, Claim No. SOV 4-353.

[23] U.S. State Dept. Decimal File 316-131-344.

[24] *Ekonomicheskaya Zhizn*, No. 153, July 7, 1929, and No. 159, July 14, 1929.

Szepisi.[25] The design of plants for specialized textile products intended for the export market was represented by the agreement with C. T. Steinert, of Frankfurt, for the design and construction of a plant for manufacture of kid leather.[26]

There is little question that these design contracts stemmed directly from 'uneconomic conditions' prevailing in the textile and allied industries. Textilstroi (trust for building textile plants) was organized in 1926 with the aim of reducing construction costs of textile plants. Investigation in 1928 showed that the trust had been undertaking construction without definite plans or sufficient materials and labor. This had resulted in heavy over-expenditures and slow construction. Administrative costs were out of line with results achieved; in 1927–8 over 500,000 rubles had been spent without producing any 'concrete results' whatsoever.[27]

FRENCH TECHNICAL ASSISTANCE TO THE SILK INDUSTRY

The silk trust (Shelkotrust) was formed in 1921. It consisted of thirty-eight prerevolutionary factories in the Moscow and Vladimir districts, including some plants with a large prewar output. The planned output for the first year of production was 1.9 million arshines (compared to 60 million for the same plants in 1913). This target was not achieved. The largest plant in Shelkotrust was the Moscow plant of the Société Anonyme Franco-Suedoise pour la Fabrication de Soie en Russie, built in 1889 and considerably enlarged in 1911. Before the Revolution the plant had employed over 2,000, but, even by 1930, with extensive foreign assistance, employment was still in the region of 350–400.[28]

In 1923 negotiations were begun with the former French owners concerning further investment. These resulted in several agreements after some four or five years of discussion. In February 1928 a contract was made between Iskustvennoie Volokno (a Soviet company), the French firm Soieries de Strasbourg S-A, and Professor E. Bronart for production of artificial silk by the viscose process. The agreement was for ten years and the French parties undertook to give technical assistance in the construction and operation of a new plant in Leningrad utilizing the patents and processes of the French firm.[29] By 1930 the firm had built two plants, one in Leningrad and another in Moscow. This was followed by an agreement to build a third plant at Mohilev

[25] Vneshtorgizdat, *op. cit.*, p. 227.

[26] *Ibid.*, p. 229.

[27] *Ekonomicheskaya Zhizn*, No. 223, September 25, 1928.

[28] J. Douillet, *op. cit.*, p. 48; and *Ekonomicheskaya Zhizn*, No. 277, December 9, 1921.

[29] *Ekonomicheskaya Zhizn*, No. 46, February 23, 1928; and Vneshtorgizdat, *op. cit.*, p. 230.

using equipment supplied by a German firm, Oskar Kohorn A-G, of Chemitz. The Kohorn company also had a direct technical-assistance contract with Shelkotrust for the supply of data and assistance in the manufacture of artificial silk by the viscose process. Combined output of the German-assisted plants was 20,000 kilograms per day of artificial silk, but nothing is known of the exact number and location of these plants.[30]

EUROPEAN BUTTON CONCESSIONS

Even the lowly button had a number of manufacturing concessions. Tiefenbacher Knopfabrik A-G, button manufacturers of Vienna, signed a concession agreement in July 1926 and was still manufacturing buttons under this agreement at the end of the decade. The company sent equipment from its Vienna plant to Moscow and took over the factory previously occupied by the Altman company.[31]

Skou-Keldsen also had a button concession at Poltava in the Ukraine and another in Leningrad. At one time the company applied for further works in Kiev and Odessa, but there is no record that the application was successful.[32] Two other manufacturers of buttons were Stock A-G and Block and Ginsberg, both German companies.

TECHNICAL ASSISTANCE TO THE FOOD INDUSTRY

Technical assistance in the food industries consisted of equipping plants in key processing industries and designing of plants for the Five-Year Plan.[33]

A concession agreement between Okman (an Estonian) and the Kharkov Provincial Council of People's Economy created a joint company to run beer and malt breweries in the Ukraine. This was a Type II concession, and both parties deposited 85,000 rubles capital. The company had three directors: Okman, and two others appointed by the Provincial Council, which received 60 percent of the profits.[34] H. Langmann and Sons, of the United Kingdom, had a concession for growing hops for the brewing industry.

[30] U.S. Embassy in Warsaw, Report No. 294, October 7, 1930.

[31] U.S. State Dept. Decimal File, 316–131–345 and 316–111–916.

[32] U.S. State Dept. Decimal File, 316–131–668.

[33] A number of concessions were rumored to be in this field but concrete evidence for them does not exist. For example, in 1922 the Bolshevik Southwestern Economic Conference opened negotiations with the Chicago meat-packing firm, Morris and Company, with a view to granting a concession to operate the slaughterhouses and meat-packing factories at Alavir. At the same time, the Conference bought 100 refrigerator cars in the United States. At about the same time, the American Association of Manufacturers was negotiating with the Ukraine Bank to equip sugar mills in the Ukraine; two of its members were in Kiev to conduct the negotiations. Both these are mentioned in IS Report at 316–139–522 but there is no confirmation elsewhere.

[34] U.S. State Dept. Decimal File 316–131–119.

Gaier, a French firm, equipped a plant in the Ukraine to produce oil from various seeds.[35] In 1930 a technical-assistance contract was concluded with Harburger Eisen und Bronzwerke A-G for design, construction, and supply of equipment for oil-crushing mills. A similar agreement was made in the same year with the Dutch firm, N.V. Maatschappij Tot Exploitatie von Veredelinsprocedes, for technical assistance in the saccharification of wood pulp to produce cattle fodder and glucose.[36]

Design of meat-packing plants was the subject of a contract between H. G. Henshien of Chicago and the food industry.[37] The German firm, Hect-Feifer, enlarged the Odessa meat-packing plants and arranged for the export of preserved meat to Germany.[38] The Mechanical Manufacturing Company, of the United States, provided technical assistance to the meat-packing industry.[39]

The design of condensed-milk plants was the subject of a contract with the McCormick Company, of Pittsburgh.[40] Another design-assistance contract was with Penick and Ford, Inc., of Cedar Rapids, Iowa, to plan factories for production of corn products.[41] General technical assistance to the food industry was the subject of an agreement with Webber and Wells, Inc., of Chicago.[42] The Romanoff Caviar Company had its nationalized plants returned, and, as the company had German and American owners, it must be concluded that the Soviets were interested in developing the foreign exchange potential of caviar.[43]

Three large bakeries were constructed by the McCormick Company. These were not only the largest in the Soviet Union but among the largest anywhere in the world, with a daily capacity of 200 metric tons, produced during three shifts. Operations were completely mechanized, so the workers numbered only seventy per shift. McCormick engineers designed the plants and supervised construction, installation, and initial operation of American equipment.[44] The output of bread in Moscow in 1927–8 was 175,000 tons and in Leningrad 278,000 tons. These were significant increases from 1925–6, when the Moscow output had been 74,000 tons and the Leningrad output 147,000 tons. Each of

[35] *Izvestia*, No. 7, January 9, 1924.
[36] Vneshtorgizdat, *op. cit.*, p. 228.
[37] American Russian Handbook, p. 99.
[38] Polish Foreign Office Report, October 7, 1929.
[39] A. A. Santalov and L. Segal, *Soviet Union Year Book, 1930*, (London: Allen and Unwin, 1930), p. 358.
[40] *Ibid.*
[41] *Ibid.*, p. 100.
[42] *Ibid.*, p. 101.
[43] Report 93130, April 12, 1930 (316–130–1293).
[44] *Bank for Russian Trade Review* II, No. 7 (July 1929), 16.

the new plants built by McCormick was able to produce 74,000 tons per year on two shifts. There is little doubt that the whole increment in bread output came from these mechanized American bakeries.[45]

Most of the sugar refineries in the Ukraine were put back into operation by German technical assistance forthcoming under the Rapallo Treaty. In 1929, however, there were, still ten refineries in a state of 'technical preservation,' and three new refineries were planned to replace these.[46]

Concessions were rare in the tobacco field. There was one in 1924 with A. Lopato and Sons, of Harbin, China, for the operation of the latter's prerevolutionary plant in Chita, Siberia. A fifteen-year lease was granted the company, which paid the Soviets 5 percent of gross output, and a tax equal to 3½ percent of the market price of tobacco.[47]

TECHNICAL ASSISTANCE IN HOUSING AND PLANT CONSTRUCTION

The American-Russian Constructor Company (ARK) made a private Type I concession agreement for house repair with the Moscow Soviet. Practically all the stock was held in the United States. Houses in need of repair were allotted to the company by the Moscow Soviet for terms of 8, 18, or 36 years, according to the amount of capital required to place them in habitable condition. The company was to furnish all materials and labor, repair the houses, and keep them in good repair for the stipulated period. During this term the company was to have renting privileges. Of the rent collected, 80 percent accrued to the company and 20 percent to the Moscow Soviet. Taxes were paid by the tenants. About 24 Americans (mostly of Russian origin) were employed by the company.[48] Little is known about the specific operations of ARK, but it probably expired in the early 1930s when the Soviet ran out of houses in need of repair. In 1923 the functions of the concession were extended to 'construction and repair work, organization, leasing and operating plants producing construction materials in the RSFSR and allied republics. . . .'[49]

In late 1923, following a decree of the Soviet of People's Commissars which removed a number of institutions and organizations from Moscow to relieve the housing shortage, an agreement was made with Geoffrey and Curting, Ltd. (United Kingdom), to undertake capital repairs on these buildings.

[45] Calculated from data in *Bank for Russian Trade Review* II, No. 7 (July 1929), 16.
[46] *Pravda* (Moscow), No. 98, April 28, 1929.
[47] U.S. Consulate at Harbin, China, Report No. 2824, September 20, 1924.
[48] U.S. Consulate at Riga, Report 212, December 23, 1922.
[49] *Ekonomicheskaya Zhizn*, No. 105, May 13, 1923.

A large company was formed for this work, but nothing has been reported about specific operations.[50]

By 1925 the housing situation had become desperate. Resultant fatigue was blamed for many industrial accidents. One article warned against placing too much reliance for construction on cooperatives and suggested that the greater part of the needed house building should be done by 'commercial organizations.'[51] This was followed by an agreement in March 1929 with the Longacre Construction Company, of the United States, to build according to the 'latest technical methods' some four million rubles' worth of workers' housing in Moscow.[52]

Another concession in housing, between Tsentrozhilsoyuz (the Central Union of Dwelling Cooperatives) and the German firm, P. Kossel A-G in 1926, provided for the establishment of a Type II joint-stock company to build houses, hotels, and apartments. Rusgerstroi had a share capital of six million rubles equally subscribed by each party. Kossel received 1.9 million rubles for patents turned over to the joint company. The Soviets received the same amount free. The concession was stipulated to last twenty-five years, but Kossel was ejected in 1928. In the meantime, the company established cement, glass, and woodworking plants.[53]

A series of articles in *Ekonomicheskaya Zhizn* suggests why concessions were attempted in the field of housing and why the plants of the Five-Year Plan were designed and built by foreign companies. Several meetings of the Soviet of Labor and Defense were devoted to the question of the extremely poor results of industrial and domestic building programs. There was no responsible supervising organ; each production unit had tried to become self-supporting. This resulted in poorly designed projects whose costs had usually been underestimated. There were gross technical inefficiency and poor technical training. The input industries—especially the glass, paper and chemical industries—were inefficient, and supplies of these products were irregular and of poor quality.[54]

SMALL HOUSEHOLD ITEMS

The Alftan pure concession granted in 1924 produced typewriter ribbons and carbon, waxed, colored, and parchment paper.[55] Elia Shulmann took over

[50] *Pravda* (Moscow), No. 224, October 4, 1923.

[51] *Torgovo-Promishlennaya Gazeta*, No. 268, November 24, 1925.

[52] *Izvestia*, No. 51, March 2, 1929.

[53] *Ekonomicheskaya Zhizn*, No. 180, August 8, 1926.

[54] *Ekonomicheskaya Zhizn*, various issues for April 1928, December 1928, and January to June 1929. Negotiations were reported in the Soviet press with the American companies Van Soon and McDonald for construction of large cement plants (*Izvestia*, No. 248, October 26, 1929).

[55] *Ekonomicheskaya Zhizn*, No. 346, November 28, 1924.

his prerevolutionary factory in Moscow for a concession to manufacture typewriter ribbons, carbon paper, indigo, copying paper, stencils, and inks. The factory employed 150 and was the largest in the U.S.S.R. making these articles. In 1926 Shulmann, a Latvian citizen, concluded another agreement for the manufacture of steel pens, penholders, drawing pins, paper clips, pencil sharpeners, and fountain pens.[56] A Finnish firm, Raabe, was granted a concession to operate the nail factory at Nerecht, in Kostroma Province.[57]

After the demise of the Harriman manganese concession, United States manufacturers were decidedly cool to further concessionary ventures. One, however, was concluded in the record time of three weeks between the Gillette Safety Razor Company and the U.S.S.R. Gillette was obligated to build a plant in the Soviet Union—the first time an American company decided to build on Soviet territory.[58]

THE HAMMER CONCESSIONS

The first Hammer concession was granted to Allied Chemical and Dye for operation of the Urals asbestos deposits, discussed in chapter 6. The best-known of the Hammer concessions was one granted in 1925 for production of pencils, pens, celluloid drawing instruments, and similar items. The cedar, graphite, and colors were imported. Machinery and skilled labor were brought from Germany. Four factories, located in Moscow, employed at their peak about 1,000 persons.[59] The pencil concession was, in effect, a monopoly, and, at the end of the first year's business, a turnover of $2.5 million, with net profits of $600,000, was reported. Some $450,000 of the profits was reported as having been exported. The second year's turnover was $3.5 million, on which profits were $550,000. A turnover tax of between 6 and 10 percent was payable, together with an income tax of 10 percent on gross income and a tax of 50 percent of all profits in excess of the first 20 percent of profits based on invested capital.[60] It was reported in 1927 that Dr. Hammer was seeking a $500,000 loan in New York for further expansion of the pencil factory. Obligations by Centrosoyuz were offered as security. Further security was offered in

[56] Troyanovsky, *op. cit.*, p. 861.

[57] *Pravda* (Moscow), No. 250, November 3, 1923.

[58] *New York Times*, December 10, 1929, p. 8, col. 4. Nothing more was reported; it is presumed the agreement was not implemented.

[59] U.S. State Dept. Decimal File, 316-136-1240. Hammer's monopoly resulted from product superiority rather than agreement. Alexander Barmine, *One Who Survived* (New York: G. P. Putnam, 1945), p. 157, says, 'The State Mospolygraph Trust undertook to make cheap pencils, but the quality was so bad they could not compete with Dr. Hammer's more expensive goods.' High import tariffs were placed on pencils to protect the State Pencil Trust (Karl Liebnecht factory). (*Ekonomicheskaya Zhizn*, August 11, 1923.)

[60] U.S. Embassy in Berlin, Report 4457, April 11, 1929.

the form of Russian government loan bonds.[61] This appears as a pre-Harriman attempt to break United States policy against long-term loans to the Soviet Union. The concession was turned over to the Soviets on December 20, 1929, in accordance with a clause in the contract which enabled the Soviets to buy out at any time at an agreed valuation.[62] There are unique features about the Hammer concessions. The pencil concession had a smooth and profitable history, quite unlike most other concession agreements. The purchase clause was invoked and accepted without the usual protest.

[61] *New York Times*, November 22, 1927, p. 40, col. 2.
[62] *New York Times*, December 22, 1929, p. 31, col. 2.

CHAPTER FOURTEEN

Transportation and the Transportation Equipment Industries[1]

RECONSTRUCTION OF THE RAILROADS

THE heart of Russian transport is the railroad. Development in tsarist times was limited by weak track, which in turn limited size of locomotives employed. The tsarist Ministry of Transport had a rather limited view of locomotive construction, and its was not until 1912 that the Vladikavkaz Railroad in the North Caucasus introduced a ten-coupled freight steam engine. This was the finest engine available in the 1920s and became the standard Soviet type. However, the comparative backwardness of the Russian railroad system was not due to lack of experimentation or innovative ability. Westwood points out the long Russian history in *steam* traction, from tsarist times to the Soviet research.[2]

Restoration of railroads and ports, both heavily damaged in the Civil War, were the essential prerequisites to economic development.[3] This reconstruction was begun in the immediate post-Rapallo period, with extensive German

[1] Locomotive construction is covered under Gomza (chap. 10).

[2] Westwood, *op. cit.*, p. 93.

[3] Just how badly the railroads were damaged is controversial. The American Relief Administration (in a telegram to the Dept. of Commerce, U.S. State Dept. Decimal File, 316–107–853) argued, 'Railroads functioning with old employees who apparently take pride in their accomplishment. Main yards on the whole clean. . . . We have traveled entirely on regularly scheduled trains and on time in every instance except once when two hours late due to wreck on main line . . . however barring ARA supplies no freight moving and passenger traffic limited foreign relief agents, government officials, repatriated refugees and occasional troop movements.' On the other hand, Hilger (then German Relief representative) states, 'The transport system was in complete ruins and what railroad travel still continued was disturbed by repeated attacks on moving trains.' (Hilger, *op. cit.*, p. 45.)

The most probable view is that little freight was moving, many bridges were out (especially in the Don), and main lines in the north were clear because of large numbers of workers rather than 'old employees.'

technical assistance, and completed between 1922 and 1924. German trade figures for exports to Russia in 1921–2 (table 14–1) suggest how much importance was attached to this phase of Russo-German cooperation.

Table 14–1 GERMAN EXPORTS TO THE U.S.S.R. AND PROPORTION OF RAILROAD MATERIALS (IN CURRENT PAPER MARKS)

1 *Year*	*Month*	*2* *Total Exports (in millions of marks)*	*3* *Locomotives (in millions of marks)*	*4* *Other RR Material (in millions of marks)*	*5* *Proportion of RR Materials (percentage)*
1921	June	18,166 million	—	3,422	18.8
	July	64,261	—	17,390	27.1
	August	130,248	—	88,944	68.3
	September	128,704	17,255	84,607	79.1
	October	54,771	—	21,417	39.1
	November	112,678	36,667	31,743	60.1
	December	136,255	—	8,628	6.3
1922	January	43,272*	42,554*	7,797*	—
	February	6,278	—	6,278	100.0

Source: U.S. State Dept. Archives, 340–650. Column 5 calculated.
* Figures as given in source.

UNITED STATES TECHNICAL ASSISTANCE TO THE RAILROADS

Two groups of American railroad engineers investigated conditions of railroads in European Russia in the middle and end of the decade. The first group, under H. G. Kelley, former President of the Grand Trunk Railroad, made an inspection of the Ekaterina Railroad and the Donetz Railroad on behalf of Percival Farquhar, who was negotiating a large concession to run both railroads and related iron and steel plants.[4] The second investigation was made in 1930 under the supervision of Ralph Budd, of the Baltimore and Ohio Railroad. The recommendations of the Budd Report were implemented by 150 engineers from the B&O after 1930.[5]

The impulse to grant major railroads as concessions resulted from their declining ability to handle traffic, although the honeyed phrases of the Kelley

[4] H. G. Kelley, *General Report on Ekaterina Railway, Donetz Railway* (New York, 1926). A copy is at U.S. State Dept. Decimal File 316–131–744, with supplement at 316–131–872.

[5] The B&O work will be covered in Vol. II. The Russian Railway Service Corps, an American organization, and the Inter-Allied Railway Commission in Siberia did major reconstruction work between 1918 and 1922. There is extensive material on this in the U.S. State Dept. Archives. The 1,100-mile Turkman-Siberia railroad was built under the direction of an American deportee, Shatof.

report slur over the operating and physical deficiences of the systems examined. Advance data supplied by Amtorg to Farquhar gives the daily average number of loaded cars handled by the Ekaterina Railroad. Traffic declined from 3,351 cars daily in October 1925 to 3,066 in February 1926, and on the Donetz system from 4,011 daily in October 1925 to 3,911 in February 1926.[6]

Both railroads had been built well before the Revolution. In the case of Ekaterina, the report indicates date of construction of the twenty-one divisions; fifteen sections were opened for traffic before 1900, and all divisions (except the Apostolovo via Snigirevka) were open for traffic before 1910. These were well-established railroads, built to provide transportation for the tsarist-developed iron and steel plants and coal mines of the Donetz. The Ekaterina comprised over 1,600 miles of first main track, and the Donetz, 1,459. Both railroads serviced coal fields, iron ore mines, manganese mines, iron and steel works, and the Ukrainian agricultural region. They constituted the most important combined system in the U.S.S.R.

They were built according to European standards with light equipment but had always been substantial net earners. The aim of the Kelley study was to determine the cost of modernization according to American standards. The first recommendations were that train weight should be increased from 1,100 net revenue tons to 3,500 net revenue tons and that suitable locomotives and capacity should be provided for the expansion. It was pointed out by Kelley that to move the anticipated 1927–8 traffic with existing equipment would require thirty-eight trains daily, while with the proposed greater train weight only twelve daily trains would be required, 'reducing the train density . . . and making room for the steadily increasing traffic of the railway in products of agriculture, manufacturing and miscellaneous commodities.' The equipment and physical resources required to support such a system were then given in detail.

The basic objective of the report was clearly to determine the requirements for expansion. Indeed, it is clear from the report that the roads were handling far less than their prewar volume. The total train mileage operated by the Ekaterina in 1913 was more than 15 million train miles, whereas in 1924–5 (latest year given) the mileage was a little over 4.5 million, or about one quarter of the 1913 volume.

In terms of car miles or locomotive miles, the proportion was about the same.[7] Total tonnage of all classes of freight carried in 1913 on the Ekaterina was 40 million, compared to 13.5 million in 1924–5. Figures for the Donetz system are not given. It may be presumed they were less, as the physical

[6] U.S. State Dept. Decimal File, 316–131–745/6.

[7] Kelley, *op. cit.*, p. 125. Again, use of 1913 as a base is misleading. Traffic increased substantially between 1913 and 1917.

operating conditions were not as good as those for the Ekaterina. The poor condition of the bridges on both lines may well have been a contributory factor to limited operations. The Ekaterina line had 1,774 bridges less than 70 feet in length and 81 bridges greater than 70 feet in length; 245 of the former and 37 of the latter had been destroyed or damaged by the Civil War and Intervention. Considering that railroad destruction was the focal point of military activity, the damage perhaps is not as great as one might have expected. Of the smaller activity, bridges, some 206 had been rebuilt and the balance of 39 put into temporary working order. Only 23 of the 81 major bridges had been rebuilt, leaving 14 operating under temporary operating conditions. These limitations were compounded by the poor condition of the roadbed and generally inadequate maintenance.

The appendix to the Kelley report includes an estimate of the amount of repair work required to restore the bridges on both systems. This estimate, when coupled with the equipment repair backlog, suggests that a massive job would have had to be accomplished before the railroads could be put into prewar operating condition.[8]

THE BEGINNING OF RAILROAD ELECTRIFICATION

Two Soviet railroads were electrified before 1930. This was recognized as an alternative which enabled increased capacity without new line construction. The first line to be electrified was a 13-mile suburban line in Baku in 1926. It was installed under German supervision. The overhead system and rolling stock were similar to that of the Berlin high-speed, multiple-unit, side-door trains. The rolling stock was made in the Soviet Union using German patterns and models and under German supervision.[9]

The second line to be electrified was the Moscow-Mytishchi line, an eleven-mile commuter line completed in 1929. This was also of German construction and utilized imported German equipment.[10]

Complete railroad electrification came under serious consideration about 1928–9, and several engineering delegations visited Western Europe, the United States, and Mexico to study various types of electrification systems. In 1929 the People's Commissariat of Transportation selected the Suram Pass section of the Trans-Caucasian railroad as a trial section for electrification.

[8] There are numerous omissions in the Kelley report which give rise to the thought that the report, as donated to the U.S. State Dept., had been considerably doctored or censored to disguise the true state of affairs. There is, for example, an inconsistency between the buoyant, flowery accolades to Russian maintenance skill and the statistical information given in support.

[9] Ruykeyser, *op. cit.*, p. 80.

[10] Westwood, *op. cit.*, p. 41.

This was a strategic section carrying oil to Batum for export, and the system decided upon there was to be used as basis for future electrification. General Electric was chosen to develop a suitable locomotive design and to provide the first eight main line units. There had been no construction of electric locomotives in the Soviet Union up to this time, so the G.E. prototype, the 'Suram', was transferred to the Dynamo works and construction of diesel electrics based upon it.[11] The system was a 3,000-volt direct-current one with 120 metric tons locomotive weight, using a 6-axle, articulated, 2-truck design. This was 'in accordance with the exhaustive studies and recommendations of General Electric.'[12] J. N. Westwood points out that current Soviet diesel-electrics stem directly from the initial G.E. design.[13]

DEVELOPMENT OF THE RUSSIAN AUTOMOBILE INDUSTRY

Russia took an early interest in the automobile; there were more than 500 automobile taxis in Moscow before 1910. Many of the vehicles were imported; nevertheless, tsarist Russia could claim the distinction of having produced automobiles without foreign technical assistance, while the Soviets, after spending a decade, finally gave up and handed the problem over to foreign companies.[14]

The Baltic Engineering Works in Moscow was producing 250–300 automobiles annually as early as 1912 and expanded its production during the war. Mechanically the Baltic was a good automobile although more expensive than its European and American competitors.[15] The Baltic plant was completely re-equipped with American machinery early in 1917, but this effort was not completed by the time of the Bolshevik Revolution. The Soviet administration put 1,000 men to work to complete the plant. This was achieved in 1920, but the plant was abandoned later the same year.[16] Next year the Baltic was placed under Red Army management and with German assistance turned its attention to heavy military vehicles. Production in late 1922 was about two

11 *Monogram*, November 1943.

12 *Ibid.*

13 Westwood, *loc. cit.*

14 The following Russian automobiles were produced before the Bolshevik Revolution: the Leutner (1911–1915), Marck (1906–1910), Russo-Baltic (1909–1913), Sevronsky (1901–1905 and 1911–1915), and the Tansky (1901–1905). [G. R. Doyle, *The World's Automobiles, 1880–1955* (London: Temple, 1957).] The Soviets have not (in 1966) produced a completely indigenous automobile design; see Vols. II and III.

15 U.S. State Dept. Decimal File, 316–164–402.

16 Keeley, *op. cit.* Compare this to the claim that there were no automobile-manufacturing plants in prerevolutionary Russia, as stated in *Ekonomicheskaya Zhizn*, No. 46, February 25 1925.

units per month.[17] A few years later attention was turned to buses, of which there were none in Russia. By a heroic effort *one* was manufactured, 'consisting of parts nearly all made in Soviet Russia, except the frame and axle.'[18] Later in 1928–9 the Italian Fiat truck was produced at the Baltic under an agreement with the Fiat company[19] and also a few British Mark IV tanks were copied from a prototype.[20]

The new AMO automobile factory was also completed in 1917 just before the Revolution. It was located in a modern building with the latest in American equipment and was designed to employ 6,000 workers. Between 1919 and 1921 the only output was repair work on a few White trucks. For this AMO employed about 1,200, under supervision of Adams, an American deportee.[21]

The Soviets have claimed there was no automobile manufacturing in Russia before 1930, although actually they had two large, well-equipped plants intact after the Revolution. As with the Westinghouse, Citroen, Singer, and other operations, Soviet skills were not available to operate the inheritance.

The Citroen plant offers an interesting example of the dilemma in which the Communist Party found itself. The plant was allowed to operate unnationalized for some years. In 1921 the firm formally applied for release from the nationalization decree, and the response was immediate enforcement of nationalization.[22] The highest levels of the Party had been well aware of the vacuum created by the Communist takeover of industry. They allowed larger plants to operate in 'capitalist hands' until solutions presented themselves. On the other hand the workers in these plants were forced to do more work under capitalist discipline and naturally pressured for nationalization. Where this pressure was taken up by the lower ranks, implementation of the nationalization decree was forced upon the Party.

The solution to the automobile-manufacturing problem was formulated slowly. The AMO plant continued miniscule production of trucks (much less than the planned 2,000 per year). The AMO truck was unsatisfactory in quality and very expensive to produce.[23] Until the 1930s, however, it was the only one in production. Beginning in 1929, production was reorganized and upgraded as the result of a technical-assistance agreement with the A. J. Brandt Company, of the United States.

[17] *Pravda*, No. 188, August 23, 1922. Probably armored cars.

[18] Heroic, as it was reported under the title, 'Our achievement—the first Soviet bus' almost as a military victory. Which parts, if any, were actually made within the USSR. is difficult to determine.

[19] U.S. State Dept. Decimal File, 316–131–417.

[20] See chap. 15.

[21] The Keeley report *op. cit.* states that the AMO output in 1921 could have been handled by any American garage with less than 20 men.

[22] Swedish Export Association, Report, 1922. (316–107–782/3.)

[23] *Ekonomicheskaya Zhizn*, No. 134, June 1, 1925.

The first tentative steps in the direction of a mass production automobile industry had been taken in 1925. A large-scale motor-vehicle driving contest was instituted to 'ascertain the types of automobiles, motor trucks, and motorcycles best suited to Russian conditions.'[24] The total stock of automobiles in the U.S.S.R. at this time was less than 16,000, of which only 10,000 were running,[25] so it is not surprising that endurance, mileage, and acceleration were tested, among other characteristics. Participants were 169 vehicles, one of each current make, including 82 passenger cars, 48 trucks, 21 special vehicles (fire engines, etc.) and 18 motorcycles. Among the entrants were all European and American models of note; if the manufacturer did not enter voluntarily (which was the case with most American producers), a vehicle was purchased by Amtorg and entered involuntarily.[26] AMO entered a truck, but this was assembled from imported parts not of Russian manufacture. The record does not show whether it completed any of the tests.[27]

The Contest Committee evaluated the results and published a report of its findings. *Ekonomicheskaya Zhizn* reported these and carried an interview with Z. T. Litvin-Sedoy, Chairman of the Committee.[28] He pointed out that both American and European manufacturing had undergone fundamental changes since the war, in both methods of construction and techniques. (He was referring to mass-production techniques, substitution of metal for wood in automobile coachwork, and the use of improved alloy steels.) It was pointed out that prewar reputations did not necessarily apply in 1925, except in the case of Mercedes, which maintained its 'excellent' reputation. The report was critical of American automobiles, but less critical of American trucks. It feared the latter could dominate the market because of their low cost, but the high fuel consumption, unknown composition of materials used, and the difficulty of acquiring spare parts were held to be serious objections. It is interesting to note, in the light of subsequent agreements, that the Ford entry failed and that, despite its low price, it was held to be very expensive in operation.[29]

Negotiations with the Ford Motor Company began in January 1926, and one immediate result was that International General Motors sent its Baltic representative, T. E. Eybye, to explore possibilities for General Motors business. Eybye was decidedly negative; he reported that he felt prospects

[24] *Ekonomicheskaya Zhizn*, No. 46, February 25, 1925.
[25] *Ibid.*
[26] U.S. Consulate in Riga, Report 3254, October 2, 1925.
[27] *Ekonomicheskaya Zhizn*, various issues for early 1925.
[28] *Ekonomicheskaya Zhizn*, No. 216, September 22, 1925.
[29] U.S. Consulate in Riga, Dispatch 3516, January 12, 1926 and Dispatch 3851, June 16, 1926.

were slight and that it was inopportune for G.M. to establish itself in the Soviet Union.[30]

The first version of the Five-Year Plan, drawn up in 1927, made provision for production of only 3,500 autos per year. This small output was vigorously assailed by V. V. Ossinsky, Director of the Central Statistical Administration, on the grounds that the U.S.S.R. was 'catastrophically backward' in automobile production, and that on both economic and military grounds there were insurmountable arguments for the establishment of a plant capable of producing 100,000 automobiles per year.[31]

In the fall of 1928, the 'activization of concessions' policy failed to produce foreign bidders to erect an automobile plant in the Soviet Union. Subsequently the Soviets incorporated their plans into the Five-Year Plan. In 1928 Ossinsky was sent to the United States to negotiate with Ford, General Motors, Durand, and Studebaker. Ford was the most promising as a supplier of automotive experience and equipment required. Negotiations moved along three separate lines: (1) American ownership and operation on a concession basis, (2) a mixed company, and (3) Soviet ownership and operation with technical assistance and financial help from the United States.

Ossinsky was followed to the United States by Meshlauk, of Vesenkha, who conducted final negotiations with both General Motors and Ford. A psychological ploy was added in the Soviet press when the Soviets suddenly announced their intention to build an automobile plant 'with their own resources' capable of producing 100,000 cars per year. Gipromez and Glavmashstroi were directed to produce plans and work out a manufacturing schedule 'within two weeks'—an absurd proposal.[32]

THE SOVIET AUTOMOBILE INDUSTRY AND HENRY FORD

On May 31, 1929, V. I. Meshlauk, a member of the Presidium of the Supreme Soviet, and Saul G. Bron, President of Amtorg, signed an agreement with the Ford Motor Company under which the Soviets contracted to purchase $30 million worth of automobiles and parts before 1933 and the Ford Motor Company agreed to furnish technical assistance until 1938 in the construction

[30] *Ibid.*

[31] V. V. Ossinsky, 'The American Automobile or the Russian Peasant Cart', *Pravda* (Moscow), Nos. 162, 163, and 194, of July 20, 21, and 22, 1927, states: 'If in a future war we use the Russian peasant cart against the American or European automobile, the result to say the least will be disproportionately heavy losses, the inevitable consequences of technical weakness. This is certainly not industrialized defense."

[32] 'Towards New Victories on the Industrialization Front,' *Torgovo i promyshlennaya Gazeta*, No. 53, March 5, 1929.

of an automobile-manufacturing plant at Nizhni-Novgorod. The plant, to be completed by 1933, was to produce the Model A (called by the Soviets Gaz-A), the Ford light truck (Gaz-AA), and the heavy truck (AMO-3). All Ford patents were placed at the disposal of Gipromez, and Ford engineers rendered technical assistance in the introduction of Ford manufacturing methods. Soviet engineers were given facilities to study Ford methods at the River Rouge plant in Detroit.

The Ford plan adopted included a schedule which potentially gave the Soviets their 100,000 automobiles per year:

		Proposed total output	*Percent imported*
1st year	1929–30	6,000	100 percent
2nd year	1930–31	24,000	100
3rd year	1931–32	48,000	50
4th year	1932–33	96,000–100,000	25

The first year's schedule covered manufacture of bodies, fenders, hoods, and all sheet metal work in the new Austin-designed plant at Nizhni-Novgorod, while assembly of complete vehicles was located at the temporary plant. The second year's schedule extended this program to cover the manufacture of fittings. The third year added engine production, by which time it was planned that the technical-assistance contract with the Brown Lipe Gear Company would have developed gear-cutting technology. The fourth year phased in rear and front axles made in the Soviet Union with the assistance of the Timken-Detroit Axle Company. This last year phased in domestic production of all instruments, batteries, and electrical equipment imported up to that time from Detroit.[33] Raw materials and semi-manufactured inputs were concurrently developed to phase into the above schedule. The plan included, for example, the manufacture of automobile-quality steels at Prioksky, Sormovo, and Vyhksunsk, and at the Novosormovo foundry. Glass was to be developed at Sormovo.

The development and learning process noted previously in this study is repeated. The first stage involved assembling automobiles manufactured abroad and imported as parts. For this purpose Ford converted an unused railroad shop at Lublin. This had the capacity to assemble 10,000–12,000 vehicles per year and was, of course, a training ground while the main plant was under construction. Production was transferred in stages to the new plant and imported parts gradually cut off. By 1934 all parts were being supplied internally, although many were of indifferent quality. In the late 1930s, Ford

[33] *Pravda*, No. 128, June 7, 1929; and Sorenson, *op. cit.*, chap. 15.

obtained one of the Nizhni-Novogorod Model A (Gaz A) automobiles which had been exported by the Soviets to Turkey. It was shipped to Detroit and there pulled to pieces; Sorenson comments 'it was a pretty poor reproduction of Model A.'[34] The Ford was still in production in the late 1930s and by 1938 production was 84,000 units per year.[35]

The automobile industry is, then, an excellent example of a planned step-by-step transfer of Western technology at minimal cost. Ford was happy to sell $30 million worth of parts and throw in invaluable technical assistance for nothing. Technical assistance in production of axles, tires, bearings, and other items required payment but, as the marginal cost to American companies was slight, the Soviets reaped a gigantic harvest of technological knowhow for almost no outlay.

Table 14-2 TECHNICAL ASSISTANCE CONTRACTS (TYPE III) IN THE SOVIET AUTOMOBILE CONSTRUCTION INDUSTRY TO 1930

Western company	*Soviet trust*	*Nature of technical assistance*
A. J. Brandt Company	Avtotrest	Reconstruction of AMO truck plant
Brown Lipe Gear Co.	Avtotrest	Geat-cutting technology
Ford Motor Co.	Avtotrest	Nizhni-Novgorod and Moscow plants
Hercules Motor Co.	Avtotrest	Truck engines for AMO plant
C. F. Seabrook Co.		Technical assistance on road building
Seiberling Rubber Co.	Resinotrest	Construction of tire plant
Timken-Detroit Axle Co.	Avtotrest	Axle and bearing technology
Austin & Co.	Glavmashstroi	Construction and design

Sources: Soviet Union Year Book, 1930, pp. 357–9.
U.S. State Dept. Archives.

As the Ford agreement was being signed in June 1929, another was being negotiated with Arthur J. Brandt for assistance in reorganizing the AMO truck plant. Preliminary technical work for the reorganization was undertaken in the Detroit office and works of Brandt, while American engineers were sent to the AMO works to investigate production conditions. Facilities were upgraded to produce 25,000 of the Ford 2½-ton truck (AMO-3), whereas previously only a few hundred a year had been produced.[36] In the following September, ten AMO engineers went to Detroit for training.[37]

One month after the signing of the Ford agreement, the Austin Company made a construction proposal to Glavmashstroi under which it guaranteed

[34] Sorenson, *loc. cit.*

[35] Report by Oberkommando der Wehrmacht, (OKW/Wi Rü Amt/Wi), March 1941. Miscellaneous German records, T 84–122.

[36] *Torgovo-Promyshlennaya Gazeta*, No. 127, June 6, 1929.

[37] *Ekonomicheskaya Zhizn*, No. 149, July 2, 1929.

to complete the Nizhni-Novgorod plant within fifteen months of conclusion of a definite contract. Austin had built the Ford and other automobile plants in the United States and had ample construction and engineering experience in this field.[38]

The contract was signed early in August; the Austin Company paid $250,000 for drafting the project and a special compensation for supervising construction and installation of equipment. Penalty clauses came into effect if costs were higher than estimated, and there was a bonus for completion at less than the estimated cost. Five engineers were delegated from Avtostroi to work with Austin in drafting the project. Austin was able to negotiate a 'cost plus' contract for supervisory operations, and compensation was calculated, as a percentage of the total cost of all building operations, including equipment, boiler room, foundry, and power station.[39]

Although these plants were built completely by Western enterprise and equipped and initially operated by Western firms, the myth has been perpetuated that these were designed, built, and run by the Soviets. Even large Western suppliers unwittingly reflect this belief. For example, the General Electric house organ, *The Monogram*, comments on the automobile-manufacturing units just described:

> When the Soviet Union built its mass production automobile and truck plants in Moscow and Gorki, where the *Ziz* and *Gaz* cars and trucks take shape on moving conveyors, General Electric, in addition to supplying hundreds of motors and controls for various high speed and special machine tools, also supplied especially designed electric apparatus to aid the mass production of vital parts. . . . For the mass production of drive shafts and rear axle housings for the *Gaz* cars and trucks General Electric designed and built special high speed arc welding machines to suit the exact requirements set down by the Soviet Engineering Commission.[40]

TELEGRAPH COMMUNICATIONS AND FOREIGN CONCESSIONS

In August 1921, a contract was signed with Det Store Nordiske Telgraselskab (the Great Northern Telegraph Association) of Denmark for the operation of telegraph lines between the Soviet Union and the Far East and all interconnections with foreign countries. A fee of 1 franc 20 centimes was payable to the Soviet Union for each word transmitted. The firm had to undertake repairs, keep the line in order, and install new apparatus capable of transmit-

[38] *Torgovo-Promyshlennaya Gazeta*, No. 169, July 26, 1929; and No. 253, November 1, 1929.
[39] *Ekonomicheskaya Zhizn*, No. 185, August 14, 1929.
[40] *Monogram*, November 1943.

ting 110 words per minute; the existing apparatus could transmit only 20 words per minute.[41]

Before the First World War the Indo-European Telegraph Company of London operated telephone and telegraph lines across central Europe, through Poland and Russia to Odessa, and through the Crimea to Persia, in addition to a cable line under the Black Sea from Odessa to Constantinople. Service was discontinued during the war. On April 12, 1922, the company signed a concession agreement with the Department of Posts and Telegraphs and again took over control of its lines through the Soviet Union. The lines appear to have been in a reasonably satisfactory condition, and workable for 200 miles northwest and 300 miles southeast of Odessa, into the Crimea. The underwater cable was also in good condition. Only a short section between Erevan and Tiflis required minor repairs.[42]

Three years later, in June 1926, a similar concession agreement was concluded between the Trans-Siberian Cables Company, a subsidiary of Great Northern, for the renewed operation of its overland cable to China. The company paid the Soviets one gold franc for each word transmitted along the line.[43]

The necessity for these concessions is rather obscure. The lines were operating when the concessions were granted. In 1913 the Indo-European cable to Persia carried one million words. This fell to 800,000 words in 1920 but was up to four million in 1923 and five million by 1926, when the concession was concluded.

It was reported in *Krasnya Gazeta* that the telegraph concessions would be of enormous advantage; without them Russia would be unable to connect to the European lines, and in any event the existant lines would be repaired and modernized. In addition to the word fee in gold the latest high-speed Western apparatus would be introduced. This would produce 'millions of francs in gold which will enable us to carry on trade with abroad.'[44] It appears in retrospect that existant traffic was straining the lines to capacity and that the concession was a device to get equipment modernization.

THE RADIO CORPORATION OF AMERICA TECHNICAL ASSISTANCE AGREEMENT

In March 1926, General Harbord, president of RCA, requested advice from the State Department concerning a Soviet request to have RCA build a modern high-power radio station in Moscow capable of communication with

[41] U.S. Consulate in Riga, Report 1199, September 3, 1921. (316–107–29.)

[42] Minutes of proceedings of the 55th Ordinary General Meeting of the Indo-European Telegraph Company, Ltd., April 26, 1922, pp. 4–5.

[43] U.S. Consulate in Riga Report 3820, June 5, 1926.

[44] U.S. Consulate in Riga, September 5, 1921.

the United States. RCA was concerned, 'as it would . . . undoubtedly afford an opportunity for their peculiar governmental doctrines to get additional circulation in this country,' and consequently: 'a station built by us, and perhaps subsidized by credit facilities, enabling Russia freely to communicate with the United States, might be a liability to us with the American public.'

In later verbal discussions with the State Department, General Harbord appears to have been hesitant concerning the Russian proposition, as it would mean 'placing in the hands of Soviet Russia uncensored and untrammeled direct means of communication between Soviet Russia and the United States over which they could send messages of any kind, including propaganda.'[45]

It was then reported that the radio station in question would cost an estimated $2.5 million and that the Soviets did not have a powerful enough station for communication with the United States. A memorandum in the Far Eastern Division files argues that the question of utilizing the station for propaganda purposes or directing subversive activities in the United States was more theoretical than practical.[46] On April 9, 1926, the State Department sent a letter to RCA indicating that the Department did not desire to express any opinion concerning the proposed transaction.

The matter then lapsed until 1927. Another letter, dated May 25, 1927, from General Harbord to the State Department, indicates that RCA anticipated further negotiations for a 'modern, high powered radio station capable of communication with the United States.' Harbord requested an indication as to whether the letter of April 9, 1926 still held good in the light of Soviet propaganda 'being promulgated from Soviet offices in London directed against the United States and other countries and that evidence

[45] Documents in this section are in the U.S. State Dept. Decimal File 316-141-714/78. The first part of Roll 141 contains material on Soviet propaganda and other communications with the Near and Far East. At this stage of the negotiations, the State Dept. view was that 'completion of the station in question would put into the hands of the Soviet regime a very powerful instrument which might be used to the detriment of the interest of the United States.' See Memorandum, Johnson, Far East Division, March 1, 1926 (316-141-714). This view was to change considerably over the next few years, for reasons which are not clear.

[46] There are however, hundreds upon hundreds of documents in the State Dept. files alone indicating this was very much a practical matter. The exact wording of part of the memorandum is, 'I am inclined to the opinion that the theoretical possibilities are not of such cogency as to justify our according to them a decisive influence in this matter.'

The draft of the State Dept. letter to Harbord is also interesting. The draft prepared by R. F. Kelley makes reference to the possibility that the station might be used for subversive activities in the United States, but this was scratched out and does not appear in the letter that went to RCA. The erased paragraph reads 'With regard to the possibility of the utilization of the wireless station by the Soviet regime to facilitate the direction of communist subversive activities in the United States, I am not prepared at this time to make any comments. I note from your letter that you realize both the possibility and undesirability of such utilization.' The final letter went out over the signature of Kellogg, Secretary of State.

thereof had been furnished to our government.' The State Department reply of June 1 indicated that their position remained the same.

RCA made an agreement with the State Electro-technical Trust on June 30, 1927. This covered the transfer of patents and technical information. In addition, RCA furnished the delegation with tenders and quotations on a considerable quantity of radio apparatus, including a high-powered radio installation for Moscow. These amounts quoted were to be paid 70 percent cash, with the balance due over a period of five years at 6 percent. RCA agreed '. . . to grant exclusive licenses to the Trust to manufacture, use and sell all patents, applications for patents and inventions owned or controlled by the Radio Corporation of America and/or the General Electric Company and Westinghouse, to the extent that it has, or will have, the right to grant licenses in and for the territory for the Trust as hereinabove provided for. . . .'[47]

It was agreed that meetings of RCA engineers and those of the Soviet trusts would be held not less than once a year, and alternately in their respective territory, in order to exchange necessary technical information.

In addition, RCA agreed 'to furnish to the Trust complete manufacturing information in respect to terminal apparatus for use in radio picture transmission, including facsimile transmission, but not including television.' Manufacturing information was supplied for terminal apparatus, including 'complete specifications, working drawings, description of process of manufacturing, detailed basic calculations for construction of apparatus and the privilege of sending the representatives of the Trust to factories, laboratories and working stations of the Radio Corporation and General Electric Company or parts owned and controlled by them.'[48]

The agreement was made contingent on Amtorg placing a firm order with RCA within four months of the date of ratification for a minimum sum of $600,000.[49] In brief, in exchange for an order valued at $600,000, RCA transferred the sum of the technical knowledge accumulated by the leading firm in the industry.

GERMAN AID FOR RECONSTRUCTION OF PETROGRAD HARBOR

This was the largest port in Russia. Its facilities were severely damaged in the Revolution—probably more so than any other sector of the economy. As late as December 1921, most of the port was still out of commission.

[47] *Ibid.*, Frame 749.

[48] *Ibid.*, Frame 760.

[49] There was also a traffic agreement covering the use of radio circuits between the U.S. and the U.S.S.R. and the supply of high-speed automatic and duplex com-

Of eight cranes, two were continually out of order, two intermittently out of order, and two unusable. The telephone system of the port could not be repaired, 'on account of lack of cable, wire, and commutators.'[60] The harbor itself, although it was the main base of the Red Navy, was not freed of mines until 1922. The harbor was not dredged from 1917 until 1923. German and British steamers calling at the port in 1921 were serviced by lighters when these were available. Although the port was a high-priority project for repair and a port telephone system was an essential part of that operation, *Krasnya Gazeta* admitted five years after the Revolution that nothing had been done.[61]

In 1922, tenders were received from German companies for repair of the port and the city facilities of Petrograd. Friedlam A-G handled the technical work of the restoration of harbor facilities, while the actual reconstruction was done by Julius Berger. Gas-works design was undertaken by Pintsch and construction also by Berger. Canals, general buildings, and cement works became the responsibility of Hecker, another German firm.[62] The city itself was the subject of another agreement 'to make the necessary repairs to all buildings that are now falling to pieces (and to) repair railways, the water and sewage systems, and other institutions belonging to the municipality.' German engineers and equipment were brought in as the navigation system opened in 1922. As payment, the Germans received the right to develop the clay industry, establish a brick plant and export lumber to Germany.[63]

By late 1922, Petrograd Harbor was being cleared of debris and put back into operation. Groups of the unemployed were used for this job, together with Latvian Communist Party members.[64] Repairs to the ice breakers went more slowly. The only unit fit for service was named the Lenin; the Svyatogor and the Ermak required extensive work.

RECONSTRUCTION OF THE RUSSIAN SHIPBUILDING INDUSTRY

The shipbuilding yards at Petrograd and Nikolaev had been heavily damaged in the Revolution. Nearly all such facilities were in a chaotic condition; this

mercial radio communications apparatus. The agreement, together with letters from the International General Electric Co. and Westinghouse Electric International releasing patent rights in favor of the Soviet trusts, may be found in the U.S. State Dept. Decimal File 316–141–757/771.

60 *Krasnya Gazeta*, December 29, 1921.

61 U.S. Consulate in Helsingfors, Report 2110, May 15, 1922. (316–107–765.)

62 U.S. Consulate in Helsingfors, Report 135, August 21, 1922. (340–5–547/9.)

63 U.S. Consulate in Helsingfors, Report 2230, April 29, 1922 (316–107–752); *New York Times*, April 28, 1922, p. 2, col. 7.

64 IS Report, September 21, 1922. (316–10–1018.)

sector suffered more than most. The Petrograd yards, previously known as Nevsky (renamed the Lenin), Putilov (renamed Northern Shipbuilding), the Baltic, the Izhorsky, and the Ochtinsky (renamed the Government Works for River Ships), were grouped into the Sudotrust. In 1924, a technical commission was appointed to consider ways and estimate the costs of clearing the Petrograd yards. The commission had a number of German members, and the Krupp engineer Ledeke did the actual job of estimating costs of repairs. This was a military matter under the Northwestern Military Industry Committee and part of the post-Rapallo military cooperation agreement. The preliminary inspection of the Izhorsky yards, the largest, indicated that only nine of the seventeen workshops were in operable condition; the others needed complete rebuilding. Of four shipbuilding stocks, only the third could be used for ship construction and then only if the associated workshops were also put back into operation. Ledeke also estimated the cost of installing a submarine department in the yards. The Krasny Putilovets plant was inspected to estimate cost of installing turbine construction facilities for class 1 destroyers.[55]

Reconstruction of the Russian merchant fleet was slow. In 1925 the hulls of 11 vessels were laid, in 1926 a further four and in 1928 another 17. By May 1929 only 15 had been completed and 30 were still under construction.[56] No oceangoing ships were completed before 1930, except three 6,000-ton-gross motor ships with engines made with German technical assistance. At the same time two larger tankers, of 11,500 tons gross, were under construction in French shipyards with imported Sulzer engines. Somewhat larger vessels, of 9,000 to 11,000 tons gross, were undertaken at Soviet yards, at first with imported Sulzer engines and then with engines made with foreign technical assistance.[57] Again, the simple was built, while the complicated was purchased. Interestingly enough, the graduated process is still going on. In the 1960s Soviet yards were making all Soviet naval craft and tankers up to about 35,000 tons. Larger tankers were made to Soviet order in Italy and Japan and other special ships in British and Danish yards. Naval craft have always been constructed in Soviet yards, with the use of imported shipbuilding equipment, except for the World War II acquisitions noted in Volume II.

FOREIGN AID IN SHIPPING OPERATIONS

The first of a series of shipping agreements was made in January 1922 between the German Orient Line, the Soviet Volunteer Fleet, and Narkomvneshtorg (People's Commissariat of Foreign Trade). Under this agreement, the

[55] U.S. Consulate at Hamburg, Report No. 417, December 12, 1925.

[56] *Izvestia*, May 12, 1929.

[57] Details from *Motor Ship Reference Book* (London, Temple Press) years 1925 to 1930.

tonnage of the Orient line was handed over to the Soviet Volunteer Fleet on preferential rate terms (20 percent lower that market rates). This enabled the fleet to establish a service between Hamburg and Odessa, Novorossisk, and Constantinople.[58]

Russtransit was a German-Russian joint-stock mixed company also organized in 1922, between the Commissariat of Foreign Trade, Ways, and Communications, and a group of five German firms, including the Orient Bank, Wenkhouse of Hamburg, and the Hamburg-Amerika line. The company established shipping routes between Germany and the Near East via the Baltic, the Marinsky canal system, the River Volga, and the Caspian Sea. This reduced the shipping time between Hamburg and Enzeli on the Caspian from a period of 4–6 months to only 3–4 weeks. Russtransit purchased several 10,000-ton vessels to operate on the river, canal, and lake routes.[59] In 1923 the turnover was 1.2 million rubles, on which the profit was 200,000 rubles.[60] The Hamburg-Amerika line put up 50 percent of the capital and received 50 percent of the profits.[61]

There were also some smaller shipping concessions. The Bergen Steamship Company was organized by the Soviets and the Russian-Norwegian Navigation Company in 1923 to provide shipping services for Arcos.[62] Another agreement was made with a German company, August Bolton, in 1924, and in April 1926 negotiations were concluded for a shipping concession on the River Volga to be operated by an Anglo-Dutch group headed by the Cunard line.[63] This was a mixed company, with the share capital split 50:50, to operate all passenger and freight services on the Volga. All boats, docks, workshops, and stores were transferred to the new company. Cunard was required to invest cash equal to the value of the boats and plant turned over to the company. The latter formed the Soviet contribution. The management was exclusively in the hands of Cunard, which had the right to hire and dismiss personnel. The Soviet government was not entitled by the terms of the agreement to interfere in the internal operations of the company.[64]

Shipping tonnage was almost completely destroyed by the Revolution, and even in 1930 only 4 percent of Soviet trade was being handled in Soviet flag vessels. The mercantile fleet was gradually built up by purchases abroad and not in the 1920s by domestic production of ships.

58 IS Report, January 19, 1922. (316–108–0006.)
59 *Ekonomicheskaya Zhizn*, No. 116, May 27, 1923.
60 *Ekonomicheskaya Zhizn*, No. 151, April 3, 1924.
61 Hilger, *op. cit.*, p. 178. Hamburg-Amerika Line also owned 50 percent of Derutra (German-Russian Transport Company), another mixed Type II operation.
62 *Ekonomicheskaya Zhizn*, No. 57, March 15, 1923.
63 *Pravda*, No. 175, August 3, 1924.
64 U.S. Consulate in Bremen, Report April 1, 1926. (316–108–1668.)

THE BEGINNINGS OF THE RUSSIAN AIR LINES

The first Russian air line was the Moscow-Konigsberg (Germany) route, started in August 1922 and, according to *Biednota*, 'created according to the plan of Red Pilot Grant and exploited exclusively by the RSFSR.'[65] In fact the line was installed and operated by the mixed company, Deruluft (German-Russian Aviation Company), and used German and Dutch (Fokker III) aircraft. Deruluft was formed specifically to conduct a regular air service for passengers, mail, and freight between Germany and Moscow. It had a stormy life and, as Hilger points out, the line survived only 'because of mutual necessity.'[66]

Dobrolet, an all-Russian company, was started one year later with German technical assistance. This company used Junkers aircraft, made in the U.S.S.R., throughout the 1920s. The third airline was Ukr-Vozdukh-Put, a private company formed in the 1920s and operated on Ukrainian routes up to 1929. The company used Dornier Comet II and III aircraft.[67]

Table 14–3 RUSSIAN SCHEDULED AIRLINES IN 1925

Route	*Operating company*	*Equipment*
Moscow-Konigsberg	Deruluft*	Fokker III
Moscow-Kharkov	Ukr-Vozdukh-Put**	Dornier Comet III
Kharkov-Rostow	Ukr-Vozdukh-Put**	Dornier Comet III
Kharkov-Odessa	Ukr-Vozdukh-Put**	Dornier Comet III
Kharkov-Kiev	Ukr-Vozdukh-Put**	Dornier Comet II
Kagan-Tazbaz	Dobrolet***	Junkers
Kagan-Dushambe	Dobrolet***	Junkers
Baku-Enzeli (Persia)	Junkers****	Junkers
Baku-Leningrad	Junkers****	Junkers

Source: U.S. State Dept. Decimal File, 316–164–244, 372.
Notes: *Type II concession.
**Private company, expropriated in 1929.
***All-Russian company.
****German company.

In addition to the three regular airlines, the Junkers company operated some routes with its own equipment under a leasing arrangement. By the middle of the decade, the air fleet consisted of just under 100 passenger planes (Junkers, Dorniers, and Fokkers) together with another 50–80 light planes.[68] The first Soviet-built planes, copies of the British De Havilland observation

[65] *Biednota*, August 26, 1922.
[66] Hilger, *op. cit.*, p. 178
[67] U.S. State Dept. Decimal File, 316–164–205.
[68] U.S. State Dept. Decimal File, 316–164–225.

plane, were produced in 1925 and at once used on a Moscow-Peking propaganda air expedition. The expedition was billed as using all-Russian-built planes, whereas in fact it used modified Junkers and De Havilland copies with imported engines.[69]

[69] U.S. State Dept. Decimal File, 316-164-391.

CHAPTER FIFTEEN

German-Russian Military Cooperation and Technology

THE Versailles Treaty forbade Germany, equipped with some of the most extensive and advanced munitions plants in Europe, the manufacture of any armaments. Soviet Russia was isolated and under attack from within and without. Her armaments plants operated only intermittently, and she had a pressing desire to expand military production for internal control and world revolution. The obvious came to pass. The German-Russian military cooperation of the 1920s and 1930s has been documented elsewhere.[1] One aspect of this transfer has, however, been missed. The military transfer was part of a much wider economic cooperation and included the reconstruction of Russian industry as well as purely military construction. It is the industrial aspects of the military cooperation which are of interest to this study.

In April 1921, Menshevik Victor Kopp reported to Trotsky concerning his trip to Germany. Kopp had visited the armaments plants of Krupp, Blohm und Voss, and Albatross Werke and found them ready to supply both equipment and technical assistance for the manufacture of war materials. Post-Rapallo negotiations widened this visit into full-blown cooperation on the economic aspects of military production.[2] Purely military production was placed under the control of Gesellschaft zur Förderung Gewerblicher Unternehmungen (or GEFU) with a capital of 75 million reichmarks.[3] This

[1] The most detailed study is in C. F. Melville, *The Russian Face of Germany* (London: Wishart Co., 1932). A more recent book by J. W. Wheeler-Bennett, *The Nemesis of Power* (New York; St. Martin's Press, 1964), is a useful supplement. Gustav Hilger and Alfred G. Meyer, *The Incompatible Allies* (New York; Macmillan, 1953), is less than forthright. Hilger was German economic attaché in Moscow throughout this period but reduces the cooperation to 'scholars and journalists with axes to grind.' (Fn., p. 189.)

[2] Trotsky Archives, Harvard University, Document T-666*.

[3] Hilger, *op. cit.*, GEFU functions after 1925 were taken over by WIKO (Wirtschaftskontor).

production included reopening the Junkers aircraft plant at Fili, developing poison gas plants, establishing factories for production of artillery and shells, tanks, and submarines. Further, the Soviets themselves placed heavy emphasis on military production and grouped many of the best-equipped tsarist works as a part of RVS, including the Putilovets, Koppel, Lessner, Phoenix, Atlas, and Pneumatic plants.[4]

TSARIST AND JUNKERS AIRCRAFT TECHNOLOGY

Aircraft development and construction had made vigorous progress in tsarist Russia under such designers as Igor Sikorsky and V. Slessarev, but the industry collapsed completely after the Bolshevik Revolution. There was no indigenous Soviet aircraft technology in the 1920s and the ill-fated 'Maxim Gorki,' designed in 1934, was the first indication of a revival in a truly remarkable prerevolutionary activity.[5]

Igor Sikorsky (since the Revolution a resident in the United States) had been the nucleus of a promising aircraft technology. In 1913 he designed and built two planes of *four-engine design*. The first was the Russki Vityazyi, a five-ton aircraft with room for seven passengers, built in St Petersburg; the second Sikorsky design was the 'Ilya Mourometz', with four 100-h.p. engines, a payload capacity of 1,500 kilograms, and a maximum speed of 55 m.p.h. Lack of more powerful engines was the impetus behind the four-engine design; a similar restriction made the 'Maxim Gorki' an eight-engine (750 h.p. each) plane rather than the originally planned six-engine (1,000 h.p.) plane.

The four-engine Ilya Mourometz was built in Russia as a bomber, and about 75 went into service in World War I. Wing span was 102 feet: only 21 inches less than the Boeing B-17 of World War II. Engines were a restricting factor, and 11 different makes were used including the Russian-built Baltic. Production of these planes was in fact limited by engine production.[6]

This interest in aviation was adopted by the Soviets. After World War I the German aircraft manufacturers Junkers, Dornier, and Rohrbach were forced, under the 'London ultimatum' to move their plants and personnel abroad. Junkers-Werke went to the U.S.S.R. and, under the April 1922

[4] U.S. State Dept. Decimal File, 316–107–391.

[5] Interest in aviation developed early in Russia. Curtiss made a trip in 1912 and estimated over 100 aircraft in use by the Imperial Russian Army at a Sevastopol base. When the United States entered the war in 1917, its combined Army and Navy air forces consisted of little more than 100 planes. ['Aviation in South Russia, 1912'. (316–164–170).]

[6] *Ibid.*, and H. Hooftman, *Russian Aircraft* (Fallbrook: Aero, 1965), pp. 142–3.

military agreement reopened the prerevolutionary aircraft plant at Fili in mid-1923. Machinery was obtained from the evacuated section of the Russo-Baltic works in Riga and installed at Fili by Junkers engineers. In the tsarist era, the plant had made RB-150 h.p. motors for the Ilya Mourometz. Under Junkers management the plant built Mercedes-Benz motors under license and the all-metal Junkers-design aircraft.[7]

Thus the famous all-metal Junkers aircraft was under construction in the Soviet Union some ten years before Lockheed and Douglas brought out their first all-metal designs in 1933. The Soviets can legitimately claim that the first all-metal plane was produced in the U.S.S.R.

Even before Junkers had moved, the Soviets were buying aircraft engines, Deutz Type UMX and complete aircraft abroad. Some 280 Fokker D-7 fighter aircraft were ordered and delivered from Holland.[8] In July 1924, the Junkers Company opened up a second aircraft plant in Tver Province under a 49-year concession arrangement, with the right to export airplanes. All the test pilots and engineers were Junkers personnel from Germany.[9]

By 1924 the Soviets began to make their own wooden aircraft, one year before the first Russian bus was produced. At first they purchased Fokker drawings, the De Havilland prototype, and imported engines. They then used engines domestically manufactured with German (Deutz A-G) technical assistance. Machine tools for the aircraft plants were supplied by Nielsen and Winther in Denmark.[10] Spruce for building the wings and fuselage was imported from the state of Washington—which in itself created a small stir in Washington, D.C.[11] The most successful of these early afforts was the copy of the De Havilland Tiger Moth, still in use in 1966 and variously called the R-1, U-2, and today the PO-2. Up to 1948, when production ceased, several thousand had been produced in about 20 versions. It was first used as a military observation plane, then as a night bomber in World War II, and is presently used as an ambulance plane and crop duster. Production of simple planes such the Tiger Moth R-1 before automobiles is not illogical. Construction of such a plane is a very simple matter involving wood and canvas, and is much less complex than automobile production. Utilizing first imported engines and then engines made with German technical assistance, the Soviets trained their cadres of aircraft engineers and technicians.

[7] IS Report, August 17, 1923. (316–108–641/2.)

[8] U.S. State Dept. Decimal File, 316–164–193.

[9] U.S. State Dept. Decimal File, 316–164–215.

[10] U.S. State Dept. Decimal File, 316–164–208.

[11] Telegram from Governor Hart of Washington to the President, January 24, 1923. (336–129–332.)

German technical assistance, supplemented by assistance from other countries, was quite extensive. Barmine recounts how, because of the large-scale purchases of aircraft equipment and components in Europe, the aircraft manufacturers signed technical-aid contracts, trained Russian engineers and sent their specialists and designers to the U.S.S.R. to build and equip aircraft plants. Barmine singles out the French aircraft industry to 'share with the American the credit of helping the U.S.S.R. to build its air power.'[12] Technical assistance in the manufacture of aircraft parachutes, and particularly the packing techniques, was provided by Irving Air Chute Co., Inc., of the United States.[13]

Numerous efforts, some successful, were made to obtain American aircraft engines and, especially, large quantities of the war surplus Liberties available in the domestic United States market at $1,000 each. The latest Curtiss engines were also secured.

In the early 1920s, the Hall Scott Motor Company sold a large lot of aeronautical equipment to the Vimalert Company of New Jersey; this found its way to the Soviet Union.[14] In late 1925 some thirty cases of aircraft engines were shipped by Amtorg to Autoimport in Moscow. These were assumed by the State Department to be Liberty engines, not automobile engines, as they were purchased by Zautinsky, the aviation purchasing agent for the Soviet Union and shipped from Little Rock, Arkansas, where the large quantities of surplus Liberty engines were stored and sold.[15] This shipment was followed by another thirty-three Liberty engines on May 6, 1926 via the Hamburg-Amerika Line to Leningrad. These had been purchased by Zautinsky in a very roundabout manner. They were originally sold to the Leoning Aircraft Company, resold to Ayers Airco, then to a dealer named Epstein and another dealer named Kelly.[16]

Table 15-1 SOVIET PURCHASES OF AMERICAN AIRCRAFT ENGINES, 1926-9

Date	*Number shipped*	*Type and make*
Nov 8, 1925	30	Liberty 400 h.p.
May 6, 1926	33	Liberty 400 h.p.
Dec 27, 1929	10	Curtis Conqueror

Source: U.S. State Dept. Decimal File, 316-164-267, 164-289, 164-317.

12 Barmine, *op. cit.*, p. 179.
13 A. A. Santalov and L. Segal, *Soviet Union Year Book, 1930* (London: Allen and Unwin, 1930), p. 358.
14 U.S. State Dept. Decimal File, 316-164-250.
15 *Ibid.*
16 U.S. State Dept. Decimal File, 316-164-250.

These comparatively small purchases were followed by very intensive efforts to obtain a larger quantity of the Liberty motors, if possible at the low price of $1,000. However, it was reported that the Soviets were willing to pay up to $10,000 per motor and give a bonus to anyone able to acquire a substantial quantity at an export price of $2,000.[17] One effort to buy a batch of 200 was made by the Payne Export and Import Company of New York in August 1927. The State Department indicated it did not look with favor upon the transaction. Payne later tried to buy through the Vimalert Company. At the same time Fox and Company attempted to purchase 700 on behalf of the Soviets. The Chase National Bank of New York, in an aside from its banking business, was actively trying to arrange export of Liberty motors at $2,000 each to the U.S.S.R.[18] A few weeks later one Max Rabinoff, a dancing instructor in New York, tried to buy 488 Liberty motors, allegedly for use by Deruluft (the German-Russian mixed company) on its flights to the Soviet Union. However, Rabinoff wanted the motors shipped to the U.S.S.R. to 'avoid customs duties.'[19] None of these orders was filled; it would appear that the Department of Justice was one step ahead each time. However, in 1929 the Curtiss Company filled an order for ten Curtiss Conquerers with spare parts—a much more advanced engine than the Liberty.[20] Just two years previously, in June 1927, the State Department had indicated that it did not look with favor on the sale of 100 Curtiss type D-12 engines to the U.S.S.R.[21] This was a situation parallel to the shipment of a high-powered radio station to the Soviet Union.

General von Seeckt, Chief of the German General Staff, had attempted to make contact with the Soviets before the Treaty of Versailles, but Hilger places the first cooperation at 1921, originating with a Junkers request for assistance from the German government in the establishment of an aircraft plant in Russia. Special Group R of the German War Ministry was established for military collaboration and gave the necessary political guarantees and financial assistance to Junkers. A branch office of Group R was established in Moscow and known as Zentrale Moskau; it operated under 'Neumann', a pseudonym for Major Oskar Ritter von Niedermayer.[22] The latter was head of Zentrale Moskau until 1932 and passed a stream of military information back to Germany, as he was far less restricted than the official military attaché

[17] Department of Justice letter to Military Intelligence (U.S. State Dept. Decimal File, 316–164–271).

[18] U.S. State Dept. Decimal File, 316–164–256.

[19] U.S. State Dept. Decimal File, 316–164–283.

[20] U.S. State Dept. Decimal File, 316–164–317.

[21] U.S. State Dept. Decimal File, 316–164–250.

[22] Hilger, *op. cit.*, p. 194. The German Foreign Office used a supersecret classification 'Z' for all documents in contravention to the Versailles Treaty.

at the German Embassy. The latter, according to Hilger 'had no opportunity to talk to the constant stream of German Army personnel passing through . . . on their way to or from different places within the Soviet Union.'[23] Hilger, as economic attaché, may have been in a similar position of isolation, because he contributed very little to our knowledge of the extensive economic transfers of the 1920s.[24]

THE RED AIR FORCE, 1929

Total personnel in the Red Air Force in 1929 numbered approximately 30,000. Purely military aircraft numbered 1,200, of which 160 were with the Red Navy. Table 15–2 summarizes Red Air Force and Navy equipment, and its origin.

Table 15–2 RED AIR FORCE EQUIPMENT AND WESTERN ORIGIN, 1929

Type of plane	*Origin*
Observation	Soviet-made R-1, copy of British De Havilland.
Attack	Fokker D-XI and D-XIII, imported French Nieuports.
Bombers	Farman-Goliath (80) and a few Rohrbachs, imported.
Navy (Black Sea)	Fokkers D-XI (Holland). Ballilo (Italy). Dornio-Wal (Italy).
Navy (Baltic fleet)	Junkers J-20 (from Sweden). Fokkers D-XI (Holland).
Aircraft engines	
R-1 observation	M-5, made with German assistance. Some imports from Bayerische Motor Werke.
Attack	450 h.p. Hispano-Suiza and German makes.

Source: U.S. Military Intelligence Report, *Combat Estimate: Russia.*

Table 15–2 can be summarized briefly. The only complete aircraft built in the U.S.S.R. was the R-1 light observation plane. All other aircraft and engines were imported—from every country manufacturing aircraft. In other words, the Soviets were able to compare, test, select for purchase, and at some point manufacture the best features from planes manufactured in all Western countries.

RUSSIAN-GERMAN TRAINING CENTERS

The main German air base in the Soviet Union was at Lipetsk. It was initially funded in 1924 by an appropriation from the German war budget and

[23] Hilger, *op. cit.*, p. 179.

[24] The United States received excellent information from its Riga Consulate.

further funded by an appropriation from the Ruhrfond (Relief Fund for Ruhr Workers). This fund was administered by Group R. Lipetsk was used as a base for final pilot training, and the testing and development of new planes by both the Germans and the Russians. Nearly everything was shipped from Germany, either by Derutra or Russgertorg by a circuitous rail route. Only very basic materials such as wood and stone were supplied by the Soviet Union. At the end of 1924, there were about 60 German pilots and another 75–100 technical personnel stationed at Lipetsk. This group was known as the Fourth Squadron of the Red Air Force.[25]

Clause two of the German-Russian Military agreement required dispatch of German naval instructors to Russia to train the Red Navy. In mid-1923 an intercepted telegram from Moscow to Berlin ordered the 'military attaché' in the Soviet Berlin Trade Delegation to arrange for the transfer of 1,200 German naval instructors.[26]

BERSOL POISON GAS PRODUCTION

A considerable amount of work was done on poison gases under the tsar. Liquid chlorine, the major poison gas used in World War I, was made in eight different plants. The difficult technical problems involved in handling chlorine gas—especially liquefaction—were solved by Russian chemists, 'since the methods and techniques used in Western Europe were unknown to us.'[27] Production was so successful that a chlorine over-supply developed, and by summer 1917 there was a tank reserve of 100,000 poods. Phosgene was produced at five plants under the supervision of Professor E. I. Spitalsky. Apart from use as a poison, gas was useful in synthesis of organic pigments and drugs. The work was done under the supervision of the Commission on Poison Gases, which also established an experimental factory under the directorship of I. Klimov, who continued as director after the Revolution.

Ipatieff was for a while chairman of the Russo-German commission which negotiated production of explosives and poison gases in the U.S.S.R. by German companies. A mixed commission of three Russians and two Germans carried out the agreement. The tsarist poison gas factory at Samara had been only partly built by the time of the Revolution, and Ipatieff was sent to

25 G. Freund, *Unholy Alliance* (New York: Harcourt, Brace & Co., 1957), p. 205 *et seq.*

26 U.S. State Dept. Decimal File, 340-5-670 (intercepted telegram, June 1923).

27 V. I. Ipatieff, *op. cit.*, pp. 212–235. It is noteworthy that tsarist Russia had little help from the Allies in the development of gases or gas masks. The Kumant-Zelinsky gas mask was a purely Russian development, and although it had defects it was more effective than the French mask and equally as effective as the German and British. The tsarist Chemical Committee supplied some 15 million of this type of mask. (Ipatieff, *op. cit.*, p. 225.)

evaluate the plant for purposes of the German agreement and to determine its use in the production of both chlorine and phosgene. Ipatieff received instructions not to underestimate the plant's value, since the greater the original value, the more the Germans would have to invest in the agreement. Although Ipatieff felt the plant valueless, he assessed it at six million rubles. The German valuation quite naturally was considerably less. The contract was awarded by the German government to Stolzenberg, owner of a Hamburg gas factory making phosgene, chlorine, and ammonium chloride. The Samara plant was renamed the Trotsky and rebuilt by German engineers. Other institutions and schools were formed to handle other aspects of poison gas production and use.[28]

Soviet interest in gases was intense. A special military agent was maintained within the Berlin Trade Delegation solely for the purpose of collecting foreign information on poison gas and allied materials. Ipatieff recounts how a Dutch engineer offered to bring the Soviets a new substance effective against all smoke and poison gas vapors. Reports were sent back on German attempts at Essen to manufacture a gasproof fabric.[29]

Not much appears to have been achieved. The Trotsky plant was a failure. In 1927, Voroshilov commented that 'our entire chemical industry for military purposes has yet to be built up. . . .' However, he placed great emphasis on chemical warfare and aviation as the weapons of the future and wanted to equip 'every laborer and every toiler' with a gas mask.[30]

PRODUCTION OF SHELLS, ARTILLERY, AND SUBMARINES FOR THE RED ARMY AND NAVY

The third major task of GEFU was supervision of factories at Tula, Leningrad, and Schlesselburg for production of artillery shells at the rate of 300,000 per year.[31] In 1927 it was reported that seventeen plants for the construction of artillery were being built by Krupp in central Asia.[32] The existence of such a large number of shell and artillery plants is credible in the light of the Soviet recoil to the German *Barbarossa* attack of 1941. The Russian counterattack in the winter was made before Western aid flowed in quantity and was made by utilizing large massed fronts of artillery and tanks of a single model.

[28] *Ibid.*, p. 385.
[29] *Ibid.*, pp. 459–60.
[30] *Izvestia*, No. 97, April 30, 1927.
[31] A booklet entitled *Sowjetgrenaden*, based on interviews with workers at the shell plants, was issued by the Social Democratic Party in 1927.
[32] U.S. Embassy in Stockholm, Report 66, August 12, 1927. (316–60–1003.)

Submarine construction is less well documented. It is known that Krupp estimated construction of submarine pens at Leningrad.[33] Bailey holds that U-boats were built at both the Leningrad and Nikolaevsk yards by German companies.[34]

EQUIPMENT OF THE SOVIET ARMED FORCES IN 1929

In 1929 the Soviet army comprised 1.2 million men. It was largely equipped with prewar or foreign weapons. The standard rifle issue was the 1891 Russian .30 supplemented by Browning automatic pistols and a mixture of Russian, French, German, and British hand and rifle grenades.[35] The one-pound guns used in infantry regiments were MacLean or German makes. Heavy machine guns were either Maxim or Colt. Light machine guns were either Browning, Chaucgat, or Lewis. Artillery was comprised of the 1902 Russian 76 mm, the 4.5-inch English howitzer, and 1909 model Russian 4.8 howitzer. The basic anti-aircraft equipment was the 1916 Russian 76 mm and the Vickers 40 mm.[36] Tanks were the Renault, built with technical assistance at Fili, and a Russian-built copy of the British Mark IV. A few Fiat tanks had been purchased from Italy.

Military strength in 1929 was, then, based entirely on foreign weapons and military production technology. Further development, at least at any acceptable rate, was possible only with Western assistance. Without it, self-generating economic development would have been prohibitively slow. Russia was without an automobile industry, without a useful aviation industry, without modern iron, steel, and metalworking facilities, and much else with which to forge a military structure. But, as the Military Intelligence estimate pointed out, 'if her economic and military recovery continue at the present rate in a few years she will be a formidable enemy.'[37]

[33] See chap. 14.

[34] G. Bailey, *The Conspirators* (New York: Harper, 1960).

[35] The Russian 1891 3-line model rifle was the subject of Clause 1 of the 1922 German-Russian military agreement.

[36] Military Intelligence Division U.S. War Dept., *Combat Estimate: Russia* (1929).

[37] U.S. State Dept. Decimal File, 316-110-347.

CHAPTER SIXTEEN

Soviet Trading Companies and the Acquisition of Foreign Markets

ACQUISITION of Western technology and skills required, of course, a source of finance. Some large-scale inter-government loans were made; of these, the 1925 German loan of 100 million marks and the 1926 loan of 300 million marks were the largest. Unpublicized private business loans and credit were much more common and more important. Export of gold was not at first considered a generator of foreign exchange. After 1925, coincident with the Lena Goldfields agreement, the export of gold became a valued means of acquiring foreign technology. Further, the extensive collections of confiscated platinum, silver, rare metals, tsarist crown jewels, plateware, and ikons gathered up by the Bolsheviks were sorted and catalogued by yet another Western expert, H. J. Larsons, Deputy Chief of Currency Administration, and then exported.[1]

The primary source of foreign exchange during the 1920s was export of raw materials—especially petroleum products, furs, minerals, and foodstuffs. Export of food to regain prewar markets was implemented even while American relief was importing supplies into Russia for the famine areas. In one case, the Soviets were loading a boat with Ukrainian wheat for export to Germany, while alongside was a boat from the United States unloading American wheat for the famine areas to the north of the Ukraine. The chicken industry was nationalized at an early date and eggs assembled for export to Europe by Russot and other mixed Type II concessions.

These markets were entered by using mixed joint-stock companies which specialized in trading. The Soviets normally held a 50 percent interest and the foreign partner the other 50 percent. Germany, Austria, and the United States each had two of these general trading companies in the early 1920s.

[1] H. J. Larsons, *An Expert in the Service of the Soviets* (London: Benn, 1929).

Turkey, Poland, Italy, and Persia had one company each. The foreign firm advanced credits to the Soviet organizations, found the buyers and arranged transportation and storage. In some cases the foreign partner undertook assembly within the Soviet Union. In addition to these general trading companies, there was a more numerous group of specialized trading companies with agreements covering trade in specific commodities. In both cases the Soviets profited by the skilled knowledge and trading skills of the Western partner until such time as they were able to organize their own institutions for foreign trade.

By far the more important of the United States general trading companies was Allied American, with its Berlin subsidiary, Alamerico. Simon Sutta was a much smaller and short-lived arrangement.

ALLIED AMERICAN CORPORATION (ALAMERICO)

The Hammer family held three concessions in the Soviet Union. One covered the Alapievsky asbestos deposits; the second, granted in July 1923, was a general trading concession,[2] and the third was the pencil and stationery concession. The Hammers had been trading with the U.S.S.R. under a Soviet trading license, since 1918; the concession gave them the right to establish an office in Moscow and represent a number of large American companies. Previous to the grant of the concession, Hammer had been described as the 'Soviet trade representative in the United States.'[3]

The Hammer trading concession represented thirty-eight large American companies. These had an aggregate capitalization in excess of one billion dollars, and included Ingersoll-Rand, American Tool Works, Heald Machine, Ford Motor Company, U.S. Rubber, U.S. Machinery, and other companies of similar stature.[4]

Hammer also made contracts in the United States for the sale of Soviet raw materials. The right was granted to conduct operations independently of the government trade monopoly: quite a remarkable situation, given the vehemence with which the Soviets normally defended their monopoly on trading rights. The only limitation on Hammer operations was that imports into the Soviet Union could not exceed exports. It appears that the Hammer concession was represented within the U.S.S.R. by Soviet organizations. For example, in the Northwestern oblast, the concession was represented by the Northwestern Trade Association, 'which institution will carry out all the transactions of the Company.'[5] The concession was financed by the U.S.S.R.

[2] *Ekonomicheskaya Zhizn*, No. 51, March 3, 1926 (advertisement).
[3] *New York Times*, November 6, 1921, p. 23, col. 3.
[4] *New York Times*, July 9, 1923, p. 3, col. 3.
[5] *Pravda* (Petrograd), No. 189, August 24, 1923.

and 50 percent of the profits accrued to the Soviet Union. It was rare at that time for the Soviets to finance operations originating outside the Soviet Union and operated by foreigners; the only other example was the Swedish locomotive firm of Nyquist and Holm, which received significant financial aid in its program of locomotive production for the U.S.S.R. However, as has been pointed out, Andersson, the director of the plant, had a special relationship with the Soviet Union.

The Board of Directors of Alamerico contained a Russian member, G. L. Rappaport, a member of the People's Commissariat of Foreign Trade.[6] A rather curious letter appeared in the *New York Times* shortly after the agreement, maintaining that the concession was neither a concession nor a mixed company but 'a temporary commercial agreement.'[7] As events turned out, Alamerico was precisely that: a temporary commercial agreement. The motivation for the letter and the source of the information can only be guessed. One might infer that it was inspired by Vneshtorg to avoid a conflict with Glavkontsesskom.

Alamerico filled the gap for the Soviets between the demise of the Soviet Bureau in New York and the establishment of Amtorg; as Amtorg found its feet, Alamerico faded into the background, and in 1926 the agreement was not renewed. In a six-month period in 1925–6, Alamerico exported $221,000, only twice the amount of the purchases of Lena Goldfields concession in the United States in the same period.[8] Clearly the Soviets were never hampered by lack of United States recognition insofar as having a trade organization in the United States; they were able to operate through individual American companies in a way denied the United States in the Soviet Union.

A formal trade agreement of a specialized nature was the mixed Type II joint-stock company which operated under the name of the Russian-American Engineering and Trading Company (RAITCO), formed in mid-1923 by Allis-Chalmers Manufacturing Company, the Bucyrus Company, and the Sullivan Machinery Company in the United States and the People's Commissariat for Foreign Trade (Vneshtorg) in the Soviet Union.[9]

Clause II of the agreement described the objectives of the concession as to import into the Soviet Union from the United States articles required for 'equipment and supply of agriculture and all kinds of industrial construction work,' and to introduce 'American working methods' and 'projects.' Clause III described the ways by which these objectives might be achieved: by representation of American firms—in particular, industrial, construction,

[6] *Ibid.*
[7] *New York Times*, July 18, 1923, p. 14, col. 6.
[8] *Amerikanskaia torgovlia i promyshlennost'* (Amtorg Trading Company, 1926).
[9] The agreement is in the U.S. State Dept. Decimal File, 316–131–70/84.

engineering, and financial firms—by organization of a staff of experts, and by the import of articles required for the equipment of Russian industry. The company was to submit proposals and initiate discussions with the necessary Soviet institutions, and for this purpose might establish offices, warehouses, and branches within the Soviet Union. The capital stock was divided equally, and each party was represented by an equal number of directors.

The first 10 percent of profits went into a reserve fund to sustain possible losses. The balance (not to exceed 40 percent of the capital stock) was to be divided equally among the parties. Of the excess, 75 percent was to go to the Soviet government and 25 percent to the group of firms. Altogether there were 24 clauses detailing precisely the methods and conduct of the business.

From the viewpoint of the Western firms this was a logical move to protect their markets in the Soviet Union, given the continued operation of the International Harvester plant in Moscow. Indeed, the Soviets may well have had such a reaction in mind.[10]

UNITED KINGDOM TRADING COMPANIES

Arcos (the All Russian Cooperative Society, Ltd.) was formed in London on July 11, 1920 with a nominal capital of £15,000, allegedly to act as the representative of Russian cooperatives in the U.K., to carry on business as an export-import merchant, and to provide all services, in the broadest sense, necessitated by these functions. Of the stock, 65 percent was personally held by Leonid Krassin, the Soviet trade representative. This agreement was followed by another all-Soviet undertaking, the First All Russian Import and Export Company, Ltd., also a trading company. Then followed a series of trading companies in joint ownership with British and other foreign shareholders.

There was considerable criticism in the British press concerning the validity of Arcos calling itself a cooperative society when 485,996 of the 500,000 shares issued were held by Krassin and his deputy, Klisko. It was argued that Arcos was in effect the Russian Trade Delegation in the United Kingdom and had no connection with the Russian cooperatives. The position was confused by the appearance of a second company also claiming to represent the Russian cooperatives. Subsequent events proved the criticisms correct. Arcos became the focal point of Soviet trade (and subversion) in the U.K. but the subterfuge was used to gain entry, in the same way that Amtorg on entry into the United States denied that it had connections with Soviet trade organizations and argued that it was solely a business organization.

[10] International Harvester's plant was expropriated for the first time in 1924, *after* the signing of the agreement with Allis-Chalmers, Bucyrus, and Sullivan.

In 1921 capital in Arcos was raised to £100,000, and Arcos began to sell Russian goods as well as to buy British manufactured goods. In 1922 capital was increased to £500,000 and in 1923 to 10 million gold rubles. The London office then employed some 500 people, about one-third of them Russians. Branches were scattered throughout the U.K. and Europe, as well as Russia. The guise of a cooperative representative was dropped when it appeared that deportation proceedings would not be continued—one of the dangers avoided by entering under the shield of a mixed company including foreign partners. By 1925 the company described itself as follows: 'The commercial organization of Arcos, Ltd. is of such a manifold and flexible character that it is able to carry out the most diverse transactions for the importing and exporting bodies of the Soviet Union.'[11]

Four years after its rather tentative entry into the United Kingdom, Arcos was handling 86 percent of all Soviet purchases in the U.K. 'made by all the companies, economic bodies and trading organizations carrying on Anglo-Soviet trade.'[12] Only 13.7 percent of the exports from the Soviet Union were being handled by Arcos. Its successful establishment was followed by a host of mixed and Soviet-owned companies in the U.K., predominantly for the sale of Russian raw materials. When these mixed companies, with foreign partners, were no longer needed, they were dropped.

THE RUSSO-BRITISH GRAIN EXPORT COMPANY

Exports of Russian grain began again in 1922 and gained new impetus in 1923. Russia had been the world's largest exporter of grain in tsarist times, and the Soviets naturally wanted to regain 'their' share of the market. One of the first agreements in the grain trade was completed in October 1923 between Centrosoyuz, Arcos, and Khlebexport on the one hand and a group of English companies on the other (the Cooperative Wholesale Society; Shipton, Anderson, Laurence and Company; and Furness Withy). As a result, the Russo-British Grain Export Company was formed. The English and the Soviets were represented equally on the board. The company had the support of British banks who provided from the outset a line of credit amounting to £1 million sterling at any one time to cover Russian grain at seaboard, in port, or afloat.

The willingness of leading banks and commerical institutions to finance trade operations in the U.S.S.R. on ordinary commercial terms, even when the question of expropriation was still far from negotiation, contributed greatly to the success of these early efforts; without such financial aid they

[11] *Commercial Year Book of the Soviet Union, 1925*, p. 250.
[12] *Ibid.*

would never have been realized. The proceeds of these grain sales were used to purchase manufactured goods in the U.K.[13]

Another Type II mixed company was formed in December 1923 between the Commissariat of Foreign Trade and Dava-Britopol (the Danzig-Warsaw British-Polish Company) called Ruspoltorg. This company had the prime objective of exporting timber, bristles, horsehair, and medical herbs. To assemble, store, and prepare these materials for export, it invested in the Soviet Union. The capital of Ruspoltorg was one million rubles invested equally by the founders, but it also had a line of credit amounting to four million rubles from a group of Polish financiers, and some additional United Kingdom backing.

Table 17-1 SPECIALIZED TRADING CONCESSIONS (TYPE II)

Lumber	*Petroleum Products*	*Transport*	*Dairy Products*
Russangloles (U.K.)	Persaneft (Persia)	Russtransit (Germany)	Eggexport (Germany)
Russhollangloles (U.K.-Holland)		Russcapa (Canada)	Union Cold Storage (U.K.)
Russnorvegloles (U.K.-Norway)	Deruneft (Germany)	Deruluft (Germany)	Siberian Co. (Sibiko) (Denmark)
Mologa-Waldindustrie (Germany)		Derutra (Germany)	G. H. Truss (U.K.)
Dvinoles Export, Ltd. (U.K.)		Ocean Travel Bureau (U.S.A.)	
Repola Wood, Ltd. (Finland)			
Deruwa (Germany)			
Cotton and Silk	*Foodstuffs*	*Animal Products*	*Miscellaneous*
Persholk (Persia)	Russot (45 percent International)	Kossayger	Persshold
Perskhlopok (Persia)	Russperssakhar (Persia)	A. Roesch (Germany)	Russian-Asiatic Stock Co.
Kazuli (Greek)		Iva (Germany)	Shark
Turksholk (Turkey)		Wostwag (Germany)	Sovmong
		Koshsuryo	Derumetall

The company paid all Soviet taxes, imposts, and duties, and an additional 10 percent of annual profits to the Soviet government. Exports amounted to about $1 million per year.[14]

GERMAN TRADING COMPANIES AND THE U.S.S.R.

In late 1921, Centrosoyuz concluded an agreement with a German trading company, Nord-Ost, for exchange of Russian raw materials for German

[13] *Manchester Guardian*, October 18, 1923.

[14] *Ekonomicheskaya Zhizn*, No. 366, December 20, 1924.

manufactured goods. The company opened a line of credit of 500 million marks, and goods were valued at prices prevailing on the Hamburg Exchange at the time of the offer.[15] In the following year, the Ukrainian Centrosoyuz signed an agreement with the Dutch firm of Amexima of Amsterdam, under which all exports of the Ukrainian Centrosoyuz to Holland were handled through Amexima, which had the exclusive right to supply the former with imported goods.[16]

By far the largest of the German trading companies was Russgertorg (Russische-Deutsche Handels A-G) a Type II concession, owned jointly by the Soviets and the Otto Wolff interests, which represented a number of large German firms, including Phoenix, Rheinische-Stahlwerke, Rheinmetal, and Zippen and Bissener. It was signed in October 1922 and at a later date included some United States firms who were unwilling to deal directly with the Soviet Union. The company was jointly capitalized at 175 million marks. It functioned as an import-export company. The Soviets determined the nature of the imports (mainly equipment for Soviet plants), and exports had to be coordinated with Vneshtorg. Russgertorg also handled shipments made under the military agreement with the Soviet Union.

Otto Wolff provided working capital of £750,000 plus a revolving credit of £500,000 and a further credit equal to the income from half of the orders placed with the company by the Soviets. The board of directors was selected equally from each side. The company established itself very quickly—Hilger suggests too quickly for its own good. In the second year of operation it was handling one-fifth of all Soviet imports—essentially machinery and industrial equipment. In the first eight months of 1925, its business doubled to over 20 million rubles, of which three-quarters was financed by the seller and did not require the company's working capital.[17]

Although there are reports that Rusgertorg made a comeback, it probably did not survive beyond 1925. It was 'extremely profitable' for both parties while it lasted. It was, however, too successful from the Soviet viewpoint, and within a short time it so dominated Soviet domestic and foreign trade that 'the Government regarded its continued existence as a threat to its interests and to its own governmental trade organizations.'[18] The company did receive

[15] *Pravda* (Petrograd), January 26, 1922.

[16] U.S. Consulate in Helsingfors, Report 2110, May 15, 1922. (316–107–763.)

[17] U.S. State Dept. Decimal File, 316–131–89/102. See also Troyanovsky, *op. cit.*, pp. 895–7.

[18] 'The case of Russgertorg was a typical example of the way in which the Soviet Government made use of its foreign partners as long as it derived benefits from such contracts, and dropped them as soon as the conditions under which the contracts were concluded had changed.' (Hilger, *op. cit.*, pp. 172–3.)

a house-building concession in late 1928 but reportedly could not raise sufficient capital for operations.[19]

Derutra (Deutsche-Russische Lager und Transport m.b.H) had a virtual monopoly of Soviet-German land transportation, but not ocean freight, between 1923 and 1926. It was a joint-stock Type II concession owned jointly by the Hamburg-Amerika line and Vneshtorg. The concession had great difficulties from the beginning, and Hilger suggests this was partly because of the clumsy Soviet economic system and partly because of Soviet distrust. An official reason for its dissolution was never given but the 'obvious reason was that the Hamburg-Amerika Line . . . had a closer view of Soviet economic conditions than Moscow desired.'[20]

Whereas Russgertorg was mainly involved with manufactured imports and Derutra with transportation, the Type II concession Wostwag was organized in 1923 for exporting raw materials—mainly furs, casings, bristles, caviar, horsehair, potash, and oil. It established a network of workshops in the U.S.S.R. for the 'working up' of bristles. Its functions were much more circumscribed than those of Russgertorg, and it was limited to a precise list of imports and exports. Furthermore, the trade in any one item in any one year could not amount to less than 1.2 million gold rubles. Profit was divided equally with Vneshtorg, and Soviet representatives sat on the board of directors.[21]

Whereas most trading concessions were of the mixed Type II variety, Rueben and Bielefeld was a pure concession in which the Soviets held neither management nor legal rights. It was concluded in 1923 to enable the firm to buy fish products within the Soviet Union and export these products. The U.S.S.R. collected 50 percent of the profits as a fee in lieu of taxes.[22] Another Type II concession was Derumetall (Deutsche-Russische Metallverwertungs G.m.b.H.), which joined the Berlin firm of N. Levy with Metallotorg to export scrap metal. This must have been a sizable business, in the early years Derumetall employed some 66 ships in removing scrap from the Soviet Union to Germany.[23] In addition there were several minor concessions, such as Rusot, operating in the oilseed and oil cake field.[24]

RUSSO-AUSTRIAN TRADING COMPANY (RUSAVSTORG)

The Russische-Oesterreichische Handels und Industrie A-G was a mixed Type II concession linking Vneshtorg to a group of large Austrian firms. The

[19] U.S. Consulate in Riga, Report 5789, December 28, 1928.
[20] Hilger, *op. cit.*, pp. 177–8.
[21] *Izvestia*, No. 126, June 9, 1923; and *Ekonomicheskaya Zhizn*, No. 102, May 10, 1923.
[22] *Izvestia*, No. 108, May 17, 1923.
[23] U.S. State Dept. Decimal File, 340–5–566.
[24] *Ekonomicheskaya Zhizn*, No. 105, February 7, 1924.

capital stock was owned jointly by the Soviet government and the firms, but the Austrians actually purchased 75 percent of the stock and donated 25 percent to the Soviet government; the other 25 percent of the Soviet share was paid out of accumulated profits and not subscribed at time of formation. In addition, the Austrian firms granted a credit of $1.6 million to the mixed company and a $1 million credit directly to the Soviet government. The profits were divided: 10 percent went to the Soviet government, and the balance (up to 40 percent of the capital stock) was divided equally between the Soviet government and the Austrian firms. Of the profits in excess of 40 percent, 60 percent went to the Soviets and 40 percent to the Austrians. The Soviets had the deciding vote and in effect controlled the company.[25]

The second Austrian trading concession was Ratao (Russische-Oesterreichische Handels A-G) a mixed joint-stock company one-half of whose capital was held by two Austrian firms and the balance by the Soviet Union.

COMPAGNIA INDUSTRIALE COMMERCIO ESTERO (CICE)

This was a jointly owned Type II trading concession handling all import and export between Italy and the U.S.S.R. The company had its head office in Milan and a branch office in Moscow and other cities throughout Europe. It was capitalized at fourteen million lire and provided exclusive representation for major Italian metalworking, leather, textile, and chemical companies, including the Fiat company, which had extensive sales and technical-assistance agreements in both automobiles and aircraft.

The transport and handling of commodities and equipment from Italy to the U.S.S.R. was handled by Società Mista Italo-Russa di Commercio e Transporti, with agents and correspondents scattered throughout Europe and Russia.

By 1924 the Soviets found they had exhausted the possibilities of the mixed Type II trading concession. Originally formed to attract capital and get into direct contact with foreign suppliers and customers, the mixed companies achieved both aims. The Soviets did not hide their reasons for dropping the foreign partners. An article in *Ekonomicheskaya Zhizn* points out they were no longer necessary: capital had been acquired and more could now be obtained by direct contact with the foreign suppliers; there was now no problem in getting in touch with foreign businessmen. It was proposed that trading companies should now become 'producing and trading companies' and that this would 'appeal to those who are really specialists in a given branch of the export industry and not merely middlemen and traders.' The example

[25] *Izvestia*, No. 148, July 5, 1923.

of the German firm, Seyfurt, egg assemblers and producers in the Soviet Union under concession, was given.[26]

What had the trading concessions achieved?

First, they had gained entry for the Soviet Union into foreign markets; this was vital for the sale of Russian raw materials to generate foreign exchange for imports of the technical means for economic development. This could not have been achieved without foreign help. Once entry had been gained then the sequence of orders could be maintained without too much skill.

Second, the use of trading companies with foreign partners effectively maintained the trade monopoly in Soviet hands. In the early years the Soviets did not appreciate the value of a trading monopoly, but once the value became obvious they defended it with vehemence. The mixed joint-stock companies, in which final control remained with the Soviets, in effect extended the trading monopoly into areas where the foreign firms might join together to establish a joint selling and buying company as a bargaining unit in the path of Vneshtorg. The trading concession performed the supremely valuable function of maintaining the trade monopoly for the Soviets until such time as they could establish their own overseas branches.

CREDIT FROM WESTERN FIRMS

It is generally believed that the Soviets received no credit during the early phases of their development. This view has been propagated by the Soviets themselves. Even well-informed writers have maintained this point.[27] There were, it is true, few government-to-government credits of any size. There were two sizable German loans and a few smaller direct loans from Austria and Czechoslovakia. However, irrespective of non-recognition, numerous firms, both American and foreign, were willing either to advance credit to the Soviet Union or to aid in the acquisition of funds through intermediaries. By the end of the decade the Soviets were no longer complaining about lack of credit; there was more than enough. They were, however, complaining about payment of interest and the fact these firms did not treat the U.S.S.R. as a 'first-class customer.' In brief, Soviet development was in no way restricted by lack of finance capital, although the proof of existence of this financing has had to be pieced together from numerous sources.[28]

[26] *Ekonomicheskaya Zhizn*, No. 127, March 4, 1924.

[27] For example, see F. D. Holzman, 'Financing Soviet Economic Development,' in M. Abramovitz (ed.), *Capital Formation and Economic Growth* (Princeton: Princeton University Press, 1955), p. 55.

[28] See Note A to chap. 7 for agricultural equipment credits.

Given the risks involved, the amount of financing forthcoming was surprisingly large. The files of the United States War Trade Board indicate that American import-export companies advanced credit for Soviet purchases on the heels of the Revolution. One firm, Foreign Products Company, bought $670,000 of clothing and condensed milk in March 1920, before trade restriction with Bolshevik Russia were lifted, on the basis of an order and a small deposit. The company then applied for export permits. This application was rejected, but the company replied 'We insist upon passing of the above mentioned applications.' Some products were getting through the blockade through foreign firms operating under various names. One such was Niels Juul of Christiania (Oslo), Norway, which, according to the War Trade Board, 'used a number of cover names and in every way had a bad standing.'[29]

Beginning in about 1921–2, credits began to flow from manufacturing companies of some size and standing. Avery and Moline, and Sullivan Machinery in the United States, the Clayton Company in England, Pamp in Sweden, the Russian-European Company in Germany, and others in Finland and Austria were advancing credit in 1922–3. From a position of 'no credit' the United States moved to one of long-term loans and security issues within a period of eight years, in a graduated erosion of executive interpretation and under constant pressure from the Soviets and American financial and manufacturing houses. The two major breaches of 'no-longterm loans' policy were the American Locomotive Sales case of 1927 and the Harriman bond issue case in 1928. By the end of the decade, more than 200 American firms were advancing credit for up to three years at quite reasonable interest rates.[30]

Chase National Bank and the Equitable Trust Company were leaders in the Soviet credit business. For some years this was handled on the basis of platinum credits, as the State Department requested return of gold shipped from the Soviet Union. In time this position also changed.[31] Some financial houses, notably Blair and Company, had a decidedly bad reputation within the State Department.[32]

Credits to the Soviet Union were supposedly against State Department policy in the mid 1920's. The German Foreign Ministry Archives has reports however of an International Harvester credit of $2.5 million for 18 months

[29] United States Export Control regulations were not always treated seriously. One shipper, on being informed by Customs that a load of coal to Murmansk required a permit, said, 'Hang the license, I will ship to Norway and then re-ship to Murmansk.' Customs reported this was not uncommon. (Memorandum, Dickson to Merle-Smith, October 29, 1920, U.S. War Trade Board files.)

[30] Bron, *op. cit.*, p. 57.

[31] U.S. State Dept. Decimal File, 316–136–471.

[32] Memorandum, Division of Russian Affairs (316–137–404).

Table 17-2 CREDITS ADVANCED TO THE SOVIET UNION BY WESTERN FIRMS

Country	*Year*	CREDIT GRANTED *Thousands of Rubles*	*Percent of Purchases*	*Average term in months*
Germany				
1st 3 quarters	1925/6	19,176	72.6	6.7
1st 3 quarters	1924/5	16,748	56.0	5.8
Italy				
1st 3 quarters	1925/6	11,987	99.7	7.7
1st 3 quarters	1924/5	651	55.6	6.2
England				
1st 3 quarters	1925/6	6,452	71.7	6.5
1st 3 quarters	1924/5	9,832	60.8	4.8
United States				
1st 3 quarters	1925/6	3,283	43.2	9.1
1st 3 quarters	1924/5	8,419	72.5	5.2
France				
1st 3 quarters	1925/6	3,598	91.9	15.7
1st 3 quarters	1924/5	519	31.9	4.4
Sweden				
1st 3 quarters	1925/6	3,233	92.1	12.1
1st 3 quarters	1924/5	1,963	87.0	9.6
Czechoslovakia				
1st 3 quarters	1925/6	3,329	99.9	7.7
1st 3 quarters	1924/5	1,091	14.0	6.4

Source: U.S. State Dept. Decimal File 661.1115/466½

in 1925; this was overshadowed by the $30 million revolving credit advanced by Chase National in 1926.[33] It has already been mentioned that American banks involved themselves in making purchases on behalf of the Soviet Union. Chase tried to buy Liberty engines.[34] The Equitable Trust Company financed a group of Bolivian tin producers to supply the tin requirements of the Soviet Union.[35]

Credits from Germany up to 1925 were limited by Germany's own economic position, by the necessity to pay reparations, by some doubt as to Soviet intent or ability to repay loans and to some extent by the necessity to avoid offending the Allies by making advances to the U.S.S.R. The first credits were on a barter basis. German reconstruction and operation of the Ukraine sugar refineries was paid for in sugar. A similar arrangement was made with grain in 1923.[36] This was followed by the October 12, 1925 short-term loan of 100

[33] German Foreign Ministry Archives, Roll 3033, Frame H109454.

[34] See chap. 15.

[35] U.S. Consulate in La Paz, Bolivia, Report, December 26, 1929.

[36] Hilger, *op. cit.*, pp. 184–6.

million marks at 8.5 percent. The loan was hailed by Solnikov, the Finance Minister, as the first breach in the financial blockade of the Soviet Union. It was handled jointly by the Deutsche Bank and Reichs Kredit Gesellschaft A-G and repayable in bills on New York.[37] In 1926 came the 300 million mark credit by German business firms, guaranteed by the German government to the extent of 35 percent in case of default. The German *lander* accepted another 25 percent guarantee. The loan was restricted to the purchase of equipment for specific industries.[38]

The International Union of Cooperatives was more skeptical. A joint meeting with Centrosoyuz in Moscow in 1922 did not impress the European delegates. It was suggested that the Moscow Co-operative Bank become a member of the International Co-operative Bank, but when it was indicated that the Moscow Bank would have to take up shares in proportion to its claimed membership, it was suggested that the international cooperative movement should meet Russia halfway because of her difficult economic position. The foreign delegates were not impressed and put off the question of credits to the international conference to be held at a later date in Milan. The point never came up for further discussion.[39] One surprising conclusion from this study has been that organizations which are often thought to be somewhat socialist in character, such as cooperative and trade unions, have consistently refused to have anything to do with the Soviet Union in the matter of credits, aid, trade, or technical assistance. The few exceptions, such as Haywood and the Amalgamated Clothing Workers, make the overall coolness of these movements very obvious. On the other hand, the industrial and financial elements in all Western countries have, in the final analysis, provided more assistance for the growth of the Soviet Union than any other group.

[37] This provision is intriguing. The Soviets were heavy buyers of American cotton at this time. One wonders where the U.S. dollars were being obtained. The Chase credit may have some connection with repayment of the German loan.

[38] Hilger, *op. cit.*, pp. 184–6.

[39] IS Report, April 1, 1922. (316–107–748.)

PART TWO

The Significance of Foreign Concessions and Technological Transfers

CHAPTER SEVENTEEN

The Foreign Firm and the 'Arm's Length Hypothesis'

THE compilation of data which forms Part I of this study yielded several supplementary hypotheses in addition to support for the basic hypothesis that Soviet economic development for 1917–1930 was essentially dependent on Western technological aid.

The most significant supplementary hypothesis is termed the 'arm's-length hypothesis.' In some concessions and agreements, the Western partner had noneconomic links to the Bolshevik cause; this particularly applies to early concessions. In other words, from the Soviet viewpoint the invitation to foreign capital was hedged, and initially limited to the more 'reliable' foreign capitalists. One such arrangement sprang directly from the New York-based Soviet Bureau of Martens before his deportation; but although the bureau had been financed by numerous American businessmen, only a few of these could be called ideological sympathizers.

The hypothesis is that some concession holders were in effect in arm's-length relationship with the Soviet government, and their contribution to the revolutionary cause was to lead the way and instill confidence in the Soviet government in the hope that other businessmen would follow.

Quite clearly all agricultural communes, the American Industrial Colony (AIK) in the Kuzbas, the Russian-American Steel Works, the Russian-American Instrument Company, the Third International Clothing Factory, and the Haywood concession (the Russian-American Industrial Corporation) were inspired by ideological fervor. The operators were either Communist Party members expelled from or emigrating from the United States and other Western countries or, as in the case of Haywood, sympathizers. That they were sadly disillusioned does not alter the fact that the initial desire was to support the Revolution; they clearly fall within the scope of the hypothesis. Others require further explanation.

CHARLES HADDELL SMITH OF THE INTER-ALLIED RAILWAY COMMISSION IN SIBERIA[1]

According to the State Department, Charles H. Smith, formerly United States representative on the Siberian Railway Commission and member of the Soviet Peasant International, was 'more or less' an agent of the Soviet government.[2] The name threads throughout the history of U.S.S.R.-United States trade relations in the 1920s.

There is evidence that Smith used delaying tactics[3] while he was American member of the Inter-Allied Railway Commission of Siberia. On April 25, 1919 the State Department sent a telegram, 'Urgent for Smith . . . please advise what materials Committee proposes to purchase in the United States.'[4] At the same time, Stevens, the Chairman of the Technical Committee of the Commission, was urgently requesting railroad materials: track motors, air brakes and high-speed tool steel.[5]

On May 2, Smith replied as follows to the urgent State Department telegram: 'Technical Board has not had time to study railway needs carefully.' Smith appended a list of items based on 'past information' and adds, 'Do not think rails and track fastenings are needed just now. . . .'[6]

By June 18, no orders had been placed, although Stevens was still requesting material urgently. By August 25, Smith had apparently been removed from the sphere of ordering supplies and now it was found that 200,000 tons of rails with 3A fastenings were needed.

The impression from the flow of telegrams from the Consul's office in Vladivostock to the State Department is that Stevens, President of the Technical Committee, was competent, active, and anxious to start work, and was requesting necessary supplies. These were delayed by inaction, and misinformation.[7]

After leaving the Railway Commission, Smith was active in the Far East, generating support and winning influence for the Soviet Union, and trying

[1] The U.S. State Dept. Archives refer to Charles Haddell, Charles H., Charles W., and Charles S. Smith, sometimes preceded by 'Colonel.' According to file notations they are one and the same. (See 316–130, 316–131, 316–136, and 316–176.)

[2] U.S. State Dept. Decimal File, 316–131–1/2. Covering letter from Consul states, 'Mr. Smith is more or less an agent of the Soviet Government, and it is to his interest to publish propaganda of this sort.'

[3] 'Delaying tactics' as a weapon were formulated by Representative Walter Judd. The Harry Dexter White case and the takeover of China by the Communists is another example. See A. Kubek, foreword to *Morgenthau Diary (China)*, Vol. I, U.S. Senate Committee on the Judiciary, February 5, 1965.

[4] U.S. State Dept. Decimal File, 316–163–442.

[5] U.S. State Dept. Decimal File, 316–163–452, 316–162–454, and 316–162–456.

[6] U.S. State Dept. Decimal File, 316–163–460.

[7] U.S. State Dept. Decimal File, 316–163–440/677.

to introduce foreign capital into the Far Eastern Republic. He was connected with the Far East Exploration Syndicate (also known as the Far Eastern Prospecting Syndicate) and various proposed lumber and mining concessions. Soviet reporting explained that Smith was 'a capitalist not under the control of the United States Government'[8] and a 'breakaway.'[9]

Part of Smith's activity involved propaganda in favor of the Soviets. Smith pleaded, for example, with Senators Borah and Johnson, on their visit to the Far East, to press for recognition of the U.S.S.R. and for the return of the Chinese Eastern Railway to Russian hands:

> As always the Chinese Eastern Railway is a key to the solution. The sooner the Russians would get it back, the better would it be for all nations except Japan. . . . We who represent America here used to say that this is a Russian railway and it must remain in Russian hands.[10]

Letters and memoranda in the U.S. State Department files testify to his consistent pro-Soviet activities. Part of this activity was in concert with another suspected Soviet agent, Lively, who represented the United States Department of Agriculture in the Far East and China.[11]

Smith turns up later in the decade as vice-president of the American-Russian Chamber of Commerce (which had such well-known members as International Harvester, General Electric, Westinghouse, American Car and Foundry, and Guaranty Trust) and Moscow representative of the Chamber.[12]

THE HAMMER FAMILY AND SOVIET OPERATIONS

Dr. Julius Hammer (born in Russia in 1874, died in the United States in 1948) was a member of the steering committee which founded the Communist Party of the United States at the First National Left-Wing Conference of the Socialist Party, held in New York City in June 1919. The Hammers were then trading under license with the U.S.S.R. They continued to trade until 1923 when they operated, jointly with the Soviets, the Allied American Corporation (Amerikanskoi Ob'edinennoi Kompanii), sharing both capital and profits on a 50:50 basis.

The secretary of Allied American Corporation was Armand Hammer;[13] who also managed the Alapievsky asbestos concession,[14] while Dr. Julius

[8] *Ekonomicheskaya Zhizn*, No. 24, October 28, 1923.

[9] *Far Eastern Times*, November 22, 1923.

[10] U.S. State Dept. Decimal File, 316–131–1/2.

[11] U.S. State Dept. Decimal File, 316–130–1259, 316–176–409 and 316–176–838.

[12] See page 289.

[13] Armand Hammer, *Quest of the Romanoff Treasure* (New York; Payson 1936). Armand Hammer is currently President and Chairman of the Board of Occidental Petroleum Corp., Los Angeles.

[14] See chap. 6.

Hammer, his father, was serving a term in Sing Sing for criminal abortion. Later in the 1920s Armand Hammer operated the American Industrial Concession, for pencil factories in Moscow.[15]

Upon grant of the Alapievsky asbestos concession, the *New York Times* reported F.B.I. investigations had ascertained that Dr. Hammer 'had for many years been prominently identified with the Socialist movement in this country and became a Lenin-Trotsky propagandist.' Dr. Hammer had then become associated with the Soviet Bureau in New York and acquired affluence. When he was sentenced to Sing Sing it appears that Martens 'and other representatives of the Soviet Government in this country had taken an active part in the effort to prevent the physician from being sent to Sing Sing.'[16]

Smith and Hammer therefore appear to fall within the 'arm's-length hypothesis.' There may be others. In 1920–1 the Robert Dollar company handled $7 million of the total $15 million worth of United States exports to the U.S.S.R. The company's Moscow representative was Jonas Lied, who had, according to the State Department, an 'interesting dossier' in the Department of Justice (i.e., the F.B.I.) and intelligence in the State Department.[17] Like other Western traders with the Soviet Union, Dollar was reluctant to say very much except to blast the 'radical element in the country (which) should not be allowed to block trade.'[18]

One of the partners in Bryner and Company, operators of the Tetiukhe metals concession in the Far East, 'was suspected of espionage for the Soviets.'[19] J. Finger and Professor Johnson of the Joint Distribution Committee (Agro-Joint) gave glowing reports of the 'new Russia.'[20]

Although the German ex-Chancellor Wirth, operator of the Mologa concession, has been described by some writers as a 'Communist sympathizer,' there is no evidence, and Hilger is probably correct in denying the charge.[21]

In brief, there is supporting evidence for the 'arm's-length hypothesis.'[22]

[15] See chap. 13.

[16] *New York Times*, November 4, 1921, p. 1, col. 2; November 6, 1921, p. 23, col. 3; November 7, 1921, p. 10, col. 2; and November 24, 1921, p. 12, col. 4.

[17] U.S. State Dept. Decimal File, 316–109–1375.

[18] *Memoirs of Robert Dollar* (San Francisco, 1925), III, p. 34. Out of a three-volume *Memoirs*, Dollar devotes only one and a half rather general pages to his Russian trade activities.

[19] U.S. State Dept. Decimal File, 316–136–1254.

[20] U.S. State Dept. Decimal File, 316–108–652.

[21] Hilger, *op. cit.*

[22] According to documents at U.S. State Dept. Decimal File, 316–139–28/9, there were also 'leaks' from the State Dept. to Moscow. Coleman suggested his reports be kept under close control and limited distribution, as the contents were finding their way to his opposite number in Riga and he feared for the security of American couriers.

Companies such as Westinghouse and International Harvester, who operated their prewar plants for some years, do not fall within the 'arm's-length hypothesis.' Westinghouse, International Harvester, Singer, and other American companies are still awaiting settlement for expropriation of their plants. Swedish General Electric, the Swedish Separator Company (manufacturers of dairy equipment) and SKF all domiciled in Sweden, had concessions, but there is no evidence that they fall within the scope of the hypothesis. In fact the unfavorable treatment of these companies when compared to those firms that do fall within the scope of the hypothesis confirms rather than denies the hypothesis.

Swedish General Electric, Swedish Separator, and SKF made considerable profits from their concessions but were blocked from transferring these profits out of the U.S.S.R.[23] Although profit figures for concessions are hard to find, it appears that Hammer and Eitingon-Schild were the only concessionaires to make substantial profits and export them. Amtorg reports that the 22 principal concessions made 6.5 million rubles profit in 1926–7 and 12 million in 1927–8, but nowhere indicates how much of this profit was transferred out of the U.S.S.R.[24]

As Paul Scheffer put the case, 'Concessions in Russia are a sort of sport for rich people who can afford to pay dearly for their experience. . . .'[25]

AMERICAN ORGANIZATIONS FOR PROMOTION OF TRADE WITH THE U.S.S.R.

American organizations with the objective of promoting Soviet-American trade were formed on the heels of the Revolution, unlike those of Britain and France, where organizations to gain recompense for expropriated capital were stronger and more vocal than those designed to promote trade.

Prerevolutionary foreign investment had been heavily concentrated under French (33 percent) and British (23 percent) control. About 20 percent was German, but only 5 percent came from the United States. Consequently there was comparatively less ex-shareholder pressure in the United States against trading with the Soviet regime.[26]

The American pressure organizations were linked directly and indirectly to the U.S.S.R. and numerous American firms.

The American Commercial Association to Promote Trade with Russia was founded in 1919 by a group of American manufacturers, including the

[23] U.S. State Dept. Decimal File, 316–131–661.

[24] Amtorg, *op. cit.*, IV, 179. SKF alone made 2.8 million rubles in 1928 and reported that exports of these proceeds were being blocked.

[25] *Berliner Tageblatt*, January 11, 1929.

[26] U.S. State Dept. Decimal File, 316–107–1323.

LeHigh Machine Company, Bebroff Foreign Trading Company, New Hide Manufacturing Company, Fairbanks Company, Morris Company of Chicago, and perhaps 100 other firms and some well-known representatives of the financial world. The first tasks of the association were to get the licensing requirements enforced by the War Trade Board removed and to press for removal of restrictions on financial transactions with the U.S.S.R. The association, according to claims of its president, Emerson P. Jennings, succeeded in both objectives. Other objectives included a writ of mandamus to release ships held in United States ports with goods for the U.S.S.R.[27]

Probably the most important of its actions (although certainly not its most highly publicized) was the financing of Ludwig C. A. K. Martens's Soviet Bureau in New York. Jennings states that this was the work of a group of American businessmen anxious to trade with Russia, rather than a plot financed by 'Soviet gold,' as ran the current hue and cry.[28]

Not only did the association finance the Soviet Bureau but it also maintained communications. The chairman of the Resolutions Committee was Martens's attorney.[29] Congressman James P. Mulvihill, who represented the New Hide Company in the association, was in contact with Heller, of the Commercial Department of the Soviet Bureau.[30] In brief, the association, comprised of American businessmen, was also intimately connected with the operation of the Soviet Bureau.

The attachment was the result of political naïveté rather than ideological obeisance to the cause of the Revolution. In the fall of 1921, Emerson P. Jennings spent a few months in the U.S.S.R. to drum up trade for members of the association. As soon as he reached Reval, Estonia, on his way back to the United States, he commenced one of the bluntest condemnations of the Soviet Union on record. While in Reval, Jennings wrote a six-page bitter denunciation of the U.S.S.R., complaining of the complete and utter unworthiness and untrustworthiness of the Bolsheviks. 'Pikers,' 'fakers,' and 'babies,' are some of the epithets used. Nevertheless, he concludes by making a plea

[27] American Commercial Association to Promote Trade with Russia, *Bulletin*, February 1920.

[28] Emerson Jennings, *Report to the Association* (American Commercial Association to Promote Trade with Russia, 1921). The Soviet Bureau had both trade and propaganda functions. For example, see A. A. Heller, *The Industrial Revival in Soviet Russia* (New York: T. Seltzer, 1922). Heller was commercial attaché to Martens and the Soviet Bureau, and liaison with the U.S.S.R. He was arrested and deported in May 1921 to Riga, Latvia, for these activities and became the Vesenkha representative in the United States. The book was an attempt to disguise the pitiful state of Russian industry at that time. [Memorandum, Poole to the Secretary of State (316–129–633).]

[29] American Commercial Association, *Bulletin*, February 1920.

[30] L. I. Strakhovsky, *American Opinion about Russia 1917–1920* (Toronto: University of Toronto Press 1961), p. 85, fn. 9.

for the United States government to advance credits to the Soviet Union for the benefit of American manufacturers.[31]

THE AMERICAN-RUSSIAN CHAMBER OF COMMERCE[32]

The American-Russian Chamber of Commerce was comprised of a group of major United States manufacturers and financial institutions interested in trading with Russia, and was a factor in the pressure for recognition of the Soviet Union and resumption of full trade with credits. In a letter to the Secretary of State (February 27, 1922), the chamber pressed for a policy statement 'announcing under what conditions you would be glad to cooperate with all nations in relation to the economic development of Russia,' and utilizing the alternative of German political domination as a pressure point.[33]

The president of the chamber was Reeve Schley, a vice president of the Chase National Bank, which was in the forefront of financing United States trade with the U.S.S.R. and reluctant to follow State Department policy.[34]

In 1926 the chamber decided, in view of its failure to persuade the State Department to send a commission or a representative to Russia, to send its own representative to 'open an office in Moscow and generally obtain information which will be of assistance to its members.'[35] The representative was Charles Haddell Smith, previously described by the State Department as being in the employ of the Soviets and a member of the Soviet Peasant International.

In 1928 'Colonel' Smith was appointed vice-president of the Chamber and toured the United States speaking in favor of increased trade with the U.S.S.R. This brought forth protests from organizations and individuals who viewed trade with the Soviet Union in a rather different light. Matthew Woll, for example, vice-president of the American Federation of Labor and president of the National Civic Federation, sent an open letter to the American-Russian Chamber of Commerce complaining of its activities and particularly called upon it to use its influence to stop Soviet propaganda and subversive activities

[31] *Report to the Association*, Emerson Jennings, August 31, 1921.

[32] The board of directors of the chamber represented many companies associated with Russian development: Deere & Co., Worthington Pump, Russian Singer, Mercantile Trust, International Fur Exchange, International Harvester, Lucey Manufacturing, American Locomotive, International General Electric, Guaranty Trust, Westinghouse Air Brake Co., and American Car and Foundry. (316–107–451.) The chamber was founded in 1916 to 'foster trade, encourage and generally promote the economic, commercial and industrial relations between the United States of America and Russia.' A Moscow office was established in 1927. By 1931 its publications were reflecting many of the propaganda shibboleths of Soviet regime.

[33] Letter from American-Russian Chamber of Commerce to U.S. State Dept., February 27, 1922. (U.S. State Dept. Decimal File, 316–107–451.)

[34] U.S. State Dept. Decimal File, 316–109–1424.

[35] U.S. State Dept. Decimal File, 316–107–451.

in the United States. Perhaps unfortunately, Matthew Woll suggested that the presence of Smith in Moscow as representative of the Chamber 'furnished additional grounds for the belief that the Bolsheviks would heed any requests or demands made by your body.'[36] If such a request had been made by the Chamber (it was not), its handling by Smith would have been a most interesting episode.

AMERICAN BANKS AND SOVIET SECURITIES

A number of American banks were partners in a Soviet attempt to float a bond issue on the American market. The Chase National at first refused to break off the relationship, using its past banking services for the U.S.S.R. as the reason.

On January 19, 1928, the State Bank of the U.S.S.R. placed an advertisement in the *New York Times* to the effect that the bank had guaranteed the principal and interest of a 9-percent Soviet railway loan and that coupons might be presented for payment at the Chase National Bank, the Amalgamated Bank of Chicago, and the Bank of Italy in San Francisco. The advertisement also contained the address of the State Bank in Moscow where 'further information' could be obtained.

Two weeks before the advertisement, a $30 million railway bond issue had been authorized in Moscow. The certificates permitted payment of interest and principal to the holder *in dollars*, thus in effect converting the bond issue to a dollar loan—flatly prohibited by the State Department. The issue was to be sold by mail in the United States, and it was estimated that at the time of the advertisement about $100,000 of such bonds had been sold, mostly to one of the fur concession holders; in other words bona fide sales were insignificant. The coupon advertisement was justifiably interpreted as an offer for sale of Soviet bonds, and this interpretation was made plain to the associated banking houses in letters from the State Department.[37]

Among other things, Chase National was called an 'international fence'[38] acting to compromise American foreign policy. It was said that they were 'a disgrace to America. . . . They will go to any lengths for a few dollars profit.'[39]

[36] U.S. State Dept. Decimal File, 316–110–268.

[37] The documents are in U.S. State Dept. Decimal File, 316–110–250. Letters from corporations and other interested parties in the files suggest that the State Dept. was by no means alone in its interpretation of the action of the State Bank and Chase National. See the three-page telegram at 316–110–259/61, from New York Life Insurance Co.

[38] By the National Civic Federation (representatives from business, labor unions and the public). (U.S. State Dept. Decimal File, 316–110–266.)

[39] By the Allied Patriotic Societies (U.S. State Dept. Decimal File, 316–110–284). The letters from private citizens were even more specific.

The Bank of Italy announced immediately that it would have nothing further to do with the loan and specifically that it would not honor the bond coupons. Other banks (the Chicago Amalgamated and Chase) were more reluctant. The Chase made a step-by-step withdrawal. One reply (February 5) stated that it wanted to conform to government policy but would continue to pay the coupons. The second step of the retreat came after the State Department bluntly pointed out that the payment of coupons would facilitate Soviet financing and was against government policy. The third letter from Chase indicated they had advised the U.S.S.R. State Bank 'that until further advice of any change in policy by the Department of State we must decline to make payment of any such coupons.'[40]

There is no doubt that stepped up purchases of American equipment and technical assistance motivated this attempt with the aid of American banking companies to break United States policy. The contracts with Dupont, Ford, Kahn, McCormick, and many others were being signed, and dollars were required for payments. The denial of the railway bond issue was followed by a substantial increase in Soviet gold deposits in the United States.[41]

The amount of pressure placed by American firms individually and through their associations on cabinet officials is very difficult to gauge. Samuel Gompers, President of the AFL, thought it was sufficient in 1923 to make a strong attack on Mr. Hearst, former Secretary Fall of the Interior Department (of Teapot Dome notoriety), the Sinclair and Barnsdall organizations, Senator King, and Senator Ladd, together with 'international bankers, oil magnates and concession hunters' all of whom he accused of placing pressure on the cabinet for trade with Russia.[42]

When the desk level in the Division of East European Affairs suggested that it would be 'unwise to *initiate*' an investigation of Harriman's negotiations with unofficial representatives of the Soviet Union, one can only infer that pressures above the desk level were at work.[43] It was widely felt that General Electric brought political pressure to bear in 1928 for permission concerning its credit agreement with the U.S.S.R. for supply of electrical equipment.[44] The American Locomotive case was decided at the presidential level, and the files certainly suggest interest by parties outside the executive branch.

American big business was almost unbelievably naïve politically concerning the Soviet Union. Standard Oil of New Jersey, for example, negotiated oil

[40] Letter from Chase National to U.S. State Dept. (Decimal File, 316–110–341.)

[41] With the collapse of the bond scheme, a shipment of $6 million in gold was made from the U.S.S.R. to the Chase National and the Equitable Trust Company. (U.S. State Dept. Decimal File, 316–110–337.)

[42] *New York Times*, November 23, 1923.

[43] See chap. 6.

[44] U.S. State Dept. Decimal File, 316–131.

development simultaneously with the Soviets and the White Russians.[45] Many major American firms, including Standard Oil of New York, Bethlehem Steel, Armour and Company, and the Pennsylvania Railroad, were represented by Ivy Lee, a well-known public relations agent. For much of the 1920s, Standard of New York was battling with Royal-Dutch Shell over Soviet oil; in 1926–7 Standard of New York decided to build a kerosene refinery for the Soviets at Batum and lease it back to supply Standard Near and Far East markets. Ivy Lee had the job of selling the switch to the American public, and after a quick trip wrote of the U.S.S.R. as follows:

> I had heard that the Russian Government, the Communist Party and the Communist International are all combined in a conspiracy against mankind, particularly *capitalist* mankind. I was anxious to find out, by first hand examination, just what is the nature of that conspiracy and how it is functioning.[46]

Quite predictably, 180 pages later, Lee concludes that the communist problem is merely psychological. By this time he is talking about 'Russians' (not Communists) and concludes 'they are all right.' He suggests the United States should not engage in propaganda; makes a plea for peaceful coexistence; and suggests the United States would find it sound policy to recognize the U.S.S.R. and advance credits.[47]

Walter Duranty felt, probably with accuracy, that the Rockefeller oil interests were playing both ends of the game. Standard Oil of New Jersey wanted compensation for its expropriated petroleum holdings, while Standard Oil of New York was buying oil in Russia and had therefore leased back the Standard-built kerosene refinery in 1927 at Batum. Duranty quotes *Izvestia:*

> While the Standard Oil of New Jersey is talking about moral reasons for refusing to do business with the Soviet Union, Ivy Lee who handles the Rockefeller propaganda recently visited the Soviet Union and carried on an unobtrusive press campaign for the improvement of trade relations between the United States and the U.S.S.R.[48]

EUROPEAN TRADE WITH THE SOVIET UNION

Promotion of trade with the U.S.S.R. became the objective of Parliamentary delegations in a number of countries. In the United Kingdom, members of

[45] U.S. State Dept. Decimal File, 316–137–83/126, 131–343/5.

[46] Ivy Lee, *U.S.S.R.: A World Enigma* (London: Benn, 1927), p. 9.

[47] *Ibid.* William White acted as interpreter for Ivy Lee in his interviews with Rykov, Sokolnikov, Karahan, Radek, Hinchuk and Piatakov. 'Mr. White stated that the interviews which he attended were extremely inane in character but that because of his Standard Oil connections Mr. Lee seemed to stand A-1 with the Soviet authorities.' [U.S. Embassy in Berlin, Report 5099, November 26, 1929 (U.S. State Dept. Decimal File, 316–110–1391).]

[48] *New York Times*, July 25, 1927, p. 33, cols. 1, 2 (quoting *Izvestia* of July 24, 1927).

Parliament sympathetic to the 'new Russia' made the usual trips and published glowing reports on their return suggesting that the Soviets had demonstrated their 'fair-minded treatment of concessionaires,' and that this removed the need for 'excessive caution' on the part of foreigners as the 'new Russia' could be relied upon to give a 'square deal to foreign capital.'[49]

On the other hand, associations devoted to émigré and prerevolutionary owner interests in France were almost equally injudicious in other respects. Émigré businessmen resident in Paris had several vocal associations, including the Association Financière, Industrielle et Commerciale Russe, which issued memoranda and booklets concerning the economic position of Soviet Russia. For these groups nothing could possibly be right nor could any development possibly take place without the return of former owners.[50]

In Germany, attempts to trade with the U.S.S.R. began in 1919, and in late 1920 German firms interested in resuming trade with the Soviet Union formed a Research Association for the Resumption of All Trade with the East (Studiengesellschaft für die Aufnahme des gesamten Handels mit dem Osten).[51] After the Treaty of Rapallo, which contained economic and commercial protocols, relations with the U.S.S.R. developed very rapidly. An all-German section of the All-Union Chamber of Commerce of the U.S.S.R. was formed, and this became the focal point for industrialists and German Embassy officials in discussion concerning the reconstruction of both Germany and the U.S.S.R. —until, as Hilger points out, the Embassy was blocked off by the Soviets from either assisting or communicating with German companies working in the U.S.S.R. The Soviets also utilized the meetings of the German section to move German industrialists along 'more desirable' lines, to reassure them that imports of German machinery would not lead to dumping, and to complain that the Americans 'do not guard manufacturing secrets so jealously.'[52] However, the U.S.S.R. found continued resistance by some German companies, especially I. G. Farben, to the transfer of technology.

On the other hand, Dr. Otto Deutsch, managing director of A.E.G. (Allgemeine Elektrizitäts Gesellschaft), was most interested in resumption of trade with the U.S.S.R. and became a member of the German commission established to further this objective. His basic arguments were that the U.S.S.R. was a vast market which could not be ignored and that, as the

[49] Anglo-Russian Parliamentary Committee, *Possibilities of British-Russian Trade* (London, 1926), p. 67. The booklet argued that the Lena and Harriman concessions 'illustrate sufficiently clearly our . . . contention.' They were both expropriated within the next few years.

[50] *La Situation Economique et Juridique de la Russie Sovietique* (Paris: Association Financière, Industrielle et Commerciale Russe, 1924).

[51] Hilger, *op. cit.*, p. 29.

[52] *Ekonomicheskaya Zhizn*, No. 225, September 29, 1929.

U.S.S.R. could not pay cash, concessions and credits would be necessary.[53][54] In 1928 during the 'Shakta Affair' when A.E.G. engineers were arrested and charged with sabotage, the initial A.E.G. reaction was to pull all their engineers out of the U.S.S.R. After a few days contemplation of the number of outstanding contracts and the losses involved, the German General Electric (A.E.G.) company decided to continue working.[55]

CONCLUSIONS

In brief, the 'arm's-length hypothesis' that some firms had noneconomic links to the Soviet Union, applies to early concessions, and these were of great importance; they were 'pour encourager les autres.'

The pressure in the United States for trade with the U.S.S.R. began while the Revolution was still in progress and was fostered by several active organizations.

Later in the decade, industry pressure was placed on the executive branch of the government to facilitate credit in trade with the U.S.S.R. and modify the State Department position of denying credits to the U.S.S.R. The latter policy was gradually eroded under pressures originating above and outside the 'desk level' of the Department.

On the other hand, German trade with the U.S.S.R. was placed on a formal basis by the government in 1921–2, and the Soviets had no need to use intermediaries to break down an unfavorable economic policy.

53 *Mittelungen der Handelskammern*, February 1922.

54 'European industrial progress cannot be restored without the active participation of the 160,000,000 purchasers in Russia. I do not defend the Russian regime as we know it, but to wait until it is transformed into something more pleasing is an idle fancy. Despite what it is today, the situation in Russia does not prevent the operation of commerce on condition that one takes reasonable precautions.' (Otto Deutsch, *New York Times*, November 13, 1927, p. 4, col. 3.)

55 'The directors of the AEG in the first flush of indignation had initially declared that they would immediately withdraw all their engineers who were in Russia mounting machinery, regardless of existing contracts. A few days later, however, they seem to have regretted their impetuosity; they withdrew their initial declaration, obviously afraid of the losses that would occur because of the non-fulfillment of contractual agreements.' (Hilger, *op. cit.*, p. 221.)

CHAPTER EIGHTEEN

Organized and Disorganized Governments: The State Department and the Acquisition of Technology

WESTERN GOVERNMENT ASSESSMENT OF SOVIET INTENTIONS

ALTHOUGH the transfer of technology involved all those Western countries with any degree of industrialization, it essentially included Germany in the 1920s, and then the United States, as German credits ran out and the U.S. State Department increasingly relaxed its stand against credits to the U.S.S.R. Another factor was the gradual acceptance of American techniques in preference to European. It was the mass production technique of Ford rather than the more conservative production horizon of European producers that at first mystified and ultimately attracted the Soviets.

At the beginning of the decade, Western governments were in substantial unity concerning the aims of the Soviet Union. Certainly the State Department in 1923 had accurate ideas of Soviet intent in so far as trade and credit were concerned. A very clear statement formed part of a 'confidential' report, no doubt for circulation to friendly governments, by New Scotland Yard in London. The relevant part of the report reads:

> Concessions are offered, and foreign capital is sought with the object of restoring the collapsed industries of Russia in the interest of the Communist State. It is calculated that in some years foreign industry and enterprise will have revived these industries which then, more firmly established and efficient than ever before, will revert to the State, which will then be able, fortified by experience and the method of foreign participants to resume the Marxist experiment. Nor need one believe that any conditions subscribed to by the Soviet Government will be faithfully observed. The capitalist and the private owner have no inherent rights. Faith need not be kept with them. Cozened into the open by their capitalist greed they will be overwhelmed when the great advance is resumed.[1]

The State Department did not hesitate to subscribe to this analysis. A memorandum from Evan E. Young, Chief of the Division of Eastern European Affairs, to the Secretary of State comments:

> I have read the report with care and attention, and while it contains no new information, it is to me of especial interest and importance in that the report agrees, in all respects and in every particular with our information and our position.[2]

However, there does not appear to have been unanimity on the question of Soviet trade, concessions, or technical assistance within the United States Administration. Arguments for resumption of trade began while the Bolshevik Revolution was still in progress. It was suggested by Mr. Edwin F. Gay at a meeting of the War Trade Board, December 1918, that the policy of economic isolation of the areas under Bolshevik control was not the best means of bringing about a stable government:

> . . . if the people in the Bolshevik sections of Russia were given the opportunity to enjoy improved economic conditions, they would themselves bring about the establishment of a moderate and stable order.[3]

EROSION OF UNITED STATES POLICY ON SOVIET TRADE CREDITS

The basic policy of the State Department in the 1920s was that the United States government would neither support nor intervene in individual or business relations in trade with the Soviet Union. In other words, it was a policy of noninterposition or 'hands off.' The individual or firm was entirely on its own, and could expect no diplomatic or consular help in the event of trouble with the Soviet government.

Toward the end of 1920, there were world-wide rumors concerning a gigantic billion-dollar concession alleged to have been obtained by a man named Washington B. Vanderlip for the development of Siberia and Kamchatka. There is some possibility that Vanderlip represented himself to Lenin as another Vanderlip, banker and friend of Senator (later President) Harding. The syndicate behind Vanderlip contained a number of substantial Southern California citizens: Harry Chandler (of the Los Angeles *Times*), E. L. Doheny,

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1 *Present Position and Policy of Soviet Russia*, U.S. State Dept. Decimal File, 316–108–699.

2 U.S. State Dept. Decimal File, 316–108–697. There are numerous indications of the State Dept. views in the files; this example was chosen because of its succinctness, clarity, and agreement with the view of a major European government.

3 *Minutes of the War Trade Board*, V, 43–4, December 5, 1918. After Mr. Gay's argument, the Board adopted a motion recommending to the Dept. of State that a policy of economic isolation and blockade ' . . . is one calculated to prolong the control of the Bolshevik authorities . . .' (p. 7). This is the earliest statement of the 'bridge-building' argument.

the Union Oil Company, Merchants National Bank, Braun and Company, and other California firms and institutions. Vanderlip's negotiations, while General Wrangel was still fighting in the South, were not well received by the United States or the British governments. In the end, although the affair took up 100 or so documents, now in the Archives, nothing was achieved, and the concession faded into thin air.[4]

It can be argued, with substantial evidence from State Department files, that the pressures in the 1920s for expanded trade with the U.S.S.R. came from business firms and promoters such as Vanderlip and Farquhar, as well as from within the State Department itself.

The American Locomotive case of 1927 was one of the turning points in erosion of United States policy. The American Locomotive Sales Corporation inquired in October 1927 concerning sales of railroad material to the U.S.S.R. on long-term (more than five years), credit. The company argument was that it was extremely desirable 'to obtain foreign orders in view of the Depression'; that bankers and manufacturers had found that the Soviets lived up to their short-term commitments, and that German sales were being financed anyway by American banks. Then could sales of United States equipment be financed on a long-term basis by American banks, preferably by the sales of securities to the American public?[5]

In the next month, two memoranda were written by R. F. Kelley, Chief of the Division of Eastern European Affairs. These indicate that the State Department had not previously objected to short-term credits incidental to current commercial transactions, but also that only one such transaction had ever been presented to the Department for approval.[6] The Department had previously objected to bank credits and loans designed to finance the sale of German manufactures to Russia. The memorandum then quotes the denial to W. Averell Harriman in 1926 concerning a scheme to float a loan of 25 to to 35 million dollars on the American market, the proceeds of which were to be used to extend credit to German industrialists in order to sell goods to the Soviet Union. It also mentions the New York Trust Company and the Farquhar denials.[7]

[4] U. S. State Dept. Decimal File, 316–132–148. The State Dept. files connect Vanderlip with Martens and the Soviet Bureau in New York.

[5] Letter from American Locomotive Sales Corp. to U.S. State Dept. October 17, 1927 (316–124–0026).

[6] Kelley Memorandum, October 28, 1927 (316–124–0031). This was in 1925 when the Chase National Bank had informed the State Dept. it was arranging a cotton credit. The State Dept. did not object, as the arrangement was 'considered as incidental to ordinary current commercial intercourse.'

[7] U.S. State Dept. Decimal File, 316–124–0031.

The memorandum makes the following very pertinent commentary:

> . . . if the object of the Department's policy with regard to Russian financing is to exercise pressure on the Soviet regime to the end that this regime may eventually come to realize the necessity of abandoning its interference in the domestic affairs of the United States and of recognizing the international obligations devolving upon it with respect to the indebtedness of Russia to the United States and its citizens, and with respect to the property of American citizens in Russia,—if such is the Department's aim the logic of the situation would seem to demand that the Department view with disfavor all financial arrangements, whether in the form of bond issues or long term bank credits and whether designed to facilitate American exports to Russia or to serve other purposes which would result in making financial resources available to the Soviet Government.[8]

In brief, the Kelley argument was that *any* financial arrangement was going to be of assistance.

The decision, made at the Presidential level after consultation with Mellon and Hoover, was to allow American Locomotive to extend long-term credit to the Soviet Union for the purchase of railroad equipment.[9]

The Soviets kept pressing foreign firms. They finally succeeded in breaching the long-term loan situation in 1928–9 by holding Harriman and Company and the State Department 'over a barrel.' Harriman had been forced out of his manganese concession[10] and the Soviets offered compensation in the form of long-term bonds. Harriman accepted bonds at an interest rate of 6 percent. This was gleefully hailed by the Soviets as the first American loan to the U.S.S.R.[11]

When the Harriman bonds were received by the Chase National Bank in New York there was no mention on the face of the certificates of the fact that they were for any specific purpose. Vice-President Schley informed the State Department as follows:

> I do not look upon the transaction in any way as an attempt to float any securities in this country, but as an obligation given in payment of a single business transaction, and I trust that the Department will view it in the same light.[12]

[8] U.S. State Dept. Decimal File, 316–124–0032.

[9] Marginal notation on letter to American Locomotive, U.S. State Dept. Decimal File, 316–124–0027. It might be added that in August 1927 a rumored Dillon Reed loan of $30 million to develop the Solikamsk potash deposits and other projects had been quashed by the U.S. State Dept., acting apparently on its own initiative.

[10] Harriman says he left by agreement (see page 91). This explanation is not at all consistent with the contemporaneous newspaper or archival material. He was forced out by interference, by high costs, and generally by what Walter Duranty called an 'utterly inept' agreement.

[11] 'This is actually the first American loan received by the Soviet Government.' (Amtorg, *op. cit.*, IV, No. 16–17, 298.)

[12] U.S. State Dept. Decimal File, 316–138–296/7.

The subsequent State Department memorandum noted that the bonds received by Chase National totalled $4.45 million, whereas the Harriman investment had only been $3.45 million. The memorandum comments:

> It would appear therefore that Harriman and Company has advanced to the Soviet Government a sum of approximately $1,000,000. . . .[13]

The memorandum goes on to suggest that this was probably a *quid pro quo* for compensation for expropriation and that:

> No useful purpose would be served by placing difficulties in the way of Harriman and Company from recovering the money invested in the concession. . . .

The memorandum then argues that the additional $1 million was not really a loan but part of the original concession. The Riga Consul (Coleman) was less vague and called the whole Harriman transaction a 'loan.' This statement, however, was given the classification (in the department) of 'confidential.'[14]

It is amply clear, in retrospect, that the Harriman 6-percent 20-year bonds were a long-term loan and effectively breached the last remnants of United States credit policy vis-à-vis the Soviet Union.[15]

THE STATE DEPARTMENT AND PATENT PROTECTION

A Soviet decree of September 12, 1924 gave patent rights, under certain conditions, to inventors for a period of fifteen years. Article 2 of the original decree stated that no invention would be considered novel if, prior to the date of application, it had either in the U.S.S.R. or abroad been 'described fully or with substantial particulars so openly as to be capable of being reproduced by experts.' This was subsequently amended to read 'described fully . . . *or applied*.' (Italics are added.) In brief, if the invention had been described or *used abroad* then protection would not be given under Soviet law.[16]

Irrespective of written law, which gave scant enough protection to foreign inventions, Bolshevik practice gave no protection whatsoever. Law and the judiciary in Leninist political theory exist only to further the ends of the state. Consequently, true patent protection, in the sense that we understand it in

[13] U.S. State Dept. Decimal File, 316–138–299.

[14] U.S. State Dept. Decimal File, 316–138–289.

[15] It will be remembered that previously the U.S. State Dept. had been unwilling to '*initiate*' an investigation into Harriman's conduct of negotiations with unofficial representatives of the Soviet Union in the United States. It is sensed, but without conclusive evidence, that the State Dept. could not become involved in a stand on principle at this point. If the documents in the United States and German Archives are viewed in toto, they give the distinct impression that political pressures well above the desk level of the department were at work.

[16] A. A. Santalov and L. Segal, *Soviet Union Yearbook, 1926*. (London: Allen and Unwin, 1926), p. 477.

the West, could in no way be construed to exist, *whatever* the written content of the decree. This was in fact the initial interpretation and conclusion of the State Department.

The Columbia Graphophone Manufacturing Company was informed by the State Department in 1921 'that the Bolsheveki had nationalized all private and industrial property in Russia and that it could therefore be inferred that any individual rights—such as patent and trademark protection—could not be secured during their regime.'[17] This was confirmed in 1922 upon a second inquiry by Columbia. This interpretation is confirmed by history as there is considerable evidence, even without the Archives, that the Soviets were indeed sequestering patents and anything else of a technical nature in the 1920s—as they do even in the present day.[18] That this confiscatory policy was widely known is suggested by the numerous letters of inquiry in the State Department decimal file.[19]

In any event, caution was indicated by a quite separate chain of happenings. In 1919 the United States had deported, as an undesirable alien, Ludwig K. Martens, organizer of the Soviet Bureau in New York and hardly a friend of the United States, although Martens had been assisted in the organization and financing of the Soviet Bureau by a number of American companies. On November 12, 1924, Martens was appointed by the Soviet of Labor and Defense as Chairman of the Committee on Inventions.[20]

In 1925 or thereabouts, there was a definite change in the administration of American policy in relation to patents. Rather than the early doctrine of noninterposition, a doctrine of positive encouragement of Soviet trade was substituted, but partially clothed in the words of noninterposition. Where caution was indicated, active and positive suggestions were made in response to inquiries for advice on patent and other matters. This change cannot be traced to any specific Congressional action, and, there is no evidence to suggest pressure from above the 'desk level' of the State Department. It predates by a year or so the changes in credit and loan policies discussed above.

17 U.S. State Dept. Decimal File, 316–108–679/680.

18 See the report of H. L. Roosevelt of RCA on negotiations with the U.S.S.R. for a long-range radio transmitter: 'The Soviets desired . . . strangely enough, the right to use Radio Corporation patents for manufacturing purposes. The latter request had somewhat amused Mr. Roosevelt as he found the Soviets brazenly copying many foreign products.' [U.S. Consulate in Stockholm, Report 248, April 10, 1928 (U.S. State Dept. Decimal File, 316–108–791).] In October 1924, the Norton Company complained that the Ilytch works in Petrograd was marketing a grinding wheel under the name of NORTON. (316–108–815.)

19 For examples see U.S. State Dept. Decimal File, 316–108. Also, see *Ford Delegation Report (1926)*.

20 *Izvestia*, No. 273, November 29, 1924. That patents were not protected, even for Russians, is confirmed by V. N. Ipatieff, *op. cit.*, p. 287, who noted that his patent for 'Ipatite,' a gas-absorbent material, was immediately turned over to the Revolutionary War Council.

An internal indicator of the change is treatment of an official Soviet notice on patents issued in June 1925. The United States Commissioner of Patents and the United States Department of Commerce questioned the State Department as to whether the notice on patents received by them should be published in the Official Gazette at all 'in view of the fact that this circular is published by or in the interest of the Soviet Government.' The State reply to the memorandum was simply to enclose a draft of the phraseology to be employed in publishing the notice without directly answering, either way, the substance of the questions.[21]

In advising American firms, after about 1926, on the patent position in the U.S.S.R., a policy of active encouragement was followed. In September 1927 the State Department received a letter from Gleason, McLanahan, Merritt, and Ingraham, attorneys at law, which indicated that a client had an 'invention of international importance' which he wanted to protect. Further, they said that 'we fear that if the process should become public in Russia and no protection can be secured, much of the value of our invention may be lost.' To be consistent with previous replies and the policy of noninterposition, the State Department reply should have indicated that it could not intervene, that there were neither diplomatic nor trade relations between the two countries and therefore that no protection could be given to a United States citizen.

The actual State Department reply gives the address of the Leningrad patent office (Ulitza Herzena, 24, Leningrad) and then adds:

> In as much as there are no official representatives of the Soviet regime in the United States, documents required for the registration of patents in Russia should be certified in the United States by the diplomatic officers of a nation with which the Soviet regime has diplomatic relations. Among such countries are Germany, France, Italy and Poland. . . .[22]

Instructions then follow on the procedures to be followed with the Soviet authorities after the necessary signatures have been obtained. There is nothing in the reply that would suggest for all practical purposes a patent could not be protected, as we know it in the West, under Soviet law and practice.

The Automatic Damper Company sent a scribbled, almost illegible, half-page note requesting general information on Soviet patent laws, obviously with the intent of patenting one of its devices.

The Automatic Damper Company must have been pleasantly surprised with the detailed two-page reply which indicated precisely how to go about patenting a device and gave two addresses in the U.S.S.R. One of these was

[21] U.S. State Dept. Decimal File, 316–108–683/6.

[22] U.S. State Dept. Decimal File, 316–108–691/3. Also see Lacey and Lacey inquiry, October 6, 1927 (316–129–687/8).

the Inventions Bureau (TsBRIZ), under the control of Martens Committee.[23] One wonders if the State Department realized that all stoking appliances, including dampers, were being produced by the Richard Kablitz concession and that this was an area where purely Russian technology was nonexistent. Work in this field was dependent on Western equipment. For example, the report of Professor L. K. Ramzin at the meeting of the 1930 World Power Conference in Tokyo covers his experiments utilizing Moscow brown coals, which have a moisture content of 32 percent. Ramzin reported that predrying had been a failure but that these coals could be completely burnt with the aid of hot-air draught as follows: 'The fuel was ground in a high speed Atritor mill of Messrs Alfred Herbert and the aerated dust was blown into two long flame burners located in the upper arch of the furnaces, the flames then being diverted downwards and forming a U. The bottom of the furnace was fitted with a Babcock and Wilcox water screen. . . .'[24]

In short, a policy was instituted of suggesting how to overcome absence of diplomatic relations and ensuring that patentable techniques would, in fact, be transferred to the U.S.S.R. without protection. If the reader is dubious, then indication of the treatment afforded another type of patent inquiry—those from individuals in trouble and requesting help—will complete the picture.

On November 21, 1928, Rector, Hibben, Davis, and Macauley, attorneys in Chicago, requested advice on behalf of the Burroughs Adding Machine Company, which

> has been requested to furnish . . . all sorts of publications describing the products of the Burroughs firm . . . we hesitate to advise the Burroughs Company to furnish the information without a little more accurate advice as to what is really going to be done with the information after it is obtained.[25]

The firm had been told by the Soviets that the information would be used in considering applications for patents, but obviously both Burroughs and Rector were skeptical. The State Department reply was that it had no information, and no means of ascertaining the purpose for which such publications might be desired and 'cannot advise you in the matter.'[26]

An appeal for help from B. Singer, a specialist in trademark and patent law who represented clients with patents registered in the U.S.S.R., was rejected. A number of patent applications had been filed through a Soviet citizen, Blau, who had been arrested by the GPU and whose office had been closed.

[23] U.S. State Dept. Decimal File, 316–108–694/6.

[24] *Engineering*, CXXX (February 7, 1930), 184.

[25] U.S. State Dept. Decimal File, 316–108–690.

[26] *Ibid.*

Singer requested the good offices of the State Department to facilitate the transfer the Blau's office records to a new associate, one Feldman. The reply curtly indicated regret but inability to help Singer in any way 'as this Government has not recognized the regime now functioning in Russia.'[27]

Thus, the State Department was willing to aid the transfer of patent information, or tacitly encouraged Soviet acquisition of information (Burroughs), but not willing to warn of possible confiscation, which was known to the department, nor outline the Soviet record or philosophy. Formal statements of noninterposition in trade relations were followed by advice or suggestions running counter to the implementation of a doctrine of noninterposition.[28]

The promotion of Soviet technical data acquisition by the State Department is particularly curious in the light of the fact that knowledge of expropriation was widely known in industrial and commercial circles, and one presumes that State Department had access to the same knowledge.

For example, the 1926 *Ford Delegation Report* makes the following pertinent comment. After pointing out that the Soviet Union has a patent law, the report adds:

> This law does not seem in any way to hinder the reproduction in Russia of foreign patented products. In the automotive line the Fordson tractor is reproduced in Leningrad under the name of the 'Red Putilov' Tractor. The Italian Fiat 1½ ton truck is reproduced in Moscow under the name AMO and the Bosch spark plug is reproduced in Leningrad by the Avtopromtorg organization.[29]

The U.S. Consul in Riga, among other U.S. representatives abroad, pointed this out on a number of occasions. It is a reasonable presumption that the State Department was encouraging transfer of technical information knowing that the result would be expropriation without compensation or permission. The reasons behind such a policy are beyond the confines of this study.

[27] U.S. State Dept. Decimal File, 316–108–763.

[28] This raises the question of the extent to which the State Dept. is able or required to go in order to protect United States citizens. In another context, State Dept. letters suggest it was not aware of any dangers for engineers or firms entering the U.S.S.R., but usually added that it could not provide protection in the absence of diplomatic relations. The State Dept. was aware in May 1928 that Rykov had ordered three German engineers involved in the Shakhta affair to be shot. This had been stricken from the official record of the Rykov speech. Yet the engineers may have been sentenced to death because Rykov was compromised by the Shakhta affair in the eyes of Stalin. It appears to the writer that United States firms are entitled to knowledge of the likelihood of this type of arbitrary action. The Baaghorn and Mott cases are more recent examples.

[29] *Ford Delegation Report (1926)*, p. 38.

THE MONOPSONISTIC POWER OF THE SOVIET TRADE ORGANIZATION

Foreign trade was a state monopoly under Vneshtorg from the beginning, and superb use was made of this monopoly in trade relations with the West, especially in playing one company, or country, off against another.

Little thought was given to this process of 'divide and conquer'; the Soviets stumbled onto it in their pragmatic search for foreign assistance.

There is an interesting report, of uncertain origin (probably written in the German Foreign Ministry in 1928), which provides a clear discussion of this problem and the pressures and counterpressures that a united front of Western firms and countries would encounter.[30] In essence the report proposed concerted action by Western powers in relation to trade with the Soviet Union. The writer expresses surprise that a decade of trade with the monopoly trade organization of the Soviet Union had elapsed before discussion of 'organized counteraction.'[31] Brief examination of the factors making for diversified rather than a unified approach leads the writer to the conclusion that the

> Soviet government in a masterly fashion took advantage of these conflicts of interest between the powers, for a consolidation of the monopoly of foreign trade. . . .

The author argued that little good could come of carefully worded articles and treaties with the U.S.S.R. Monopoly of foreign trade was one of the 'commanding heights' of the Soviet economy; and attempt to create an international 'united front' had been met with claims of an 'anti-Soviet front.' In 1928 only the German and French chemical industries were able to agree with the Soviets on prices and joint deliveries. Finally, the author suggested that such international cooperation would have to take the initial form of uniform credit and delivery conditions.

Hilger suggests that neither the Germans nor the Soviets were aware in 1921–2 of the potential power of a trade monopoly, and that the opportunity of meeting the Soviet trade monopoly with a central German business organization was missed 'because of the tenacity with which the predominantly Socialist Government of Germany stuck to the principles of free enterprise.' Later Germany formed the Russian Committee of the German Economy (Russland Ausschuss der Deutschen Wirtschaft) to provide advice and orientation on German-U.S.S.R. business. Hilger comments that, once the Soviets

[30] U.S. Consulate in Riga, Report 5156, March 26, 1928 (316–109–579).

[31] The author of the report would be even more surprised to learn that in 1966, almost fifty years after the Bolshevik Revolution, there was still no unified counteraction, although NATO, SEATO, and CENTO are the military and political equivalents of such counteraction.

realized the importance of the trade monopoly, they were suspicious of any attempt to impede its value and began to block embassy aides from aiding German firms in negotiations, especially with the Main Concessions Committee.[32]

The Soviet Union, supposedly the opponent of monopoly, has in fact been the greatest recipient of monopsonistic profits in the history of industrialized society. Neither has it been slow or backward in recognizing and protecting the value of this monopoly.

THE BOLSHEVIK ATTITUDE TOWARD THE FOREIGN FIRM

Bolshevik unity was split by Lenin's concession policy. The rank and file Bolshevik questioned the wisdom of, and the necessity for, the return of the capitalist—after all, had not the Revolution just ejected him? The Party had difficulty in convincing its ranks that foreign capitalists were a necessary evil. In particular, the OGPU, charged with the purity of the Revolution, was dubious concerning foreign elements. Whenever it had the chance, as in the Shakhta affair, the OGPU exercised punitive measures with great zeal. The pleas to the Party faithful to accept foreign capitalists and engineers give the clue that Communist intent was to absorb capital, skills, and technology, and then, 'when the lemon was sucked dry,' to discard it. There are numerous speeches and articles in contemporary Soviet literature which suggest both the captive nature of the concession and, on the other hand, the necessity for the concession in the reconstruction and development of a socialist society.[33]

The Urquhardt negotiations in 1922, although a failure, are interesting in this regard. Urquhardt was president of Russo-Asiatic Consolidated, Ltd., which had held very large concessions in tsarist Russia. Negotiations with Urquhardt for operation of his former properties, then lying idle, would have led the way for other entrepreneurs. Although Urquhardt was well aware of Bolshevik strategy, he made a concession agreement with Krassin in 1921; the latter then went to Moscow for ratification by Lenin and Trotsky. Before this could be obtained, word leaked out and the hue and cry within the Party forced Lenin to scuttle the agreement, using British activities in the Middle East as a pretext.

[32] Hilger, *op. cit.*, pp. 166–67. This may have colored Hilger's interpretation of the value of concessions. If the embassy was denied data, they could have assumed a minute impact of the concession.

[33] See Volume II. Not all the clumsiness was on the part of Western businessmen. In a conversation between Mr. Arlt of the Königsberg Chamber of Commerce and a 'high Soviet official' the latter, in reply to a question concerning the safety of German investments in Russia, said, 'Until Germany goes through a successful World Revolution they will be safe. If Germany goes Bolshevist, however, it will make little difference to German industrialists whether their possessions are expropriated in their own country or in Russia.' (316–133–140.)

Some early Bolsheviks were clearly aware of the necessity for foreign help. Krassin had formerly been managing director of Siemens Schukert in Petrograd. He then became a revolutionary, and in 1920–1, as Soviet Trade Representative in London, he argued that

> Russia . . . cannot without assistance organize her trade. She cannot bring together her resources in a productive manner and she must rely upon capital, the experience and initiative of foreign capitalists. . . .[34]

An article by Arsky in *Krasnya Gazeta* in 1921 in effect clarifies this policy: 'The question of concessions has been under discussion for the last half year but so far it has mostly been in the air . . . nothing has been done.'[35] The writer then describes the proposed Northern Telegraph concession, argues its advantages as a generator of foreign exchange, and the alternative of not being able to use the line at all. 'As a result of this treaty,' he writes, 'we shall get a repaired telegraph line and hundreds of millions of francs in gold to carry on trade with abroad.'

Arsky then discusses a Kuban sulphates concession in the same glowing terms: 'Of course the concessionaires will profit hugely but let them do so for it will bring wealth to us and we must pay for that.' Finally, considering a Baku forest concession, Arsky argues that, although the concessionaire will profit, 'as Lenin foretold we shall have to pay a high price to foreigners for their help, science and energy in enterprise.' He then adds that in any event there are not enough skilled Soviet workmen, nor could the Soviets feed them, nor will they be able to in the near future—'*We must seize the moment.*' The Soviets, he says, are well able to take care of their own interests, certainly in the matter of concessions: 'They will demand from those who get them the maximum of profit for the country and its re-establishment.'

The Party line had to be sold to the rank and file, and it would appear that the closer the explanation got to the factory and farm level the less circumscribed was the description of the fate awaiting the foreign specialist. For example, Ipatieff quotes a collective farm chairman, Kopylov, in a speech at Tikhonova Pustyn in Kaluga Province:

> Of course we need bourgeois specialists for a short time. As soon as Party members learn what these specialists know we'll get rid of the specialists fast enough. Right now we must treat and feed them far better than ourselves; but their time will come, just as it did for the rest of the bourgeoisie.[36]

34 *New York Times*, June 12, 1921, p. 2, col. 3.

35 *Krasnya Gazeta*, September 3, 1921. Arsky was, at least, able to look after his own interests; by 1924 he had acquired 30,000 shares in Moskust, a joint-stock company in Moscow.

36 Ipatieff, *op. cit.*, p. 486.

The opposition to foreigners at the plant level became overt on numerous occasions, but it is not always clear whether this was due to ideological dislike, counter-revolutionary activity or just plain antipathy for those who came along to improve plant discipline. It is reasonably likely that the majority of Party members were kept in line by Party discipline, whatever they thought. It is more likely that the opposition came from non-Party bureaucrats and perhaps counter-revolutionary segments, except where discord was created on direct orders of the Party, as part of a campaign to eject a specific concessionaire. It is entirely conceivable, on the other hand, that the OGPU overtly attempted to scuttle the introduction of foreign elements in the name of protecting the Revolution. Douillet, Belgian consul in Russia, relates how the OGPU arrested and jailed an Austrian aircraft worker at the Junkers plant and a diesel specialist in Shelkotrust. They were retained without charges and then expelled.[37]

The Americans at the Kuzbas project (the American Industrial Corporation) had clearly ideological opposition. The newcomers were classified as either Communists or sympathizers and neither was particularly popular among Kuzbas coal miners. McDonald, an engineer with a technical-assistance agreement with Uralmed, met opposition from Soviet engineers, whom he accused of 'seriously interfering with the progress of important work.'[38] This is rather similar to the opposition met by Ruykeyser at Uralasbest—fear that technical inadequacy might meet dismissal, or worse.

By the end of the decade opposition had become serious, especially at the Dniepr generating plant, the largest in the world, being built by American and German engineers. There was a rather natural conflict between the two foreign groups, but there was also an 'unfriendly attitude' on the part of the local workers serious enough to warrant the attention of V. V. Kuibyshev in a speech to the Supreme Soviet:

> But, have these foreign and alien hands not been brought by the proletarian state, and is the transplantation of foreign technique not necessary in order to enable socialist technique . . . first to overtake and then excel European capitalist technique? Without resorting to foreign assistance on a still greater scale, this is impossible. The application of foreign technique is one of the keys to hasten the tempo of our development. . . . Such

[37] Douillet, *op. cit.*, pp. 74, 76.

[38] *Pravda* (Moscow), No. 239, October 16, 1929. Similar cases were reported in a special supplement on foreign specialists in *Ekonomicheskaya Zhizn*, No. 243, October 20, 1929; for example, German engineer Scheibil at the Karl Liebknect works of Ugostal was 'abused and persecuted.' Another engineer (Mashik) at the Tomsky plant of Ugostal was subjected to an 'inquisition' and put to work in a shop (316-130-927/8). Two German engineers at the Komintern pottery works under reconstruction were isolated because one of them (the technical director) gave 'strong orders' to the workers (*Ekonomicheskaya Zhizn*, No. 245, October 23, 1929).

> assistance is absolutely necessary in the ferrous and non-ferrous coal and chemical industries.[39]

Kuibyshev then went on to add that in the non-ferrous, ferrous, and pottery industries there were cases of hostility to foreign workers.

Hilger, economic attaché at the German Embassy in Moscow, confirms that resistance to concessions and foreign aid came from the lower levels of the Communist Party, the bureaucracy, and the OGPU.[40] He also suggests that the Soviet leaders intended duplicity in the long run and that 'it was never more than a retreat,' although he quite correctly points out that it is difficult to distinguish cause from effect. In retrospect, it seems that the Soviets were never honest in their concessions operations. Hilger avoids, or perhaps momentarily forgets, the numerous references in Lenin's speeches in which concessions were held to be temporary and destined for expropriation when their purposes had been achieved.

BOLSHEVIK LEADERS AND THE JOINT-STOCK COMPANIES

Some of the Bolshevik leaders found this a suitable time to improve their personal fortunes and a number had holdings in private enterprises and mixed companies.

Moskust, one of the most important stock companies, controlled a cloth mill and paper, shoe, tarpaulin, glass, and leather factories. Trotsky owned 80,000 chervontsi shares, while Arsky held 30,000, Šklyansky 45,000, and Muralov, the Commander of the Moscow Military District, an unknown number. It was believed other leaders participated through relatives.

Zinoviev was interested in Arcos and the Leningrad Tobacco Trust and owned 45 percent of the Volkhovstroi stock company. Chicherin held an interest in the mixed company Turksholk (Turkish silk), and Dzerzhinsky was chairman and held 75,000 chervontsi shares in the Coal Mines Exploitation Joint-Stock Company.[41]

Krasnatchokov, former Chicago lawyer and President of the Far East Republic (later absorbed into the Soviet Union), rose to become a member of Vesenkha and President of Prombank. While in the latter position he made a

> . . . rather liberal contract with a Russo-American concern, with which he was personally connected, and from which his wife drew monthly assignments payable in the United States.[42]

[39] Speech at Sixth Plenary Session of the Supreme Soviet, October 1929.

[40] Hilger, *op. cit.*, pp. 170–1.

[41] U.S. State Dept. enclosure to U.S. Consulate in Riga, Report 2394, September 24, 1924 (316–129–1229). Ipatieff comments acidly on the behavior of Party functionaries attached to the Berlin Trade Delegation and Purchasing Commission. (*Op. cit.*, pp. 408–9.)

[42] Scheffer, *op. cit.*, p. 129.

Although these cases may prove shocking to the ideological purist who considers the Marxist to be above personal gain, they are insignificant, considering the opportunities available in a complete dictatorship, and are certainly less than the personal empires built up by Stalin and his henchmen in more recent times.

CHAPTER NINETEEN

The Necessity for Foreign Technology and the Process of Acquisition

THE IMPACT OF REVOLUTION ON THE INDUSTRIAL STRUCTURE

It has been assumed almost axiomatically that World War I, the revolutions, the Intervention, and the Civil War created the catastrophic collapse of the industrial and agricultural sectors in 1922.[1]

The basic cause for the collapse was the economic illiteracy of an ideology which had neglected to think out its economic counterpart and drove a viable growing economy into a shambles. The campaign to inflate the ruble to zero value, the demobilization of industry, the policy of 'free' transport, utilities, and other services, the massive decline in labor productivity, coupled with doubled and tripled wages, were contra-developmental in effect.

In the first year of the war, the Russian economy had changeover problems which persisted until industry was on a war production basis; then growth, as measured in terms of output and employment, resumed. The industrialization mobilization campaign of 1916 created significant growth. New industrial centers were created at Nizhni-Novgorod, Rybinsk, and Samara, in addition to the expansion of existing centers in Moscow, Petrograd, and earlier industrial areas. One result was an increase in the demand for raw materials, and the

[1] The following is a typical statement: 'Russian industry, agriculture and transportation declined greatly during the war, and by 1917 were in a condition approaching collapse. The civil war served to accelerate economic disruption, with the result that by 1920–1 industry was practically at a standstill while agriculture was fast approaching the condition which, coupled with a severe drought, precipitated the famine of 1921–22.' [American-Russian Chamber of Commerce, *Economic Handbook of the Soviet Union* (New York, 1931), p. 7.]

This myth has been compounded by using 1913 as a comparative statistical base. In fact, some industries had a 1916 output twice that of 1913. Some chemical products (such as benzene, toluene, and zylene) not produced at all in 1913 were produced in quantity between 1914 and 1917. (Ipatieff, *op. cit.*, p. 210.)

excess of imports over exports in 1916 was due to this upsurge in activity. *Between January 1, 1916 and January 1, 1917, industrial employment increased by 8.9 percent.*[2]

The greatest increase was in metallurgy and food products. Agricultural implement works were turned over to munitions production: 'there was hardly a repair shop of any size connected with the textile, confectionery, macaroni or other industry which was not assigned to the manufacture of grenades, mines, field kitchens, or other war materials.'[3] In a few industries output declined due to enemy action: most sugar refineries were in occupied territory, cement production declined because of a shortage of hoop iron for barrels, and there was a shortage of spare parts. But on balance, in the year before the revolutions, Russia had resumed her economic growth, new industries were being created, and industrial employment was greater than ever.

The first revolution was a shock to this expanding structure. The Ministry of Trade and Commerce undertook a survey which covered five months between the Kerensky Revolution and the Bolshevik Revolution. Between March and July, 568 industrial enterprises were closed down and 104,000 employees lost their employment. Almost one-third of the enterprises closed were engaged in manufacture of food products, with textiles and metalworking next in importance. The most important single reason for failure was lack of fuel. Less than 10 percent closed for lack of orders, a condition which could well have come about as a secondary result of lack of fuel and supplies elsewhere. Excessive demands of workmen and financial difficulties comprised a very small proportion of failures, considering that this was a period of revolutionary unrest. Most firms closed were small and unable to plan against these factors. In spite of this decline in industrial activity, concentrated in smaller enterprises, all the larger and important plants were operating at the time of the Revolution; nor is there a reported case in the two major industrial centers of Moscow and Petrograd of a large plant looted, burned or destroyed by the Revolution itself.[4]

The largest single blow to the structure of industry was a decree issued by the Soviet Commissariats of Labor and War on December 21, 1917, calling a halt to all military production and dictating a return to peacetime activities

[2] *Report of the Ministry of Trade and Commerce*, August 1917 (316–111–1015).

[3] U.S. Military Intelligence Report, *Russian Industries*, October 1918 (316–129–25).

[4] There are reports in the U.S. State Dept. Archives which mention 'looting' of plants, but this always refers to removing specific items of value (especially brass or copper) and not to physical destruction of the plant or its equipment. Overt destruction was limited to institutional symbols of the tzars. For examples, see the Sokoloff collection of photographs at the Hoover Institution, Stanford University. In 1920 Petrograd was deserted but intact. For instance, in photograph No. 24, taken on the Neva, large plant buildings and smoke stacks are still standing, but idle.

within *one month*. Industry at this time was working at full capacity on war material and had no alternate plans for consumer products. This simple order had a major adverse effect. One month was, of course, an insufficient time to change course completely. Not one factory was able to start peacetime production by January 21, 1918, and most were forced to close. The only exceptions were those plants where workers insisted on fulfilling military contracts as an alternative to closure. The resultant chaos compounded an earlier problem. The Bolshevik Revolution had caused most foreign and numerous Russian skilled workers to flee abroad along with the managers and engineers. The 'instant demobilization' decree hastened the exit of skills, but workers now went to the villages.[5] In brief, this single decree robbed the industrial structure of that skill and technical component which had not already left. This structure, which, despite supply difficulties, had been operating reasonably well, and in 1916 was giving definite signs of renewed growth, was now placed on the road to collapse.

The period of War Communism was entered with neither technical nor administrative apparatus, under a government of Soviets which had neither plans nor solutions for the chaos. Feeble attempts at planning civilian production were made by some worker's committees; this led to duplication of effort, and, in any event, neither financial nor technical problems were overcome. The Soviets then tried centralization, but lack of knowledge and information led to conflicts among makeshift managements. Concurrently came a major decline in productivity as the discipline of a market system collapsed. Inflation led to payment in kind rather than in depreciated paper money. Lack of goods was instrumental in creating self-supply organizations in factories, until the principal task of the factory became feeding and clothing its own workers. Resultant losses were made up by state subsidy, thus furthering the inflation.

The decline in production of one of the largest Moscow machine shops, which was producing iron and steel castings and forgings, was reported to the State Department. In January 1917, just before the Revolution, the index of production was at a base of 100. The difficulties of the inter-revolutionary period are reflected by a decline in the index to 76. By the following January, just after the 'instant demobilization decree' the index had fallen to 45. By August 1918, reflecting attempts at stabilization, the index had fallen only to 37. Data from other sources supports this chain of events. On the Northern Railways there was 0.67 a laborer per verst of line in 1913 and 5.8 laborers in 1919; on the Moscow-Kursk line there were 6.48 laborers per verst in 1913 and 18.9 in 1919. Railroad work was a preferred occupation as it gave access to food supplies in the villages.

[5] Rykov, in a speech before the Third Congress of the People's Council in January 1920, indicated that 90 percent of skilled workers left the factories at this time.

The labor supply position in the large plants confirms that skilled workers left in droves while the plants themselves were intact. In 1920 about 30 factories in Petrograd were attempting to work for the Red Navy. The major problem was lack of skills. The Baltic plant employed 3,500 and required another 5,800. The Franco-Russian factory had no workers and was looking for 1,500. The famous Putilovets had only 350 workers and wanted another 1,100. The Petrograd Metal Works employed 150 and was looking for another 1,000. In the 30 or so works listed, a total of 11,000 people were employed and a total of 22,000 additional workers were required. This counters the myth that the plants lacked equipment. The plants lacked skilled labor and management, both of which had been dispersed by the Bolshevik Revolution.[6]

In brief, as we already know, there was a complete collapse under War Communism. This collapse had little to do with the Civil War. It was created at the very beginning of the period of War Communism by dispersion of skills, absurd decrees, and the removal of disciplinary market forces.

THE TROUGH OF THE INDUSTRIAL DECLINE

In many sectors, production declined to almost zero by 1922. Cast iron reached less than 1 percent, cotton yarn 1.5 percent, rubber galoshes about .33 percent, and gold about .5 percent of 1913 production. Food products, especially if processed, fell to less than 5 percent. Per capita production of sugar was less than 1.5 pounds per year, and vegetable oils about .33 pound per year.[7] The accepted explanations for these abysmal declines were the war, revolutions, the Civil War, and the blockade. Actually production increased during the war, and the revolutions did little physical damage to production facilities. General Wrangel still occupied the Crimea, but this was a small part of the vast Russian geography. The allied blockade had been raised in 1921 and foreign products began to flow in larger quantities. The decline continued after these 'reasons' had ceased to exist. The real cause must be sought elsewhere than in political and military factors; the decline was essentially caused by economic factors.

THE NEW ECONOMIC POLICY (NEP)

NEP was introduced to offset the economic problems caused by Bolshevik economic policy. Nonpayment for work removed incentives. Nationalization, when there was no managerial talent available, was suicidal. NEP was a temporary move to utilize the knowledge and experience of the capitalist class

[6] U.S. State Dept. Decimal File, 316-111-1157.
[7] See Report by Vesenkha to IX Congress of Soviets.

to revive the economy, 'This is not an attempt to restore the capitalist class but to adapt it to our constructive work.'[8] The major impact of NEP was in the spheres of trading and small manufacturing, although it has also been seen as an accommodation to the reluctant peasant. Implementation turned nationalized enterprises back to private operations. This was somewhat more widespread than Dobb has suggested.[9] *Pravda* (January 18, 1922) gives a summary by region of the number of enterprises remaining under government supply and finance after the initial NEP reorganization.

Table 19–1 REGIONAL DISTRIBUTION OF ENTERPRISES UNDER GOVERNMENT AND PRIVATE CONTROL AFTER NEP REORGANIZATION, 1922

Region	PRIVATE			STATE		
	Number of Factories	*Number of Workmen*	*Average Workers per Plant*	*Number of Factories*	*Number of Workmen*	*Average Workers per Plant*
Moscow	477	118,457	248	110	78,375	710
Vladimir	118	7,262	61	74	13,487	182
Ivanov	45	7,887	175	10	1,746	174
Tver	59	1,173	20	47	5,199	111
Valuga	54	3,929	73	n.a.	517	n.a.
Riazan	23	2,242	97	16	3,436	215
Total	776*	140,950	182	257	102,760	400

Source: Adapted from *Pravda*, January 18, 1922, p. 2.
* 775 in original text in *Pravda*.

A decree in *Krasnya Gazeta* for August 13, 1921 signed by Lenin divided all industrial enterprises into two groups: the first included those large enterprises to be supplied with raw materials and operated by the state, and the second group included factories leased to private individuals and foreign concessions. All other plants were closed and the workers transferred to operating factories. It will be noted that those enterprises retained under state control were almost always the largest, irrespective of regional distribution. The clash between the data in table 19–1 and in Dobb turns on a point of definition. Dobb argues that few were turned back to private *ownership* but that numbers were turned over to groups of workers including artels. The

[8] *Krasnya Gazeta* (Petrograd), December 20, 1921.

[9] '. . . there was a certain amount of denationalization. . . . The extent of this . . . should not be exaggerated; and its economic significance was nothing like as great as foreign commentators at the time were inclined to suppose.' (Dobb, *op. cit.*, p. 142.) Dobb then adds that private enterprise covered only 12.5 percent of workers in the 1923 census, but he does not mention the limits of the 1923 census, which only covered part of the industrial structure.

enterprises listed in table 19–1 are those in which supply of inputs and finance is from private sources. It implies nothing about ownership, an academic question since 1917; the important point is the mechanism for overcoming deficient working capital and input supplies. It was to private mechanisms that the Soviet government turned. Any statement concerning ownership under a Soviet regime is illusionary.

Bogdanov, President of the Supreme Economic Council, stated emphatically on December 20, 1921, that large scale industries could only be re-established by foreign investment and technology (i.e. by private mechanisms):

> The investment of foreign capital is absolutely unavoidable as the equipment of whole branches of our industry depends upon foreign countries in so far as they were never created and supported in Russia by our own resources. It will be necessary to support these branches of industry in the future for a certain time by means of foreign capital and the introduction of foreign technical equipment.[10]

This capital and technology, added Bogdanov, were to be admitted in a controlled manner, 'only . . . where it is absolutely necessary, i.e., exploitation of new mines.' NEP had succeeded, he said, in moving industry from 'almost a standstill' in June 1921 to 'very, very slight' progress; but then he added a warning against optimism and suggested the road would be a long one, although the turn had been made. The policy of decentralization—i.e., the improvement in supply conditions by private trade and small plant leasing —was the factor behind the reversal in fortunes. NEP had a limited objective—to arrest the decline. In this it had been successful. The next step was reconstruction—restarting the numerous large and intact tsarist plants.

CONCENTRATION, TRUSTIFICATION, AND CONTRACTION

After several alternate solutions had been tried, it was decided to shrink the economic system by abandoning those plants making losses, grouping the remaining plants into trusts, and turning smaller or inoperable units back to domestic or foreign private enterprise.

The trust was designed with the introduction of foreign technical assistance in mind. The declared intent was to make the trust the vehicle for the transfer of foreign capital and technology demanded by Bogdanov. Examination of those trust agreements that are available confirms this objective. As reported in *Krasnya Gazeta*,[11] the twin aims of all trusts were, to obtain capital and assistance from abroad, and to retain chief controlling interest in the hands of the Soviets. One presumes the order of ranking was not accidental. The original

[10] U.S. State Dept. Decimal File, 316–107–661.
[11] January 26, 1922.

intent was to encourage foreign participation only in those trusts with dormant plants which were backward technically or which required large injections of capital. In practice most of the trusts looked to the West for assistance.

In the electrical and petroleum industries, technological progress was impossible without Western assistance, and so even comparatively well-run trusts looked westward. Trustification moved along fairly rapidly in late 1921 and 1922 but did little to improve the economic situation. Industrial production continued to slide downhill at an alarming rate and reached a nadir in the summer of 1922. The adopted countermeasure was the 'contraction of industry' policy. In order to reduce government subsidies, it was proposed by Vesenkha to select and close down nonessential industries.[12] A curious rationalization of this policy, made by Jacub, was that a socialist economy has alternate booms and slumps: 'each autumn and winter industry expands, while each spring it undergoes a crisis and contracts.' This statement was made in mid-summer and ignored the almost continual decline, winter and summer, which had been underway since the Bolshevik Revolution. Jacub viewed a condition of permanent crisis and suggested that a temporary contraction was not enough:

> There are only two ways to go—either pronounce our industry incurable . . . and close it down entirely, or else adopt measures, not for its contraction, but to keep it operating at capacity.[13]

In other words, technical and managerial rationality had to be injected into the shambles that the Bolsheviks had created from a buoyant, viable economy.

The end was reached in August 1922. There is a report in the State Department files concerning a meeting at Vesenkha. Bogdanov made the opening address and again stated in the bluntest language the condition of industry organization: it had 'reached its limit.' The situation was 'appalling and desperate.' The only hope, concluded Bogdanov, was the receipt of foreign capital and a good harvest coupled with complete denationalization.[14]

THE TREATY OF RAPALLO (APRIL 16, 1922)

After the collapse of the Genoa Conference, the Soviets and the Germans signed the Treaty of Rapallo, under which they reciprocally renounced all war claims and war losses. Germany also agreed to renounce compensation for nationalized property in the U.S.S.R., 'provided that the Soviet Government

[12] This policy is described in the four issues of *Ekonomicheskaya Zhizn*, Nos. 122–5, for June 2, 4, 7, and 8, 1922. Engineer Jacub read the report before a joint meeting of Gosplan and Vesenkha. Judged from the amount of space devoted to it, the report seems to have had top-level backing, but a lowly engineer was selected to present the total admission of failure.

[13] *Ekonomicheskaya Zhizn*, No. 125, June 8, 1922.

[14] IS Report (316–107–727).

does not satisfy similar claims of other States.' Diplomatic and consular relations were resumed, the most favored nation principles applied mutually, and the basis was established for resumption of trade and economic relations.

Rapallo laid the groundwork for economic recovery. American and European relief stemmed the famine. The military agreement of 1922 was the basis for development of the Red Army, Navy and Air Force, and gave the Soviets the benefit of German military technology. The long-denied economic protocols were the basis for German economic and technical assistance and gave the Soviets sufficient breathing space to consolidate the Revolution and turn to other members of the Western world for capital and technical assistance. It was a successful three-pronged policy and brought the U.S.S.R. back from the brink of complete collapse.

The State Department files contain a remarkable summary of the Communist viewpoint of Rapallo from a top-level source:

> . . . we are still the gainers from the Rapallo Treaty. Apart from the fact that our industry will be restored with the aid of German experts, our political activity and importance through the medium of Germany will increase very rapidly. . . . German specialists therefore are being welcomed into all branches of our State life and have already penetrated into the most important branches of industry. General Bauer's Commission now in Moscow is acquainting itself with all sides of our military life and advising the General Staff, although its official mission is merely to improve our aviation.[15]

With Rapallo and its important military and economic protocols came the International Barnsdall agreement which effectively halted the decline of Baku and modernized production techniques to make this area the most important earner of foreign exchange. By late 1922 the Soviets felt sufficiently strong to recommence exports of grain and renationalize privately operated organizations. The turning point of Soviet fortunes was mid-1922 and was dependent on the Rapallo protocols.

RECONSTRUCTION AND THE SECOND BOLSHEVIK REVOLUTION

Reconstruction as used in this era does not mean physical reconstruction but the revival of dormant enterprises. The revival of trade and distribution, together with the limited contribution of NEP, enabled a return to the Bolshevik road. The growth of small retail and manufacturing enterprises

[15] U.S. State Dept. Decimal File, 340-7-10. The document originated with IS and was marked 'CONFIDENTIAL For Secretary and Under Secretary.' See Appendix A for reliability of IS. The above extract comprises about one-third the total report, so that, on the basis of space, the impact of German assistance should be considered as a prime objective of the Soviets.

was choked off in 1924 as reconstruction by German technicians placed the Soviets into a stronger overall economic position. Over 300,000 private enterprises were closed within a few months.[16] An article in *Ekonomicheskaya Zhizn* entitled 'Results of the struggle against private capital' summarizes these major changes. Such a revolution would not have been dared unless Vesenkha felt confident about the possibilities of economic revival. In textiles, 44 percent were produced by private means in the first quarter of 1923–4 and only 14 percent in the last quarter. In flax, the percentage declined from 11 to 6 percent, and in woolens from 7 to 2 percent. The sugar trust had early German help and reported 27 percent in the first quarter and only 5 percent in the last. The salt syndicate, also with German aid, reported a decline from 40 percent to 10 percent. Both the sugar and salt trusts benefited from American machinery, for example, the Fulton Iron Works made extensive shipments of sugar machinery in 1922–3.[17]

The early Soviet economy was full of paradoxes, not the least of which was the source of the strength enabling the Second Bolshevik Revolution. Destitute in 1922, they were back on their feet in 1924. As individual trusts gained strength, private Russian elements were eliminated and replaced once again by the Soviet state. The foreign elements, however, were still needed. Their turn was to come at the end of the decade.

THE PROCESS OF ACQUIRING FOREIGN TECHNOLOGY

The Bolsheviks were revolutionaries *par excellence.* But revolutionary dogma contained no hints on the operation of a socialist economy. On this subject Marx, Engels, and Lenin were silent.

In spite of this silence, there was a clear recognition of the place of technology. The machine was the Marxian engine of progress. Given ignorance of the functions of the entrepreneur, it is not surprising that 'industrialization' and its superficial symbols, the tractor, the automobile, and machines in general, were seen as the high road to plenty. The assessment was superficial. It was assumed that the machine would work as well in a socialist environment as in a capitalist environment. The concepts of scarcity, rationality, and choice in relation to technology and innovation did not penetrate Leninist thinking. The end result was technological naïveté, and this was compounded by an overriding concern with things political.

Exhortations, slogans, shock methods, and ideological purity were seen as the solution to all problems, including machine and production problems. The collapse after the Revolution was a blow to the ideologues and was

16 Scheffer, *op. cit.*, p. 174.

17 U.S. State Dept. Decimal File, 661.1115/484. See *New York Times*, November 16, 1921, p. 13, col. 2, for German assistance to the salt industry.

explained away on the basis of exogenous conditions and enemies of the Revolution rather than a deficiency in the political ideology applied to economic fact. It was not Lenin who saw the solution; it was Krassin, ex-director of Siemens-Schukert A-G in Petrograd—capitalist turned revolutionary. Lenin had the pragmatic wisdom to adopt the Krassinist solution.

Introduction of NEP, concessions, and foreign skills and technology did not completely inhibit experimentation with a 'socialist technology.' Attempts were made to develop an indigenous technology to reduce reliance on the West. No attempt in the 1920s was successful, unless one counts the 2 percent of drilling by the turbine method (an indigenous development). If we place to one side the technical incompetence of the trust personnel, the root cause for failure was the superficial political view of technology and the denial of the necessity for choice among innovations. Choice became a political decision. The attempt to manufacture the GNOM, a small Soviet-developed tractor was a complete failure. Machinery was purchased in Germany and installed in the old Balakov factory. No tractors were ever produced. There were two fully equipped automobile plants (the AMO and the Russo-Baltic); neither produced an indigenously designed automobile. The comic opera production of the Putilovets tractor (a copy of the Fordson) prompted Sorensen to suggest blowing the plant out of its misery. The 700 'tractors' produced held together only a few weeks. The German and American engineers who tried to re-design and re-start the Kertsch steel works complained of political interference in decision-making. And so on. In the face of these failures, complete reliance was placed upon Western help, a solution rationalized as the necessary prelude to 'socialist construction.' The reliance became so great that the Five-Year Plan did not get off the ground until after contracts had been placed with Western companies and stiff penalty clauses inserted for failure to meet construction deadlines.

THE GERMAN 'SECRET' ENGINEERING DEPARTMENTS

The protocols to the 1921 trade agreement and the Rapallo Treaty with Germany were the foundation for the transfer of massive German technical aid. Inconclusive references to this transfer can be found throughout the State Department and German archives; nothing of substance has appeared in Western news media or books on Soviet development. This transfer has been as deeply buried as it was extensive.

It has been extraordinarily difficult to quantify the transfer. The data is exceedingly fragmented—much more so than that for any other aspect of this study.[18] A number of lists of German firms marked 'Streng vertrauchlich,'

[18] Material on German engineers in the U.S.S.R. is scattered throughout Microcopy T-120, Serials L2?3, L308, and L391 to L395.

for the attention of Minister Wallroth, were found in the German archives. Two of the lists were dated the 14th and the 19th of August 1922: a significant fact, as this was exactly the point at which Bogdanov proclaimed 'the end.' Material in the State Department files backs up the belief that when 'the end' was reached, massive German assistance moved in to restart the closed plants. In some cases the lists make reference to specific projects, such as Carbo II and some Agrar projects which have not turned up elsewhere and which cannot be identified.

The 2,000 or so German engineers and technicians who moved into Soviet industry after Rapallo were replaced by a greater number of American engineers after 1927–8. These were employed by almost all trusts, including Giprotsvetmet, Selmashtroi, Steklostroi, Giproneft, Gipromez, Resinotrest, Tsentroboom, RKI, AKO, Zernotrest.[19] The most noticeable feature, apart from their numbers, was the fact that they were spread across the face of the Soviet economy (see table 20–3). They were employed by all design and construction bureaus. The only gap was in the furniture industry. Large numbers of American specialists were concentrated in 'key' activities. For example, in 1929 there were 66 foreign engineers in the three trusts Tokmekh (instruments), Mosstroi (Moscow Building Trust), and Khimtrust (the Chemical Trust).[20] The range of employment went from water irrigation projects to candy manufacture. Nor were the Soviets reticent in admitting their acquisitive dragnet (although in more recent times they appear to have gone to great lengths to reduce dependence on Western skills):

> In matters of technical assistance we follow neither an English, nor a German nor an American orientation. Our orientation is a Soviet orientation. In every country we are ready and willing to learn in those areas in which that country is most advanced. When we had the problem of modernizing the petroleum, automobile and tractor industries we turned to the United States, as America is the leading country in these industries. When it came to the chemical industry we asked for German help and it is no fault of ours if we were forced to go elsewhere for part of our technical assistance. . . .[21]

Planning and administrative posts were handed over to foreigners. H. J. Larsons was Deputy Chief of Currency Administration; Alcan Hirsch was Chief Engineer at different times for Chemstroi, Chemtrust, Giprokhim and Giproazot, as well as Chief Consultant to the heavy chemical industry;

[19] See Bron, *op. cit.*, pp. 145–6, for a more complete listing.

[20] *Torgovo-Promyshlennaya Gazeta*, No. 166, July 23, 1929.

[21] *Ekonomicheskaya Zhizn*, No. 225, September 29, 1929. Compare this Soviet statement, which is clear enough, to the numerous statements in Western literature which argue that the Soviets developed without any foreign assistance. (See Holzman, *op. cit.*, L. Fischer, *op. cit.*, and M. Dobb, *op. cit.*)

Littlepage was chief engineer, later Deputy Director of Soyuszoloto. Downs was Technical Director of the Altai Polymetal Trust and so on. Even the sacred post of planning director at Gosplan was at one time reportedly held by a Swede.[22] That these individuals were needed is reflected in Party speeches and articles. Rykov, speaking before the First Moscow Oblast Soviet Congress in October 1929, related that the U.S.S.R. had had considerable success with foreign technology and the use of foreign techniques and that this had overcome technical backwardness and the shortage of engineering cadres. He indicated the practice was to be extended, and mentioned cases in which Soviet institutions had been working 'a great length of time' on projects when foreign consultants had checked and found the plans and construction deficient, which had necessitated starting again.[23] Ruykeyser's experience at Uralasbest confirms this possibility. One problem was that the proportion of technical personnel to factory workers in the more advanced countries of the West was about 10–15 percent, while in the Soviet Union it was not more than 2 percent. Of this 2 percent, only half had more than an elementary education. Of the plant directors in 770 works, 3.5 percent had no school education whatsoever, 71.6 had an elementary education, and the rest a high school education.[24] Given this shortage, it is not surprising that large numbers of Russians were sent abroad for training. All technical-assistance agreements and most equipment-purchase agreements contained clauses enabling the Soviets to have groups of their personnel trained abroad. This training was normally a few months, and no case has been uncovered where it ran longer than one year. In 1925–6 about 320 Soviet engineers were sent abroad; this rose to more than 400 in 1927–8 and to more than 500 in 1928–9. These were individual training visits in addition to the much greater number of technical delegates who went abroad for exploratory purposes.

Although there were ways of ensuring that these engineers returned to the U.S.S.R., it was more difficult, but not impossible, to retain Western engineers against their will. There are however some cases of the latter.[25]

The concession itself was a method of technological transfer. All such agreements required the transfer of the latest in Western technology, and some of the trading agreements (such as RAITCO) appear to have been much more

[22] U.S. State Dept. Decimal File, 336–129–99.

[23] U.S. Consulate at Riga, Report 6496, October 22, 1929.

[24] U.S. Consulate in Vienna, Report 2158, April 9, 1929 (316–110–1079.)

[25] For example, see Fred E. Beal, *Proletarian Journey* (New York: Hillman Curk, 1937). Beal met H. N. Swayne (an American) in Fergana, Uzbekistan. 'He was supervising the building of a gin mill for the Uzbekistan Soviet. He had two co-workers in this enterprise, an Englishman and a German. All of them were kept in the district against their will. How? The Russians couldn't find their passports. . . .' (P. 254.) Beal was a Communist Party member.

vehicles for the transfer of Western technology than means for the Western partner to 'trade' with the U.S.S.R. When the transfer was completed, the concessionaire was expropriated, as Leninist dogma dictated. There were few cases of compensation and these (Mologa and Harriman) were for tactical reasons involving the possibility of acquiring other fields of Western skills. After 1925, news of concessions was heavily restricted and in 1927 made an act of espionage.

Foreign companies did little to enlighten the Western public, and indeed there are reports that the companies themselves put effective clamps on news concerning concessions.

After 1927 the Type III technical-assistance agreement was widely used. Where assistance had previously been tied to the purchase of equipment on a 'turnkey' basis, it was now the subject of separate agreements. At the same time, the emphasis moved away from Germany and toward the United States, although the Soviets still had great interest in acquiring the fruits of German scientific endeavors. From January 8 to 15, 1929, a German 'Technical Week' was held in Moscow, and a series of lectures was presented by German professors and experts who came (all expenses paid) for the occasion. The lectures included several by technical directors of German firms such as Telefunken Radio, A.E.G., and Frederich Krupp, and directors of technical institutes such as the Mulheim Coal Mining Institute and the Chemical Research Institute. The theme was the transfer of German work to the Soviet Union in the 'search for peace.'[26]

The Smolensk archives contain an example of the efficiency of the internal distribution of Western technology within the U.S.S.R. The State Institute for Foreign Technical-Economic Information published a monthly entitled *Fruitgrowing Economy* (presumably one of a series of such journals). This was a mimeographed circular which detailed in a summary manner the current results of Western research. It abstracted such obscure journals as the *Agricultural Gazette of New South Wales*, which would be difficult to locate in even a well-stocked Western library. Matching dates of the original articles with date of publication shows that the time difference was only a matter of months.[27]

PROBLEMS IN THE ACQUISITION OF FOREIGN TECHNOLOGY

The transfer was by no means smooth and efficient. *Ekonomicheskaya Zhizn* made a survey of the inefficiencies resulting from use of foreign technology.[28]

[26] U.S. Consulate at Riga, Report 5869, February 2, 1929. (340–6–499.)

[27] Smolensk Archives, Microcopy T 87, Roll 31, File WKP 264.

[28] *Ekonomicheskaya Zhizn*, No. 57, March 7, 1928; No. 72, March 25, 1928; and No. 83, April 7, 1928.

Enormous wastage of funds was found. This was partly due to lack of foresight, partly to inexperience and lack of coordination, and also to lack of funds at strategic moments.[29] Many British and German firms may have supplied inferior equipment, although this may be a Soviet rationalization of inability to cope with more advanced technical systems. However, it is difficult to see what protection was available if foreign manufacturers for one reason or another wished to foist second-rate and inferior equipment onto the Soviets. In the absence of an indigenous technology, they could compare performance only to their own antiquated plants or to other foreign purchases. There were no impartial arbiters built into the economic system.[30] It is also difficult to see how they could adapt a technology developed for another and presumably different set of relative factor scarcity patterns.

There were many cases of machinery being bought before the plant had been erected, so that complete factories were left standing, often with inadequate protection, until plants were erected. There were cases of plant and equipment not suiting each other. Given the very precise civil engineering tolerances required in modern construction, this is not too surprising. A paper factory in Leningrad had a building ready but only part of the equipment, 'and even this [could not] be assembled before the arrival of special foreign technical personnel who [were] having difficulties in obtaining visas.' Lack of coordination between foreign suppliers of equipment for the same plant was quoted as a major delay. A textile mill with a capacity for 127,000 spindles had only received 15,360. Equipment for a power station in the Don was lying on the ground, as the project had been abandoned. There were no funds available to install equipment at the Marti plant in Nikolaev; two plants of Ugostal (Petrovsk and Lenin)—the railroad workshops at Dniepropetrovsk and the Ukrainian Silicate Trust—had the same problem. The Komintern locomotive plant at Kharkov changed its plans and would not use equipment imported for its use. Other equipment valued at almost 400,000 rubles at the same plant was idle because there was no electrical power for installation. Transportation, communications, and similar problems were delaying and confusing, and diverted quantities of imported materials.

This problem of unused foreign equipment appears to have been widespread. *Izvestia* (March 31, 1928), in an article entitled 'Problems with imported equipment,' reported that Khimugol had imported 1.3 million rubles worth

[29] Barmine and Kravchenko both made this point.

[30] For example, in 1931 the Soviets bought one-third of the output of Ruston-Bucyrus (U.K.), a manufacturer of mechanical shovels. 'The Soviet purchases . . . not only helped to improve our earnings record, but also enabled Ruston-Bucyrus to clear out most of its stocks of obsolete Ruston and Hornsby models.' *Designed for Digging*, p. 260.

of equipment which could not be used for at least two years. Similar delays were reported for the Kharkov locomotive works, the Krivoi Rog power station, and a bolt-making works. Curiously enough, on the same day *Pravda* ran an article entitled 'Methods of transferring foreign techniques,' which described the channels to be used: first, sending Soviet engineers abroad; second, importing foreign engineers; and third, utilizing technical-assistance contracts. The actual ranking order of use appears to have been the reverse. This article laid the blame for mistakes on the procurement organs of the government and especially their failure to use up-to-date catalogs. There were cases of machinery imports in which the design was of 1890 vintage.

Restoration and modernization of the electrical equipment industry was almost entirely dependent on imported machinery, and in 1930 this represented 90 percent of all boilers, turbines, and generators installed. It was the resultant wide diversity of models which resulted 'in complicating the design, erection and construction of generating installations to a large extent.'[31] The balance of 10 percent was produced within the U.S.S.R. with foreign technical assistance and further compounded the diversity problem. Further problems arose because the Soviets insisted on non-standard features in turbine development; these turbines were produced at the U.K. works of Metropolitan-Vickers, and, if the Soviets are to be believed, some 25 of these turbines were giving trouble by about 1930–1.[32]

The uninhibited copying of Western products may not always have been the outright gift it superficially appears. Sorensen, of the Ford Motor Company, comments on this:

> What the Russians had done was to dismantle one of our tractors . . . and their own people made drawings of all the disassembled parts. I visited a department where the rear axle and the final drive were being assembled . . . a lot of trouble with the worm drive . . . it was apparent that, while the Russians had stolen the Fordson tractor they did not have any of our specifications for the material that entered into the various parts. And you can't find that out merely by pulling the machine apart and studying the pieces.[33]

Sorensen probably understates the problems. Even if a qualitative analysis was made, for example, on the axle steel, and a specification produced, the grade still had to be manufactured. The heat-treatment problems alone would be a major headache. Many Soviet products reported as of poor quality are probably no more than imperfect copies of Western products. Production of quality required concomitance of design, development, and production.

[31] *Electric Power Development in the U.S.S.R.* (Moscow: INRA, 1936), p. 101.

[32] *Correspondence Relating to the Arrest of Employees of the Metropolitan Vickers Company at Moscow*, Command Paper 4286. (London: H.M.S.O., 1933), p. 9.

[33] C. E. Sorensen, *op. cit.*, p. 202.

THE SHAKHTA AFFAIR

In 1928 the Soviets staged the first of their show trials involving foreign engineers. The Shakhta affair concerned five German engineers of A.E.G. working in the Shakhtinsky coal mines in the Don region.[34] The official charge was discovery of 'a counter-revolutionary plot to destroy and disorganize the coal industry.'[35] The engineers were accused of having links with former mine owners and the Polish counter-espionage service. It was said they had started fires, created explosions, wrecked coal-cutting machines, broken-down shafts, and generally created mayhem in the mines. In sum, they were accused of sabotaging 'socialist construction.' The burden of the accusation was placed on the foreign engineers as individuals and not on the foreign companies. Rykov carefully avoided accusing the firms of improper behavior.[36] The timing of the arrests, just as a German-Soviet treaty was to be negotiated and when the Soviets clearly needed German help, mystified most observers. U.S. State Department archives contain a number of foreign government reports, and their concensus is that the real reason for the arrests was the dominant place achieved by the Germans in Russian industry. They had become too powerful and threatened the hold of the Party. The move was against the 'united front' of specialists, old-time Russian engineers, trade unions, many of the workers, and some of the 'red' plant directors.[37]

The specialists controlled operation of many of the most important plants. They had supported and been supported by the old-time Russian engineers, not only because of similarity of political thinking but also by common background training and experience. The trade unions supported the foreign specialists as a means of getting production; many workmen viewed the foreign engineers with respect and the new 'red' engineers with derision. Many 'red' directors were interested primarily in output, recognized that the foreign specialists could get output, and placed day to day operations in their hands.[38]

Remaining Trotskyites used the question of specialists to 'prove' the Stalinist clique bourgeois; the latter then had common cause with the OGPU to attack this threat to Stalinist power. Terrorism via mass arrests was used to

[34] About 35 German engineers were jailed at this time on various charges, but only five as a result of Shakhta; and two of these were immediately released. The number in prison is an interesting indicator of the large number of German engineers in the U.S.S.R.

[35] *Izvestia*, No. 60, March 10, 1928.

[36] *Izvestia*, No. 61, March 11, 1928.

[37] U.S. State Dept. Decimal File, 316.6221/13 (Polish Foreign Ministry, Report); 361.6221/25 (German Foreign Ministry, Report); and 316–6221/28 (Greek Chargé d'Affaires in Moscow, Report).

[38] *Sevodnia* (Riga), March 21, 1928 [article by 'KC' (Moscow)].

frighten the foreign elements and their Russian allies. Choice of Shakhta was not accidental. Here the conflict between the 'red' and the foreign engineers was acute. Lambert, formerly a Belgian consul in Moscow, argued that the choice of the Ukraine was part of a reaction to Ukrainian nationalism which had sent many Muscovites back to Moscow and promoted native Ukrainians.[39] The Polish Foreign Office pointed out that it was noticeable that the many Belgian, Austrian, English, and American engineers were not molested. The Ministry argued this was one major aspect of an attack on *German* engineers. Further they were to be seized as scapegoats for the general inefficiency.[40]

[39] U.S. State Dept. Decimal File, 316.6221/32.

[40] U.S. State Dept. Decimal File, 361.6221/13, Report 1671, April 10, 1928. In view of the advice given to American firms in 1928 that it was 'safe' to enter the U.S.S.R., the following facts should be noted: (1) There was no shred of evidence of sabotage against the Germans. None was produced at the trials and none has ever been produced since 1928. They were 'acquitted' by the 'court.' (2) They were imprisoned in conditions described by the German Embassy representative Legationssekretaet, Dr. Schliep, as 'incredibly horrible,' while one of the unfortunate Germans was suffering from pneumonia (U.S. State Dept. Decimal File, 361.6621/13, Report 3403, April 13, 1928).

This once again raises the question whether the U.S. State Dept is justified in giving advice to United States firms and individuals which is contrary to the interests of these parties in the light of evidence with Departmental files. One presumes the function of the State Dept. is to protect American citizens, and yet today (1966), after the Baaghorn and Mott cases (among others), the State Dept. is still encouraging travel by tourists in the U.S.S.R.

CHAPTER TWENTY

The Western Contribution to Soviet Production and Productivity, 1917-30

THE CONTRIBUTION OF THE EARLY CONCESSIONS

The original intent of the concession was to acquire both foreign finance and technology; both were deemed equally necessary. As it turned out, only technology was acquired, but this was facilitated by sufficient private credits to enable the transfer to take place in a reasonably satisfactory manner. It is misleading to argue that economic development depends only on finance capital; the latter is only a vehicle for the transfer of technology. It is also misleading to argue that, because there were no government-to-government financial transfers, the Soviet Union developed without Western assistance. The major factor in development is technical progress. The key question to be asked in the case of Soviet development is, from what did its technology derive? From internal resources, or from external transfers?

Examination of the role of the early concessions suggests that they played an important part in reversing the industrial decline and establishing the base for development. International Barnsdall introduced modern American methods of rotary drilling and deep-well pumping with results described in chapter 2. The lumber industry was wholly dependent on the transfusion introduced by the operating sections of the mixed companies Russangloles, Hollandoles, and Norvegloles. All transportation was dependent on early German concessions (Russtransit, Derutra, etc.). The locomotive repair program was undertaken abroad. Most modernization work in textiles and clothing originated with the Sidney Hillman concession. Foreign markets were developed by Type II mixed company concessions. These early concessionary arrangements (not numerous, but located in strategic sectors of the economy), when coupled with the post-Rapallo assistance from Germany, helped the Soviets to turn the corner.

There was an interval in 1921–2 when contemporary sources were reporting industrial revivals in some sectors and shutdowns in others. These parallel but opposite movements are related precisely to foreign assistance and the concessions. McKeevsky was reporting its mines were closing down while the Kuzbas coal mines were responding favorably to the work of the American Industrial Corporation. In 1923 shafts in the Don were reduced from 202 to 176, while AIK doubled Kuzbas output. While Embaneft and Grozneft were declining, Azneft was picking up new life with International Barnsdall.

In sum, the upswing may be linked precisely to the introduction of the first concessions and German technical assistance. No case of an upswing was uncovered which was not so linked.

SECTORAL IMPACT OF CONCESSIONS ON THE EARLY SOVIET ECONOMY

The proposition that every industrial sector of the early economy had foreign technical assistance, specifically in the form of pure Type I, mixed Type II, or technical-assistance Type III contracts, has been examined in detail. The proposition is much too important to be dismissed with the verbal generalizations typical of much discussion of Soviet development. The next pages contain an empirical demonstration of the validity of the argument that every corner of the economy was penetrated by Western technology between 1917 and 1930.

The structure of the inherited tsarist economy was sufficiently broad that it can be spanned with the Standard Industrial Classification.[1] This economy contained in embryonic form representatives of most modern industries. The SIC is an identification code for the modern American structure, but the components of today's structure can be traced clearly to the first two decades of this century. All sections of the modern SIC were represented by at least one plant in tsarist Russia, and this was the structure inherited by the Soviets. The structure included aircraft and automobile manufacturing. The advantages of using the SIC code are that we may be sure that every sector in the economy presents itself for examination, that we are sure of discussing the whole economy, and that we do not dismiss some sectors because they happen to be inconvenient for the hypothesis. It has been, for example, inconvenient for the Soviets to admit there were aircraft and automobile technologies (of an indigenous nature) in tsarist Russia.

[1] *The Standard Industrial Classification (SIC)* (Washington, D.C.: Bureau of the Budget, 1957). Manufacturing is divided into 43 sectors, numbered 0 to 49. (Numbers 03 to 06, 18, and 43 are not used by the Bureau.) Sector 50 has been added by the writer to include trading.

Tables 20–1 and 20–2 classify concessions by country of origin and relate these to major groups in the SIC. Table 20–1 covers Type I (pure) and Type II (mixed) concessions while table 20–2 covers Type III or technical-assistance agreements. Where a concession has been identified and described in the text for a specific sector, its name has been inserted into the relevant portion of the matrix. In some sectors more than one concession existed but the extent of duplication is not indicated and can be determined from the text. A later set of tables examines the depth of technological impact within each sector. It should be added that the identification of concessions is still incomplete; it is estimated that less than 70 percent have been described and listed in this study. The remaining 30 percent will not come to light until the Soviets decide to release their archival data.

After compilation, the tables were scanned to determine the concession type and country making the greatest contribution to the Soviet industrial

Table 20-1 SECTORAL IMPACT OF FOREIGN CONCESSIONS (TYPES I AND II)

Standard Industrial Classification (Major Group)	*Industry*	*Source of Concessions Skill and Capital*		
		United States	*Germany*	*Others*
01*	Commercial farms	Ware	Druag	Cannon (U.K.)
02	Noncommercial farms	Communes	Communes	Communes
07	Agricultural services	Hudson's Bay (Canada)	Druag	Vinge (Norway)
08	Forestry	—	Mologa	Russangloles (U.K.)
09	Fisheries	—	Hochseefischerein	Romanoff Caviar
10	Metal mining	Harriman	Rawack & Grunfeld	Tetiukhe (U.K.)
11	Anthracite	RAITCO	—	Lena Goldfields (U.K.)
12	Bituminous coal	AIK	—	Grumant (U.K.)
13	Crude oil	Int'l Barnsdall	—	Gouria (U.K.)
14	Quarries	Int'l Mica	Krupp	Lena Goldfields (U.K.)
15	Building, general	ARK	Kossel A-G	Geoffrey & Curting (U.K.)
16	Building (not housing)	Ragaz	Krupp	—
17	Special trades	ARK	Russgertorg	Kablitz (Latvia)
19	Ordnance	—	GEFU	—
20	Food	Morris	Seyfurt	Union Cold Storage (U.K.)
21	Tobacco mfr	—	—	Lopato (China)
22	Textile mills	RAIC	—	Altman (Austria)
23	Apparel	RAIC	Stock	Trilling (Poland)
24	Wood products	—	Mologa	Dava-Britopol (U.K.)

Table 20-1 Continued

Standard Industrial Classification (Major Group)	*Industry*	*Source of Concessions Skill and Capital* United States	Germany	Others
25	Furniture	—	—	—
26	Paper products	—	—	Raby Khiki (Japan)
27	Printing	—	Berger & Wirth	—
28	Chemicals	—	Bersol	—
29	Petroleum refining	Standard of New York	—**	—
30	Plastics	Kahn	—	S.I.M.P. (France)
31	Leather products	Eitingon-Schild	Wostwag	—
32	Stone, glass	AIK	Krupp	AGA (Sweden)
33	Primary metals	Russian-American Steel	Bergman	Lena Goldfields (U.K.)
34	Fabricated metal	—	Derumetall	Raabe (Finland)
35	Machinery (not electrical)	Westinghouse Brake Works	Leitz	SKF (Sweden)
36	Electrical equipment	International General Elect.	—	Swedish General Electric (Sweden)
37	Transportation equipment	International Harvester Co.	Junkers	Fiat (Italy)
38	Scientific instruments	Russian-American Instrument	—	Sovmetr (France)
39	Misc. mfg.	Alamerico	Block & Ginsberg	Schulmann (Latvia)
40	Railroads	—	Mologa	Lena Goldfields (U.K.)
41	Local transit	—	—	Cunard Line (U.K.)
42	Motor freight	—	—	—
44	Water transport.	—	Hamburg-Amerika Line	Norway-Russian Navigation (U.K.)
45	Air transport.	—	Deruluft	—
46	Pipelines	—	—	—
47	Transportation services	Russcapa	Derutra	Irtrans (Italy)
48	Communications	RCA	—	Great Northern Telegraph(Denmark)
49	Utility services	—	Hecker A-G	—
50	Trading	Alamerico	Russgertorg	Rusavstorg (Austria)

* All sectors in the SIC have been listed. Some numbers were not used in the original classification. This accounts for number gaps above.

** File 312 of the Bureau of Foreign and Domestic Commerce indicates the Germans obtained 'operating privileges' in the Maikop oil fields under the Rapallo Treaty protocols. No other data is known nor have other German Type I or II concessions been unearthed for this activity.

structure (i.e., which type is represented in most sectors). The type with the largest number of representations was United States Type III technical-assistance agreements, of which there were 36. This is consistent with our argument that United States technology was the preferred technology. Out of a total 43 sectors[2] that could have received concessions and the transfer of Western skills and technology we identified 36, or 84 percent. As the early economy consisted of only a few plants of prerevolutionary origin in each sector, the transfer could be rapidly spread within the sector. The agreements were made with either the trust overseeing the plants or with the best equipped and largest member of the trust group. Consequently, identification of even one technical-assistance agreement with a member of a narrowly defined industry with only a few plants implied that the transfer could be rapidly spread. Bogdanov indicated that the trusts were created with the prime purpose of transferring foreign technology; in practice they were well suited for this purpose.

It is interesting to note the contiguity of trusts and the SIC classification groupings; it is almost as if Lenin had the SIC Manual in front of him when he drew up the contours of the trusts. Crude oil (SIC 13) plus petroleum

Table 20–2 SECTORAL IMPACT OF FOREIGN TECHNICAL ASSISTANCE AGREEMENTS (TYPE III)

Standard Industrial Classification (Major Group)	*Industry Name*	*Source of Technical Assistance*		
		United States	*Germany*	*Others*
01	Commercial farms	None outside	Type I and II	concessions
02	Noncommercial farms	Campbell	Druzag	Truss (U.K.)
07	Agricultural services	Sullivan Machinery	Wostwag	Langmann (U.K.)
08	Forestry	—	—	Harry Ferguson, Ltd.
09	Fisheries	—	—	—
10	Metal mines	Oglebay, Norton	Rawack & Grunfeld	—
11	Anthracite	Stuart, James and Cooke	Steinback & Taube	—
12	Bituminous coal	Allen & Garcia	Knapp A-G	—
13	Crude oil	Int'l Barnsdall	Machinenbrau	Mitsubishi (Japan)
14	Quarries	General Engin. Co.	Deilmann Bergbau	—
15	Building-general	Longacre	Humboldt	—

[2] Table 20–2 consists of 43 sectors, as commercial farms were not relevant for the U.S.S.R., but table 20–1 includes 44 sectors, as there were concessions operating commercial farms. In any event, it makes little difference to the basic argument.

Table 20–2 Continued

Standard Industrial Classification (Major Group)	Industry Name	Source of Technical Assistance: United States	Germany	Others
16	Building (not housing)	Koppers	Koppers	Karlsrads Mechaniska
17	Special trades	Austin	Gefrierschachbau	—
19	Ordnance	—	Krupp	Fokker (Holland)
20	Food	McCormick	Harberger	Maatschappij (Holland)
21	Tobacco mfr	—	—	—
22	Textile mills	Lockwood, Green	Kohorn	Soieries de Strasbourg (France)
23	Apparel	RAIC	—	—
24	Wood products	—	—	—
25	Furniture	—	—	—
26	Paper products	Hardy, Ferguson	—	—
27	Printing	Fulton Iron	—	—
28	Chemicals	Dupont	I. G. Farben	Casale (Italy)
29	Refining	Graver	Wilke & Pinsche	Vickers (U.K.)
30	Plastics	Seiberling	—	—
31	Leather products	—	Steinert	—
32	Stone, glass	Thomas Co.	—	Vakander (Sweden)
33	Primary metals	Freyn	Demag	SKF (Sweden)
34	Fabricated metal	McDonald	Faudewag	RIV (Italy)
35	Machinery (not electrical)	Mechanical Mfg.	Deutz	Separator (Sweden)
36	Electrical equip.	GE	A.E.G.	Metropolitan-Vickers (U.K.)
37	Transportation equipment	Koehring	Hohernzollern	Armstrong-Whitworth (U.K.)
38	Scientific instruments	Sperry Gyroscope	A.E.G.	Compagnie Générale de TSF (France)
39	Misc. mfg.	Underwood	Messer	—
40	Railroads	Baltimore & Ohio	Siemens Bau	Brown-Boveri (Switzerland)
41	Local transit	Seabrook	Siemens Bau	—
42	Motor freight	Ford Motor	—	—
44	Water Transport	Moissieff	Friedlam	—
45	Air Transport	Irving Chute	Junkers	—
46	Pipelines	J. I. Allen Co.	Mann	Crossley (U.K.)
47	Transportation services	Davis, Bishop	Derutra	—
48	Communications	RCA	Telefunken	Ericsson (Sweden)
49	Utility services	J. G. White	Siemens Schukert	Werksaden Kristinegamm (Sweden)
50	Trading	Heller	Derumetall	Johnson, Mathey (U.K.)

refining (SIC 29) equals the Neftsyndikat, comprising Azneft, Grozneft and Embaneft. Anthracite mining (SIC 11) plus bituminous coal mining (SIC 12) equal the coal trusts (Donugol, etc.). Ordnance (SIC 19) equals the military trust. Scientific Instruments (SIC 38) equals Tokmekh; SIC 30 equals Resinotrest; SIC 33 equals Ugostal; and so on. There are two possible explanations. First, when the trusts were being designed with the objective of technological acquisition as their prime purpose, they may have been grouped in order to facilitate the transfer. Second, there is an internal logic to the structure of modern industrialization, and the early Soviet economy had the same structure as the early American economy, although the similarity has not persisted. In other words the grouping may have been obvious on grounds of logic.

Examination of the 36 (out of a possible 43) sectors covered by United States technical agreements and the 7 sectors not covered by such agreements suggests that, in fact, coverage was greater than 84 percent and was virtually complete. In other words the Soviets transferred United States technology to every sector.

Of the seven listed as not receiving technical assistance, several received *informal* aid as a by-product of purchases of large installations. Purchases of sawmill equipment included equipment installation. Fisheries received indirect aid from Pacific Coast manufacturers in the construction of large crab and salmon canneries. Even SIC 19 (ordnance) received indirect aid through the purchase of Curtiss engines. This problem is overcome in table 20–7, which examines the degree of impact and includes two types: direct and indirect technical impact.

The second largest group of concessions is the 'other country' Types I and II category (table 20–1). These comprise pure and mixed concessions with countries other than the U.S. and Germany. Out of 44 possible 'other country' sectors, these concessions were identified in 33 sectors, or 75 percent. They were concentrated in raw materials development. The category contains Lena Goldfields, Ltd., Tetyukhe, Kablitz, Trilling, the Japanese Sakhalin concessions, SIMP, ASEA, SKF, Union Cold Storage, Altman, Raabe, and so on. Pure 'other country' concessions were comparatively rare in the industrial and transportation fields. When they were granted, they were limited in scope, occupied prerevolutionary plants in decrepit condition, and were granted a technological area in which the limited company was an acknowledged world leader such as AGA, SKF, and the Cunard Line.

There were no 'other country' pure concessions in the fields of ordnance, chemicals, petroleum refineries, and, generally, transportation. These were strategic sectors requiring the transfer of German or United States technology.

The third largest group is German technical-assistance contracts. There were 32 sectors with identifiable agreements of this type, or 74 percent. This group contains many of the largest and best-known German companies: Demag, Koppers, Humboldt, Krupp, A.E.G., Siemens, Junkers, and so on.

The fourth largest group comprised German pure and mixed concessions representing work in 29 sectors, or 66 percent. This group also contained well-known German firms; Leitz, Krupp, Hamburg-Amerika Line, etc.

The fifth group comprised United States pure and mixed concessions and is represented in 27 sectors, or 61 percent. This included also some well-known names: Harriman, International Oxygen, International Harvester, and Standard Oil of New York.

The last and smallest group comprised the 22 'other country' technical-assistance agreements, represented in 51 percent of the economy. This small group confirms the argument that the desirable technology was from Germany and the United States. When it was transferred from one of the 'other countries' it was always in a highly specialized and narrowly defined area, such as ball bearings, synthetic nitrogen, radio apparatus, telephone equipment, dairy apparatus, and artificial silk technology. In sum, the Soviets went to countries other than the United States and Germany when there was a decided superiority in the technology in question.

Table 20–3 SUMMARY STATEMENT OF SECTORAL IMPACT OF TYPES I AND II CONCESSIONS

	Types I and II Concessions Associated With:		
	United States	*Germany*	*Other countries*
Sectors with Type I & II concessions	27 (61 percent)	29 (66 percent)	33 (75 percent)
Sectors without Type I & II concessions*	17 (39 percent)	15 (34 percent)	11 (25 percent)
Total sectors**	44 (100 percent)	44 (100 percent)	44 (100 percent)

* This is a conservative statement, as less than 70 percent of operating concessions have been unearthed.

** Summary regardless of geographic association:
95.0 percent of all sectors had concessions (42 sectors)
5.0 percent of all sectors did not have concessions (2 sectors)

There is another way of looking at tables 20–1 and 20–2 and the summaries contained in tables 20–3 and 20–4. How many sectors of the early Soviet economy received concession agreements? Of the 44 sectors of the economy open for Types I and II concessions, 42 sectors, or 95 percent, actually received them. Of the 43 sectors open for Type III technical-assistance agreements, some 40 sectors or 93 percent received them.

Table 20–4 SUMMARY STATEMENT OF SECTORAL IMPACT OF TYPE III TECHNICAL ASSISTANCE AGREEMENTS

	Technical Assistance Agreements Associated with:		
	United States	*Germany*	*Other countries*
Sectors with t/a agreements	36 (84 percent)	32 (74 percent)	22 (51 percent)
Sectors without t/a agreements	7 (16 percent)	11 (26 percent)	21 (49 percent)
Total sectors	43 (100 percent)	43 (100 percent)	43 (100 percent)

Note: Summary regardless of geographic association:
93 percent of all sectors had technical assistance agreements (40 sectors).
7 percent of all sectors did not have technical assistance agreements (3 sectors).

Source: Table 20–2.

Finally, if we assume that the technical transfers take place irrespective of legal ownership or operational status (i.e., that we do not distinguish between concession types), *then only one sector out of the 44* (furniture and fixtures) did not receive a concession and thus had no opportunities for technological transfer. Of the total sectors 98 percent took advantage of foreign technology, and this was supplemented by indirect transfers.

Table 20–5 SUMMARY STATEMENT OF THE SECTORAL IMPACT OF ALL CONCESSIONS, IRRESPECTIVE OF TYPE

	Concessions Associated with:		
	United States	*Germany*	*Other countries*
Sectors with concessions	38 (86 percent)	38 (86 percent)	39 (89 percent)
Sectors without concessions	6 (14 percent)	6 (14 percent)	5 (11 percent)
Total sectors	44 (100 percent)	44 (100 percent)	44 (100 percent)

Note: Summary regardless of geographic association:
98 percent of all sectors had some form of concession (43 sectors).
2 percent of all sectors had no form of concession (1 sector).

Source: Tables 20–1 and 20–2.

SECTORS WITHOUT IDENTIFIABLE CONCESSIONS

To this point discussion has been concerned with sectors possessing identifiable concessions. The results imply an infusion of Western skills and technology. As Krassin foresaw, 'Each concession (would) . . . infuse a spark of vitality into the country's industrial life and would be in itself a training ground for Russian technical specialists and workmen.'[3] Use of the SIC code ensured that all sectors came up for consideration in an impartial

[3] Krassin, *op. cit.*, p. 184.

manner and that any possible biases on the part of the researcher would be eliminated. Possible criticism of the use of the SIC is far outweighed by the impartiality obtained.

Examination of sectors without concessions indicates the thoroughness with which the Soviets undertook this program. It is difficult to see how the canard of 'no large number of concessions' arose and spread to the point of becoming part of State Department advice to a well known scholar.[4] It is interesting to note that the handful of books written in 1928–9 on the impact of concessions universally reduced its importance, and nothing has been written since that time.

Of 44 sectors, only one had no identifiable concession. This is SIC 25 (furniture and fixtures): hardly surprising, as furniture making is a small scale industry with a static technology. Further only two sectors (apart from furniture) had fewer than two concessions: tobacco manufacturing and motor freight transportation, each of which had one concession. Given the extensive makhorka industry, the former exception is not surprising. The lack of motor buses until 1924 and absence of roads makes the latter exception understandable. There was no Soviet automobile industry until the Ford-Fiat agreements of 1928–9. All other sectors had concession agreements with two or more countries. Reliance was not placed on one source of technology. The net was spread wide enough to capture all the benefits of Western technology wherever they originated.

THE DEGREE OF TECHNOLOGICAL IMPACT WITHIN SPECIFIC SECTORS

It now remains to estimate the degree of impact within each sector. Table 20–6 estimates the direct and the indirect impact of Western technology upon each of the sectors discussed in Part I.

Table 20–6 DIRECT AND INDIRECT IMPACT OF WESTERN TECHNOLOGY BY SECTOR AND SUBSECTOR

Industry	*Estimated Direct Impact*	*Estimated Indirect Impact*
Oil industry (chap. 2)		
Exploration technology	Complete	Not applicable
Drilling technology	Complete	Not applicable
Pumping technology	Complete	Not applicable
Oil-field electrification	Complete	Not applicable
Pipeline construction	Complete	Not applicable
Refinery construction	Complete	Not applicable
Market acquisition	Complete	Not applicable

[4] See page 10.

Table 20–6 Continued

Industry	*Estimated Direct Impact*	*Estimated Indirect Impact*
Coal and anthracite mining (chap. 3)		
Coal fields: Donetz	Heavy	Significant
Kuzbas	Complete	Not applicable
Moscow	Heavy to complete	Not applicable
Far East	Complete	Not applicable
Sakhalin	Complete	Not applicable
Shaft development	Complete	Not applicable
Mine mechanization	Complete	Not applicable
Ferrous metallurgy (chap. 4)		
Iron-ore mining	Heavy	Limited
Blast-furnace repairs	Limited to significant	None
Blast-furnace new design	Complete	Not applicable
Steel-plant construction	Complete	Not applicable
Rolling-mill construction	Complete	Not applicable
Nonferrous Metallurgy (chap. 5)		
Zinc mining	Significant	Limited
Zinc smelting	Complete	Not applicable
Lead mining	Significant	Limited
Lead smelting	Complete	Not applicable
Copper mining	Significant	Limited
Copper smelting	Complete	Not applicable
Silver mining	Complete	Not applicable
Silver smelting	Complete	Not applicable
Manganese production	Complete	Not applicable
Manganese markets	Complete	Not applicable
Miscellaneous mining and smelting (chap. 6)		
Gold mining	Complete	Not applicable
Platinum mining	None	Heavy
Platinum markets	Heavy to complete	None
Bauxite exploration	Heavy	None
Pilot aluminum smelting	Complete	Not applicable
Mica mining	Complete	Not applicable
Asbestos mining	Heavy to complete	Not applicable
Asbestos mill technology	Complete	Not applicable
Asbestos shingles manufacture	Complete	Not applicable
Agricultural technology (chap. 7)		
Wheat farming	None	Significant
Seed growing	Limited	Limited
Cotton growing	Limited	Limited
Merino flocks	Complete	Not applicable
Dairy industry	Significant	Limited
Egg and butter markets	Complete	Not applicable
Tractors	Complete	Not applicable
Other agricultural equipment	Limited	Limited

Table 20–6 Continued

Industry	*Estimated Direct Impact*	*Estimated Indirect Impact*
Other food industries (chap. 8)		
Fishing	Limited	None
Fur collection	Limited	None
Fur sales	Heavy	None
Fish canneries	Heavy	Limited
Lumber industry (chap. 9)		
Forestry production	Heavy	None to limited
Lumber markets	Complete	Not applicable
Pulp and paper mills	Not applicable	Complete
Machine construction (chap. 10)		
Locomotive construction	Heavy	Not applicable
Machine building	Heavy to complete	Not applicable
Ball bearings	Complete	Not applicable
Steam boilers	Heavy	Not applicable
Precision engineering	Complete	Not applicable
Electrical equipment industry (chap. 11)		
High-tension equipment	Complete	Not applicable
Electrical motive equipment	Complete	Not applicable
Low-tension equipment	Complete	Not applicable
Accumulators	Complete	Not applicable
Turbines and generators	Complete	Not applicable
Hydroelectric technology	Heavy	Limited
Chemicals, compressed gases and dyes (chap. 12)		
Synthetic ammonia	Complete	Not applicable
Nitric acid	Complete	Not applicable
Superphosphates	Complete	Not applicable
Sulphuric acid	Complete	Not applicable
Coke oven by-products	Complete	Not applicable
Oxygen and hydrogen	Complete	Not applicable
Basic and intermediate dyes	Complete	Not applicable
Glass technology	Complete	Not applicable
Rubber technology	Heavy	Limited
Clothing, housing, and food (chap. 13)		
Textiles	Heavy	Limited
Clothing manufacture	Limited	Limited
Artificial silk	Complete	Not applicable
Buttons	Limited	None
Food processing	Significant	Limited
Construction industry	None to limited	Limited
Misc. small items	None to limited	Limited

Table 20-6 Continued

Industry	*Estimated Direct Impact*	*Estimated Indirect Impact*
Transportation and transportation equipment industries (chap. 14)		
Railroad operations	None to limited	Heavy
Railroad electrification	Complete	Not applicable
Telegraphic communications	Heavy	None
Radio communications	Complete	Not applicable
Automobile construction	Complete	Not applicable
Truck construction	Complete	Not applicable
Shipping	Heavy	Limited
Shipbuilding	Heavy	None
Port construction	Significant	None
Freight transportation	Limited	None
Military technology (chap. 15)		
Airplane construction	Complete	Not applicable
Pilot training	Complete	Not applicable
Poison gas production	Heavy	None
Artillery and shells	Complete	Not applicable
Armored cars and tanks	Complete	Not applicable
Trading companies (chap. 16)		
United States markets		
United Kingdom markets	All trading companies had heavy assistance in the early years of the decade.	
German markets		
Austrian markets		
Italian markets		

Note: This table summarizes the evidence presented in Part I concerning the degree of impact of Western technology on the Soviet economy. The 'direct impact' treated in column 2 refers to identifiable technical associations between Western firms and Soviet institutions. This involves not only Soviet adoption of Western processes *in toto* but also the employment of foreign engineers in the U.S.S.R. for production or training of Soviet engineers.

The 'indirect impact' treated in the last column refers to the acquisition of Western equipment not, however, operated by a foreign company. Such instances are comparatively rare in this period, but they become more common in the periods to be covered by later volumes. The characteristic distinguishing the two types of influence is the supply of supplementary services; training, installation, break-in operations and servicing. The degrees of impact are defined as follows:

Complete	80 percent of all new capacity
Heavy	60 to 80 percent of all new capacity
Significant	40 to 60 percent of all new capacity
Limited	20 to 40 percent of all new capacity
None	0 to 20 percent of all new capacity

Thus, in a sector such as oil-field rotary drilling, there was a complete and direct impact. The adopted technology was almost completely Western, and the equipment was installed and initially operated by a Western company.

THE CONTRIBUTION OF IMPORTED TECHNOLOGY TO SOVIET PRODUCTION

In 1921 production was zero or rapidly approaching zero. Large segments of the industrial structure were in a state of 'technical preservation.' The first task was to get these plants started; the second was to repair plants damaged or in disrepair; and the third was to modernize. Although each industry solved its problems in a slightly different manner, the importation of foreign skills was common to all of them.

The description in the preceding pages indicates that foreign technology had both an extensive coverage within the economy and a significant impact within each sector. No other factors were capable of bringing about the same end result. If internal skills or internal capital accumulation had existed then perhaps the answer would not be as obvious. As the facts stand, the conclusion is quite clear. The rapid growth of the 1920s was dependent on foreign operative and technical skills. Electrical energy grew more rapidly than any other sector; from a base of 100 in 1913 the index grew to 412 in 1929. There is no reason to doubt the basic accuracy of these figures. The assistance given Soviet trusts, together with the equipment known to have been imported, could have accomplished this increase, even allowing for the previously mentioned problems and inefficiencies in the transfer. By the end of the decade, Lenin's dictum that socialism equals electrification was well on the way to implementation. This was heralded as a triumph of socialist construction, but unless one defines the latter as Western enterprise operating in a socialist economy, it should be hailed as a triumph of Western private enterprise working under enormously difficult technical and political conditions. Western engineers were aghast, as their writings show, at the interference from political 'straw bosses' whose contribution to construction was purely verbal, generating great heat in a show of ideological fervor. The remarkable growth of production in the 1920s is in those sectors which received the greatest Western aid; coal, oil, pig iron, and rolled steel. Those sectors without a great deal of aid barely improved their position during the course of the decade.

The Western contribution to Soviet production between 1917 and 1930 was total. *No important process has been isolated which was not a West-to-East transfer*. The Soviets quite rationally made no attempt whatsoever to develop completely new processes; even experimentation was limited and soon abandoned. They concentrated on acquiring new Western processes, training cadres of politically reliable engineers and establishing numerous basic and applied research institutes. The question was not *whether* to transfer Western technology but *which* process to transfer. Decisions were made on the basis of Western factor resource patterns and these may, or may not, have been applicable to the U.S.S.R. There are a few signs that the Soviets were aware of this problem and induced Western companies to undertake the necessary research and development work.

CHAPTER TWENTY-ONE

The Significance of Foreign Technology and Concessions for Soviet Exports

THE COMPOSITION OF SOVIET EXPORTS

THE Bolsheviks were realists. There was little hope that largescale Western government credits would be forthcoming. World revolution was being actively promoted, and great things were expected daily from the German proletariat, for instance. It could not be assumed that even the most naïve of Western Governments or the most grasping of capitalists was going to subsidize its own downfall on credit terms. The alternatives were concessions, gold, or exports.

The concessions policy was closely related to the drive for exports. A decree signed by Lenin in August 1921 established an Extraordinary Export Commission to assemble, process, and store raw materials for export. The Commission had the right 'to impose fines and inflict punishment on persons guilty of delays.'[1]

Table 21-1 CAPITAL GOODS AS PERCENTAGE OF U.S.S.R. TRADE, 1920 TO 1930

	Capital Goods		*Raw Materials, Foodstuffs*	
	% Imports	*% Exports*	*% Imports*	*% Exports*
1920	39.7	—	60.3	100.0
1921–2	45.6	—	54.4	100.0
1922–3	76.2	—	23.8	100.0
1923–4	82.7	0.1	16.3	99.9
1924–5	68.5	0.3	30.8	99.7
1925–6	82.6	0.1	16.2	99.9
1926–7	89.5	0.1	9.3	99.9
1927–8	86.4	0.1	12.5	99.9
1928–9	88.4	0.3	10.2	99.8
1929–30	88.1	0.2	9.8	99.8

Source: Alexander Baykov, *Soviet Foreign Trade* (New Jersey: Princeton, 1946).

[1] *Ekonomicheskaya Zhizn*, August 26, 1921.

After this decree, a number of concessions were concluded under which foreign companies entered the Soviet Union to handle the assembly and export of animal products (eggs, butter, casings, fish and similar products). In 1920, imports were primarily food and raw materials; by 1923 imports were primarily capital goods. The first function of the concession was to help solve the supply crisis and then develop materials for export. After 1923, exports were between 99.7 and 100 percent raw materials and foodstuffs.

Table 21–1 suggests the significantly high proportion of Soviet imports which consisted of capital goods. This is consistent with our hypothesis of complete technological dependence on the West. The counterpart was a very high proportion of raw material and foodstuffs exports. The U.S.S.R. was exchanging consumer goods and raw materials for capital goods. This is not just the mere exchange of resources; the gains from trade were far more effectively captured by the Soviets as a result of their monopsonistic trading organizations facing atomistic Western sellers. Further, even with equality of bilateral bargaining, the Western investment in research and development could not be recouped in sales to the U.S.S.R. Only if the Soviet Union were to export freely its own technological advances would the balance be approximately even.

Very early trading efforts by the Soviets suggests that they did not then appreciate the advantages of a monopoly trading organization, but after about 1923, any attempt by Western sellers to form a buying group was met by vehement opposition and any concession (such as Russgertorg) which appeared to be gaining bilateral bargaining strength was quickly disbanded or had its wing clipped. Certainly the monopoly profits earned by the U.S.S.R. in the fifty years following the Bolshevik revolution far exceed that of the 19th century American trusts and 'robber barons' dealt with by the Sherman Act of 1890.

In sum, trade was used as a development mechanism. Manganese, oil, lumber, gold and butter developed by concessions operating inside the Soviet Union were sold on the Western markets by other concessions in which the Soviets held a controlling interest. The foreign exchange generated was used for purchase of capital equipment for the expansion and modernization of the industrial structure.

THE SIGNIFICANCE OF PURE AND MIXED CONCESSIONS IN RAW MATERIAL DEVELOPMENT

The concession may be related directly to the development of exports. Table 21–2 takes the twelve leading exports and lists the related importance of the concession as it has been detailed in Part I of this study.

Table 21-2 LEADING SOVIET EXPORTS AND SIGNIFICANCE OF CONCESSIONS

Rank Order	*Exports (1927–8)*	*Value of Exports thousand rubles*	*Percent of Total Exports*	*Significance of Concessions*[1]		
				Type I	*Type II*	*Type III*
1.	Oil	124,090	19.1	X	X	X
2.	Furs	119,207	18.3	X	X	—
3.	Lumber	118,540	18.2	X	X	X
4.	Clothing	103,163	15.9	x	x	x
5.	Eggs	40,462	6.2	—	X	X
6.	Butter	39,120	6.0	x	X	x
7.	Sugar	33,803	5.2	X	X	X
8.	Flax	25,893	4.0	x	—	—
9.	Manganese	13,781	2.1	X	X	X
10.	Wheat	11,210	1.7	x	—	x
11.	Casings	10,659	1.6	—	X	—
12.	Fish	10,367	1.6	x	X	x
		650,295[2]	99.9 percent			

Notes: [1] X = major significance
x = minor significance
[2] Percent of all exports: 80.9 percent

These items include just under 81 percent of all Soviet exports. Oil, furs, and lumber contributed just less than 20 percent each (together 55.6 percent) of this total; each activity was completely dominated by foreign assistance supplied through concessionary arrangements.

CHAPTER TWENTY-TWO

Conclusions

THE industrial structure of the Soviet Union between 1917 and 1930 was the reorganized tsarist structure. This consisted of several hundred medium-to-large manufacturing enterprises located in urban centers, notably Petrograd and Moscow. This manufacturing complex was supplemented by numerous self-contained mining enterprises in the Donbas and the Urals which were centers of incipient industrialization. Some of these plants were large by any standards. The International Harvester plant at Omsk for example was the largest in the company's world-wide network. The first major conclusion is that the tsarist industrial structure was not at all negligible. To say that 'Russia prior to 1917 was not unlike a country such as India on the one hand or large areas of southeastern Europe on the other,'[1] is rank absurdity. Airplanes and automobiles *of indigenous Russian design* were produced in quantity before the Bolshevik revolution. Although industrialization was restricted to a few population centers, it utilized modern, efficient plants operating on scales comparable to those elsewhere in the world. Further, there were obvious signs of indigenous Russian technology in chemicals, aircraft, automobiles, turbines, and railroad equipment.

The second major conclusion was that this structure was substantially intact after the Bolshevik Revolution. Intervention did not affect the main *manufacturing* areas. There was damage to the railroad system, particularly in the Donbas and Siberia, and the Port of Petrograd was heavily damaged and mined. Petrograd industry, however, was basically in operable condition. Industrial damage was concentrated in the Ukrainian sugar industry and in the Ural and Donetz Basin mines.

What, then, created the economic debacle of 1921–2?

It was not brought about by absence of operable production facilities. While plants were in a state of 'technical preservation,' work discipline collapsed,

[1] M. Dobb, *op. cit.*, p. 11.

and skilled workers, engineers, and managers fled into the villages or abroad. The distribution system was abandoned as unnecessary in a socialist economy. Productivity consequently sank to abysmally low levels, and the 'supply crisis' followed on the heels of the rejected distribution system. Systematic destruction of a viable economy was aided by the inflation of the ruble to zero value (on the basis that money was not needed in socialism), the 'instant demobilization of industry' decree, 'free' public services, and the replacement of skilled managers with unskilled proletarians. By August 1922 the Soviet economy was at the point of collapse. This is not deduction. Lenin, Bogdanov, Arsky, Krassin and others have made the point clearly. The end had come. As Krassin phrased the problem, 'Anyone can help pull down a house; there are but few who can re-build. In Russia there happened to be far fewer than anywhere else.'[2]

The economic decline which directly followed the Revolution is unparalled in the history of industrialized society; however, the Soviets not only survived, but in 1924 were able to institute the Second Bolshevik Revolution and return to the path of State control of industry. The factors behind the miraculous recovery are detailed in the text.

In mid-1922 Soviet industry was at a standstill. Soviet inability, for lack of skilled engineers and workers, to restart the tsarist plants is well illustrated by the Russo-Baltic plant at Taganrog, moved during the war from Reval. Four massive buildings were visited (and photographed) by the 1926 Ford Delegation. The plant had furnaces, hammers, hydraulic presses, and a power station, as well as approximately 2,000 machine tools. These had been idle since 1917, although coated with oil to keep the tools in some sort of preservation. The photographs indicate the gigantic size of the plant, idle for at least nine years. It was operable although perhaps technologically out of date compared to the rapidly developing industries in the West. The urgent needs were two-fold: to restart the silent plants and modernize the equipment. The trust was the organizational vehicle adopted for these objectives. As Bogdanov pointed out, the primary aim of the trust was the transfer of foreign skills and technology to fulfill both these urgent requirements.

Trustification and technical transfer were achieved step by step. First, a selection from among important industries was made. Choice was on an ideological basis. Railroads, mining, and machinery sectors were selected on the basis of political, not economic, choice; they were only coincidentally key sectors in the economy. In the process of selection, several key economic activities, such as gear-cutting (Citroen plant) and air-brake manufacture (Westinghouse Air Brake Company) were left in foreign hands. The pragmatic

[2] Krassin, *op. cit.*

Communists understood their own inability to run these rather complex enterprises. After selection, the remaining operable units were isolated from the inoperable, and the latter were left outside the trust structure. The inoperable units were offered to foreign firms as concessions (the Berger and Wirth dye plant, the Bergman ferrous metallurgy plant, the Kablitz boiler-making operation, the AIK textile plants, the Lena and Kemerovo mines, etc.). In sum, the isolation procedure eleminated two categories of economic activity from the trusts: first, complex operations requiring lengthy foreign assistance, and second, those units requiring substantial modernization. These were leased directly to foreign operators as pure concessions.

The remaining or operable units were then grouped into trusts. Most were either dormant or working on an intermittent basis; given technical and managerial skills, they were operable. The names were 'proletarianized' and attempts were made to restart. In some plants 'white' engineers took over from unskilled 'red' directors—notably in the electrical and machinery sectors. But in all cases operation without the discipline of the market system led to hopeless inefficiency. The answer to a massive loss was a massive subsidy. These got out of hand by 1923 and were countered by the 'contraction of industry' policy.

Contraction (i.e., elimination of the most heavily subsidized plants) was concurrent with the injection of foreign assistance. Although this began as early as 1919–1920, it received a strong assist from the German Trade Agreement of 1921 and the Rapallo economic, military, and trade protocols. Extensive documentation in the German Foreign Ministry Archives attests to the thoroughness and completeness of German economic and technical help after 1922.[3] Such assistance was at first almost completely German, in fact. The Shakhta affair reflects the influence of Germany in the U.S.S.R. The Soviets were concerned about the massive infiltration and influence of German specialists in Soviet industry. They had penetrated most large industrial and mining enterprises, and in many cases had formed understandings with the prerevolutionary engineers. Whatever the judicial failings of the Shakhta 'trials,' the OGPU was probably correct in recognizing a threat to the Revolution. As late as 1928, Soviet industry was run by a partnership of German and prerevolutionary engineers independent of nominal Party control.

The tendency at the end of the decade was to turn increasingly toward American technical leadership. Of the agreements in force in mid-1929, 27 were with German companies, 15 were with United States firms and the remain-

[3] The writer examined rather cursorily more than 25,000 documents, including a small group of Russian documents relating to this cooperation and the work of the various committees and sub-committees formed to channel the assistance. Committees IV and V were mainly concerned with the economic and technical aspects.

ing ones were primarily with British and French firms. In the last six months of 1929, the number of technical agreements with U.S. firms jumped to more than 40.[4] It is this change which forms a logical break in the examination of Soviet technology and industrial development. The usual break point—1928 (the beginning of the first Five-Year Plan)—is meaningful only in propaganda terms; the Plan was implemented *after* a sequence of construction and technical-assistance contracts with Western companies had been let.

The Freyn-Gipromez technical agreement for design and construction of giant metallurgical plants is economically and technically the most important.[5] Despite the German work, the metallurgical industry was on a 1913 technical level. It had not incorporated current advances in rolling techniques such as the American wide strip mill or the powerful, heavy blooming mills developed in the mid-1920's. The A. J. Brandt-Avtotrest agreement for reorganization and reconstruction of the prerevolutionary car plant (the AMO) was overshadowed by the 1930 Ford Motor Company agreement to build a completely new integrated plant for the mass production of the Model A, the 2.5-ton Ford truck, and buses using Ford patents, specifications, and manufacturing methods. The plant was erected by Albert Kahn, the builder of River Rouge and so enabled the Soviets to duplicate the immense advances of American automobile engineering within a few years of inception in the United States. Two agreements with Orgametal by other American companies completed assistance in the heavy engineering field. The electrical industry had the services of International General Electric (in two agreements), the Cooper Engineering Company and RCA for the construction of long-range powerful radio stations. The Stuart, James and Cooke, Inc., contracts with various coal and mining trusts were supplemented by specialized assistance contracts, such as the Oglebay, Norton Company aid agreement for the iron ore mines and the Southwestern Engineering agreement in the non-ferrous industries. The chemical industry turned to Dupont and Nitrogen Engineering for synthetic nitrogen, ammonia, and nitric acid technology; to Westvaco for chlorine; and to H. Gibbs to supplement I.G. Farben aid in the Aniline Dye Trust. This was supplemented by more specialized agreements from other countries: ball bearings from Sweden and Italy; plastics, artificial silk, and aircraft from France; and turbines and electrical industry technology from the United Kingdom.

4 Bron, *Soviet Economic Development and American Business.*

5 The U.S. State Dept. Decimal File contains a rather curious exchange of letters between Freyn Engineering and the State Dept. Obviously there had been a major communication of ideas and attitudes between both parties. Both sides, however, refrained from placing the understanding on paper; or at least an understanding has not been traced within the Archives. Those documents in the files suggest that Freyn was powerfully influenced by the State Dept. viewpoint. (See U.S. State Dept. Decimal File, 661.1116/62.)

The penetration of this technology was complete. ***At least 95 percent of the industrial structure*** received this assistance. To demonstrate this, all sectors of the economy have been examined impartially.

We may conclude therefore, that the basic Soviet development strategy was to learn from that country considered to have the most advanced processes within a given field of technology and to leave no industrial sector without the benefits of this transfer process. In 1929–30, some 40 million rubles were spent for technical-assistance agreements alone. When it is considered that the marginal costs to the Western supplier were very small, that this ensured extremely low purchase prices for technology (in the light of opportunity costs), and that much of the transfer was done informally at no cost as a part of equipment-supply agreements, then the magnitude of the benefits becomes very clear. The greater part of this sum was spent in the U.S.; 'In America,' it was said, 'they do not guard manufacturing secrets so jealously.'[7]

The success of this strategy was not lessened by the fact that political interests always dominated economic requirements. When individual concessions threatened the hold of the Party even remotely, the reaction was sharp and ruthless. The Shakhta affair was an example of Leninist terror used to bring a 'united front' into line, whatever might be the economic consequences. The move from German to American technology was partially dictated by the probability the American engineers were less likely to get tangled in the meshes of counter-revolution, which had its origin in Europe rather than the United States. Import of equipment always reflected the domination of the political. One of the first imports from the U.S., after the lifting of the blockade, was 1,300 printing presses from the Fulton Iron Works. Production of long-range radio stations went ahead rapidly with the help of RCA and International General Electric, at the time when the State Department files had ample evidence of subversion (see, for example, Microcopy 316, Roll 141 for Soviet activities in the Dutch East Indies in 1928, the cracking of the Bolshevik code and instructions to Soviet agents at precisely that time at which permission was given to RCA and IGE to export radio stations to Soviet Russia). One at least understands why RCA checked and then double-checked with the State Department on permission to export high-powered radio stations.

The dominance of the political aspects over the economic did not restrain development; the Soviets correctly foretold the inaction of major Western

[6] To place U.S. technical aid to the U.S.S.R. in perspective, the reader is referred to *Current Technical Service Contracts* (U.S. Dept. of State, 1966). Brazil is the largest country in this listing. Pages 62–6 list AID technical-assistance projects in Brazil. Comparison of these with U.S. aid agreements in the U.S.S.R. in 1928–9 will convey the enormous size and scope of the latter. There is nothing comparable to the Ford Motor Co. agreement, for example.

[7] *Ekonomicheskaya Zhizn*, No. 225, September 29, 1929, p. 3.

governments during the transfer of technology. The Soviets were determined and based their moves on accurate information. Western governments failed to cooperate one with another and made policy determinations inconsistent with material on file.

The concessions policy itself had two aspects. On one hand the Soviets described to the Western businessman the profitable opportunities awaiting entrepreneurs in the U.S.S.R. These were presented in hopeful little booklets, backed up by trade journals and trade delegations. On the other hand, the Soviets had only limited interest in the concession hence their eventual expropriation of the Western entrepreneur naïve enough to invest in the Soviet economy. There was no danger to the Revolution, said Lenin: 'They are a foreign thing in our system . . . but whoever wants to learn must pay.' The West was needed to build up socialism, did it matter if the Soviets gave away a few tens of millions in resources? As Lenin said, 'afterward we shall get it back with interest.'[8] The closer the explanation got to the rank and file, the more explicit were the Communists in describing the fate awaiting the Western businessman. It was unlikely that W. Averell Harriman was reading *Komsomolskaya Pravda*, and on this the Soviets guessed correctly. It is less credible that the State Department did not investigate the ample data at its disposal—data backed by very accurate field reports—to determine the fate of investors in the U.S.S.R.

As the lesson penetrated Western business circles, the pure and mixed concessions were replaced by the technical-assistance agreement, under which the assistance was either bought outright or was included as part of a large equipment order. After the 1928 Gillette Razor Blade concession, no further pure concessions were concluded. Mixed companies persisted for a few years. The technical agreement remains and is currently in use.

[8] *Komsomolskaya Pravda*, October 9, 1928.

APPENDIX A

A Guide to Sources of Material

ALMOST all of the material used in this study, including the microfilmed copies of State Department and other records, has been deposited with the Hoover Institution on War, Revolution and Peace, at Stanford University.

THE STATE DEPARTMENT DECIMAL FILE

The National Archives has published much of the State Department Decimal File for 1910–30 on microfilm. Microcopy 316 is the main source for this study, particularly Rolls 107 to 143. Wherever possible, references are given to the National Archives microfilm copy, not to the original Decimal File copy.

The first three figures of such a reference consist of the Microcopy number (usually 316); the second group of figures refers to the roll number in the microcopy, and the last group refers to the frame number.

Thus, 'U.S. State Dept. Decimal File, 316–131–228' means that the source is the Decimal File and the reference may be found in National Archives Microcopy 316, Roll 131, Frame 228.

Some Decimal File records have not been microfilmed; these are referred to by the original Decimal File number (i.e., 361.6221/1). They may be specially ordered on microfilm, or the original documents may be examined at the National Archives.

For readers in Washington, D.C., wishing to see the original document (not the microfilmed copy), the National Archives has finding aids which make it possible to trace the Decimal File number from the Microcopy-Roll numbers given in the text.

Documents of the Bureau of Foreign and Domestic Commerce are referred to by file number only. No roll and frame identification exists.

For German Foreign Ministry records references are to National Archives Serial, Roll and Frame numbers. Thus, 'German Foreign Ministry, T120–3032–H108752' refers to Microcopy T120, Roll 3032, Frame H108752.

RELIABILITY OF DATA ORIGINATING INSIDE THE U.S.S.R.

Archival material from United States and German sources was assessed according to the reliability given by the respective foreign offices. During the 1920s the United States had excellent sources of information inside the Soviet Union. Two agents (IS and IS/2) provided much political and economic material. IS was especially prolific and passed over many hundreds of documents. These were assessed by the State Department as reliable, and a number were marked for the attention of the Secretary and Assistant Secretary. The writer checked a selection of IS material against later events and found it to be very precise. No case was found where IS was wrong in an important fact.

APPENDIX B

List of Operating Concessions, 1920 to 1930

TYPE I (PURE) CONCESSIONS

Name	*Country of Origin*
Aktiebolaget Svenska Kullagerfabriken (SKF)	Sweden
Aktiengesellschaft für Bauaufurungen	Germany
Alftan Concession	Lithuania
Allezundsky Union	Germany
Allgemeine-Warren Treuhand A-G	Austria
Allied American Corp. (See Hammer, Julius)	
Allmanna Svenska Elektriska A/B (ASEA)	Sweden
Altebauag	Germany
Altman	Austria
Aluminum Company of America (ALCOA)	United States
American Asbestos Co.	United States
American Industrial Colony	United States
American Industrial Concession	United States
American Model Industrial Corp.	United States
American-Russian Constructor Co. (ARK)	United States
Anglo-Russian Grumant Co., Ltd.	United Kingdom
Aschberg Concession (Russian Bank of Commerce)	Germany
Ayan Corp. Ltd.	United Kingdom
Beloukha Corp.	United States
Berger and Wirth A-G	Germany
Bergman A-G	Germany
Block and Ginsberg	Germany
Boereznsky	Lithuania
Bolton, August	Germany
Brand, Leo	Germany

Name	*Country of Origin*
Brock A-G	Germany
Bryner & Co., Ltd.	United Kingdom
Cannon Co. Ltd.	United Kingdom
Caucasian-American Trading and Mining Co.	United States
Chatkeiama Gomei Kaisha	Japan
Chatma Co.	Greece
Christensen Concession	Norway
Control Co.	Unknown
Czestochova Concession	Poland
Deutsch-Russische Agrar Aktiengesellschaft	Germany
Deutsch-Russische Film Allianz A-G (Derufa)	Germany
Deutsch-Russische Saatbau Aktiengesellschaft	Germany
Dyer Concession	United States
Ericsson A/B	Sweden
Estonian-American Oil Co.	United States
Euroamerican Cellulose Products Corp.	United States
Far Eastern Prospecting Co., Inc. (Far Eastern Syndicate)	United States
Farquhar, Percival	United States
Gaso-Accumulator A/B	Sweden
German Fishing Union (Hochseefischerein)	Germany
Gesellschaft für Wirtschaftliche Beziehungen mit den Osten (Eastern Relations Society)	Germany
Gesellschaft zur Förderung gewerblicher Unternehmungen (Gefu)	Germany
Gillette Co.	United States
Gouria Petroleum Co., Ltd.	United Kingdom
Great Northern Telegraph Co. (Det Store Nordiske Telgraselskab)	Denmark
Hagakeyama Gomeikaisha	Japan
Hammer, Julius (see American Industrial Concession, etc.)	United States
Hammerschmidt, D. A.	United States
Harriman, W. A. Manganese Concession	United States
Haywood Concession	United States
Heller, L., and Son, Inc.	United States
Hillman Clothing Concession	United States

Name	*Country of Origin*
Hokushinkai	Japan
Holland-Ukraine Syndicate	Holland
Holter and Borgen	Norway
Holz Industrie Aktiengesellschaft Mologa	Germany
Hudsons Bay Co., Ltd.	Canada
Iasima Chatchiro	Japan
Igerussko (I. G. Farben)	Germany
ILVA Alti Forni e Acciaierie d'Italia s.p.a.	Italy
Indo-European Telegraph Co., Ltd.	United Kingdom
International Barnsdall Corp.	United States
International Harvester Co.	United States
International Mica Co., Inc.	United States
Italian Kuban Concession	Italy
Junkers-Werke	Germany
Kablitz, Richard (Gesellschaft für Okonomie der Dampferzeugungskosten)	Latvia
Kahn, Montefiore	United States, Germany
Kita Karafu Tau	Japan
Marchand et Cie.	France
Netherlands Spitsbergen Co.	Holland
Nichiro-Giogio Kabusiki-Kaisha	Japan
Otopitel (Refrigeration)	Unknown
Polar Star Concession	Unknown
Priamur Mines, Ltd.	United Kingdom
Prikumskaya (See Russian-American Agricultural Corp.)	United States
Raabe A/B	Finland
Resch Concession	Germany
Rheinbaden	Germany
Rorio Rengion Kumai	Japan
Rorio Rengio Rumian	Japan
Ruben and Bielefeld A-G	Germany
Russian-American Agricultural Corp. (Prikumskaya)	United States
Russian-American Engineering and Trading Co. (Raito)	United States
Russian-American Industrial Corp. (Raico)	United States
Russian-American Mining and Engineering Corp.	United States
Russian-American Steel Works	United States
Russian Mining Corporation	United Kingdom

Name	*Country of Origin*
Separator A/B	Sweden
Serkovsky, Yan	Poland
Shirak Oil (see Società Minere)	
Shova Kiuka Kabushiki Kaisia	Japan
Shulmann, Elia	Latvia
Siemens-Schukert	Germany
Sinclair Exploration Co.	United States
Singer Sewing Machine	United States
Skou-Keldsen	Germany
Società Minere Italo-Belge di Georgia	Italy, Belgium
Société Industrielle de Matières Plastiques (SIMP)	France
Spies Petroleum Company, Ltd.	United Kingdom
Stock A-G	Germany
Storens, F.	Norway
Tetuikhe Mining Corp., Ltd.	United Kingdom
Tiefenbacher Knopfabrik A-G	Austria
Trans-Siberian Cables Co.	Denmark
Trilling, O.	Poland
Tschemo A-G	Germany
Tsukahara	Japan
Union Minière du Sud de la Russie	France
United German-American Corp.	United States
Vega	Norway
Vinge and Co.	Norway
Vint Concession	United States
Ware, Harold (see Russian-American Agricultural Corp.)	United States
Westinghouse Air Brake	United States
Windt	
Wirtschaftliche Verband der Deutschen Hochseefischerein	Germany
Yasimo Hachiro	Japan
Yasimo Tanaka	Japan
Yotara Tanaka	Japan
Zatbaugesellschaft	Germany
Zellugal	Germany
Zhest-Western	Austria

TYPE II (MIXED COMPANY) CONCESSIONS

Name	*Country of Origin*
Alamerico (Berlin)	United States
Allied American Corp.	United States
American Foreign Trade Corp.	United States
American Industrial Corp.	United States
Amexima	Holland
Arbor Co.	Estonia
Baltische Russische Transport und Lager A-G (Baltrustra)	Germany
Bersol A-G	Germany
Brenner Bros.	United States
Compagnia Industriale Commercio Estero (CICE)	Italy
Cunard Line	United Kingdom
Dava-Britopol (Ruspoltorg)	Poland, United Kingdom
Deruluft	Germany
Deruneft	Germany
Derutra (Deutsch-Russische Transport u. Lager Gesellschaft)	Germany
Deruwa (German-Russian Merchandise Exchange)	Germany
Deutsch-Russische Metallverwertungs Gesellschaft m.b.H. (Derumetall)	Germany
Duverger Concession	France
Dvinoles Export, Ltd	United Kingdom
Eggexport	Germany
Eitengon-Schild	United States
Exportles	United Kingdom
French Steamship Lines	France
German Orient Line	Germany
German-Russian Krupp Manushka Co.	Germany
Hamburg-Amerika Line	Germany
Holland-Amerika Line	United States
International Oxygen Corp. (see Ragaz)	United States
Internationale Warenaustauschgesellschaft (IVA)	Germany
IRTRANS (Società Mista Italo-Russa di Commercio e Transporti)	Italy

Name	*Country of Origin*
Kazuli Co.	Greece
Kossayger	International
Kossel, P., A-G	Germany
Kossuryo	International
Krupp'sche Landconcession Manytsch G.m.b.H.	Germany
Narova Co.	Estonia
Nord-Ost	Germany
Norway-Russian Navigation Co., Ltd.	Norway, United Kingdom
Ocean Travel Bureau	United States
Persaneft (Persian-Azerbaidjian Naphta Co.)	Persia
Perskhlopok	Persia
Persshold	Persia
Perssholk	Persia
Raby Khiki Kansha	Japan
Ragaz (Russian-American Compressed Gas Co.)	United States
RAIF Iron Co. for aid to Volga Colonists	Germany
Ratao (Russische-Oesterreichische Handels A-G)	Austria
Rawack and Grunfeld A-G	Germany
Repola Wood, Ltd.	United Kingdom, Finland
Royal Dutch Shell	United Kingdom, Holland
Ruben and Bielefeld	Germany
Rugerstroi (see Kossel, P., A-G)	
Russangloles, Ltd.	United Kingdom
Russavstorg (Russisch-Oesterreichische Handels und Industrie A-G)	Austria
Russgertorg (Russische-Deutsch Handels A-G)	Germany
Russhollandoles, Ltd.	United Kingdom, Holland
Russian-Asiatic Stock Co.	International
Russian Bristles Co.	United Kingdom
Russian-Canadian Navigation Co. (Russcapa)	Canada
Russian Land Concession Manytsch, Ltd.	United Kingdom
Russian Wood Agency, Ltd.	United Kingdom
Russnorvegloles, Ltd.	Norway, United Kingdom

Name	*Country of Origin*
Russo-British Grain Export Co. (Russobrit)	United Kingdom
Russo-Latvian Co.	Latvia
Russ-Norwegian Navigation Company, Ltd.	United Kingdom, Norway
Russot	International
Russotgorn	Turkey
Russo-Turkish Export-Import Co. (Russo-Turk)	Turkey
Russperssakhar	Persia
Russpoltorg	Poland
Russtransit (Russo-German Trading and Transit Co.)	Germany
Sale and Company, Ltd.	United Kingdom
Seyfurt A-G	Germany
Sibiko (Danish-Siberian Co.)	Denmark
Società Mista Italo-Russa di Commercio e Transporti (IRTRANS)	Italy
Société Russo-Anglaise des Matières Premières (Raso)	United Kingdom
Sorgagen A-G	Germany
Sovmetr	France
Sovmong	Mongolia
Standard Oil of New York	United States
Stern	United Kingdom
Suomen Nahkatehtaitten Osakeyhtio	Finland
Sutta, Simon	United States
Sveaexport	Sweden, Finland
Truss, G. H. and Co., Ltd.	United Kingdom
Turksholk	Turkey
Ukrainian Brewing Co. (Okman)	Estonia
Union Cold Storage, Ltd.	United Kingdom
United States Lines	United States
Vlessing	Holland
Warren, G. and Co., Inc.	United States
West-Oestliche Warenaustausgesellschaft (Wostwag)	Germany
White Sea Timber Trust, Ltd.	United Kingdom
White Star Line, Ltd.	United Kingdom

TYPE III (TECHNICAL-ASSISTANCE AGREEMENT) CONCESSIONS

Name	*Country of Origin*
Allen, J. I., and Co.	United States
Allen and Garcia, Inc.	United States
Allgemeine Elektrizitets A-G	Germany
Allis-Chalmers Manufacturing Co. (see RAITCO)	United States
Akron Rubber Reclaiming Co.	United States
Aufbau Trade and Industrial Co.	Germany
Austin Co.	United States
Badger, E. B., and Co.	United States
Baldwin Locomotive Works	United States
Birmingham Small Arms Co.	United Kingdom
Borsig, A. G.m.b.H.	Germany
Brandt, Arthur J., Inc.	United States
Brown Lipe Gear Co., Inc.	United States
Burrell-Mase Co., Inc.	United States
Compagnie de Produits Chimiques et Electrométallurgiques S.A.	France
Campbell, Thomas	United States
Casale Ammonia S.A.	Italy
Caterpillar Tractor Co.	United States
Chase, Frank, Inc.	United States
Cheretti i Tonfani	Italy
Compagnie Générale de TSF	France
Cooper, Hugh L., and Co., Inc.	United States
Davis, Arthur P., Lyman Bishop, and Associates	United States
Deilmann Bergbau u. Tiefbau Ges.	Germany
Demag A-G	Germany
Deutz Motorenfabrik A-G	Germany
Deutsch Tiefbohr A-G (Deutag)	Germany
Du Pont de Nemours and Co.	United States
Electric Autolite Co.	United States
Electrokemisk	Norway
Ferguson, Harry S., Ltd.	United Kingdom
Ford Motor Co.	United States
Foster-Wheeler Corp.	United States

Name	*Country of Origin*
Fröhlich und Knüpfel Maschinenfabrik	Germany
Freyn Engineering Co., Inc.	United States
Gasmotoren-Fabrik Deutz A-G	Germany
Gebrüder Sulzer A-G	Germany
General Engineering Co.	United States
Geoffrey and Curting, Ltd.	United Kingdom
Harry D. Gibbs	United States
Goodman Manufacturing Co., Inc.	United States
Graver Corp.	United States
Harburger Eisen und Bronzewerke A-G	Germany
Hect-Feifer A-G	Germany
Henshien and Co., Inc.	United States
Hercules Motor Co., Inc.	United States
Hilaturas Casablancas S.A.	Spain
Higgins, John J., Co.	United States
Humboldt-Deutz Motoren A-G	Germany
International General Electric Co.	United States
Irving Air Chute Co., Inc.	United States
Albert Kahn, Inc.	United States
Karlstad Mechaniska Verkstaden A/B	Sweden
Kohorn, Oscar A-G	Germany
Koppers Construction Co.	United States
Frederick Krupp A-G	Germany
Lockwood, Green and Co.	United States
Longacre Engineering and Construction Co.	United States
Lurgie Gesellschaft für Chemie und Hüttenwerke m.b.H.	Germany
Maschinenfabrik Augsburg-Nürnberg A-G (MAN)	Germany
Maschinenbau A-G	Germany
Maschinenbau-Anstalt-Humboldt	Germany
Maatschappij Tot Exploitatie von Veredlinsprocedes	Holland
McCormick Co.	United States
McDonald Engineering Co.	United States
McKee, Arthur T., and Co., Inc.	United States
Mechanical Manufacturing Co., Inc.	United States
Messer A-G	Germany
Metropolitan-Vickers Electrical Co., Ltd.	United Kingdom
Multibestos Co.	United States

Name	*Country of Origin*
Neumeyr A-G	Germany
Newport News Shipbuilding and Drydock Co.	United States
Nitrogen Engineering Corp.	United States
Officine Villar Perosa (RIV)	Italy
Oglebay, Norton & Co., Inc.	United States
Penick and Ford, Inc.	United States
Pierce, Charles and Co.	United States
Pflanzennamme G.m.b.H.	Germany
Radio Corp. of America (RCA)	United States
Radiore Co., Inc.	United States
Reidinger, A-G	Germany
Roberts and Schaefer, Inc.	United States
Scintilla A-G	Switzerland
C. F. Seabrook Co., Inc.	United States
Seiberling Rubber Co.	United States
C. V. Smith and Co., Ltd.	Canada
Frank Smith Co., Inc.	United States
Société de Prospection Electrique Procédés Schlumberger	France
Société du Duralumin S.A.	France
Société Française Anonyme Lumière S.A.	France
Soieries de Strasbourg S.A.	France
Southwestern Engineering Corp.	United States
Sperry Gyroscope Co.	United States
Standard Oil Co. of New York	United States
Stein A-G	Germany
Steinert, C. T.	Germany
Stuart, James and Cooke, Inc.	United States
Sullivan Co. (see RAITCO)	United States
Szepesi, Eugene, Consulting Management Engineers	United States
Telefunken Gesellschaft für Drahtlose Telegraphie	Germany
Thyssens A-G	Germany
Timken-Detroit Axle Co.	United States
Torfplattenwerke A-G	Germany
Underwood Typewriter Co.	United States
Union Shoe	Austria

Name	*Country of Origin*
Vakander A/B	Sweden
Vattenbyggnadsbyran A/B	Sweden
Verein Deutscher Werkzeugmaschinen Fabriken Ausfuhr Gemeinschaft (or Faudewag)	Germany
Vereinigte Carborundum und Elekritwerke A-G	Germany
Vereinigte Kugellager Fabriken A-G	Germany
Warren, G. W., Co.	United States
Webber and Wells, Inc.	United States
Westinghouse Company (see Metropolitan-Vickers)	
Westvaco Chlorine Products, Inc.	United States
Wheeler, Archer E., and Associates	United States
J. W. White Engineering Co.	United States
Winkler-Koch Engineering Co.	United States
W. A. Wood Co.	United States

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Index

Western Technology and Soviet Economic Development 1930 to 1945

Second volume of a three-volume series

By

ANTONY C. SUTTON

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TO MY WIFE

Betty Janet

Preface

THIS is the second volume of an empirical study of the relationship between Western technology and entrepreneurship and the economic growth of the Soviet Union.

The continuing transfer of skills and technology to the Soviet Union through the medium of foreign firms and engineers in the period 1930 to 1945 can only be characterized as extraordinary. A thorough and systematic search unearthed only two major items—SK-B synthetic rubber and the Ramzin 'once-through' boiler—and little more than a handful of lesser designs (several aircraft, a machine gun, and a motorless combine) which could accurately be called the result of Soviet technology; the balance was transferred from the West.

Once again I must express sincere appreciation to those who have helped me—and absolve them from responsibility for my errors. The Relm Foundation granted research funds and a fellowship tenable at the Hoover Institution, Stanford University. In addition the Hoover Institution provided research assistance from its Special Fund. Among those at Hoover who have given their personal assistance, particular recognition is due Dr. W. Glenn Campbell, Director of the Hoover Institution, for his unfailing support; Mr. Alan Belmont, Associate Director for Administration, for his prompt solutions to my varied problems; and Miss Carolyn Conrad, for research and secretarial work well and conscientiously performed. To these and others, thank you; without your understanding assistance, this study could not have been completed.

Acknowledgment is also due Congressman John E. Moss (Democrat, Sacramento) and his staff for assistance in locating some 600 boxes of Lend-Lease cargo manifests and letter files which had been temporarily mislaid by the Executive Branch of the Federal Government.

Finally, I must express my appreciation to the Douglas Aircraft Company (now McDonnell-Douglas) of Santa Monica, the Warner & Swasey Company of Cleveland, and the Kern County Land Company (now a division of

TENNECO) of San Francisco, and also to Dr. Roger Freeman of the Hoover Institution, and Colonel Samuel F. Clabaugh and Mr. Joseph Gwyer (both of Washington, D.C.) for various forms of assistance. London G. Green handled the editorial chores with his customary expertise.

None of these is, of course, in any way responsible for my errors, arguments, or conclusions.

A. C. S.

Stanford, California
November 28, 1968

Contents

Tables

Figures

Glossary

Aluminstroi:	Aluminum Plant Construction Trust
Amburo:	American Bureau
Azneft:	Azerbaidjan Oil Trust
Burtsvetmet:	Non-ferrous Drilling Trust
CAXO:	Central Asia Cotton Union (strictly Sakho, but spelt thus in Gorton Papers)
Dalles:	Far East Lumber Trust
Donugol:	Don Coal Trust
Elmashstroi:	Electrical Machinery Construction Trust
GET:	State Electro-Technical Trust
Gipromez:	State All-Union Institute for Planning of Metallurgical Works
Giproshakht:	State Institute for Design of Coal Mines
Giprotsvetmet:	State Institute for Planning of Non-Ferrous Metals
Glavkhlopkom:	Chief Cotton Committee
Glavkontsesskom:	Chief Concessions Committee
Goelro:	State Commission for the Electrification of Russia
Gosplan:	State Planning Commission
Grozneft:	Georgian Oil Field Administration
GUAP:	Main Administration of the Aircraft Industry
Hectare:	2.47 acres
Khimstroi:	Chemical Industry Construction Trust
Kokstroi:	Coke Industry Construction Trust
Kombinat:	Combine
Kramkombinat:	Kramatorsky Combine
Lenmashstroi:	Leningrad Machine Building Trust
Mashinoimport:	All Union Association for Import of Machinery
Mekhanobr:	State Institute for Planning Ore-Treatment Plants

Moskhimkombinat:	Moscow Chemical Combine
Moskvugol:	State Association for Coal Industry in the Moscow Region Basin
Mosstroi:	Moscow State Construction and Installation Trust
Narkomvneshtorg:	People's Commissariat for Foreign Trade
OGPU (also GPU):	All-Union Political Administration of the Council of People's Commissars (Secret-Police)
Orgametal:	Institute for Organization of Production in Machinery and Metalworking Industries
Pood:	36.1128 pounds
Resinotrest:	Rubber Trust
Selmash:	All-Russian Syndicate of Agricultural Machines and Implements
Shakhtostroi:	Shaft-Sinking Trust
Sharikopodshipnikstroi:	Ball Bearing Industry Construction Trust
Sovnarkom:	Council of People's Commissars
Soyuzstroi:	All-Union Construction Trust
Sredazvodproiz:	Central Asia Water Authority
Stal':	Steel Trust
Skeklofarfor:	Glass and Ceramics Trust
Svirstroi:	Svir Dam Construction Unit
TsAGI:	Central Aero-Hydrodynamic Institute, im. Zhukovski
Tsvetmetzoloto:	All-Union Association for Mining, Processing and Sale of Non-Ferrous Metals, Gold and Platinum
Udarnik:	Shock Worker (Leader in establishing new production norms under Party instruction)
Uralgol:	Urals Coal Trust
Uralmash:	Urals Machine Combine
Uralrud:	Urals Ore Trust
VATO:	All-Union Automobile and Tractor Trust
VEO:	All-Union Electrical Trust
Vesenkha (VSNKh):	Supreme Council of the National Economy
VINITI:	All-Union Institute of Scientific Information
Vostokugol:	Far East Coal Trust
Vsekhimprom:	All-Union Trust for the Chemical Industry
Vsekomvodgosplan:	All-Union Committee for Planning of Water Projects
Yugostal:	Southern Steel Trust

CHAPTER ONE

Introduction

METHODOLOGY AND SOURCES

THE first volume of this study[1] concluded that foreign concessions and technical transfers were the most significant factor in Soviet economic development between 1917 and 1930. Concessions were abandoned in the early 1930s and replaced by technical-assistance agreements with Western companies. Later, as Soviet technical cadres became more skilled, the technical-assistance agreements were in turn partly, but never completely, replaced by purchases of complete Western plants built by Western companies, imports of Western equipment, and domestic duplication of this equipment. The technical-assistance agreement and the sale (or gift, under Lend-Lease or reparations arrangements) of Western equipment, in short, replaced the concession as the major transfer mechanism for the period 1930 to 1945.

Early Soviet recognition of the value of these transfer processes was well stated in *Za Industrializatsiiu* in a comment on Soviet industrial achievements prior to 1933: 'A combination of American business and science with Bolshevik wisdom has created these giants in three or four years. . . .'[2] Such frank recognition of the Western contribution has now been expunged from official Soviet history, although the existence of advanced technology within capitalist systems can be explained in Marxian terms. N. Bukharin held that a 'modern capitalist economy is *pregnant with a new technical revolution*. But this technical revolution *cannot develop* unless it breaks through its capitalist shell. . . .'[3] Thirty years later both Khrushchev and Kosygin urged their planners and engineers to look westward in the perennial effort to 'overtake capitalism'

1 A. C. Sutton, *Western Technology and Soviet Economic Development, 1917 to 1930* (Stanford: Hoover Institution, 1968).

2 *Za Industrializatsiiu*, August 14, 1933.

3 N. Bukharin, *Socialist Reconstruction and Struggle for Technique* (Moscow: Co-operative Publishing Society of Foreign Workers in the U.S.S.R., 1932), p. 10.

and utilize the capitalist 'technical revolution' for the building of socialism. This Bukharinist argument may still be found in present day Marxist writing.[4]

The inability of the Soviet Union to carry out, with its own internal technical resources, the gigantic construction plans envisaged was in the 1930s frankly recognized in the Soviet press. For example, *Pravda*, in discussing the important Solikamsk potash project, admitted that 'the attempt of the Potash Trust to carry on work without foreign technical assistance proved futile. Thus in 1927–28 several large foreign companies were hired for technical assistance in the construction of the first potash mine. . . .'[5]

Of primary interest was the Soviet attempt in the 1920s to develop even more extensive and technically advanced projects without foreign assistance; such attempts were abandoned in 1929–30 and hundreds—perhaps thousands —of foreign companies[6] were called in to supervise construction of the First Five-Year Plan. This phenomenon, substantially supported by evidence concerning construction dates from Soviet sources alone, is in this book called the 'inability hypothesis.'

Most of this first group of foreign engineers entered Russia in 1929 and left in 1932–3 as a result of the valuta crisis. The benefits of the huge industrial capacity developed under their supervision gave considerable hope to the Communist Party. A rude awakening came in 1936–7 when the product of the enormous capacity developed in the early 1930s reached a plateau, to be followed by four to five years of stagnation during the purge era. Between 1936 and 1941 a number of highly important, but unpublicized, agreements were made with American companies in aviation, petroleum engineering, chemical engineering, and similar advanced technological sectors in which the Soviets had been unable to develop usable technology.

The Nazi-Soviet trade agreement of August 1939 gave the Russians another significant technological boost, although this has been overlooked in literature on the subject. The Soviet view of the pact was well expressed by Molotov: 'This agreement is advantageous to us because of its credit conditions (a seven-year credit) and because it enables us to order a considerable additional quantity of such equipment as we need. . . .'[7]

[4] Even today there is partial admission of continued dependency on the West. For a recent example, see *Pravda* of October 23, 1968, on increasing the effectiveness of technology. This article contains a straightforward directive from the Central Committee to use 'foreign licenses or technical documentation' as a basis for achieving higher technical levels, and also instructs Gosplan and other organs not to plan industrial production on the basis of Soviet experience alone.

[5] *Pravda*, January 16, 1930.

[6] The Stalingrad Tractor Plant alone called on the resources of 80 American firms and a lesser number of German companies.

[7] V. Molotov, *Statement at the Session of the Supreme Soviet of the U.S.S.R. on the Ratification of the Soviet-German Non-Aggression Pact* (New York: Bookniga, August 31, 1939).

Similarly, American Lend-Lease after 1942 gave a massive injection of modern technology which carried the Soviet economy well into the 1950s. Although Congressional intent was to limit Lend-Lease to the military prosecution of the war against Germany and Japan, at least one-third of the shipments had reconstruction potential,[8] and shipments continued through 1947, formalized in the 'pipeline agreement' of October 15, 1945.[9]

Complete corroboration for the general argument of this study comes from an excellent source: Josef Stalin. In June 1944, W. Averell Harriman, reporting to the State Department on a discussion between Eric Johnston and Stalin, made the following significant statement:

> Stalin paid tribute to the assistance rendered by the United States to Soviet industry before and during the war. He said that about two-thirds of all the large industrial enterprises in the Soviet Union had been built with United States help or technical assistance.[10]

Stalin did not add (it would have been irrelevant to his purpose) that the remaining third of large industrial enterprises had been built with German, French, British, Swedish, Italian, Danish, Finnish, Czech, and Japanese 'help or technical assistance.'

This heavy assistance has been briefly recognized heretofore in Western economic literature—the brevity due, of course, to a lack of systematized supportive data. Schwartz, for instance, observes that large numbers of foreign engineers went to Russia in the 1920s and 1930s, and that:

> Many of the Soviet Union's major new plants erected in the late 1920's and early 1930's were equipped with foreign-made machinery. . . . It seems correct to say that every or almost every major branch of the Soviet productive system received substantial aid from abroad and had much of its rapidly expanding corps of native engineers and technicians of all kinds trained directly or indirectly by foreigners.[11]

Bergson suggests that, 'in transforming its production methods under the five-year plans, the U.S.S.R. has been able to borrow technology from abroad on an extraordinary scale.'[12] Later Bergson provides the astute comment that

> . . . there is little necessary correlation between the quantity of imports and the quantity of technology imported; a prototype machine, a blue-

[8] U.S. State Dept., *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington, D.C.: Office of Foreign Liquidation, 1945), pp. 19–28.

[9] See Schedules 1 and 2 of the Agreement between the Governments of the U.S. and the U.S.S.R. on the Disposition of Lend-Lease Supplies in Inventory or Procurement in the United States, October 15, 1945 (Washington, D.C., 1945).

[10] U.S. State Dept. Decimal File, 033.1161 Johnston, Eric/6–3044: Telegram June 30, 1944. (For references to Decimal File, see Appendix D.)

[11] Harry Schwartz, *Russia's Soviet Economy* (New York: Prentice-Hall, 1950), p. 132.

[12] Abram Bergson, *Economic Trends in the Soviet Union* (Cambridge: Harvard University Press, 1963), p. 34.

> print, a technical book, or a technician can (but may not) suffice to transfer the 'knowhow'.[13]

Finally, however, Gershenkron in 1962 pointed out the unusual research gap: 'A serious study of the economic aspects of Soviet technology is still searching for its author or authors. . . .'[14]

Thus, although it has been quite correctly assumed by Western economists that the Soviets have borrowed technology from the West on a large scale, the assumption has not been empirically demonstrated. This study is designed to close the empirical gap. The conclusions suggest that Western scholars have been duly cautious and conservative concerning the impact of Western technology on Soviet development (as indeed they should be in the absence of complete data) and have underestimated the importance of the technological transfers, although their educated guesses have been in the right direction.

On the other hand, this technological impact does not appear to have been investigated by the U.S. State Department, although such an investigation would clearly come within the province of the Intelligence and Research Office of that Department.

Apart from Werner Keller's book *Ost minus West = Zero* (Droemersche Verlagsanstalt: Munich, 1960) which does not meet the methodological standards of the economist, the only previous research specifically related to the empirical aspects of Soviet technical transfers consists of several articles by D. Dalrymple of the U.S. Department of Agriculture.[15] The State Department Decimal File was found to be a superlative source of material in the form of reports from attachés and diplomatic offices, but the Department has not used this data for its own assessments; indeed, public statements by the Department are completely at variance both with previous academic assumptions and with the empirical findings of this study, itself based heavily upon the Decimal File.

For example, Edwin M. Martin, Assistant Secretary of State for Economic Affairs, made the following statement in 1961:

> I don't think there is convincing evidence that the net advantage to the Soviet Union of the continuation of trade is a major factor—or a particul-

13 *Ibid.*, p. 311.

14 Alexander Gershenkron, *Economic Backwardness in Historical Perspective* (Cambridge: Harvard University Press, 1962), p. 265.

15 Dana G. Dalrymple, 'American Technology and Soviet Agricultural Development, 1924–1933,' *Agricultural History*, XL, No. 3 (July 1966), pp. 187–206; 'American Tractors and Early Soviet Agriculture,' *The Smithsonian Journal of History*, II (1967), pp. 53–62; 'Joseph A. Rosen and Early Russian Studies of American Agriculture,' *Agricultural History*, XXXVIII, No. 3 (July 1964), pp. 157–60; and 'The Stalingrad Tractor Plant in Early Soviet Planning,' *Soviet Studies*, XVIII, No. 2 (October 1966), 164–8.

arly significant factor in the rate of their overall economic development in the long term.[16]

A State Department publication briefly reviewing 40 years of Soviet economic development between 1920 and 1960 concluded that the U.S.S.R. has a 'self-developed technology.'[17]

This viewpoint was reflected by Secretary of State Dean Rusk in 1961 before the House Select Committee on Export Control: '. . . it would seem clear that the Soviet Union derives only the most marginal help in its economic development from the amount of U.S. goods it receives. . . .'[18]

There is then a problem of credibility similar to one suggested in the first volume.[19] It was suggested previously that the concession as a development vehicle underwent a significant change in historical interpretation. Recognized as an important development mechanism in the 1920s, it was heavily downgraded by economic historians and almost completely forgotten in the years after 1930. The events covered by this study have also been ignored or given contrary analysis by the State Department. A prime requirement, therefore, is to establish acceptability for the data and credibility for the conclusions. This is particularly necessary because, as noted, academic assessments, although accurate, have not been based on precise empirical findings but on more or less unsystematic reports and general statements.[20] Further, the writer has used State Department files to establish a thesis apparently refuted by the State Department itself. Under such circumstances a high degree of precision and extensive and accurate detail are obviously necessary. For these reasons, fully documented detail, including names of individual foreign engineers and operating characteristics of specific items of equipment, is included within this volume.

[16] Edwin M. Martin, Assistant Secretary of State for Economic Affairs, before the House Select Committee on Export Control, December 8, 1961. This statement is surprising in the light of specific data found in the State Dept. files. For example, there is a European Affairs Division memorandum concerning an Ingersoll-Rand order for 100 gas-engine-driven compressors for Soviet oil fields, to cost $1.5 million. It is clearly estimated in the memorandum that this would increase production by 100,000 barrels per day. (See U.S. State Dept. Decimal File, 861.6363/364, December 12, 1939.) A glance at the footnote references in this volume will verify that the Decimal File alone, excluding the specialized Departmental collections, is replete with detailed information, contrary to Secretary Martin's statement.

[17] U.S. State Dept., *Background Notes—U.S.S.R.* (Washington, D.C.: Office of Media Services, Bureau of Public Affairs, 1965).

[18] U.S. House of Representatives, *Hearings before Select Committee on Export Control*, 87th Congress, 1st Session, October 25, 26, and 30, and December 5, 6, 7, and 8, 1961.

[19] Sutton, *Western Technology . . ., 1917 to 1930*, pp. 9–11.

[20] One of the most quoted sources (see Schwartz, *op. cit.*, p. 132) is Hans Heymann, *We Can Do Business with Russia* (Chicago: Ziff Davis, 1945). As the title suggests, this book is not a critical survey of technical transfers.

It is almost certain that this book heavily understates the volume of technical transfers. The State Department files, although excellent, are not complete. The Douglas Aircraft Company granted the writer access to its records (see chapter 14) and these yielded data on important technical assistance in far more detail than has been found in the State Department files. Some companies, such as Caterpillar Tractor and General Electric, which were involved in many important transfers, have not retained their records. In brief, there are at least two gaps in information: they occur when companies made agreements (as they legally could if they did not infringe the Espionage Act of 1917) without informing the State Department and when files have been destroyed. In addition, this study does not include widespread unofficial —or illegal—Soviet acquisitions: no doubt the object of Federal Bureau of Investigation and Congressional study.

METHODOLOGY AND DATA SOURCES

Details were obtained from several sources to determine both the technology used in Soviet manufacture and plant construction and its place of origin in the period 1930–45. For example, the Soviet standard blast furnace of 930 cubic meters has been identified as a Freyn Company, Inc., design. The turbines at the Baku Power Plant were built and installed by Metropolitan-Vickers, Ltd., of the United Kingdom. The merchant rolling mills at Kuznetsk were made and installed by Demag A-G of Germany. The coke ovens at the same plant and at Kertch were built and installed by Disticoque S.A. of France. The Karakliss cyanamide plant was built by Superfosfat A/B of Sweden. These and thousands of similar facts are precisely recorded and verifiable; the sources are always stated. Consequently those who wish to challenge the arguments have the initial burden of disproving recorded statements of fact.

These statements of verifiable fact are then aggregated. When individual plant construction of this period is analyzed, it is found that almost all major units, with only a few isolated exceptions, utilized a technology originating in the West; before 1933 most were built by[21] Western companies or at least had foreign equipment installed by Western engineers. No significant new plant built before 1933 without some major Western technical and construction effort has been identified. Indeed, as Josef Stalin himself stated, two-thirds of all large enterprises built before 1944 were built with U.S. assistance.

By far the most important source of data is section 861.5 of the U.S. State Department Decimal File, from 1928 to 1946. Some of the most useful information concerning technology, engineering, and construction was, however,

[21] See p. 13 for definition of 'built by.'

filed by the State Department Index Bureau under '861.5017—Living Conditions,' with few meaningful Document File cross-references, although 'living conditions' have no obvious connection with engineers' reports. This source was unearthed by a systematic search of all documents listed in section 861.5 purport lists which the Department was willing to declassify.[22] A few documents (no more than about 1 percent) have not been declassified. The purport list description of those still classified suggests they may support the case. The point to be made is that the reader should not be dissuaded by the *title* of the document reference (i.e., 'Living Conditions').

Unfortunately, a few reports (perhaps 5 percent or so) submitted by American companies to the State Department and supposedly at one time in the Decimal File are now listed as missing and are no longer to be found. These reports would contribute detail rather than substance to the argument; information on almost all technical-assistance agreements has been traced somewhere in the files. Blueprints and equipment specification lists are, however, invariably missing; this is particularly unfortunate, as blueprints are a means of tracing technological diffusion *within* the Soviet Union.

This official primary source is supplemented by three serial publications of Soviet trade delegations resident abroad: *Economic Review of the Soviet Union*, published by Amtorg in New York: *La Vie Economique des Soviets*, published by La Représentation Commerciale de l'U.R.S.S. en France in Paris; and *Sowjetwirtschaft und Aussenhandel*, published by the Soviet trade delegation in Berlin.

The German Foreign Ministry, Oberkommando der Wehrmacht, and Oberkommando des Heeres files provide data for the period between 1936 and 1945, as does the Nazi Party Hauptarchiv, at the Hoover Institution. This latter source contains lists of German equipment for which negotiations were made under the Nazi-Soviet pact of 1939.

Relatively little data (compared to that for 1917–30) originated in Soviet internal sources. The Trotsky and Smolensk archives are almost bare of industrial engineering papers. Gosplan (State Planning Commission) publications on the various plans are useful only as a check on anticipation; even the 'not to be distributed' *Gosudarstvennyi plan razvitiya narodnogo khozyaistva*

22 The State Dept. had two main sources of interview information: returning American businessmen and American engineers. Several hundred reports of both types were read closely by the author to determine distortions and inaccuracies. In the final analysis much greater weight has been given to the engineers' reports. Engineers had the advantage of being in day-to-day communication with Soviet construction sites, had less reason to make thinly disguised pleas to the State Dept., and were by training more objective observers. Rarely did businessmen contribute anything of substance to State Dept. knowledge. However, the engineers consistently provided hard information; for an example, see the Ufa refinery flow diagram on p. 83. The original in the State Dept. files was obviously drawn during the interview with the State Dept. officer. The version in the text was redrawn by the writer.

SSSR na 1941 god (the 1941 annual economic plan) was rarely useful. Soviet newspapers concentrate on operating problems which came about as foreign engineers handed over facilities to Soviet personnel. Although technical-assistance agreements were briefly announced in the Soviet press in 1929–31, few details are given, except in the case of the 1929 Ford Motor Company agreement. However, a number of Soviet technical books are surprisingly open about foreign technology,[23] and some contemporary Soviet technical journals are helpful.[24]

The Fish Committee Hearings on Communist propaganda in the United States, held in New York in 1930,[25] provide an unexpected fund of information. Amtorg, under criticism for its espionage activities and anxious to show that it had some legitimate trade functions, submitted documentation concerning the activity of Russian nationals in the United States. This information was analyzed and yields an excellent picture of Soviet technical assistance from the U.S. in 1929–30.

IDENTIFICATION OF FOREIGN TECHNOLOGY

A consistent policy of positive identification of foreign technology is retained throughout this volume. In other words a unit, process, or technology must be clearly identified from acceptable sources as being of Western origin before it is so named. In cases in which this cannot be done, the assumption is that the technology is Soviet. For example, the Pengu-Gurevitch process used in construction of a small lubricating oil unit at Baku in 1931–2 has not yet been positively identified as Western, although, given the nonexistence of Soviet developments in petroleum refining, it is unlikely that the process was purely Soviet; it was probably 'copied.' However, in the absence of evidence to the contrary, it is noted as a Soviet development. A unit is thus always assumed to be Soviet-designed and Soviet-constructed in the absence of positive information to the contrary. *In brief, identification is always biased toward Soviet design and Soviet construction.* Identification sometimes becomes a complex matter. One cannot say, for example, that the Ufa refinery complex built between 1936 and 1941 was completely Western *or* completely Soviet

[23] See, for example, L. Aisenshtadt, *Ocherki po istorii stankostroeniya, SSSR* (Moscow: 1957).

[24] For example, *Za Standardizatsiiu, Za Industrializatsiiu,* and *Stal'*. The most useful (and the rarest) are newspapers produced by individual factories: *Industrial Spark,* produced (in English) by the Stalingrad Tractor Plant and *Informatsionnyi Biulleten,* produced by the Magnitogorsk Iron and Steel Combinat.

[25] U.S. Congress, Special Committee to Investigate Communist Activities in the United States, *Investigation of Communist Propaganda,* 71st Congress, 2nd session, Part 3, Vol. 3 (Washington, D.C.: 1930).

in origin.[26] Four units were built by Soviet organizations using Western processes, and ten units were built by Western companies: Alco Products, Lummus, and Universal Oil Products. Thus, Ufa can be claimed by both Soviet organizations and Western companies.

Derivation of the origin of equipment is not altogether a simple matter. In practice there is only one way to ensure that a process or piece of equipment is of Western origin: one must trace its physical transport from Western manufacturer to Soviet plant. It is possible, given sufficient time and data, to do this when the equipment is large or unique: for example, the General Electric generators for the Dniepr Dam or a Davy Brothers flywheel for the Kuznetsk rolling mill. It is a slow and complex but highly accurate method. In a few cases, Soviet sources report the origin of equipment; for example, the excavation work for the Magnitogorsk Iron and Steel Plant was handled completely by identifiable foreign draglines and excavators—Bucyrus, Marion, Oren-Koppel, etc.—and production statistics were reported on an individual machine basis.[27]

On the other hand it cannot be assumed that use of a Western name by the Soviets is necessarily an indicator of immediate Western origin for a specific item. There are cases in which a Western technological process was used, with or without assistance or permission, and given the Western name in cyrillic characters. Thus Sulzer, MAN, and Deutz diesel systems are listed by cyrillic equivalents of these names in Soviet literature in addition to Soviet model numbers.[28] By about 1930 small and medium diesel engines were being manufactured in the U.S.S.R. and still listed by Western diesel system names.

When equipment was unique or had a world-wide reputation, it was often duplicated in the U.S.S.R. and known simply by its Western name in cyrillics. Thus we find 'stoneya mashina' for Stone's machine in foundries, 'rokvell' for Rockwell hardness testing, 'kruksa trubka' for the Crookes X-ray tube, 'shtauffera maslenka' for the Stauffer lubricator, and 'blyming' for blooming mill; and the ubiquitous Stillson wrench is known as 'stil'sona klych.'

In still another category, completely Western technology was used, but with no indication of its Western origin in the Soviet name. For example, the Ford Model A automobile was 'Gaz AA' from the start of production, and the Hispano-Suiza aircraft engine was designated 'M 100'. In neither case was the Western name ever utilized. Thus use of a particular name, either Russian or Western, is not a clear indicator of origin; there must be supporting evidence for accurate identification.

[26] See pp. 83–4.

[27] Magnitostroi, *Informatsionnyi Biulleten*, Magnitogorsk, No. 1 (January 1931).

[28] *Izvestia Vsesoyuznogo Teplotekhnicheskogo Instituta*, No. 5 (1930), pp. 84–5.

A QUANTITATIVE FRAMEWORK FOR TECHNICAL ASSISTANCE DISCUSSION

This section provides summary statistics concerning the number of foreign concessions, technical-assistance agreements, and individual engineers and consultants in the U.S.S.R. from 1930 to 1945, as a framework for subsequent discussion.

Concessions were the main vehicle for technical transfers from 1920 to 1930. A fairly large number were in operation at the end of the decade. The official Soviet figures are as follows:[29]

Table 1–1 FOREIGN CONCESSIONS IN U.S.S.R., 1927–9

Date	*Concessions in Operation*	
	All Types	*Pure Concessions*
October 1, 1927	110	73
October 1, 1928	146	68
October 1, 1929	162	59

Source: A. Gurevitch (Chief, Bureau of Information and Statistics, Glavkontsesskom), in *Moskauer Rundschau*, No. 5 (February 2, 1930).

The decline of the concession is described in chapter 2. By 1935–6 only the Standard Oil, Danish telegraph and Japanese Sakhalin fishing, coal and oil concessions remained; the latter were liquidated in 1944.[30]

Technical-assistance agreements replaced the concession. Firm figures have been published by the Soviets for a few years only, but such agreements were actually in force throughout the period under discussion.[31]

Table 1–2 TECHNICAL-ASSISTANCE AGREEMENTS IN U.S.S.R., 1928–30

Date	*Number of Agreements*
1928–9	25
October 1929	70
March 1930	104

Source: La Vie Economique des Soviets, No. 116 (May 20, 1930), p. 20.

[29] See also Sutton, *Western Technology . . ., 1917 to 1930*, p. 9. When that volume went to press, these figures were not available; they supplement the data in table 1–1 of that volume.

[30] See p. 28 fn. 47.

[31] Indeed, they continue down to the present day; the Soviet Government has not since 1930–1 publicized its great dependence on foreign countries. Today, in late 1968, there are about 100 technical-assistance agreements in force between Western firms and the Soviet Union. (See *Business Week*, October 5, 1968, p. 124.) There are also periodic instructions from the Communist Party for more effective application of foreign science and technology. For a Soviet description see A. Kolomenskii, *Kak my ispol'zeum zagranichnuiu tekhniku* (Moscow: 1930).

Of the 104 technical-assistance agreements in force in 1930, approximately 81 were with German and American companies and were distributed among the following Soviet industries:

Table 1–3 TECHNICAL-ASSISTANCE AGREEMENTS IN U.S.S.R., 1930 DISTRIBUTION

Industry	*Number of Agreements*
Metallurgical	37
Chemical	25
Electrical	13
Minerals and fuel	12
Textiles	5
Clay and glass	3
Miscellaneous	9

Source: La Vie Economique des Soviets, No. 116 (May 20, 1930), p. 20.

This study identifies about 200 technical-assistance agreements between the Soviet Union and foreign companies in force between 1929 and 1945. These are listed in Appendix C; the list is almost certainly incomplete.

In considering aggregate numbers of individual foreign workers hired on a contract basis, two points should be borne in mind: first, that plant construction during the period from 1930 to 1945 took place mainly in the years 1930–2, so that most of the balance of the period to 1945 was taken up with absorbing this enormous capacity, expanding existing plants, and building smaller subsidiary units; and second, that foreign individuals travelling to the Soviet Union were usually highly skilled workers—the only groups of unskilled workers were American Communist Party members and Finnish Americans in the lumber areas. Engineering consultants and experts comprised the great majority.

How many were there? A Soviet source reported in 1936 that some 6,800 foreign specialists of all types worked in heavy industry in 1932.[32] Another Soviet source reports that 1,700 American engineers worked in heavy industry.[33]

These figures can be broken down further. In 1932 there were 200 Germans at Magnitogorsk.[34] About 400 to 500 Finnish Americans were reported working on the First Five-Year Plan.[35] More than 730 American engineers and specialists worked inside the U.S.S.R. at one time or another on the Stalingrad Tractor Plant.[36] There were about 20 U.S. engineers and 20 Germans at

32 American-Russian Chamber of Commerce, *Handbook of the Soviet Union* (New York: John Day, 1936), p. 347.

33 Amtorg, *Economic Review of the Soviet Union*, VII, No. 10 (May 15, 1932), p. 225.

34 U.S. State Dept. Decimal File, 861.5017—Living Conditions/569.

35 *Ibid.*, 861.50—FIVE YEAR PLAN/200.

36 See p. 185. Some sources say 300 to 400; it depends on what one means: the total employed at any one time, the total at all times, or the peak employment figure.

Kramatorsk in 1931–2 and half a dozen Americans and more Germans in 1936–40 under a different contract.[37] The Metropolitan-Vickers Company of the United Kingdom had, prior to 1933, 350 erectors in the U.S.S.R.[38]

Numbers by themselves can, of course, be misleading. A single engineer with the right qualifications, used in the right place at the right time, even briefly, can have a fundamental influence on a plant or even an industry. Thus we find a Soviet source reporting, in reference to a small group: 'In a term of two or three months the American engineers investigated in detail all of the southern and Ural steel plants. . . .'[39]

We can, therefore, focus profitably upon individual engineers. L. A. Swajian, construction engineer for the Ford Motor Company River Rouge plant, was in turn Chief Engineer for construction of the Stalingrad Tractor Plant (1929 to July 1930) and the Kharkov Tractor Plant (after July 1931).[40]

John Calder's work epitomized American engineering practice in the U.S.S.R. At one time connected with construction of the River Rouge plant as well as the Packard plant in the U.S., he was from 1929 to 1933 the chief Soviet trouble-shooter, sent by Soviet authorities to any project in trouble or behind schedule. Calder held numerous official positions—Chief Construction Engineer at Stalingrad Tractor Plant (before Swajian), a similar position at Chelyabinsk, Technical Supervisor of 90 steel plants under the Stal' Trust, Technical Director at Magnitogorsk, Chief Consultant at the Lake Balkash copper project, and so on. Called by Maurice Hindus 'Russia's miracle man,'[41] he received the Order of Lenin (the highest Soviet order) and is generally known as the hero of the Soviet play *Tempo*, by Nikolai Pogodin.[42]

In 1940 we find individual American engineers in such high regard that the Soviets appealed through diplomatic channels to ensure continuation of their work in the Soviet Union. For example, the Soviets expressed to the American Embassy in December 1939 an 'urgent desire' to keep a Mr. Rasmussen (who was bringing into operation at Grozny a new aviation gasoline-cracking plant built by the Max B. Miller Company) on the job until work was completed.[43]

Those foreign engineers who worked for the Soviet Union between 1930 and 1945, whether under the First Five-Year Plan, during the 1936–9 period,

37 U.S. State Dept. Decimal File, 861.5017—Living Conditions/568.

38 See p. 170.

39 A. Zaviniagin, 'U.S.S.R. Favors American Engineers and Equipment,' *Freyn Design*, No. 11 (March 1934), 19.

40 Amtorg, *op. cit.*, VI, No. 18 (September 15, 1931), p. 412.

41 Maurice Hindus, 'Pinch Hitter for the Soviets,' *American Magazine*, CXIII, No. 4 (April 1932), pp. 31–3, 134–6.

42 Eugene Lyons, ed., *Six Soviet Plays* (Boston: Houghton Mifflin, 1934), pp.157–224.

43 U.S. State Dept. Decimal File, 700.00116 M.E./24, Telegram, December 29, 1939.

under the Nazi-Soviet pact, or under Lend-Lease, were usually top-flight consultants, without whom the projects would have remained on paper only. The Soviets were adept at selecting, in almost every field from irrigation to metallurgy, first-rank foreign construction companies and the finest individual talent. This should not obscure the fact that the Soviets did hire a few grossly unqualified engineers—even outright frauds: e.g., garage mechanics posing as mechanical engineers. These occasionally survived their contracts by practising local politics in lieu of engineering.

DEFINITION OF THE PHRASE 'BUILT BY WESTERN COMPANIES'

In order to gage accurately the contribution of Western firms to the Soviet Union under technical-assistance contracts and similar mechanisms, a clear interpretation of the phrase, 'built by Western companies,' used extensively in the text, is necessary.

A few technical-assistance agreements called only for the transfer of a process technology and the provision of such drawings, specifications, and literature as were necessitated by the transfer. These were, however, uncommon in the period under discussion. Sometimes, as in the Douglas Aircraft agreement,[44] the Soviets started with this limited kind of contract and then expanded it to include the supply of construction materials, subassemblies, specialized tooling, engine-test results, and operator training. As used in this study, the term 'technical assistance' has the widest interpretation. It normally includes not only the supply of technology, patents, specifications, and laboratory results for an agreed period, but also the supervision of construction and equipment installation, including initial operation of at least the first plant. In other words there was at least one (and sometimes several) 'turn key' plant installation in almost every contract. On this account, many equipment sales contracts are viewed as technical-assistance agreements. When a foreign firm sells a complete plant, prints training and maintenance manuals in Russian, trains the operators, and provides backup service, this certainly constitutes technical assistance.

Thus engineers, specifications, and drawings would be sent from the United States, and the foreign engineers would organize and direct, through interpreters, the Soviet engineers and workers. For example, Stuck, at Magnitogorsk, stationed 27 American engineers at strategic points around the blast-furnace site to direct operations. The Soviets supplied raw labor, interpreters, and Soviet engineers, whose function was primarily to learn; these systems

44 See p. 232.

were always advanced, and not only beyond the experience of tsarist engineers tolerated as holdovers or as 'prisoner engineers,' but also certainly far outside the experience of hastily trained but politically reliable Soviet engineers. Almost to the last man, American engineers in their reports and interviews made the comment that the contribution of the Soviet engineers was detrimental rather than useful. Theirs was a hastily acquired theoretical textbook training, and modern construction practice does not follow theoretical textbook lines.

Initial operation (start-up procedures) was almost always included in technical-assistance contracts. The training of operators and the provision of operation and maintenance manuals in Russian were commonly included. However, there are not a few cases reported in which the Communist Party intervened when a plant was superficially ready and brought the plant into operation with Soviet engineers and operators for propaganda purposes before the schedule established by the Western company. This resulted, of course, in serious damage to the plant; for example, the furnace linings at Magnitogorsk were burned out and the rolling mill bearings at Zaporozhe were damaged in this way. The Communist director usually placed the blame on his Russian technical assistants,[45] although the latter had no part in the decision and foreign engineers bitterly protested such practices. The French Chief Engineer for Disticoque S.A. coke-oven construction projects, for example, finally lost his temper, burned the construction drawings, and returned with his engineers to France. By 1935–6 foreign companies were including in their contracts a clause requiring control of start-up procedures and inspection of all equipment to be installed (even when parts originated in the Soviet Union) before taking responsibility for a project.

Thus 'built by' includes provision of technology and equipment, plus responsibility for satisfactory operation in a 'turn key' installation during an agreed initial period. Provision of labor (including middle-grade engineering talent), raw materials, and, increasingly, semi-fabricated materials (i.e., structural steel) was a Soviet responsibility.

THREE POINTS OF CLARIFICATION

Once again it must be emphasized that the argument is not that technology is the only factor in economic development, although the study is limited to this aspect and the writer himself considers it the most important factor.

[45] See S. Frankfurt, *Men and Steel* (Moscow: Co-operative Publishing Society for Foreign Workers in the U.S.S.R., 1935).

Other elements play their role: one of particular significance in the Soviet Union has been forced labor.[46]

Further, the distinction must be made between the Soviet system and the Russian people. It is easy to confuse an examination of this type with adverse reflections on Russian abilities. Such confusion would be grossly unfair. The Russian people have as much technical and scientific ability as any other people; indeed in certain areas of science and mathematics they appear to excel.

In short, the Soviets have been extraordinarily successful in presenting a façade of indigenous 'socialist' technological progress which they compare to continuing 'capitalist crises.' The statistical presentations of 'expanding socialism' and 'declining capitalism' emanating from Soviet and Western Marxist sources have been ingenious in their use of statistics, graphs, and reasons why capitalism, allegedly in decline for 50 years, still needs to be overtaken. Technical extravaganzas, such as Sputnik and Lunik, involving heavy investment in a narrow sector, are periodic stimuli intended to remind us that Soviet science and technique are, of course, far ahead of that of decadent capitalism.

Those readers who have not forgotten the fallacy of composition might, however, ponder on the alleged quip from one Muscovite to another: 'Why, if things are so good, are they always so bad?'

[46] See S. Swianiewicz, *Forced Labour and Economic Development* (London: Oxford University Press, 1965) and D. J. Dallin and B. I. Nicolaevsky, *Forced Labor in Soviet Russia* (London: Hollis and Carter, 1947). The State Dept. files contain considerable data on forced labor, including numbers and locations of the specific camps.

CHAPTER TWO

Soviet Liquidation of the Foreign Concessions

LIQUIDATION of the more than 350 foreign concessions which operated in the Soviet Union during the 20 years after the Bolshevik Revolution is a neglected topic of some importance. No comprehensive examination of the circumstances and methods of liquidation has been made, and this chapter, for reasons of space, can only outline some of the major factors.

By the end of the 1920s the Soviets were convinced they had found a more effective vehicle than the pure concession or the mixed company for the transfer of Western skills and technology. After 1928 the technical-assistance agreement (called the Type III concession in Volume I) and individual work contracts with foreign companies, engineers, skilled workers, and consultants replaced the pure and mixed concessions. These assistance agreements were more acceptable to the Soviets because under them the Western operator had not even a theoretical ownership claim and the Soviets could control more effectively both the transfer of technology and operations inside the U.S.S.R.

However, even while concessions were in the process of liquidation, proposals for new concessions were being solicited and some were even granted. For example, in 1930 the emphasis in Soviet trade journals was on public-utility concessions to develop power plants and water, gas, sewage, and city-transport supply systems.[1] Housing construction concessions were also offered from 1928 onwards to relieve the severe housing shortage.[2] After 1930, however, few concessions were granted—the last known, in March 1930, was to Leo Werke for production of dental products.[3]

[1] Amtorg, *op. cit.*, V, No. 3–4 (February 15, 1930), p. 62; also V, No. 11 (June 1, 1930), p. 233.
[2] *Ibid.*, V, No. 5 (March 1, 1930), p. 83.
[3] *Ibid.*, V, No. 6 (March 15, 1930), p. 114.

The formal end of the concessions policy came in a resolution of the All-Union Soviet of People's Commissars on December 27, 1930, repealing all former concession legislation and reducing Glavkontsesskom (chief Concessions Committee) to merely informational and advisory functions. Technical-assistance agreements, however, were specifically omitted from repeal.[4]

Liquidation of pure and mixed concessions had started as early as 1923 and continued throughout the 1920s, but the final stage began only with this resolution in 1930. At the end of the decade only 59 concessions, 6 joint-stock companies, and 27 'permissions to operate' remained in effect.[5] By 1933 no manufacturing concessions remained and the few trading concessions were closed down by the mid-1930s. Only the Danish telegraph concessions, the Japanese fishing, coal and oil concessions, and the Standard Oil lease remained after 1935.

The liquidation of foreign concessions followed the Communist plan. The political theory of such a system demands ejection of capitalist elements at some point, although Leninist tactics may promote temporary compromises such as concessions or joint ventures with capitalists for immediate goals or to solve pressing problems. The concessions were, as Lenin dictated, the means of obtaining 'the basics.' When their Western operators had been cozened into transferring as much capital, equipment, and skill into the Soviet Union as their credulity would allow, the concessions were expropriated. In 1930 Yugoff[6] concluded that the whole concessionary policy and practice of the Soviet Government had been guided by such a principle: to make war upon capitalism.

Let us examine the expropriation of foreign concessions by the Soviet Government in more detail. It was the economic and not the political factor in a concession which usually determined its duration. The only recorded attempt to use the concession as a purely political weapon occurred after the assassination of the Soviet diplomat Vorovsky in Switzerland in June 1923. As a result of the acquittal of the alleged murderers, the Soviets announced that no further concessions would be granted to Swiss citizens and that all offers would be rejected. As there were no Swiss concessions, and few Swiss commercial dealings of any kind, the announcement was merely a gesture.[7]

In all cases a period of duration was agreed upon and written into the concession agreement. In the case of a trading concession, the contract was

[4] A translation of the resolution is in U.S. State Dept. Decimal File, 861.602/237, Riga Consulate Report No. 8019, September 4, 1931.

[5] *Za Industrializatsiiu*, February 4 and 16, 1930.

[6] A. Yugoff, *Economic Trends in Soviet Russia* (New York: Smith, 1930), p. 223.

[7] Veridicus (pseud.), *Suisse and Soviets: Histoire d'un Conflict* (Paris: Delpeuch, 1926), pp. 103–4.

for one year and renewable; in the case of a manufacturing concession, the contract was for a much longer term, as would indeed be necessary to induce a foreign entrepreneur to invest his capital. For example, it was agreed that the Swedish General Electric (A.S.E.A.) concession, started in 1927, was to run to 1962. The Bryner and Company concession was to run for 36 years, or until 1960. The Japanese Hokushinkai oil concession on Sakhalin and most of the British Lena Goldfields concession were to run until 1975.

In no case, however, was a manufacturing or mining concession allowed to operate its full agreed-upon length, with the possible exception of the Japanese fishing concessions on Sakhalin and the telegraph concessions, which had clauses allowing revocation by either party on six months' notice. Two other concessions—with the Anglo-Russian Grumant and the Netherlands Spitsbergen Company, both operating coal mines on Spitsbergen—are reported to have been purchased from their operators in 1932,[8] but such purchases were rare.

By early 1930 the Soviet intention to close out the remaining concessions was clear, and Western government officials were remarkably united in their interpretation as to the reasons for, and the circumstances surrounding, closure. The Polish Foreign Office noted that only six Polish concessions remained in February 1930, and that, although they had been quite successful in the past, now 'with the exception of the Serkowski, most Polish concessions in the U.S.S.R. are faring very poorly, for two reasons; namely, the difficulty which the Soviets place in the way of shipment abroad by the concessionaires of their profits and the question of labor. . . .'[9]

By 1931 the German Government, which had previously encouraged concessions, was now urging its nationals that German concessions be closed out and no further capital invested, the principal difficulty being the transfer of cash balances to Germany. At this point the Stock Company, a large Leningrad concession, had already closed down and the Resch concession in the Ukraine, the Tiefenbacher button concession in Moscow, the German Building Construction Company, and the Krupp concern had applied for permission to close. The German Foreign Office pointed out that 'the difficulties of these firms in the past have been the subject of almost continuous diplomatic correspondence.'[10]

The American legation in Warsaw suggested in January 1930 that the Soviets were no longer interested in pure concessions and that the Soviets

[8] *Izvestia*, No. 294, October 23, 1932.

[9] U.S. State Dept. Decimal File 861.602/211, Warsaw Legation Report, February 8, 1930.

[10] U.S. State Dept. Decimal File, Report 936, Berlin Embassy, May 26, 1931.

'have even gone as far as sabotage in order to discourage the operators.'[11] Further, it was added that this interpretation was 'universal' among foreign diplomats in Moscow.

While officially the Soviets stated that disagreement with the British concession Lena Goldfields was over violation of the contract, the real reasons, according to well-informed circles in Moscow

> lay in the fact that the time had now come when the enterprise was about to yield profits for the concessionaires and that difficulties had arisen in connection with the transfer of these profits to foreign countries.

Similar problems beset the Estonian concessionaires. As long as concessions were being developed

> and as long as Estonian funds were being invested in these enterprises all was well. When, however, the moment arrived when the Estonian merchants began to secure returns from these investments, such difficulties were placed in their way by the Soviet authorities that the projects had to be abandoned. In this way great losses were incurred by the Estonians who had attempted to carry on business in the Soviet Union.[12]

Thus as each concession became profitable, it also became a target for expropriation.

METHODS OF EXPROPRIATION: PHYSICAL FORCE

Physical force was used in very few instances. Indeed, force was not necessary; the Soviet had ample economic weapons—unions, credit policy, customs, currency-export restrictions—which could be utilized without resorting to crude physical ejection of concessionaires.

However, physical force was used in at least one instance at an early date, before many—indeed most—concession agreements had even been made. What is curious is that the U.S. State Department had affidavits and detailed reports on file in 1924 relating to the forcible expropriation of the Caucasian-American Trading and Mining Company in 1923, but did not subsequently warn other venturing American businessmen.[13]

[11] U.S. State Dept. Decimal File 861.602/210, Warsaw Legation Report, January 13, 1930. The legation also reported a Rykov speech at a session of the Central Executive Committee in which he was reported as saying that foreign firms should invest capital, not capitalists—meaning profit-earners.

[12] U.S. State Dept. Decimal File, 861.5017—Living Conditions/163.

[13] See National Archives Microcopy T 640 (Claims against the Soviet Union by the United States), Roll 2 (end) and Roll 3 (start) for extensive material including maps and photographs, and particularly the following document addressed to the Dept. of State: *In the matter of the Application for the Support of a Claim—Caucasian-American Trading & Mining Co., a Delaware Corporation—against—Soviet Government of Georgia (Russia)*, February 9, 1924.

The Caucasian-American Company, registered in Delaware with the objective of developing the use of American agricultural equipment in Russia, signed a concession agreement with the Soviet Government on April 20, 1921. This was agreed to run until 1970. Agricultural equipment, including 70 Moline plows, was imported, and two American engineers were sent with it.[14] The company claimed that it was the first to introduce tractors into Russia, that it spent half a billion rubles, erected buildings, reclaimed marshes, trained workers, and introduced advanced methods in Georgian agriculture.

Two years later the company was physically ejected from its property. The description of the ejection contained in a memorandum to the U.S. State Department is worth quoting extensively. After stating that on February 26, 1923 a group of 'Bolsheviks,' including the top Party officials from Tiflis, came to the company property at Nakalakevie, the memorandum continues:

> . . . they were heavily armed, ordered [the company] to stop the work, arrested the apprentices, assaulted them, intimidated the American engineer, called a meeting at which it was resolved to take over the estate and to offer to the company land somewhere else. After the meeting they organized looting and destruction (pogrom) of the Company's property, much against the wishes of the terrorized population. The estate was looted, buildings, orchards and other property destroyed in the most barbarous manner, beautiful trees cut down, live-stock stolen, employees and books seized, goods supposed to have been given as promised, taken away. . . . Orachelashvili, who is now President of the Republic of Georgia seized the offices of the Company in Tiflis, including furniture. . . . Finally, the President of the Company, D. P. Abashidze was sentenced to death, to save his life he had to escape from the Caucasus and from Russia through Siberia which he did partly on foot. All this had been done in order to secure the documents in his possession, and which are proving that the Company fulfilled all terms of the agreement. . . . All this was done at the very time when after six years of Revolution, the Soviet Government advertised, that it was not as bad as described, and was inviting the outside world to have business dealings with it.[15]

METHODS OF EXPROPRIATION: BREACH OF CONTRACT

Few contracts have been found in which the Soviets fulfilled all the conditions agreed upon; the only exceptions were the short-term one-year renewable trading contracts and those covered by the 'arm's-length' hypothesis.[16] There

[14] *Agreement, Moline Plow Company and Caucasian-American Trading & Mining Company*, dated 6 February, 1922, National Archives Microcopy T 640–3.

[15] *Ibid.* The documents mentioned in the quotation are now in the National Archives files; these include translations, bills of lading of goods moved into the U.S.S.R. by the company, and signed agreements with the Soviet Government. See Microcopy T 640–2/3.

[16] See Sutton, *Western Technology . . ., 1917 to 1930*, chap. 17.

are numerous complaints recorded by concessionaires that the Soviets interpreted concession agreements only to suit their own purposes, and abided by neither the letter nor the spirit of the agreements.

One case involving breach of contract and economic pressure is recorded by the German courts: that of I.V.A. (International Warenaustausch Aktiengesellschaft).[17] I.V.A. was a concession devoted to assembling and packing eggs and exporting them to Germany. In late 1929 the Soviets arbitrarily denied I.V.A. the right to continue to export eggs and began to build up a Soviet egg-export organization. This dispute was submitted by I.V.A. to a Moscow court of arbitration, as allowed in its concession agreement. The Soviets then removed the only German member of the three-man court and replaced him with a third Russian member. The court found against I.V.A.

The Soviet Union then brought suit in the German courts to enforce its own decision against I.V.A. The German court decided in favor of I.V.A. 'on the grounds that the elimination of the German member of the Court of Arbitration had taken place illegally and without due course.'[18] The decision was upheld in the Kammergericht in Berlin, sitting as a court of appeals. A damage suit by the Soviets against I.V.A. in the Landgericht in Berlin was also decided in favor of I.V.A. However, the Soviets appealed these decisions within the German courts and the company, 'despairing of a definite settlement within a reasonable time,' went into bankruptcy.[19]

METHODS OF EXPROPRIATION: TAXATION

When concessions were profitable, domestic taxes were used to force expropriation. A prominent example is the Richard Kablitz Company, a Latvian concession which operated six plants in the U.S.S.R. from 1921 to 1930. Kablitz manufactured stokers, economizers, and boilers, and was the only manufacturer of this equipment in the Soviet Union. Although working conditions were not good, the company undertook a very large quantity of work, installing, for example, boilers in more than 400 Soviet factories. Until 1926 Kablitz made significant revenue and, although taxes limited profits, some earnings were exported.

In June 1926 Kablitz was forbidden to send currency abroad—a breach of the concession agreement. After negotiation, Kablitz was granted permission to export 40,000 rubles per year, but the necessary export certificates were not

17 U.S. State Dept. Decimal File, 861.602/204, Report 373, Berlin Embassy, July 14, 1930. The file includes copies of the German court summaries.

18 The German court held this was a 'positive violation of contract' (U.S. State Dept. Decimal File, 861.602/216, April 1930).

19 Data from *Sevodnia* (Riga) No. 39, February 8, 1931. Copy in U.S. State Dept. Decimal File, 861.602/233, February 16, 1931, and Report No. 7506 (Riga).

forthcoming in either 1928 or 1929. An explicit demand by the company to export 40,000 rubles in 1929 was countered with a Soviet demand for a 'normative tax' of 300,000 gold rubles.[20] This tax forced the company into liquidation.

While admitting loss of its six factories and all invested capital, Kablitz requested compensation only for exploitation of its patents. This is in itself a revealing episode. One year previous to the imposition of the 'normative tax,' the OGPU had ordered Ramzin, a first-rate Russian engineer,[21] to work out designs to replace those of Kablitz. This was done, but the Ramzin-Kotloturbin designs developed were found to be useless and, in spite of protests of the now-expropriated firm, the Soviets continued to use the Kablitz patents without compensation.

Other concessions suggest that taxation was a common weapon used either alone or with other means to force out the foreign operator. The Czenstochova celluloid factory in Leningrad was burdened with a poorly prepared contract which the Soviets consistently interpreted to allow only a minimum of profits. The coup de grâce was applied in early 1930 when tax difficulties forced the firm to close down.[22] The Vint concession was forced out by continual increases in taxation from 1923 to 1928.[23]

The Soviet monopoly of foreign exchange meant that denial of permission to export proceeds could be coupled with taxation as a weapon. Tiefenbacher Knopfkonzession, employing 1,100 persons, is one example in which both methods were used.[24]

METHODS OF EXPROPRIATION: HARASSMENT

Harrassment, less open than physical ejection, was used as a weapon for expropriation. Drusag, the German agricultural concession owned 90 percent by the German Government, is an example in which Soviet harassment was countered by unsuccessful peace offerings by the German Government.

In 1929 and 1930 a series of labor incidents involved the German management of Drusag. These were climaxed in the trial of Director Ditlow on minor charges involving labor regulations. Ditlow was accused of allowing shepherds to work more than eight hours per day and of not supplying work clothes

[20] The U.S. Riga Consulate did not know of the 'normative tax.' Kablitz provided a jocular explanation: 'The telephone number of the respective concessionary is multiplied by the age of his wife. If the amount thus calculated looks insufficient, one or two ciphers are added to it.'

[21] Later tried on charges of industrial sabotage.

[22] U.S. State Dept. Decimal File, 861.602/221, May 6, 1930.

[23] Sutton, *Western Technology . . ., 1917 to 1930*, pp. 101–2.

[24] U.S. State Dept. Decimal File, 861.602/216, April 1930.

(which were in any event unobtainable). The 'evident object in view was to undermine the discipline at the concession.'[25] The Soviet authorities then seized and auctioned off the Drusag automobiles and typewriters. A levy of 3 percent was placed on the salaries of all German workers. Messages to the outside world were confiscated.[26]

A search of the U.S. State Department Decimal File produced numerous statements concerning such harassment. For example, the Tetuikhe Mining Corporation concession (after Lena, the largest such concession), was liquidated December 26, 1931, as the following attests:

> . . . in 1930 the Soviet Government having forced the Lena Goldfields concessionaires out of the U.S.S.R. began a campaign against the Tetuikhe Corporation, and published reports alleging that it had been in conflict with its workmen. Eventually, at the end of last December, the corporation suspended operations. . . .[27]

The Novik concession, for manufacture of felt products near Moscow, was liquidated in November 1929, 'due to the impossibility of the concessionaires to work in face of the opposition put in its [*sic*] way by the Soviets on labor questions.'[28]

In the case of the Standard Oil lease of a Batum refinery, we find the local press stirring up trouble. For example, *Zaria Vostoka* ran an article critical of the American management of the plant and took exception to the way 'the Americans talk to the Russian workers.'[29] Despite the criticism, Standard Oil was still operating its Batum refinery in 1935.

HISTORY OF THE LENA GOLDFIELDS, LTD., CONCESSION

The experience of Lena Goldfields, Ltd., largest of the concessions, is well worth exploring as a case history. The company was required to make specific investments in properties transferred to its care and to produce stipulated quantities of various minerals and metallurgical products.

An investment of not less than 22 million rubles was required. The Moscow *Izvestia*[30] reported early in 1929 that total investments by the company had reached 18,129,000 rubles, of which 15 million for mining equipment had

[25] U.S. State Dept. Decimal File, 861.602/212, Report No. 25, Berlin Embassy, February 20, 1930. The director of the Zellugol concession was fined 10,000 rubles and the director of the Leo Werke concession was fined 5,000 rubles on similar charges.

[26] *Ibid.*

[27] U.S. State Dept. Decimal File, 861.602/244, Report No. 89, Riga Consulate, February 26, 1932.

[28] U.S. State Dept. Decimal File, 861.602/211, Warsaw Legation Report, February 8, 1930.

[29] *Zaria Vostoka* (Tiflis), 'The Smoke of the Fatherland,' No. 268 (September 29, 1931), p. 3.

[30] No. 69, March 26, 1926.

been provided by a banking consortium including the Deutsche Bank of Germany and Blair & Company of New York.

The agreement further required a minimum annual production of 420 poods of gold, 1,000 poods of silver, one million poods of copper, 600,000 poods of zinc, and 180,000 poods of lead. According to *Ekonomicheskaya Zhizn*,[31] the 1926–7 output of gold was 499 poods, an amount which exceeded the required minimum by 79 poods. No reports of failure to meet stipulated production totals have been traced. The company paid royalties of two million rubles in 1926–7.

Although the Soviets breached the agreement from the start by not turning over to Lena Goldfields all properties included under Articles 1 and 2 and, more importantly, by not allowing the free sale of gold on the London gold market, signs of trouble did not appear until early 1928. In April of that year *Ekonomicheskaya Zhizn* printed an article, 'There Must Be an End to It,'[32] objecting to the Lena Goldfields policy of allowing mineral exploration to be undertaken by private prospectors (starateli), although this was allowed under the agreement and indeed was the system used by the Soviets themselves in the Alden fields. Some 18 months later the Soviet Government complained that 1928–9 royalties amounting to one million rubles had not been paid. Lena was unable to pay, as the fixed price paid by the Soviets for Lena's gold was approximately one-fourth the world price. Free export of Lena's gold, although permitted under the concession contract, was in practice prohibited. This forced default was followed on October 22, 1929 by an article criticizing trade unions for 'leniency' toward the company: 'The concessions stand as a sort of appendix, apart from the rest of our life. This part of class warfare has been neglected and all kinds of weeds grow there. . . .'[33]

This Soviet pressure coincided with completion of Lena's technical reconstruction and plant-expansion program. Herbert Guedella, Chairman of the company, reported in late 1928 that three years of intense reorganization and investment were producing results.[34] The large Bucyrus dredge was installed at Lenskoie in 1928. The new plant at Seversky was completed in September 1929. The Revda Iron and Steel Plant additions and renovations were completed in early 1929. A considerable amount of work had been done in opening up the Degtiarsky copper mines and 12,000 tons of copper per year were scheduled to be produced in 1930. The Altai district mines were completely re-equipped by the end of 1929. All this was facilitated by credits provided by Western bankers on the Lena Goldfields account.

31 No. 283, December 11, 1927.
32 No. 93, April 21, 1928.
33 *Izvestia*, October 22, 1929.
34 *Times* (London), November 20, 1928.

The actual ejection of Lena Goldfields personnel, as distinct from preliminary propaganda skirmishes, was a multi-pronged effort involving the OGPU, the Central Committee of the Party, the trade unions, and Glavkontsesskom. The latter requested payment of royalties within four months. Simultaneously, the OGPU raided and searched all units of Lena's widespread operations; these raids were not publicized in the Soviet press. Alexei Rykov, a prominent Bolshevik leader, then made a speech to the Central Committee suggesting that concessionaires were welcome if they operated on imported capital, did not expect unlimited profits, and did not indulge in counter-revolutionary activity. The Soviets sabotaged some Lena operations, and company personnel were ejected from other properties.[35] *Ekonomicheskaya Zhizn* then accused the company of delaying wage payment to workers for up to six days.[36]

These acts were followed by a propaganda campaign in both the domestic and foreign press concerning alleged nonpayment of royalties, nonfulfillment of the construction program, and demands for compensation to the Soviet Union for 'uneconomic work.' These accusations were then 'proven' by finding four Lena employees guilty of espionage.

An arbitration court, with Dr. Otto Stutzer as chairman, met at the Royal Courts of Justice, London, in the summer of 1930. Their decision was published on September 2, 1930.[37] The court found the main factors in the failure of the Lena Goldfields concession to be a series of unilateral actions taken by the Soviet Government.

It was determined that Lena had fulfilled its agreement by producing 1,844 poods of gold in four and a half years and by making the specific investments stipulated under the concession agreement.

A number of Soviet acts, explained below, were identified by the arbitration court as breaches of the contract. Article 20 gave Lena the absolute right to sell freely on foreign markets all gold produced. If the gold was sold to the Soviet Union, Article 20 stipulated that the prevailing London market price be paid. The Soviets breached Article 20 by instituting the penalty of death for selling gold abroad, by purchasing Lena's gold only for rubles and at an exchange rate fixed, not in relation to the London gold price, but arbitrarily at about one-quarter of the London price. Thus Article 20 was found by the court to be a 'nullity.'

The Soviet Government, it was found, had not provided police protection as required in Articles 35 and 80. Thefts of gold, estimated at between 30

35 U.S. State Dept. Decimal File, 861.63—LENA GOLDFIELDS LTD./18, January 13, 1930, Warsaw Report.

36 No. 20, January 25, 1930.

37 *Times* (London), September 3, 1930.

and 40 percent of total output, were encouraged at least partly by this refusal of protection.

The Soviets did not transfer to the concession all properties specified in Article 2: particularly certain gold mines, iron-ore mines and the Altai fire-clay deposits. This forced Lena to import fire clay at great cost from Germany. The company had also been physically ejected from the marble-limestone field granted to it under Article 1. Limestone was essential as a smelter flux, and Lena was then forced to buy inferior limestone at great cost.

The civil rights of Lena employees had been removed and simultaneous OGPU raids had been made at nearly all the company's numerous establishments, spread over 2,400 miles. The OGPU had seized and searched 131 company personnel; 12 were arrested and 4 placed on trial and sentenced to prison terms for espionage.

The Soviets did not put in an appearance at the arbitration court, which awarded damages of £12,965,000 sterling (about $65 million) to the Lena Goldfields, Ltd.[38]

The question of compensation was immediately taken up by the British Government, and it is clear that only continued assistance from official sources, five years of negotiation, and the possibility of closing off trade between Britain and the U.S.S.R. brought any compensation at all to Lena.

An agreement was reached in November 1934 under which the Soviet Union agreed to compensate Lena Goldfields to the amount of £3 million ($12 million at 1934 rates of exchange) over 20 years. These payments, in the form of non-interest-bearing notes, were to comprise £50,000 on ratification by Lena shareholders, and 20 installments of £92,500 each, followed by another 20 installments of £55,000 each, paid at 6 monthly intervals beginning in May 1935.[39] This settlement was ratified by the Soviet of People's Commissars in March 1935.[40]

A routine inquiry by the Commodity Credit Corporation to the State Department in early 1937 reopened the Department's file and brought forth information about the notes given by the Soviet Government for Lena

[38] *New York Times*, September 3, 1931, p. 12, col. 3.

[39] Details from 861.63—LENA GOLDFIELDS LTD./36, quoting House of Commons, *Parliamentary Debates*, November 12, 1934, col. 1502. Lt. Col. J. Colville (Secretary, Overseas Trade Department): 'the company recognizes that the prospects of any settlement at all without the assistance they received from His Majesty's Government would have been slight.' This settlement was not received enthusiastically in the Commons. For example, Sir William Davison asked, 'Do I understand that this British company has been obliged, on the recommendation of the British Government, to settle for a sum of £3,000,000 which is to be paid over 20 years, in lieu of an arbitral award of £13,000,000?'

[40] *Za Industrializatsiiu*, March 22, 1935.

Goldfields and the Tetuikhe mining properties. These notes had been distributed to shareholders and privately traded in London. The Commodity Credit Corporation was offered a quantity of Lena Goldfields notes by Cookson Produce & Chemical Company, Ltd., of London in exchange for 15 million pounds of American tobacco.[41] The Departments of Commerce and State, in determining whether to accept such notes, concluded that payments had been made promptly by the Soviet Government and that there was no open market in the notes, although there had been a number of private sales at varying discount rates, one authority quoting 9 percent.[42]

From this source we also learn that the Soviets paid £940,000 in similar non-interest-bearing notes for the Tetuikhe claims. One-third of these fell due before 1938 and two-thirds before 1949. This agreement was concluded in 1932.[43]

The end result was that in the few cases in which the Soviet Union did pay compensation, it was below arbitrated value and did not bear interest, and thus gave the Soviet Union an advantage equivalent to long-term no-interest loans.

SOVIET EXPLANATIONS FOR LIQUIDATION

The reasons for liquidation given in the Soviet press can be summarized under three headings.[44] First, it was argued that concessions were losing their 'monopoly' or 'semi-monopoly' position and consequently the possibility of making 'enormous profits.' This explanation is consistent with Leninist teaching that private capital can only exist in monopoly circumstances. Second, the concessions were said to be unable to compete with 'more advanced' Soviet enterprises coming into production. Third, it was said that capital investment by foreign concessionaires was absolutely inadequate, and that in any event working capital was coming from State banks and not from capital imports; this was coupled with statements that British and American banks had refused credits.

These statements are only partially true and are not by any means full explanations. They ignore the acts of harassment, breaches of contract and trade-union pressure. The 'loss of monopoly' argument was hardly relevant

[41] U.S. State Dept. Decimal File 861.63—LENA GOLDFIELDS LTD./40.

[42] U.S. State Dept. Decimal File 861.63—LENA GOLDFIELDS LTD./41. However, the reader should not infer that all sales took place at this discount. The Soviets inserted some unusual redemption clauses and there were several methods of working out the discounts, giving quite different end results.

[43] See Sutton, *Western Technology . . . , 1917 to 1930*, p. 286, concerning Tetuikhe and the 'arm's-length hypothesis.' Tetuikhe obviously received more favorable treatment than Lena Goldfields.

[44] See, for example, *Izvestia*, March 2, 1930.

in a goods-short economy such as the Soviet Union. The concessionaires were always more efficient than the new Soviet enterprises and sold their products with little difficulty. It is true that foreign banks were reluctant to advance credits for internal operations, yet Drusag, for example, was amply financed by the German Government for many years and was, nevertheless, expropriated.

A standard propaganda ritual was practiced before expropriation of each concession. This ritual consisted of increasingly stronger criticism of errors or supposed errors committed by the concessionaire. Nothing appears to have been too remote or insignificant to escape attention. For example, the Control Company concession gave its employees small sums of money as Christmas gifts. *Izvestia* reported that these gifts were indignantly refused by the workers because 'tips have been abolished' and that Christmas was 'a new weapon for deceiving the workers.'[45] The point, of course, was brought up to prepare the way for expropriation.

Sometimes the ritual became a trifle forced, particularly when the operator had substantially fulfilled his agreement. For example, the Japanese coal concession, Kita Karafuto Kugio Kabusiki Kaisha, signed in 1925 for operation of three coal fields on Sakhalin, was criticized on insignificant grounds. The company built a 300-kilowatt electric-power station, a 361-meter cableway and a 1,500-ton conveyor system, but, it was said, brought in only 'obsolete new machines' with nothing for Soviet engineers to learn. This became the basis for criticism.[46] The company was expropriated in 1944.

In the case of a Japanese oil concession, the Soviets accused the concession of wasting oil because it allegedly utilized 16.5 percent of its output in operating the concession. The future of the concession, warned *Za Industrializatsiiu*, would depend on the ability of the Japanese concessionaires to 'supply sufficient capital.'[47]

Statements by the Hammer concession (the Moscow Industrial Concession) on its own liquidation reflect the official Soviet argument, but the Hammers were in an 'arm's length' relationship with the Soviet Union.[48] The official reasons for liquidation were that inadequate capital had been imported by the Hammers and that further credit had been denied by British and American banks. Thus expansion into new lines was curbed by inadequate capitalization.

[45] January 15, 1930.

[46] *Za Industrializatsiiu*, May 16, 1930.

[47] February 23, 1930. The Japanese coal and oil concessions on Sakhalin, the last surviving concessions, were liquidated in 1944. Harriman reports that Vyshinsky replied to a question concerning compensation for their expropriation: '. . . the Soviet Government would pay a small sum for a large property.' U.S. State Dept. Decimal File 861.b.6363/191: Telegram.

[48] Julius Hammer was a founding member of the U.S. Communist Party.

The concession was in debt to Gosbank, and there was competition from new State enterprises. As a result Hammer was reported as willing to sell, and the factory was put into the Moscow Chemical Trust.[49] Unlike those of other concessions, the Hammer debts, internal and external, were paid by the Soviet Government, and the Hammers were allowed to export their profits. Shortly after leaving the U.S.S.R., they opened the Hammer Galleries in New York and became the sales outlet for confiscated tsarist art treasures.

This favorable treatment, however, was unusual; most concessions were expropriated without meaningful compensation. However, the propaganda ritual was used to preserve a façade of legality over expropriation of the concession. Censorship of the operating results of concessions, coupled with the propaganda ritual, ensured that the historical record would be favorable to the Soviets. This objective has been almost completely achieved.

An excellent review of concession operations and liquidations before 1926 was made by W. Kokovzoff,[50] who concluded that others would suffer the fate of liquidation. He foresaw correctly, for example, the demise of the Harriman concession and that Harriman would one day be faced with 'insurmountable difficulties.'[51] Kokovzoff also noted that in 1926, of the 110 concessions granted, 24 had been liquidated, of which only 13 had not assumed their contractual obligations.[52] This means that 97 concessionaires had already made their investments as required in the contract. Kokovzoff pointed out that the most innocent report by any concession director to his home office was considered an act of 'economic espionage' and cited the case of Professor Clair, a Swiss citizen condemned to 10 years in prison for such activity; on this basis Kokovzoff correctly forecast the circumstances surrounding the expropriation of Lena Goldfields.

The Soviets themselves warned explicitly of the ultimate fate of the concession. Kokovzoff quotes several examples. One from *Le Messager de Paris* reports a speech by Bukharin:

> On the one hand, we admit capitalist elements, we condescend to collaborate with them; on the other hand our objective is to eliminate them completely ['radicalement'] to conquer them, to squash them economically as well as socially. It is a type of collaboration which presumes a furious battle, in which blood may necessarily be spilled.[53]

That this message was not seen and correctly interpreted by Western businessmen is almost incredible. About 250 agreements had yet to be

[49] *Izvestia*, March 2, 1930.

[50] 'Les Soviets et les concessions aux étrangers,' *Revue des Deux Mondes*, XXXV (1926), p. 158.

[51] *Ibid.*, p. 168.

[52] *Ibid.*, p. 162.

[53] *Ibid.*, p. 161. *Le Messager de Paris* was an official Soviet publication in Paris.

concluded; yet no warning was given by Western governments to their businessmen.

THE LESSONS OF THE FOREIGN CONCESSION

The concession was a Leninist tactical maneuver consistent with the announced plan to acquire the fruits of Western economic and technical strength. The policy began as the foreign counterpart of the New Economic Policy and continued long after the domestic Russian entrepreneur had been expropriated for the second time in 1924. As Lenin pointed out to the Russian Communist Party on November 27, 1920, 'Concessions—these do not mean peace with capitalism, but war upon a new plane.'[54]

Thus the ultimate fate of the concession was never in doubt. When his skills and his last dollar, pound, mark, or franc had been squeezed from the foreign concessionaire, the door would be slammed shut and his assets inside the Soviet Union expropriated.

In the final stage of this policy, the Russians employed an exquisite combination of tactics. The argument used in 1928–31 to encourage even more Western investment and designed to maximize economic benefits to the Soviet Union was also utilized as the main reason for expropriation. The Soviet theme in 1928–31 was 'either supply more capital or we will expropriate.' This threat worked well, for example, with Drusag, in which the German Government itself made further investments from 1926 to 1931, until it owned 98 percent of the concession. When the foreign businessman discovered such investment was endless, he withdrew and suffered his losses in silence. It is noteworthy that expropriation was given a façade of legality, usually preceded by a propaganda ritual designed specifically for foreign consumption.[55] A policy of rigid censorship concerning concession operation, particularly after the 1927 law which made the publication of concession news a crime of espionage, prevented widespread Western knowledge of the fate of the concession. This policy was aided by the silence of Western businessmen anxious to hide their failures and by the grant of compensation in several key cases in which the concessionaires had considerable political influence in the West.

The Polish, Estonian, Latvian, Lithuanian, Czechoslovakian, and Hungarian concessionaires came off worst, in the final analysis. After helping the Soviets develop Russia, they were ejected not only from their concessions but, in another 15 years, from their own homelands as well.

[54] V. I. Lenin, 'Report on Concessions to the Bolshevik Fraction of the Eighth Congress of Soviets,' December 21, 1920, in *Dokumenty vneshnei politiki SSSR*, III (Moscow: Gospolitizdat, 1957).

[55] It should be noted that ultimate expropriation was predicted by the United Kingdom and the United States foreign offices when the concession policy was first announced. See Sutton, *Western Technology . . ., 1917 to 1930*, pp. 295–6.

In brief, the lesson for the West is that any joint economic enterprise with a Communist nation is inexorably destined for seizure when the advantages to the Communist nation have ceased or when no further financial or technological investment can be extracted from the foreign partner.

Regrettably, a further lesson for Western businessmen is that his own government, for reasons of policy, may not always be in a position to provide prompt and accurate information on Soviet intentions. The U.S. State Department and the British Government had policies of 'noninterposition' and the German Government a policy of concession encouragement even when it was evident from material on file that concessions were a temporary tactic, and indeed had been predicted as such by all Western foreign offices.[56]

[56] Some British Members of Parliament went so far as to encourage investment in concessions for reasons of ideological sympathy with the Soviet Union rather than concern for the interests of British businessmen; see Anglo-Russian Parliamentary Committee, *Possibilities of British-Russian Trade* (London: 1926). Moreover, although most Western businessmen have been able to learn from their experiences, the same cannot be said for Western politicians. For example, the J. G. White Corporation of New York had unpaid claims against the Soviet Union totalling $387,000 and commented to officers of the State Dept., 'We believe it would be a great mistake for the Government of the United States to recognize the Government of Russia, for if our government did, there would probably be the same history of relations on a larger scale that we have had on a smaller scale.' (U.S. State Department Decimal File, 861.602/252, December 31, 1930.) Four years later President Roosevelt recognized the Soviet Union. The Soviets broke every one of their political commitments within a few months of signature.

CHAPTER THREE

Technical Assistance to Irrigation Construction

THE TURKESTAN IRRIGATION PROJECT OF A. P. DAVIS

THE Russian cotton-manufacturing industry was organized into factories about 1825. By World War I it was the third largest in Europe, with over eight million spindles in 745 factories and employing 388,000 workers. Domestic cotton growing, which supplied about one-half the raw material requirements, was concentrated in the Ferghana district of Turkestan and cultivated by an extensive irrigation system.[1]

After the October Revolution both cotton growing and cotton manufacturing almost ceased. Production of cotton textiles was restarted with German assistance and imported American raw cotton financed by the Chase National Bank.[2] These imports were a major drain on limited foreign exchange, and consequently there was a major drive to restore the old irrigation systems, add further irrigated acreage, and increase domestic cotton production. Irrigation of areas in Turkestan and Transcaucasia offered more promising solutions.

In tsarist times Russia had had 4,222,000 hectares under irrigation. Gosplan anticipated expending more than one billion rubles between 1928 and 1932 to increase this irrigated area by 1.5 million hectares: 50 percent in Central Asia, 20 percent in Kazakstan and Transcaucasia, and the remainder in the North Caucasus area.[3]

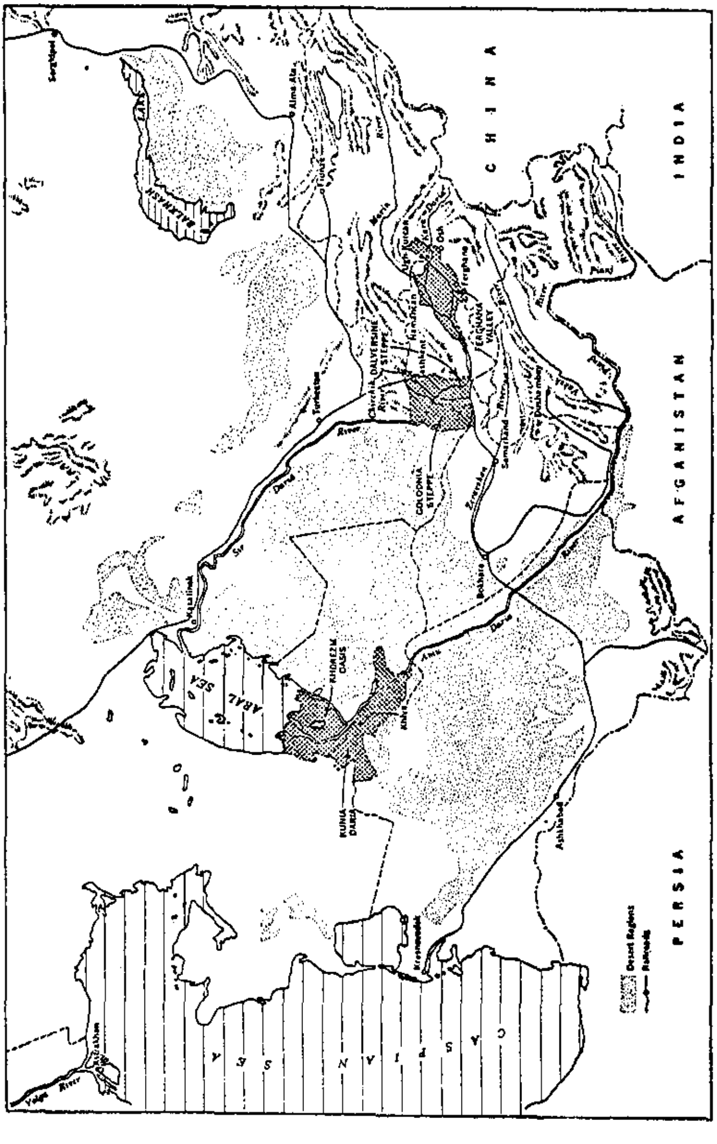
In 1913, Arthur P. Davis, construction consultant for the Panama Canal, former Director of the United States Reclamation Service, and one of the best-known of American irrigation engineers, had surveyed the feasibility of irrigating the Kara Kam desert of the Golodnaya Steppe (Hungary Steppe)

[1] W. Busse, *Bewasserungs Wirtschaft in Turan* (Jena: 1915).

[2] Sutton, *Western Technology . . ., 1917 to 1930*, p. 297.

[3] Amtorg, *op. cit.*, IX, No. 5 (May 1934), pp. 116–7.

Figure 3–1 CENTRAL ASIA IRRIGATION PROJECTS



Source: *Civil Engineering*, II, No. 1 (January 1932), p. 2.

in Central Asia. He finally recommended further surveys and preliminary planning work. For 15 years he heard nothing more about the project; then in June 1929 he was invited to Moscow and informed as he reported later, that his recommendations for Golodnaya Steppe had been adopted and that 'it had been ready for construction for several years and was then awaiting my criticism and approval. . . .'[4]

Davis concluded a preliminary technical-assistance contract with the Soviets, re-examined his earlier proposals and all available surveys and plans, inspected the ground, and agreed to remain in the Soviet Union as a consultant, 'giving advice as to necessary changes and further work to be undertaken.'[5] Davis was given complete engineering responsibility for the irrigation program in Central Asia. The organizational structure of Glavkhlopkom (Chief Cotton Commission) and its irrigation construction departments is outlined in figure 3–2, based partly on the original Soviet chart. Amburo (American Bureau) was the all-American engineering consultant organization within Glavkhlopkom and was responsible for new irrigation construction and operations. Davis was chief of Amburo in Tashkent, and a Major Olberg was chief of a similar office in Tiflis.[6] Although the American contingent was by far the most important, other foreign irrigation specialists were used. In 1930, for example, Amtorg reported, 'Twenty-three Japanese and Korean specialists have arrived to assist in the irrigation and sowing work.'[7]

THE AMERICAN BUREAU (AMBURO) IN TASHKENT

This is a sector of the Soviet economy in which the Western technical contribution can be precisely identified. Willard Gorton, a U.S. irrigation consultant employed by the Soviets as Chief Consulting Engineer for the Vaksh irrigation project and C. C. Tinkler of the Seabrook Engineering Corporation (which had road-building contracts in the Turkestan irrigation areas) smuggled their working papers and reports out of the U.S.S.R.[8] These papers throw

[4] A. P. Davis, *The University Hatchet* (Washington, D.C.: May 1932). See also: A. P. Davis, 'Irrigation in Turkestan,' *Civil Engineering*, II, No. 1 (January 1932).

[5] Davis, 'Irrigation in Turkestan,' *Civil Engineering*, II, No. 1 (January 1932).

[6] The Amburo office at Glavkhlopkom in Tashkent had two engineers from the United States in addition to Davis. The staff also included one interpreter, two translators, and two Russian-English typists.

[7] Amtorg, *op. cit.*, VI, No. 12 (June 15, 1931), p. 285.

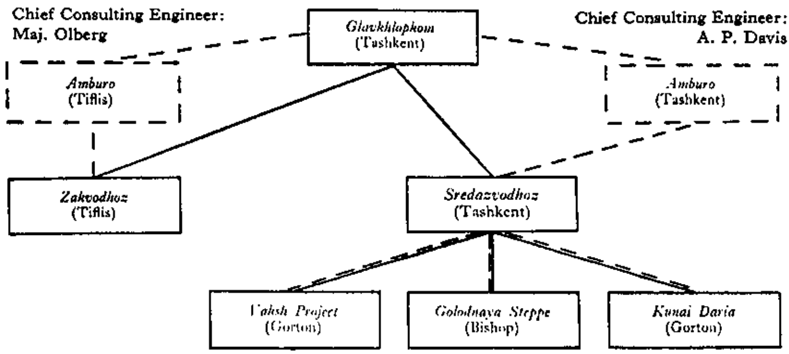
[8] Both document collections are in the vaults of the Hoover Institution on War, Revolution and Peace at Stanford University. The Gorton Papers owe their survival in the West to a negligent OGPU border guard. Tinkler's collection is smaller and does not contain original Soviet memoranda, orders, and reports, but is useful, as it covers the same time periods and locations as the Gorton Papers. The success with which the Soviets have thus been able to bury the record of foreign technical-assistance is illustrated by the observation that, if reliance were

considerable light on the actual, rather than the propagandized, processes of Soviet economic development in the 1930s. The difference between the propaganda image, which has unfortunately been reflected in most Western writing on Soviet economic development, and the actual construction process is almost unbelievably great. The work of this single American consultant is therefore described in detail. Willard Gorton's problems and functions were more or less similar to those of other foreign engineers and technicians.

Glavkhlopkom Order No. 220,[9] issued in Tashkent on November 22, 1930, placed Amburo under direct control of Glavkhlopkom Chairman Reingold. Instructions passed from Reingold to the Chief Consulting Engineer of Amburo (A. P. Davis) either directly or through the Liaison Officer (V. V. Tchikoff), also known as the Technical-Administrative Officer, or through the Chief of the Irrigation Department, F. Skorniskoff-Nelson.

A. P. Davis was director of Amburo work, with Liaison Officer Tchikoff in charge during his absence. It was specifically stated in Order No. 220 that the Liaison Officer had no authority over technical activities of the various *consulting* engineers without the prior authorization of Reingold, but all

Figure 3–2 ORGANIZATIONAL STRUCTURE OF GLAVKHLOPKOM (CHIEF COTTON COMMITTEE), 1930



———Soviet nominal control
- - - -American advice and technical responsibility

Source: Gorton and Tinkler Special Collections, Hoover Institution, Stanford University. The Gorton papers include an original Soviet 'Administrativnaya skhema Amburo' (Administrative Chart of Amburo).

placed only on Soviet-released information, this chapter would be limited to one sentence: 'The Zakvodhoz (Transcaucasian Water Economy Service) engaged two irrigation engineers.' [S. Bron, *Soviet Economic Development and American Business* (New York: H. Liveright, 1930), p. 145.]

[9] Order No. 220 is in the Gorton Papers.

Russian employees of Amburo were placed under direct charge of the Liaison Officer, who was a naturalized U. S. citizen.

Paragraph five of Order No. 220 begins, 'The American engineers of the Trusts (W. L. Gorton, L. E. Bishop, and others) although directly under orders of the Chairman of the Trust are at the same time members of the American Bureau. . . .' The paragraph then details instructions for the work of these engineers. The Amburo office had to co-ordinate its work, including that of employees of individual consulting engineers. Foreign engineers were required to present a verbal report every 15 days and submit written reports in duplicate not later than the fifth day of each month; these reports were to include the work of interpreters and others working under the consultants. All translations, memoranda, reports, minutes, and official correspondence had to be turned over to Glavkhlopkom in duplicate.

The objective of Order No. 220 was clearly to subordinate the American engineers to detailed central direction and maintain a check on implementation of Glavkhlopkom instructions by means of verbal and written reports. This betrayed Soviet misunderstanding of the abilities of a capable engineering consultant; these engineers had world-wide experience and were accustomed to developing large-scale government projects on a responsible individual basis.[10]

THE WORK OF FOREIGN IRRIGATION ENGINEERS

Gorton's experience is typical for a foreign consulting engineer in the Soviet Union in the 1930s and 1940s. Shortly after arriving he was appointed Chief Consulting Engineer for design and construction of the Vaksh irrigation project, the largest irrigation project implemented between 1930 and 1945.[11] A design and development program for Vaksh was drawn up by an engineering commission comprising engineers Khrustalev, Vassiliev, Yaltenovsky, and Rabinovitch, with Willard Gorton as Chairman. The charge to this commission was to consider: (a) the number of engineering designs to be established and the extent to which each design was to be developed, (b) the type and size of the important structures of the project, (c) the time objectives for the various plans, (d) co-ordination of investigations and preparatory work, and (e) any other technical matters. Any engineering disputes were to be settled by A. P. Davis through the chairman of Sredazvodproiz (Central Asia Water Authority). All Soviet engineers on the irrigation projects were to work under the super-

[10] The detailed check may have been due to lack of trust, or the need for bureaucratic 'make-work;' or perhaps the Russians believed that absolute central direction was more efficient in both the economic and the engineering phases than decentralized planning and individual responsibility.

[11] Gorton Papers, Glavkhlopkom Order No. 99, May 9, 1930.

vision of the American consulting engineers, and *Gorton was given full technical and economic responsibility for the Vaksh project.*[12]

It is this charge of responsibility by the Soviet authorities that counters any possible claim that the contribution of American engineers may have been negligible or secondary. This question of engineering responsibility was much in the minds of Reingold, Chairman of Glavkhlopkom, and his Party assistants. The top men in the trust were Communists with no engineering training and only a superficial knowledge of either cotton, irrigation, or construction.[13] They protected themselves from the omnipresent OGPU threat by placing full responsibility on foreign consultants. Gorton's appointment letter from Reingold contains the significant phrase, 'said engineer is entrusted, upon his full responsibility with the direction of designing the Vaksh project and its subsequent construction . . . [underline in original].'[14]

The direction is clear: 'full responsibility' for both design and construction. This is, of course, consistent with Gorton's position as Chairman of the Engineering Commission for the Vaksh project.

Choice of design was a separate and equally important task. The Russian and American engineers each developed designs for these irrigation projects. All designs then underwent evaluation by Amburo. Wilbur, assistant engineer to Davis, made initial evaluations and recommendations. A major part of Davis's work was to choose between competing designs according to Wilbur's evaluations. For example, on the design of the Vaksh head regulator, Wilbur wrote Davis that the Gorton design 'is satisfactory in every respect,' and, after proposing a few changes, concluded that 'the Gorton design is cheaper and better than the type B-7 proposed by Sredazvodproiz.' Thus a private American consulting engineer had the responsibility of deciding which of two designs, one American and one Russian, was to be used.[15]

Gorton's reports to the trust CAXO (Central Asia Cotton Union) give an excellent indication of the nature and extent of his work. A program was turned in covering each six-month period; a copy is available for the period March to December, 1931. During the first two weeks in March he was required to give written conclusions on the Vaksh project. This was followed by a two-week field trip to examine canal-cleaning methods. The next two weeks were spent examining earth work under progress at large projects and

12 Gorton Papers, letter from Gorton to Yanchur, November 29, 1930.

13 A. P. Davis, *The University Hatchet*, May 1932.

14 Gorton Papers, Letter No. 4074, Reingold to Davis, May 4, 1931.

15 Gorton Papers, memorandum from Wilbur to Davis, February 13, 1931. There is insufficient data to determine which parts of these irrigation projects, as finally built, were Soviet designed and which were American. It should not be assumed that they were all American-designed, as Russia had a history of irrigation projects originating in the nineteenth century.

indicating specifically, the ways in which imported equipment could be more profitably utilized. From May 15 to June he examined the tsarist-built Palvan and Gazavat canal systems and made proposals for redesign. June was spent on the problem of mechanizing canal cleaning, earth-work removal, and canal construction, and on proposals concerning the simplest type of mechanical equipment for use in Central Asia. After a month's leave, he spent August on the mechanization of large-project construction and made recommendations for the best use of existing equipment, the organization of labor, the choice of standard types of machines, and the production of parts for small irrigation structures. September was spent studying the use of local building materials in irrigation structures. October was utilized in determining the final design and construction schedule for the small Golodnaya Steppe project, and November on compiling conclusions concerning the 1932 construction schedule for the Vaksh project.[16]

For the six-month period covered by the next work program we also have copies of reports submitted by Gorton. On November 12, 1931, Gorton submitted to the manager of the Irrigation Department of CAXO a report entitled 'Conclusions with Reference to the Kunai Daria Project in Turkmenistan.' Three weeks later, on December 2, 1931, he submitted another report to the same department entitled 'Construction of the Lower Khan Main Canal Structures across Angren River.' Written answers to five questions submitted by CAXO were given on December 13, 1931, and a report on the Vaksh project is dated January 3, 1932. The next report was dated January 11, 1932. This was to the chairman of CAXO and entitled 'Methods of Doing Work and the Type of Canals in Ground with Considerable Settlement and Particularly in Ground Which Has Quicksand,' and was submitted with another report concerning the 'Cheapest Rational Method of Lining Farm Ditches in Cobbles and Loess Grounds.'[17]

The basic function, then, of a Western consulting engineer working for a Soviet irrigation construction bureau was to consider and report on problems, plans, and ideas submitted. Gorton's practice was to underscore deficiencies. For example, in his report to the chairman of CAXO concerning the Vaksh construction plan and proposed work for 1932 (January 3, 1932), Gorton points out the importance of transportation to the success of the project. This detailed report, the 'Vaksh Construction Plan, 1932,' emphasizes the key role of transportation and the probability that inadequate transportation would delay the project.

[16] Gorton Papers, 'Rabot Program.'

[17] Gorton Papers, Envelope 2.

There were also reports on soil problems: one on the results of soil analyses in the Vaksh River Valley (October 6, 1931); one to the Laboratory of the Water Institute concerning use of copper sulfate to remove algae (September 21, 1931), and others.

RELATIONS BETWEEN AMERICAN IRRIGATION ENGINEERS AND THE SOVIETS

Apart from normal engineering problems, there were two major areas of conflict between American engineers and the Soviet authorities. The Soviets did not, except in a very few favored cases, provide the living accommodations, transportation, or personal assistance specified in their agreements. Further, salary payments were almost always late and in most cases final terminal payment was either not made or made only in part after protracted argument.

The more experienced engineers learned to cope with bureaucratic procedures and shortchanging from Party officials. Gorton, for example, arranged his travel program according to the expense amount actually advanced to him. He decided that prepayment was essential, as travel expenses were 'forgotten' if claimed after actual expenditure. Before one trip to Ferghana Valley he wrote as follows:[18]

April 8, 1931
Tashkent

To Mr. Lezinoff
Manager, Irrigation Department

Dear Sir;

I estimate that I need 1000r for my coming trip to the Ferghana Valley. On my last request for advance funds of 1000r only 500 was supplied. Any shortage of funds supplied less than that requested meets with no objection from me but I must advise that when the money supplied is expended it will be necessary for me to return to Tashkent. I must further advise that expenses for meals and foods are at least 50% higher than they were when I was traveling in 1930.

Very respectfully,
W. L. Gorton
Consulting Engineer

[18] *Ibid.* Gorton retained a sheaf of copies of letters, labeled 'bellyaches,' which he had sent to various Soviet authorities. They are worth reading to illustrate the pettiness of Soviet officialdom. For example, they walled up Gorton's apartment so that he could not fuel the stove; this could only be done from the next-door apartment, occupied by a Party functionary concerned with fuel conservation.

Gorton's complaints were numerous. There was no interpreter. He was not paid for two months. His apartment had no heat. On other occasions the house needed repairs, the water was cut off, there was no coal and no electric power, and the well-pump was broken.[19]

In early 1931 Gorton finally exploded in a letter to Reingold:

> In view of all the above, I think the time has come to terminate the contract. For the Vaksh project you have your workers' enthusiasm, your exemplary brigades, and your socialistic competition and a highly trained corps of Soviet engineers all of which you pointed out yesterday. Furthermore, you pointed out to me that you had men capable of filling the position on the Vaksh which you had proposed to me to occupy. Under such conditions it appears to me that my services are unnecessary and that my work is not considered important enough to allow me what I require in order to perform my duties. Moreover, by dispensing with my services you will be able to carry the Vaksh construction to a conclusion with a 100% Soviet force.'[20]

However, it was Reingold, Chairman of the Cotton Commission—and not Gorton—who was finally replaced.

Gorton had trouble getting salary checks on time and was never completely paid for his work in the Soviet Union. Letters to Amtorg in New York from his wife, and letters between Amtorg in New York and Amtorg in Moscow illustrate a continuing problem of irregular salary payment.

At one point Gorton's checks were two months in arrears; no check was ever paid at the time required by the contract. The terminal payment was never made. Gorton received only 23 out of the 24 monthly payments, and received no payment for the $500.00 balance of his travel expenses. The exchange of letters with other engineers in the irrigation projects (Bremer, Fisher, and Major Olberg) indicated they did not receive full payment either. In effect, engineers' services were acquired at a discount, by breach of contract.[21]

This group of road and irrigation engineers, as a result of their excellent interpersonal communications, became hard bargainers where the Soviets were concerned.[22] Although they were shortchanged on their contracts, they certainly did considerably better than engineers in other sectors.

19 *Ibid.*

20 *Ibid.*

21 Appendix A is a copy of the Gorton-Sredazvodhoz contract with the method of payment specified. It is often claimed in the West that the Soviets have never failed to live up to a commercial contract. This is demonstrably not so.

22 A letter from Lyman Bishop to Tinkler (in Moscow) enclosed a check for $50 to cash on his return to the United States and requested him to 'see if I have any money in the bank.' The inference is obvious. April 1, 1930. (Tinkler Papers.)

IRRIGATION PLANNING AND CONSTRUCTION

At the end of two years in irrigation construction, Gorton had made two trips to the Vaksh valley, one trip to the Middle Anu Daria, two trips to the Ferghana valley, and three trips to the Dalverzin valley. He was then requested to report his conclusions. Gorton's report indicates that two things strongly impressed him: the necessity for good roads preliminary to construction and the necessity for proper maintenance and operation of equipment.[23] Neither recommendation was being followed. Further, he said, housing, storage, water, and sanitation facilities should be emplaced *before* construction started:

> It may appear that time will be lost if all such preparations are made in advance, but experience has demonstrated that both time and money as well as human lives are saved in the long run by adequate preparatory work.[24]

Gorton commented on the extreme shortage of capital equipment. He noted, for example, that a simple 18-inch circular saw operated by a 5- to 7-horsepower diesel engine by 'two unskilled but intelligent workmen will saw easily as much lumber in a day as 25 men using hand saws. . . .'[25]

Construction did not follow design; at the four-compartment square opening underdrain near Macoshkent, the walls were being built 8½ centimeters thick, although the design called for 10 centimeters.

> The reinforcing rod was being placed in such a way that the bars were twice as far apart in some places than in others. As a matter of fact the reinforcing was placed in such a manner as to be indescribable on account of the lack of uniformity in spacing. In some places where the reinforcing was supposed to be 5 cm. from the wall it was 1 cm. and in other places it was in the middle of the wall. . . .[26]

There were poor concrete pouring and form work, no machine mixing, no accurate measurement of the concrete mix, and no inspection of finished work. Gorton singled out the Dalverzin main canal where 'Large stretches . . . were of such poor quality as to be a shocking waste of money. . . .'[27] The concrete lining of the canal was 'badly defective' and the canal could not stand a full head of water.

Gorton then pointed out that the Soviet six-month and one-year plans were 'mostly a waste of time' unless certain data were known, and these

23 Gorton Papers, W. L. Gorton, 'Report on the Assignment: General Conclusions and Recommendations on Questions Concerning Irrigation Construction on the Basis of Your Two Years Work in the American Consulting Bureau' (Tashkent: January 1932).

24 *Ibid.*

25 *Ibid.*, p. 6.

26 *Ibid.*, p. 10.

27 *Ibid.*, p. 12.

generally were not known. It was not necessary, wrote Gorton, to wait until final design decisions were made before ordering equipment and materials. It was possible to order materials for 10 million cubic meters of earth excavation, for instance, without knowing whether the final excavation total would amount to 18 or 19 million cubic meters.[28]

CONCLUSIONS ON IRRIGATION AND COTTON DEVELOPMENT

Soviet planners correctly recognized the principle of import substitution as an aid to internal economic development, and planned construction of irrigation networks and domestic production of cotton to replace cotton imports from the United States. Prerevolutionary irrigation projects were revived. A. P. Davis, one of the world's foremost irrigation experts, was hired, and a group of top American irrigation engineers percolated into the organizational structure of Glavkhlopkom.

Although most sectors of the early Soviet economy had a shortage of trained Russian engineers, this was not the case in irrigation. However, those Russian engineers who had developed and operated the prerevolutionary irrigation network could not, from the political viewpoint, be trusted. The function of the American engineers was partly as consultant, partly as technical watchdog.

Planning, as well as choice and development of design, was an American responsibility between about 1928 and 1933. Only the shortage of valuta forced the Soviets to dispense with this assistance.

Table 3–1 EXPANSION OF ACREAGE UNDER IRRIGATION, 1928–50

Time Period	*Planned Construction*	*Estimated Actual Construction*
Pre-1917, built under tsars	—	4,222,000 hectares
1928–1932	1,500,000 hectares	1,140,000 hectares*
1933–1937	1,012,200 hectares	1,000,000 hectares*
1937–1941	608,000 hectares	None
1945–1949	656,000 hectares	None (all rehabilitation and completion of earlier projects)
Estimated Total, 1950		6,362,000 hectares

Source: Naum Jasny, *The Socialized Agriculture of the U.S.S.R.* (Stanford: Stanford University Press, 1949), pp. 483–4.

* Jasny takes his figures from the official plans and points out that 'part of this had been irrigated previously.' According to Kh. M. Dzhalilov, *Golodnaya step' i perspektivy ee osvoeniya* (Tashkent, 1957), only about 200,000 hectares were under irrigation in Golodnaya Steppe by the late 1950's; this suggests the First Five Year Plan was only about 20 percent fulfilled as late as 1956.

[28] *Ibid.*, p. 13.

Table 3–1, based on Naum Jasny's data, suggests that the period of American engineering responsibility (1929–33) was also that period in which construction of the greatest irrigation area since tsarist times was initiated.

In the irrigation sector, transfer of Western process technology, as distinct from engineering skills, was not a significant factor. Irrigation is not a complex technology; it relies on applying a set of well-established engineering principles to solution of agricultural problems. The construction problems are those met in canal construction, i.e., soil mechanics and concrete work. Although a number of American gate and regulator designs were introduced, and American terminology came into general use—for example Shiti Staneya (Stoney Gate) and Shiti Teintera (Teintera Gate)—the American technical design contribution was probably not of major significance.

In plans for mechanization of canal construction and manufacture of excavating and operating equipment, however, the American engineers had a central role. The bases for mechanization of canal construction in Central Asia were calculated and reported on by Gorton. This work included a survey of existing equipment manufacturing facilities and recommendations of Western equipment models for introduction and duplication. There is every indication that he put the interests of his Soviet client first: the recommendation to purchase single models of Western equipment for examination and duplication was hardly in the interests of the U.S. manufacturer.

From other reports we learn that irrigation projects faced major difficulties in 1932. The valuta crisis led to cancellation of the contracts with most Western engineers. The Soviets were entitled to do this under the terms of most contracts. Heavy inflation boosted costs. Gorton estimated that on Vaksh, up to 1932, the Soviets nad spent more than 30 million rubles to do $300,000 worth of work and comments that 'they are going to have a sad awakening some day. . . .'[29] The project almost collapsed in the summer of 1931 owing to transport difficulties. At the same time there were 26 imported draglines ready for work, but neither operators nor fuel were available.[30]

The general waste and inefficiency were enormous. Gorton estimated he lost 251 working days in two years through inefficient travel arrangements, workers' holidays, and lack of a skilled interpreter.[31]

In irrigation then, we find a sector in which the Western contribution in engineering alone was not as significant as in other sectors, but in which the use of Western technical skills enabled organizational difficulties inherent in the socialist form of 'planned construction' to be partially overcome.

[29] Gorton Papers, letter from Gorton to Davis, November 28, 1932.

[30] *Ibid.*

[31] These calculations are on the back of the small envelope in Envelope 2.

CHAPTER FOUR

Technical Assistance to the Non-Ferrous Metals Industry

In 1930 the engineering and metallurgical position of the Russian non-ferrous metals industry was extremely weak. The entire industry, including gold and rare metals, in all its phases from mining to refining, utilized only 346 Russian engineers and 458 Russian technicians. Moreover, three-quarters of these had less than one year of experience and only seven percent had more than three years of experience.[1] In short, almost all experienced Russian engineers had left Russia; only 20 with more than three years of experience remained. This handful of remaining engineers could by no means undertake the ambitious plans proposed for the industry, nor indeed even keep it operating. The only solution was to import experienced foreign engineers.

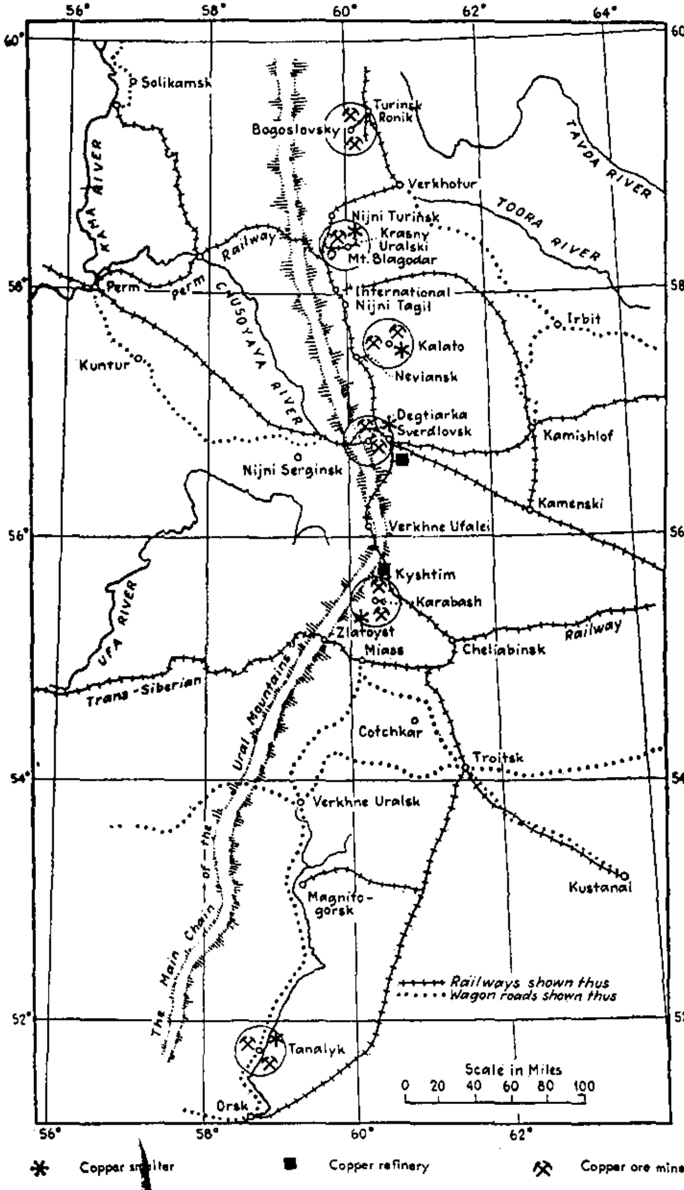
The scattered nature of non-ferrous mining and metallurgical activities makes this reconstruction of Soviet technological acquisitions more than usually complex and frustrating. There are, however, two clues which provide a quantitative framework. Soviet sources report that there were approximately 200 American engineers employed in their non-ferrous mining and metallurgical industries in addition to technical-assistance programs with foreign companies and consulting engineers. Further, John Littlepage, an American engineer and Deputy Director of Tsvetmetzoloto (Non-Ferrous Metals Trust), reported that he had four or five American engineers in each mine in the trust.[2] This suggests there were 10 American engineers in the Soviet Union for every Russian engineer of equivalent skill between 1929 and 1933.[3]

[1] I. P. Bardin, ed., *Metallurgy of the U.S.S.R. (1917–1957)* (Moscow: 1958), p. 598.

[2] John D. Littlepage, *In Search of Soviet Gold* (London: George G. Harrup and Co., 1939).

[3] Just over 10 percent of these 200 Americans replied to an enquiry by H. H. Fisher of the Hoover Institution in 1934. This was remarkable, as mining and metallurgical engineers, because of the confidential nature of their work, do not usually discuss their clients. Moreover, many anticipated the possibility of further Soviet

Figure 4–1 LOCATION OF URALS COPPER MINES, SMELTERS, AND REFINERIES



The influx started in December 1929, when J. L. Thomson, an American mining consultant, arrived in Moscow to conduct an inspection of the Urals copper mines in behalf of Tsvetmetzoloto. Thomson's first survey trip was to Sverdlovsk, with instructions to determine how many foreign engineers and how much equipment was required to re-establish the copper mines in the Urals area. After visiting the Kalata and Karabash districts, he returned to Sverdlovsk and reported:

> What I saw was appalling—the waste, the slackness, the inefficiency, the divided authority, the disregard for human life, the consumptive faces of the workmen, the women performing the most grinding manual labor, the crooked shafts, the frayed cables, the worn out and obsolete equipment. . . .[4]

Extraordinary mining practices were observed by Thomson. For example, accepted mining practice is to sink the main working shaft in country rock, and then tunnel across to the ore veins. In this manner ground settling does not affect shaft alignment and the shaft guides remain true. In the Urals, shafts were being sunk right on the vein so that ore could be taken out on the way down. The ore is mined a little quicker but only at a heavy long-run cost. However, Thomson observed that 'if the technical man doesn't believe in this method, the Communist does and that's where the shaft is sunk. . . .'[5] In the United States dry drilling is banned by law in all states: it leads to silicosis. In the Soviet Union in 1930 no one had heard of wet drilling.[6]

Thomson recommended immediate hiring of 48 American mining engineers, mill-construction men, and plant operators for the Urals copper mines and smelters.

A reconstruction of the management organization between August 1931 and April 1933 is contained in figure 4–2. There was a thorough percolation of American engineers into all levels of the organizational structure. Leading positions in all units of the non-ferrous metals industry were held by Americans,

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contracts and were unwilling to prejudice the possibility of future employment. This factor was reinforced by the depression uncertainty and a clause in their contracts prohibiting discussion of work in the U.S.S.R. The response came from the middle layers of personnel: i.e., the key operating, design, and consulting personnel. Only rarely did individuals at the top level or the foreman level respond.

4 *The Saturday Evening Post*, June 27, 1931.

5 *Ibid.* Thomson also noted that at least one-third of the Kalata smelter had been built over mine workings and was in danger of caving in.

6 Similar Western newspaper reports in the 1930s gave rise to claims of exaggeration, as well they might. However, even reports of the more absurd practices check out. For example, Warren, an American engineer, was called in to straighten out the Kalata smelter; of 21 pumps in the smelter, 16 had been rigged to pump *downhill*. There is no question that these things happened; too many independent reports cross-check for them to have been completely false. The only logical explanations are sabotage or complete incompetence.

including the position of Assistant Director of Tsvetmetzoloto, held by John Littlepage under Serebrovsky, the Russian Director. At lower levels, positions of director and technical director at combinats and mine managerships were commonly held by American engineers with Russian assistants.

This use of American engineers in everyday working positions was supplemented by several technical-assistance agreements with leading American companies which introduced their own consultants and methods. Between 1929 and 1933, then, the Soviet non-ferrous industry was almost completely run by American engineers. Between 1933 and 1936 these engineers were gradually withdrawn and hastily trained Russian engineers substituted; from 1936 to 1945 very few foreign engineers were employed.

THE KARABASH AND KALATA MINES AND SMELTER

The largest copper smelter in prerevolutionary Russia was the Karabash in the Urals, producing about 8,000 tons of black-fired copper per year. It was closed until 1925 and reopened with American technical assistance.[7]

Karabash was supplied by four mines: the Stalinsky, the American (later called the First of May), the Dzerzhinskya, and the Rikovsky. G. Jermain was the mine manager in 1931[8] under Milo Krejci, who was Technical Director of the Karabash Combinat, which included the Karabash smelter. Krejci had 11 American engineers, of whom three were Party members, working in the mines and smelter. There was considerable friction in the Karabash complex. Russian engineers, almost all non-Party men, resented the presence of Americans, and there is some evidence of sabotage.

In the early 1930s the Karabash smelter was under the supervision of Krejci and at that time produced about 80 percent of planned production, although 'it [was] an old project built before the war, [and] most of the original machinery [was] English, although the plant [had] some new German machinery.'[9] By 1939 the Karabash smelter was equipped with four Nichols-Herreshoff ovens, a Martin oven, and four Pierce-Smith converters.[10]

The Kalata mines were also under U.S. supervision in the early 1930s. The district is 80 kilometers north of Sverdlovsk in the Urals. After being flooded during the Revolution, it was reopened in 1923. The main mine—the Kalata—produced about 300 tons a day of 2.25-percent copper ore, but in 1933 the mine was on fire and only the neighboring Lovochka mine was producing ore.

[7] Sutton, *Western Technology . . . 1917 to 1930*, p. 81.
[8] Later Chief Engineer of Tsvetmetzoloto.
[9] U.S. State Dept. Decimal File, 861.5017—Living Conditions/643, Report No. 115, Riga, April 4, 1933.
[10] National Archives Microcopy T 84, Roll 27, Frame 663.

Figure 4–2 ORGANIZATIONAL STRUCTURE OF SOVIET COPPER MINING, SMELTING, AND REFINING INDUSTRY (1931) WITH WESTERN TECHNICAL ASSISTANCE

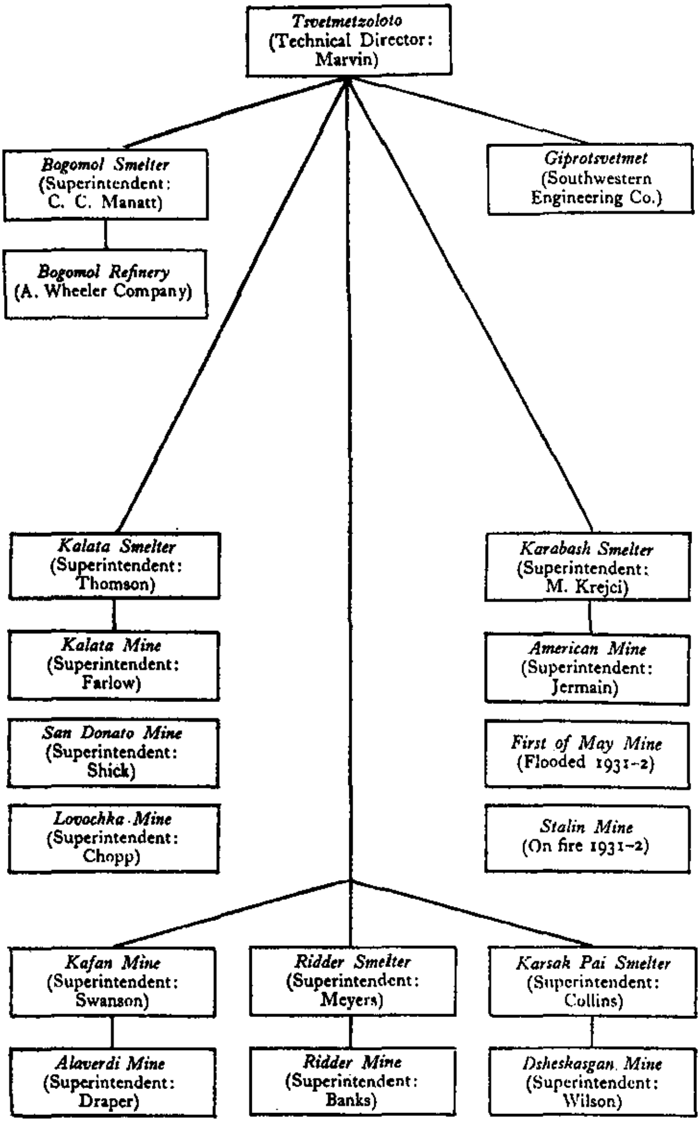


Table 4–1 SOVIET COPPER SMELTERS, 1941

Plant	Location	Capacity 1937 (Tons/Concentrate)	Production 1936	Production 1942 (Planned)	Western Technical Assistance
Karabash	Chelyabinsk	25,500	20,128	25,000	Expanded tsarist plant with U.S. and German equipment and U.S. technical assistance
Kalata (later Kirovgrad)	Sverdlovsk	38,500	22,996	40,000	
Karsak Pai	Karaganda	10,000	6,388	10,000	
Krasnoural'sk (Ordzhonikidze)	Sverdlovsk	40,000	22,840	40,000	Arthur Wheeler Corp. project
Lake Balkash	Karaganda	50,000	—	—	German technical assistance and John Calder as consultant
Baymak	Bashkir	5,000	4,759	10,000	Southwestern Engineering Corp. projects
Alaverdi	Armenia	5,000	4,744	10,000	
Kafan	Armenia	3,000	1,501	10,000	

Source: Die Kupfererzeugung der UdSSR (Berlin: Der Reichsminister der Luftfahrt und Oberbefehlshaber der Luftwaffe, 1941), pp. 24–5. Geheim Report No. 788, Microcopy T-84, Roll 127, Frame 1427764.

A description of an incident at Kalata offers some insight into the problems involved. The mine manager in the early 1930s was Hawkins, and his final act, as recounted by Thomson, was roughly as follows:

> Something else that the Russians do not believe in is leaving pillars to support the roof. Hawkins did succeed in having a pillar left in place in a certain station, and he posted a placard forbidding that it be shot. Furthermore, he gave pointblank orders to everyone to leave it alone. One morning it was gone. And when the level caved a loud cry went up that the Amerikanski was to blame. Hawkins blew up with a loud bang.
>
> The Trust heads did not want to lost Hawkins, and a meeting of executives was called to find out what he was angry about and soothe his ruffled feelings if possible. He was offered more money, more food, a better house but rejected them all. Two other Yankees and I heard him tell them, in good old Texas language that they were 'absolutely hopeless' and incapable of learning the first principles of good mining. No American miner he declared could be of any help to them or himself.[11]

This, by the way, dramatizes the problem of choosing between sabotage and incompetence as possible explanations. The incident could have been sabotage; it could just as well have been caused by a Russian miner on the night shift trying to make his ore quota the easy way by loading a close-at-hand pillar of ore.

[11] J. L. Thomson, 'Red Metal Mining in Russia,' in *American Engineers in Russia* (manuscript collection in Hoover Institution, Stanford University), p. 18.

Kalata had a prewar smelter supplied by these local mines and 'equipped with English and some German machinery.'[12] The capacity of the smelter was 100 tons per day, with one reverbatory furnace, three Great Falls 10-ton converters, and one Pierce-Smith 40-ton converter. The smelter and mines together employed 22 American engineers and technicians between 1930 and 1933, but later became a completely Russian-operated enterprise.[13] New installations included a Cottrell plant and an American 1,000-ton flotation mill.

GIPROTSVETMET: NON-FERROUS PLANNING INSTITUTE

Giprotsvetmet had responsibility for the design of non-ferrous mining and metallurgical installations. The bureau was headquartered in Moscow with field offices in Sverdlovsk and Leningrad.

In March 1930 the design bureau concluded a technical-assistance contract with the Southwestern Engineering Corporation of Los Angeles, which would act, according to Amtorg, 'as consultants in the preparation of projects, and the construction and operation of new and existing concentration plants in the Soviet Union.'[14] After pointing out that the company had designed milling plants in the United States, Mexico, and Canada, Amtorg added that the company would 'make available to the Soviet non-ferrous industry the latest developments and patents with regard to the concentration of ores.'

The Southwestern party of engineers was headed by E. R. Cullity[15] and was in Russia from June 1930 to January 1932, with responsibility for the supervision of design, installation, and initial operation of ore-dressing plants. The Southwestern projects were in Dzhezhakgan district, previously known as the Atabasarski concession, and the Caucasus and Urals. The company designed extensive concentrating facilities and complete plans for a 6,000-ton-per-day flotation mill.[16]

An agreement with the Radiore Company of Los Angeles was signed at the same time as that with Southwestern Engineering. Radiore, a front-rank geophysical exploration concern, contracted to locate non-ferrous and precious-metal ores by geophysical means.[17] Several exploration engineers left imme-

[12] U.S. State Dept. Decimal File, 861.5017—Living Conditions/643, Report No. 115, Riga, April 4, 1933.

[13] *Ibid.*

[14] Amtorg, *op. cit.*, V, No. 7 (April 1, 1930), p. 131.

[15] *American Engineers in Russia*, Fisher, Folder 4. S. E. Hollister was a Southwestern engineer working on projects in the Don, South Kazakstan, Urals, and Leningrad. Other engineers in the Southwestern group were E. R. Kinney, T. H. Oxnam, and A. J. Bone.

[16] *Engineering and Mining Journal*, CXXXVI, No. 2 (February 1935), p. 4.

[17] Amtorg, *op. cit.*, V, No. 7 (April 1, 1930), p. 131.

diately for the Soviet Union.[18] Little is known of their work except for one brief reference to indicate that the Radiore Company reported unfavorably on a copper deposit south of Kafan in Armenia.[19]

ARTHUR WHEELER ENGINEERING CORPORATION TECHNICAL ASSISTANCE AT COPPER SMELTERS AND REFINERIES

The Wheeler Engineering Corporation specialized in design and construction of non-ferrous metal plants, with experience not only in the United States and Canada but also in Chile and the Belgian Congo, where they had undertaken large copper-development projects. Extensive interviews with Frederick W. Snow, Chief Engineer of Wheeler, and other company engineers by U.S. State Department officials in the early 1930s have left a detailed picture of the development of the Soviet copper industry during the first 20 years after the Revolution.[20] As Snow had access to Tsvetmetzoloto records, his information is of great value and, as his salary was $25,000 per year, his services were no doubt highly appreciated.

The Snow memoranda suggest immense copper deposits in Russia. These were little prospected, and many were of low grade and required extensive construction of transportation facilities. In 1932, about 70 percent of the copper metal mined was coming from old re-equipped tsarist plants in the Urals, with Bogomol as the only Soviet-era development. Although the production plan for 1931 called for 150,000 metric tons, the total reported production in 1930 had been 47,000 tons, and in 1931, 48,423 tons. However, production actually *fell* in 1931, as more copper in that year came from scrap rather than mining operations. Accidents and the failure to open Bogomol were cited by Snow as reasons for the decline. The forced pressure of the Five-Year Plans created cave-ins at Kompaneinsk and fires at both Kalata and Karabash.

Although Wheeler then tried hard to get the proposed Lake Balkash development project, which opened about 1940, the company was unable to compete with credit terms offered by German and British firms. In September 1932 Wheeler retired completely from Russia. Chief Engineer Frederick Snow, however, returned to Tsvetmetzoloto as a consultant on individual contract at $25,000 gold (plus ruble payments) per year.[21]

[18] *Ibid.*, V, No. 13 (July 1, 1930), p. 281. Geolkom (Geological Committee) hired nine geologists, geophysicists, and engineers, of whom five were connected with the Radiore Company.

[19] U.S. State Dept. Decimal File, 861.5017—Living Conditions/691, Report No. 174, Riga, July 11, 1933.

[20] Based on several lengthy reports at 861.6352/15 and 861.5017—Living Conditions/471. These reports contain a great deal of information not available elsewhere on conditions in Soviet copper mines.

[21] U.S. State Dept. Decimal File, 861.6352/15.

THE BOGOMOL (KRASNOURAL'SK) COPPER COMBINE

Bogomol was the first Soviet copper combine; it required development of new copper ore mines, mills, a smelter, and a town. Designed by the Arthur Wheeler Engineering Corporation and started in 1926–7, it was not only a copy of the Noranda smelter in Quebec, Canada, but was also designed and supervised in the construction phase by the same company and many of the same engineers.[21] On completion of construction in 1931, it was taken over by the Red Army and renamed first Krasnoural'sk, and then Ordzhonikidze.

Construction records of the Bogomol copper smelter present a unique opportunity to compare the building of similar plants in free-enterprise and socialist environments. The writer knows of no other case where the parallels can be drawn so closely from the engineering, economic, and social points of view. This comparison is given in table 4–2.

Table 4–2 COMPARATIVE CONDITIONS AND RESULTS IN CONSTRUCTION OF SIMILAR COPPER SMELTERS IN CANADA AND U.S.S.R.

	Noranda Smelter (Quebec, Canada)	*Bogomolstroi Smelter (Urals, U.S.S.R.)*
Smelter design	Arthur Wheeler Engineering Corp. (New York)	Arthur Wheeler Engineering Corp. (New York)
Construction supervision	Wheeler Engineering and Noranda Mines, Ltd. (Canada)	Wheeler Engineering and Tsvetmetzoloto (U.S.S.R.)
Superintendent of construction	J. Gillis	Frederick W. Snow
Start of construction	Spring 1926	Spring 1926
Start-up of smelter	Dec. 16, 1927	Late 1931
Construction time	18 months	5 years
Cost (including mines development)	$3 million	Estimated 350 million rubles
Climate	Winter: −50°F	Winter: −50°F
Railroad link required	40 miles	Already built
Road link required	45 miles	Already built
Power supply required	Installed by Dec. 27, 1926	Supplied from existing Kushva plant
Labor employed	Average: 400 (maximum: 600)	Average: 6,000–7,000
Production	End 1929: passed 1,000 tons/day 1930: passed 2,000 tons/day 1931: passed 2,500 tons/day	1931: 3 tons/day
Incentives	(1) Management: profit (2) Labor: wages	(1) Soviet management: fear and ideology (2) Labor: coercion, wages and propaganda (3) U.S. consultants: profit

Sources: Noranda: L. Roberts, *Noranda* (Toronto: Clarke, Irwin and Co., 1956). Bogomolstroi: U.S. State Dept. Decimal File, 861.6352/15.

[21] U.S. State Dept. Decimal File, 861.6352/20, in which a report by George F. Kennan says that Bogomol was developed with the help of 'hundreds of foreign engineers and thousands of Russian engineers and workmen.'

Although climatic and engineering conditions for both smelters were substantially the same (except for the fact that road and rail links for Bogomol were already built), there was a significant difference in results. Noranda was built in 18 months by only 400 workers, while Bogomol required 5 years and 6,000 to 7,000 workers. Labor efficiency was far lower in Russia but the larger amount of labor available was used in an attempt to compensate for this disadvantage.

The Krasnoural'sk smelter was described by Jermain as 'new and beautiful, being equipped entirely with American machinery.'[23] There were four roasting furnaces, two reverbatories, and two Pierce-Smith 20-ton converters. The plant was equipped almost entirely with new American machinery, the bulk of which was from the Allis-Chalmers Company, with the balance from the Nichols Copper, General Electric, and Western Electric companies.[24]

Twenty-five Americans were employed at one time in construction. When completed, Krasnoural'sk employed 350 in the smelter, 2,000 in the mines, and 1,475 in the offices.[25]

Chief Engineer Snow of Wheeler Engineering recounted the difficulties attending the start-up of Bogomolstroi (Krasnoural'sk) to the State Department, but concluded:

> Red Urals is a good plant and will eventually produce. Particularly since the Red Army officials are now taking a distinct interest in it because of its military significance. It is a splendid illustration of all the weaknesses of the Soviet methods. Built as a rush plant of great military and industrial significance, it has taken five years to complete it, whereas a similar plant was built in one year as an ordinary commercial undertaking in Canada. Provided with a tremendous supply of labor and all modern equipment, it has failed to produce for a year after being in a theoretical position to do so. . . .[26]

In addition to the Bogomol smelter and mines, there was a 'gigantic copper refinery' at Sverdlovsk, also built under the Wheeler contract. It was similar in design to the Phelps Dodge refinery in Texas, and designed to produce 100,000 metric tons of refined copper with provision for expansion to 400,000 tons by the mid-1930s. This plant took about three years to erect, whereas the Phelps Dodge plant had been erected in 11 months as a regular job. Snow suggested that 'the delays at this plant and at Bogomolstroi have recently had

23 U.S. State Dept. Decimal File, 861.63/92, Report No. 174, Riga, July 11, 1933.

24 U.S. State Dept. Decimal File, 861.5017—Living Conditions/643, Report No. 115, Riga, April 4, 1933.

25 *Ibid.*

26 U.S. State Dept. Decimal File, 861.6352/15, which includes a report by Frederick W. Snow, Chief Engineer of Arthur Wheeler Engineering Corp. for the Bogomolstroi project.

a salutary effect in convincing the military and other authorities that something is wrong with the Soviet construction system.'[27]

THE KARSAK PAI AND KAFAN COPPER SMELTERS

In the years between 1910 and 1930, metal extraction procedures moved towards flotation of ores into concentrates followed by smelting in reverbatory furnaces. The first copper smelter in the Soviet Union to use such flotation methods with reverbatory furnaces was Karsak Pai, where flotation yielded a 30-percent concentrate converted by Bonnett system reverbatory furnaces into a 50-percent-plus matte and acid slag. The matte was then treated in converters to obtain blister copper.

The Karsak Pai plant needed only completion; the equipment was pre-revolutionary.[28] In the early 1930s the Technical Director was a Russian trained in the United States, and the Chief Engineer an American, as was the flotation plant superintendent, who increased mill capacity from 250 to 400 tons per day. Karsak Pai was also assisted by Milo Krejci, attached to Giprotsvetmet to solve field problems. As part of his work he produced a training manual which was translated, printed, and distributed to plant workers.[29]

The Chief Engineer between 1930 and 1932 was H. R. Wilson. He had the prime responsibility for bringing the mines up to standard, although two months after he left output was down to 15 percent of capacity.[30]

One of the two copper smelters in Armenia was the Kafan, formerly a French concession and almost completely rebuilt in the 1930s. T. F. Collins, an American mining engineer employed at the Kafan mines for 22 months in the years 1930 and 1933, commented that 'the new plant was planned by an American engineer and is entirely built according to American plans,' with a 1,000-ton-per-day flotation mill and two 150-ton smelters.[31] In 1933 the smelters were operating to capacity but there were still difficulties with the flotation plant. According to the Luftwaffe files, the plant operated only at 50 percent of capacity in 1941.[32]

THE LAKE BALKASH PORPHYRY COPPER DEPOSITS

Very large deposits of low-grade (1 percent and less) copper ore were prospected in the late 1920s near Lake Balkash. A mine was sited at Kounrad,

[27] U.S. State Dept. Decimal File, 861.6352/15.

[28] Sutton, *Western Technology . . ., 1917 to 1930*, p. 83.

[29] Milo W. Krejci, 'The Korsak [*sic*] Pai Enterprise,' *Case Alumnus*, XII, No. 3 (December 1933), pp. 12–3, 25–7.

[30] U.S. State Dept. Decimal File, 861.5017—Living Conditions/323 and 861.50—FIVE YEAR PLAN/189.

[31] U.S. State Dept. Decimal File, 861.5017—Living Conditions/854.

[32] *Die Kupfererzeugung der UdSSR* (Berlin: 1941).

and a refinery at Bertish Bay on the northern shores of Lake Balkash, a power plant, and a rail line to the coal deposits at Karaganda were also built. Construction laborers were predominantly expropriated kulaks. The Balkash project was typical in the extraordinary brutality utilized in Soviet construction:

> I saw them die at Balkashstroi by the tens of thousands. . . . We were doing a lot of grading and excavation work and having no machines we needed much labor. . . . But they were poor workers. So the chief of construction—a brutal drunkard named Ivanov, who was the husband of the sister of Stalin's first wife, Aleluyeva—enforced piecework rate, making not only the men's wages but their rations dependent on their work. There was never enough food. . . . They died like mice in the winter.[33]

The Wheeler Engineering Corporation made strong efforts to get the Lake Balkash development contract, but lost out to strong competition from European firms who were willing to take ruble payments and grant extensive credit.[34] Although New York banks offered to back Wheeler, his offer was not as favorable as those of the European group. Thus Wheeler himself remained on an individual contract, and development work was taken over by German firms. We know very little about the actual German development work at Balkash; there is a report in the Hoover files concerning a 'trainload' of German workers on their way to erect a plant at Lake Balkash in 1933.[35] John Calder was chief adviser to Ivanov and took over when Wheeler withdrew completely from Russia.[36] By October 1941, the Lake Balkash plant had two converters and two ovens producing 85 tons of copper per day, and employed some 5,000 workers. The equipment was chiefly of American origin.[37]

DESIGN AND OPERATION OF ZINC AND LEAD PLANTS

American engineers designed all Soviet zinc and lead plants. W. C. Aitkenhead worked for Giprotsvetmet from August 1930 to June 1932 and worked on the design of three electrolytic zinc plants, of which one was built and put into operation. Another metallurgical engineer, J. H. Gillis, worked from May 1930 to 1936 on the design and construction of 15 metallurgical plants. In one project he worked on the initial plans and then was promoted to a position as technical director, and then moved on to another plant as technical director. As Gillis specialized in electrolytic zinc plant design, it can be assumed that he had a dominant influence in the zinc industry. A 1937 State Department report indicated that most of his work had been 'with

[33] *Fortune*, April 1949, p. 82.
[34] U.S. State Dept. Decimal File, 861.6352/15.
[35] *American Engineers in Russia*, Fisher, Confidential Report.
[36] U.S. State Dept. Decimal File, 861.6352/15.
[37] National Archives Microcopy T84, Roll 127, Frame 665.

design, construction and operation of electrolytic zinc plants of which two have been completed and are in successful operation.'[38] His conclusions were that the plants as constructed were capable of efficient operation but that the irregularity of ore supply and fluctuating power supplies handicapped zinc output.[39]

Several large zinc concentrators, smelters, and refineries were built between 1930 and 1945. One was the Ukrtsink, at Konstantinovka in the Ukraine, with a 35,000-ton input of concentrate to produce 12,000 tons of refined zinc and 30,000 tons of sulphuric acid from roaster gases. Another was the Ordzhonikidze in the North Caucasus, to produce electrolytic zinc. According to Chamberlain[40] the plant produced 5 tons of zinc per day and for this required 300 office workers and 1,600 plant workers. In St. Louis a similar refinery producing 50 tons of zinc a day required only 16 in the office and 170 in the plant.

The Ridder lead-zinc smelter and refinery in Leninogorsk was completely Western in equipment. The concentrator had Blake crushers and Dwight-Lloyd roasting machines. The refinery had Parkes kettles with a Howard mixer, and a small Cottrell furnace copied from the one located at Port Pirie, Australia. There were five Faber du Faur retort furnaces, all Soviet-made but

Table 4–3 LEAD AND ZINC SMELTING AND REFINING WORKS, 1930–45

Location	*Plant Name*	*Capacity (1941) (Metric Tons)*	*Type of Plant*
Ukraine	Konstantinovka (Ukrtsink)	12,000 zinc	Zinc distillation
Transcaucasia	Elektrosink (Ordzhonikidze) (formerly Vladikavkaz)	30,000 electro-zinc 7,500 zinc 14,000 lead	Electrolytic zinc Zinc distillation Lead smelting
Chelyabinsk	Zinc plant	20,000 electro-zinc	Electrolytic zinc
Leninogorsk	Ridder lead works	14,000 lead	Lead smelting
Tschimkent	Kalinin lead works	60,000 lead	Lead smelting
Novosibirsk	Belovo	18,500 zinc	Zinc distillation
Primorsk	Tetuikhe	15,000 lead	Lead smelting
*Altai	Ust' Kamenogorsk		Electrolytic zinc

Source: Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941. Miscellaneous German Records, National Archives Microcopy T 84–122.
* Built during World War II.

[38] U.S. State Dept. Decimal File, 861.5017—Living Conditions/795, Report No. 1172, Paris, June 11, 1937.

[39] Both Aitkenhead and Gillis have reports in *American Engineers in Russia.*

[40] William H. Chamberlain, *Russia's Iron Age* (Boston: Little, Brown, and Co., 1934), p. 57.

copied from a Belgian 500-kilogram type.[41] The Belovo zinc plant at Novosibirsk, opened in 1931, had U.S. equipment.[42]

DEVELOPMENT OF AN ALUMINA-ALUMINUM INDUSTRY

A great deal of research was undertaken in tsarist Russia in aluminum technology. Bayer worked at the Tentelev chemical plant (St. Petersburg) perfecting the Bayer process, patented in 1887 and still the world's standard process for alumina reduction. Six years later Penyakov patented a dry process for converting bauxite into alumina. This process was used in France and Belgium before World War I. Work by other Russian scientists, including Fedotiv on the reduction cell, helped put prerevolutionary Russia in the forefront of aluminum technology, although the country was weak in production facilities.

The basic problem, which also presented itself to the Soviets, was that Russian bauxite deposits were small and of low grade. The Tikhvin bauxite deposits were initially explored in 1882 and in detail during World War I. Nevertheless, Russia did not manufacture alumina, but only a few aluminum goods from imported aluminum metal. The Alcoa concession[43] in the mid-1920s explored and drilled known bauxite deposits and confirmed these prerevolutionary findings.[44] The basic Soviet choice then was either to build an aluminum industry on the low-grade, limited Tikhvin bauxite deposits or to use nonbauxite raw materials. Nonbauxite material had not been used elsewhere in the world and required development of a new technology. A military demand for self-sufficiency dictated the choice of the nonbauxite option as well as use of the Tikhvin deposits.

Development of the aluminum industry in the late 1920s and 1930s was 'under the direction of Mr. Frank E. Dickie.'[45] Dickie, previously with Alcoa, was attached as consultant to Tsvetmetzoloto. A commission from Aluminstroi (Aluminum Plant Construction Trust) also visited Germany in 1929 to study the German aluminum industry.[46]

The first plant built in the Soviet Union, for production of 40,000 tons of alumina and 13,500 tons of aluminum per year, was at Volkhov, 75 miles east of Leningrad. Construction was begun in 1930, and the plant was brought

41 *Engineering and Mining Journal*, CXXXVII, No. 10 (October 1936). This issue contains an extensive article on the Ridder plant.

42 Amtorg, *op. cit.*, VI, No. 3 (February 1, 1931), p. 64.

43 Sutton, *Western Technology . . . 1917 to 1930*, pp. 106–7.

44 Alcan Hirsch, *Industrialized Russia* (New York: Chemical Catalog Co., 1934), pp. 89–90. Hirsch reported that even by 1934 only 7 million tons of bauxite had been located at Tikhvin.

45 *Ibid.*, p. 90.

46 Amtorg, *op. cit.*, V, No. 2 (January 15, 1930), p. 43.

into partial operation in mid-1932. Technical assistance was provided by Cie. de Produits Chimiques et Electrométallurgiques Alais, Troques et Camargue, of Lyons, France, and covered both design of the plant and supervision of erection by French engineers. Soviet operating engineers were trained in plants (Sabart et St. Jean de Maurieme) belonging to the company in France.[47] The alumina plant received bauxite from the Tikhvin deposits and converted it to alumina by the old Deville-Péchiney process, called the Mueller-Yakovkin process in the Soviet Union.

Another aluminum plant, also started in 1930, at Zaporozhe in the Ukraine, began to produce aluminum in June 1933 and alumina in early 1934 from Tikhvin bauxites. This was also designed and built under the technical-assistance agreement with Cie. de Produits Chimiques and included plants for the manufacture of synthetic cryolite and carbon electrodes—not part of the Volkhov project. Dneprovsk used the Pedersen process,[48] called the Kuznetsov-Zhukovski process in the U.S.S.R. The equipment for the plant was reported by a member of the U.S. Embassy in Moscow as coming from Italy.[49]

Kamensk, finished in 1939 to produce 108,000 tons of alumina and 30,000 tons of aluminum per year, used the standard Bayer wet alkaline process.

The Kandalakskii plant, using nepheline and not bauxite, was started in 1934 but not completed until 1955: a measure of the advantage of transferring known foreign techniques.

THE UNITED ENGINEERING CONTRACTS FOR ALUMINUM ROLLING MILLS

The United Engineering and Foundry Company contracts of January 1938 exemplify the advanced nature of the technology supplied by Western firms to the Soviet Union: indeed some of these projects strained the research and development abilities of the most advanced Western firms and were far beyond the abilities of the Soviet Union at that time.[50] The contracts do suggest, however, that the Soviet Union has had a remarkable ability to recognize advanced technology and enlist front-rank foreign firms in the acquisition process.

47 Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941. Miscellaneous German Records, National Archives Microcopy T 84–122, Bericht No. 10, p. 14; R. J. Anderson, 'Russian Aluminium,' *The Mining Magazine* (London), February 1938.

48 The Pedersen process was developed by Prof. Harold Pedersen in Norway and patented in 1926. The work was financed by Norsk Aluminum (Norway) and Alcoa.

49 U.S. State Dept. Decimal File, 861.6463/66, Dispatch No. 183, American Embassy in Moscow, September 28, 1934.

50 The wide-strip mill used in the steel industry may even today (1968) be beyond Soviet capabilities. Only one such mill has been produced: a copy of the original United mill, installed in Poland, not the U.S.S.R.

The January 1938 agreement involved the sale of $3 million worth of equipment and technical assistance for aluminum mills at Zaporozhe. These were 66-inch (1680-millimeter) hot and cold mills complete with auxiliary equipment: the most modern mills in the world. Jenkins, the United Chief Engineer in the U.S.S.R., said of the Zaporozhe mill that 'not even the Aluminum Company of America has machinery as modern as it is.'[51] Both mills were 'completely powered and controlled by General Electric apparatus. . . .'[52]

The Stupino mill (Plant No. 150) near Moscow, by far the most important Soviet aluminum development project, was also the subject of an agreement in May 1939 between Mashinoimport and United Engineering and Foundry for the installation of hot and cold rolling mills. These were mills of extraordinary size, and, if erected in the West, would certainly have been the subject of interested discussion in the trade literature.

The Stupino installation comprised two sections: a hot mill and a cold mill. The hot mill had two units. One was a 2-high 66-inch hot rolling mill for rolling cast duraluminum, including Type 17-S and 24-S ingots. On a basis of 300 working days with two shifts operating at 70 percent efficiency, its capacity was rated at 45,000 metric tons of aluminum sheet per year. The 66-inch mill came into regular operation about February 1, 1940 and the 112-inch mill a few weeks later.

The cold mill contained two mills of similar size for cold working sheets produced in the hot mill. The 66-inch cold mill started about March 1940 and the 112-inch cold mill late in 1940. All finishing equipment was supplied and placed in operation by United Engineering for the Soviets.[53] The complete contract was worth about $3.5 to $4 million to United Engineering; for this amount the Soviets acquired an installation capable of rolling 2,000-foot-long aluminum sheets for aircraft. United Engineering said of it that 'nothing of such a size has ever been produced before.'[54] The electrical equipment for Stupino was supplied by General Electric, as was the equipment for a third (name unknown) aluminum mill.[55]

The Brown-Boveri Company supplied equipment for annealing and hardening aluminum (almost certainly associated with the above rolling mills) to an unknown plant operated by Tsvetmetzoloto.[56] The company commented on this equipment as follows:

[51] U.S. State Dept. Decimal File, 861.6511/37, Report No. 902, Moscow Embassy, January 31, 1938.

[52] *The Monogram*, November 1943. Although the source does not mention Zaporozhe, it does refer to the 'first rolling mill,' which was probably Zaporozhe.

[53] U.S. State Dept. Decimal File, 861.25/420, Report No. 298, February 5, 1940.

[54] *Ibid.* The Stupino plant also manufactured Hamilton 2-blade and 3-blade variable pitch propellers for aircraft.

[55] *The Monogram*, November 1943. Location of the third mill is not known.

[56] *Brown-Boveri Review*, January 1932, pp. 24–6.

> The large output required from this plant, the exceedingly large dimensions of the pieces to be treated, and the resulting high power requirements made necessary designs which considerably exceeded in dimensions and type of construction the scope of our furnace designs as used up to date.[57]

Twenty-one furnaces were constructed for a continuous process system with electrically driven conveyors. Two pusher-type furnaces were made for the 600-ton press, and another electric furnace with a step-type conveyor was made for the 1,500-ton press. Yet another continuous electric furnace with conveyor chain was installed by Brown-Boveri in the 3,000-ton press shop. The hot rolling mill was supplied with two electric continuous furnaces as well as a pusher-type furnace and a hardening furnace. The sheet and tube rolling mill had two electric annealing furnaces and a hardening furnace. The laboratory was supplied with eight small electric furnaces.[58]

Thus we may conclude that the technically weak Soviet non-ferrous metals industry was essentially designed and constructed by Western companies specializing in this field. In mining operations the assistance was given in the early 1930s only and limited to the provision of foreign equipment and American superintendents, later supplanted by Russian management. However, the design of smelters and refineries was completely American and the Russian operators were trained by foreign construction engineers.

[57] *Ibid.*, p. 24.
[58] *Ibid.*, p. 26.

CHAPTER FIVE

Technical Assistance to the Iron and Steel Industry

GENERAL DESIGN OF SOVIET IRON AND STEEL PLANTS

STALIN placed great emphasis on iron and steel as the basis for a socialist economy. His plans included rebuilding and expanding 20 prerevolutionary plants (suitably renamed after favored Bolsheviks) and construction of three gigantic new plants at Magnitogorsk, Kuznetsk, and Zaporozhe.[1] What has escaped Western economists is that the Soviet Union lacked entirely the technical resources to build even tsarist-era metallurgical plants, quite apart from the highly complex systems contemplated. No amount of Soviet investment, within a politically acceptable time period, could have replaced importation of the latest Western smelting and rolling-mill technologies.

Between 1927 and 1932 the responsibility for directing the transfer of modern technology to the Soviet iron and steel industry belonged to Gipromez and the Freyn Engineering Company of Chicago. Mr. Henry J. Freyn, President of the company, described the objectives of his 1928 technical-assistance contract as follows:

> The work of our group of engineers and operators located in Leningrad and attached to Gipromez [State All-Union Institute for Planning of Metallurgical Works], consists in making available to Soviet executives, engineers, and operatives [*sic*] the American training, knowledge and practical experience of our organization, to the end that the reconstruction and enlargement of the existing plants and the planning and construction of new iron and steel works be predominantly of American design and standards.[2]

[1] A. I. Gurevitch, *Zadachi chernoi metallurgii v 1932 g* (Moscow: 1932), pp. 8–9.

[2] Henry J. Freyn, 'Iron and Steel Industry in Russia,' *Blast Furnace and Steel Plant*, XVIII, January 1930, p. 92. See also Sutton, *Western Technology . . ., 1917 to 1930*, pp. 14–5.

The degree of his involvement in the actual planning process may be judged from Mr. Freyn's comment that 'one of the principal tasks of our Leningrad force is the allocation of the steel production demanded by the five-year plan, and provision for the necessary plant capacity. . . .'[3]

Freyn had retained a staff in the U.S.S.R. since 1927 and Kuznetsk was one of the projects designed with this assistance. The company agreement to build the Kuznetsk plant,with a pig-iron capacity of one million tons per year, was signed on June 4, 1930 with Novostal. A contemporary wrote: 'Between fifty and sixty American engineers will constitute the organization which will direct the execution of design, specifications, fabrication, and superintend the erection and initial operation of the Kuznetsky Steel Works.'[4]

In 1928 a Soviet commission of four members visited the offices of Arthur G. McKee and Company in Cleveland. These Cleveland discussions resulted in broad agreement on the type and location of another major unit, the Magnitogorsk plant, although the drawing completed in early 1928 was 'one small general plan showing the proposed plant layout that had been agreed upon by our engineers and the Russian Commission. . . .'[5] This McKee design was based on the Gary, Indiana, plant of United States Steel, at that time the largest integrated iron and steel plant in the world. The proposed project was then reduced to drawings by 450 American engineers working day and night. Design work alone on Magnitogorsk cost the Soviet Union two million gold rubles. R. W. Stuck describes this McKee design as complete 'to the last nut and bolt' before construction started; 'nothing of this size and magnitude had ever been done before . . . it is the finest design of a steel plant that was ever reduced to drawings. . . .[6]

Design work completed, a group of McKee engineers then outlined the mill layout and specifications to an audience of 75 to 100 Russian planners, bureaucrats, and steelworks engineers in Moscow. This design became the largest project in the First Five-Year Plan, and the showpiece of 'socialist construction.'[7]

Most competent Russian construction engineers had left Russia, and the tsarist metallurgical equipment plants such as Sormovo and Kramatorsk,

[3] *Ibid.*

[4] Arthur J. Whitcomb, 'Soviet Union to Build Steel Plant,' *Blast Furnace and Steel Plant*, XVIII, July 1930, p. 1135.

[5] *American Engineers in Russia*, Stuck MSS, Folder 5. R. W. Stuck was Chief Engineer in charge of blast-furnace construction at Magnitogorsk and later head of the McKee group in the Soviet Union.

[6] *Ibid.*, p. 26.

[7] John Scott has remarked, 'It was necessary to give this contract to a foreign contractor because of the obvious incapacity of any Soviet organization then in existence to do the work.' [*Behind the Urals* (Cambridge: The Riverside Press, 1942), p. 68.]

which in the late nineteenth century had produced some types of iron and steel plant equipment, had been stripped of their technical forces. The remaining competent engineers were in and out of OGPU camps. German engineers running the metallurgical plants in 1927–8 were politically suspect, and the hastily trained 'red engineers' more apt to talk than to do. Accordingly, Gipromez was initially charged with the transfer of American metallurgical technology to Soviet industry, rather than with the development of new designs. This transfer was achieved by employing American (and some German) engineers to simplify and standardize this foreign technology. This technology was then duplicated by metallurgical equipment plants such as the new Uralmash and the greatly expanded Kramatorsk plants. It is a mistake to assume that the Freyn Company, the McKee Corporation, and similar Western contractors acted only as consultants in the development of the industry.[8] Individual American engineers managed Gipromez departments, and the technical staff of Gipromez was for some years heavily Americanized. One engineer, W. S. Orr, at work in Leningrad Gipromez headquarters from 1929 to 1933, has provided a description of this technical penetration:

> When we first joined Gipromez we were only asked questions—the Russians made the layouts, reports and decisions. In about six months we were asked in on the layouts and decisions, in about nine months we were made Chief Engineers of steel plant projects and at the end of the first year some of our men were heads of departments. Last year one was the Assistant Chief Engineer of the entire bureau. Naturally we instituted American short-cut methods, weeded out a lot of unnecessary work and when we left we considered that Gipromez was the most efficient organization in Russia.[9]

The Americanization of Gipromez is significant as it coincides with a Sovnarkom (Council of People's Commissars) decision, in line with a McKee Corporation specification, to change Magnitogorsk from a plant 20 percent the size of the United States Steel plant at Gary, Indiana, to a plant equal in size to the Gary plant and with a pig-iron output of 2.5 million tons per year.

Koptewski,[10] Chief Engineer at Soviet steel plants in the early 1930s and with Gipromez at that time, recalls these significant German and American technical contributions, and suggests that both made 'a tremendous contribution towards facilitating the manufacture of standard metallurgical equipment. . . .' Koptewski also suggests that not only the standardization of the

[8] For example, see M. Gardner Clark, *The Economics of Soviet Steel* (Cambridge: Harvard University Press, 1956), p. 56. This is not intended as a criticism of Clark's excellent study. The data has not been previously forthcoming.

[9] *American Engineers in Russia*, Fisher material, Folder 3, Report 15.

[10] Sergei Koptewski, *The Costs of Construction of New Metallurgical Plants in the U.S.S.R.* (New York: East European Fund, Inc., 1952), p. 9.

blast furnace but also the advances in construction simplification and maintenance methods were initiated by Westerners. Blast-furnace equipment was standardized on foreign models by Gipromez to simplify production at the new machinery plants being built and equipped by foreign companies. For open-hearth departments, standard plans were drawn up for stripping, scrap yards, mixers, and 150-ton fixed and 250-ton tilting furnaces. Cast-iron teeming equipment, single- and multi-stage electric gas purifiers, and turbo air-blowers were standardized in drawings. In rolling mills the significant standard model was a blooming mill with an annual capacity of 1.5 million tons, based on a Demag 1150-millimeter design. Koptewski states that great effort was made to incorporate latest Western techniques into these standard designs. The procedure was much like converting a military aircraft from the development stage to mass production by freezing design at a particular point; in the case of Soviet industrial development, design was frozen on the most suitable of foreign designs.[11]

In the reports of foreign delegations and observers visiting those iron and steel plants, there is consistent evidence of the widespread use of foreign equipment and methods. The Hanczell Industrial Delegation from Finland, for example, reported as follows:

> Organization methods and most of the machinery are either German or American. The steel mill MORNING near Moscow, which was visited by the delegation is said to be one of the most modern establishments of its kind in the world. Constructed, organized and started by highly paid American specialists, it employs 17,000 workers and produces steel used by motor plants, naval shipyards and arms factories.[12]

We may then assert that Soviet iron and steel technology, a favored development sector, was wholly dependent on foreign design and engineering ability. This assertion is now examined in detail.

DEVELOPMENT OF IRON-ORE MINES BY THE OGLEBAY, NORTON COMPANY

Historically, Krivoi Rog is the base of Russian iron-ore production and was operated in the 1920s by mining engineers of Rawack and Grunfeld A-G of Germany. Early reports by the German firm were adopted and expanded by an Oglebay, Norton Company technical-assistance contract with Novostal.

[11] The saving in drafting costs alone was substantial. About 30,400 engineering drawings are required for an integrated iron and steel plant. Koptewski estimates these to have cost about 16 million (1934) rubles (*op. cit.*, p. 12). Scott estimates that the McKee Corp. had over 100,000 such blueprints in the cellar of the combinat building. (*Op. cit.*, p. 67.)

[12] U.S. State Dept. Decimal File, 861.5017—Living Conditions/456, Report No. 665, Helsingfors, April 2, 1932.

In January 1928 a group of American mining engineers specializing in iron-ore development reported on the Krivoi Rog ore mines and formulated plans for their rehabilitation, expansion, and future operation.[13] Their objective was to prepare operating and development plans and schedules for Vesenkha (Supreme Council of the National Economy). Between 1928 and 1934 the firm worked on all the major iron-ore deposits in the U.S.S.R. but concentrated its efforts on Krivoi Rog, the four major Urals iron-ore deposits, and those supplying Kuzbas. (See table 5–1.) J. M. Price was manager and a corps of American mining engineers was retained in the U.S.S.R. until 1934. Their work covered all phases of open-pit and underground iron mines and was the key element in modernization and mechanization. Initial implementation of modern methods and the introduction of imported mining equipment were supervised, and assistance was given in developing early Soviet models of Western equipment. Magnitogorsk, for example, was equipped with the largest current model of Traylor and Gates ore-crushers.[14]

Rodin[15] has pointed to the absolute and relative gain in *per capita* output of iron ore in the U.S.S.R. in the face of a 'marked deterioration' of two naturally determined factors: a decline in the proportion of open-pit-mined ore from 68 to 31 percent and a fall in yield of mined crude ore from 100 to 88 percent. Increased production was due to counterbalancing advantages: the amount of power equipment available per unit of output, the size of the average mine, and improvement in mining practices and mining equipment. These three advantages can be specifically traced to Western origins, while the disadvantages, as Rodin pointed out, were 'naturally determined.' The size of a mine is primarily determined by type of mining desired: open-pit or underground. Open-pit mines tend to be larger and, in the U.S.S.R., labor productivity at the best open-pit mines is three to four times greater than at

[13] *American Engineers in Russia*, E. S. Dickinson, Folder 4, No. 6. Oglebay, Norton Company is a large independent iron-ore producer based in Cleveland, Ohio. The company supplied (letter of April 12, 1934) a list of 21 engineers who had worked in the U.S.S.R. Some stayed on with individual contracts after expiration of the company agreement. Engineers were hired on one-year or two-year contracts. At least five have left detailed accounts of their work. F. W. Uhler was Chief Engineer at Sverdlovsk, directing the work of the Urals group of mines from June 1930 to July 1931. C. M. Harry was on a two-year contract to project new operations for Krivoi Rog. K. H. Donaldson was based at Sverdlovsk and traveled to mines at Zlatoust, Turin, and Samsky. H. H. Angst was on a two-year contract specializing in mining techniques, and worked at Lipetsk, Tula, Sverdlovsk, and the Urals mines. An anonymous engineer was based in Leningrad and made consulting trips for specific problems to Kharkov, Lipetsk, and Kerch'. See also U.S. State Dept. Decimal File, 861.5017—Living Conditions/347, for interviews with returning engineers.

[14] *American Engineers in Russia*, 'Statement of J. S. Ferguson Covering Personal Experiences in Russia over a Period of Eighteen Months,' April 30, 1933, p. 26.

[15] N. W. Rodin, *Productivity in Soviet Iron Mining, 1890–1960* (Santa Monica: The RAND Corp., 1953), Report RM-1116, p. 2.

the best underground operation (Krivoi Rog). The amount of ore mined by open-pit methods, however, has declined heavily since tsarist times (from 68 percent in 1913 to 31 percent in 1940), a reversal of the trend in the United States. The reasons are not clear. There is no reason to believe that iron-ore deposits with heavy overburden, requiring underground mining, are concentrated in the Soviet Union. In any event the U.S.S.R. has a much greater land surface, and iron ore is a commonly occurring mineral. These problems suggest inefficient iron-ore exploration methods.

Rodin concludes that there is a technological lag not explainable in terms of deficient power capacity. Rodin's conclusion is consistent with reports of Oglebay, Norton engineers working on development of these deposits. Modernization between 1928 and 1935 increased technical efficiency but was introduced unevenly and may have taken a long time to penetrate some mining areas.

This suggested technological lag may be exemplified by the much smaller size of power shovels at open-pit iron-ore operations. Introduction of power shovels began only in 1929, but the average shovel capacity remained small throughout the period under study. In 1929 Uralrud (Urals Ore Trust) had 17 power shovels averaging 0.88 cubic meters; in 1940–2 its shovels

Table 5–1 DEVELOPMENT OF SOVIET IRON-ORE MINES, 1928–40

Mine	*District*	*Million Metric Tons Produced in 1940*	
		Developed by Oglebay, Norton Engineers (1928–1934)	*Not Known to Have Been Developed by Oglebay, Norton*
Tula	Central industrial	0.63	—
Lipetsk	Central agricultural	0.49	—
Crimea	Kerch'	1.92	—
Tagil-Kushva	Urals	1.23	—
Kusa	Urals	—	0.25
Bakal	Urals	—	0.63
Magnitogorsk	Urals	7.85	—
Zagazine-Kamarevskaya	Urals	—	0.50
Khalilovo	Urals	—	0.35
Telbess-Temir Tau	Siberia	0.70	—
Krivoi Rog	Ukraine	18.90	—
Others		—	0.19
TOTAL		31.72*	1.92

Source: D. Shimkin, *Minerals: A Key to Soviet Power* (Cambridge: Harvard, 1953), pp. 43, 48–9.

* 95% of iron ore produced in 1940 by Oglebay, Norton-developed mines.

averaged 1.73 cubic meters. Rodin compares this to Lake Superior mines, which in 1924 had 447 power shovels averaging 2.5 to 3.0 cubic meters, and explains the difference on the basis that small-ore bodies are better worked with small shovels. This is, however, a remote argument. Ore-deposit size does not affect shovel size to any extent in the range of 1 to 3 cubic meters, although it might inhibit the use of very large shovels. The technological lag is more likely to have been due to the Soviet inability to duplicate large foreign excavators, thus restricting iron-ore mining operations to the use of smaller shovels.

DEVELOPMENT OF THE STANDARD BLAST FURNACE

Until 1928 Russian blast furnaces were units of comparatively small capacity, although they were well-suited to the widespread geographical distribution of Russian metal-consuming industries. The Freyn-Gipromez design assistance contract of 1928 resulted in a standard blast furnace of 930 cubic meters capacity which could produce 1,000 tons of pig iron per day, with features enabling expansion to 1,200 tons. This standard furnace was a definite innovation. It conformed closely to American Freyn basic design and was patterned for the use of Krivoi Rog ores, which are similar to Lake Superior hematites. The innovatory feature was the use of the same standard design (capable of slight change for different site conditions, raw materials, and pig iron specifications) in multiple locations.[16] Standardization yielded economies

Table 5–2 FREYN STANDARD BLAST FURNACES IN THE SOVIET UNION, 1934

Name of Plant	*Number of Standard Blast Furnaces*		
	Operating	*Building*	*Projected*
Dzerjinsky	1	1	5
Zaporozhe	1	1	4 or 6
Voroshilov	1	1	4
Azovstal	1	1	6
Lipetsk	0	2	4
Tula	0	2	4
Krivoi Rog	1	1	6
Nikopol	0	0	2 or 3
Tagil	0	0	6
Total	5	9	41 or 44

Source: Adapted from *Freyn Design*, No. 11 (March 1934), p. 6.

[16] Gordon Fox and Owen R. Rice, 'Soviet Standard Blast Furnace,' *Freyn Design*, No. 11, March 1934, pp. 1–6. For another detailed description of the standard blast furnace see: Gordon Fox and Owen R. Rice, 'Soviet Standardizes Blast Furnace Design,' *The Iron Age*, CXXXIII, No. 10, March 8, 1934, pp. 20–4, 58. Fox was Vice-President of Freyn Engineering Co. and Rice a metallurgical engineer at Freyn. The article includes furnace dimensions, details of Freyn-designed equipment, and locations in the Soviet Union.

in the engineering and production costs of equipment; about 22 furnaces were finally built from the Freyn drawings.[17] The first units required imported American (and German) equipment; later units utilized the same equipment design but were manufactured at the new Uralmash and Kramatorsk plants.

In brief; no new blast furnaces were built between 1917 and 1928. From 1928 to 1932 all Soviet blast furnaces were designed and built under supervision of either the McKee Corporation or Freyn Engineering, to U.S. designs. After 1933 the standard Freyn and, to a lesser extent, the McKee design (1,180 cubic meters) were duplicated until 1938, when the Gipromez 1300-cubic-meter or second standard design was introduced.

Turbo-blowers for the hot-blast stoves (Cowpers units) for blast furnaces of 115,000-cubic-foot-minute capacity were supplied for Kuzbas and Magnitogorsk by the Brown-Boveri Company of Switzerland.[18] This was 'one of the biggest modern blower plants' in the world, built at the Brown-Boveri works in Mannheim (Germany) and Baden (Switzerland), and installed and started up by Swiss and German engineers. Altogether five of these gigantic units went to Kuznetsk and six similar units, built at Mannheim, went to Magnitogorsk. Of new design, they were far beyond the technical capability of the Soviet Union at this time.[19] General Electric turbo-blowers were installed in at least six other iron and steel plants.[20]

Soviet plants fabricated some constructional steelwork for the new plants and then, after about 1932–3, ventured into the manufacture of simple blast-furnace equipment items, starting with Dewhurst slag ladles of 10-cubic-meter capacity at Kramatorsk. These were large, heavy ladles mounted on a railroad wagon chassis for removal of hot slag from blast furnaces to adjacent slag dumps. Ferguson, blast-furnace superintendent at Kutnetsk, reported 25 slag ladles of Soviet manufacture: the only Soviet-supplied equipment there, apart from some mill electrical motors of less than 25 horsepower.[21] Shortly afterwards came manufacture by Uralmash (Urals Machine Combine) of larger, Dewhurst-type, pig-iron (i.e., hot-metal) ladles of 12-cubic-meter capacity.[22] Both slag and pig-iron ladles had been manufactured, however, as far back as 1890 at the Sormovo and Briansk works. Then, in the 1930s,

[17] Institut promyshlenno-ekonomicheskikh isslodovanni NKTP, *Chernaya metallurgiya SSSR v pervoi pyatiletke* (Moscow: 1935), p. 55.

[18] *The Brown-Boveri Review*, XX, No. 1 (January/February 1933), pp. 46–9.

[19] 'A blower plant of this kind attains the thermal efficiency of a gas engine driven plant but is much cheaper to build and keep up and more reliable in operation.' *(Ibid.)*

[20] Amtorg, *op. cit.*, VII, No. 9 (May 1, 1932), pp. 209–10.

[21] *American Engineers in Russia*, 'Statement of J. S. Ferguson Covering Personal Experiences in Russia Over a Period of Eighteen Months,' April 30, 1933, p. 3.

[22] Koptewski, *op. cit.*, table 19. Koptewski calls Dewhurst 'Duerst,' being unfamiliar with the English spelling.

the Soviets manufactured more and more types of blast-furnace equipment, all to foreign design, until by 1940 they had the capability to produce more or less efficient duplicates of all such equipment.

STANDARD OPEN-HEARTH FURNACES

Open-hearth design was based on American and German models, standardized largely to one basic size: the 150-ton (56-square-meter) model.

Table 5–3 ORIGIN OF EQUIPMENT DESIGN FOR OPEN-HEARTH STEEL-MAKING

Unit	*Country of Origin*	*Firm*
Open-hearth furnaces (150 tons per heat)	U.S.	Freyn Engineering Co.
Charging equipment	U.S.	Morgan Engineering Co.
Electric stripper cranes	U.S.	Morgan Engineering Co.
Pouring equipment	Germany	Demag A-G
Soaking pits	U.S.	Freyn Engineering Co.
Roller bearings for cranes, charging cars and ingot cars	Sweden	SKF

The Kuznetsk plant had 15 American-designed open-hearth furnaces and Magnitogorsk had 14 similar furnaces of 150 tons per heat, installed to operate on either producer or mixed blast-furnace/coke-oven gases. The shops were equipped with Morgan (United States) and Demag (Germany) charging and pouring equipment, all in duplicate.

Of steel-making shops constructed before 1934, five plants (Kuznetsk, Magnitogorsk, Zaporozhe, Kirov, and Dzherzhinsk) are described as having 'modern Martin shops of the American type.' These furnaces were mainly 150-tonners, although there were three 300-tonners of Freyn design. Four other plants had 'modern German shops' with 70-square-meter furnaces. The remainder had tilting or special furnaces of foreign design.[23]

A German study made in 1944 suggests that this foreign influence continued at least through World War II.[24]

DEVELOPMENT OF STANDARD BLOOMING AND SLABBING MILLS

Primary blooming and slabbing mills are used to break down ingots into sizes more suitable for final rolling into various shapes. Such mills are essential

[23] Institut promyshlenno-ekonomicheskikh issledovanni NKTP, *op. cit.*, p. 72.

[24] Report No. 68 of the Gmelin-Institute, *Eisenhüttenindustrie*, National Archives Microcopy T 84–127–1428293 *et seq.*

to large-tonnage operations and form part of all modern integrated iron and steel plants. There were no modern primary mills of this type in the Soviet Union before 1932. Each of the metallurgical giants, Magnitogorsk and Kuznetsk, was equipped with a Western-built mill—a Demag 45-inch mill with General Electric control and drive equipment—produced abroad and installed and started up in the U.S.S.R. by Demag and General Electric engineers.

The Soviets then adopted a standard blooming mill based on United and Demag 1150-millimeter (45-inch) design and duplicated at the Izhorsky and Kramatorsky plants, with the help of United Engineering, for installation in other iron and steel plants. Western blooming mills range from 40-inch to 78-inch roll widths; adoption of a standard 45-inch width obviously imposed limitations on the range of rolled products produced by the mills, but was consistent with the planning objective of producing a limited range of steel shapes and sizes with standardized equipment.[25]

Table 5–4 DESIGN CHRONOLOGY OF SOVIET LARGE BLOOMING AND SLABBING MILLS, 1932–45

Date of Mill Start-Up	*Mills of Foreign Design and Manufacture*	*Mills of Foreign Design and Technical Assistance, Made in Soviet Union*	*Mills of Soviet Design and Manufacture*
Nov. 5, 1932: Kuznetsk	Demag A-G 45-inch mill; G.E. Co. control and drive equipment	—	—
1932: Magnitogorsk (section 1)	Demag A-G 45-inch mill; G.E. Co. control and drive equipment	—	—
Early 1933: Kirov (McKeevsky)	—	Izhorsk 45-inch 'standard'	—
June 1933: Dzherzhinsk	—	Izhorsk 45-inch 'standard'	—
August 1933: Magnitogorsk (section 2)	—	Kramatorsk 45-inch 'standard'	—
1934–1941: Zaporozhstal	—	Kramatorsk 45-inch 'standard'	—
Chelyabinsk	Demag A-G 43-inch	—	—
Zlatoust	—	Probably Kramatorsk	—
		Demag A-G and United Engineering	
Total Mills	3 before World War II	5 before World War II	None between 1917 and 1945

[25] See chap. 9 for information on assistance by United engineers in building the standardized duplicates.

Izvestia correctly claimed that the blooming mills at Kirov, Dzherzhinsk and Zlatoust utilized 'Soviet materials, Soviet workers and engineers.'[26] What *Izvestia* did *not* state was that these mills were of foreign design and duplicated in the Soviet Union with the help of U.S. steel-mill designers and engineers.[27] Adoption of a standard blooming mill design, although advantageous given the limited technical and innovatory resources available, inhibited adoption of newer rolling improvements. For example, the high-lift blooming mill, to handle wider ingots, was adopted in the United States after about 1940, but not in the U.S.S.R. The choice facing the Soviets, therefore, was to concentrate on duplication of a single standard proven design and achieve large-tonnage production by sacrificing the flexibility and economic advantages of a slower pace of technical adaptation. The road taken enabled training of cadres of mill operators and very rapid increases in production.

Bolshevik haste to meet propagandized deadlines also affected output; Frankfurt relates that the Kuznetsk mill was started up over the objections of Freyn engineers.[28] Output figures in the first four months suggest that a series of mill breakdowns was caused by this impatience. Start-up on November 5 produced 2,934 tons in that month and 6,108 tons in December. Then came two months with a little over 1,000 tons per month: less than 1 percent of capacity. In March the mill was in better shape and in September produced 30,000 tons, or 25 percent of capacity.[29]

THE UNITED ENGINEERING CONTRACT FOR HOT AND COLD CONTINUOUS WIDE-STRIP MILLS

By far the most significant advance in rolling technique in the twentieth century has been the American wide-strip mill producing hot and cold rolled wide steel strip—a prerequisite essential for automobile and appliance production.

The United Engineering and Foundry technical-assistance agreement, signed in February 1935, provided for transfer of both hot and cold stripmill

[26] November 26, 1932.

[27] See chap. 9.

[28] S. Frankfurt, *op. cit.*

[29] S. M. Veingarten, *Ekonomika i planirovanii a chernoi metallurgii SSSR* (Moscow: 1939), p. 361. Frankfurt's recollections of the premature start-up of the mill state that the Freyn engineers objected and boasts that 'Soviet people—builders, erectors, the operating staff—succeeded in mastering the complicated machinery without the help of Americans.' (Frankfurt, *op. cit.*, p. 113.) Any reader familiar with the highly skilled procedures of steel-mill operation will readily envisage the chaos that came to pass on November 5, 1932 at the Kuznetsk blooming mill.

Table 5–5 ORIGIN OF MAJOR ROLLING MILLS (OTHER THAN BLOOMING AND SLABBING MILLS) INSTALLED 1930–45

Plant	*Flat Strip, Sheet, Skelp, and Plate*	*Light Structurals and Rod Bar Mills*	*Rail and Heavy Structural Mills*	*Continuous Hot Strip Mills*	*Cold Reduction Mills*
Magnitogorsk	Sack skelp mill	Krupp rod mill Demag light bar mill	Demag rail and bar mills	U.S. 66″, Siemag	U.S. 66″
Kuznetsk	Schloemann plate mill	Two Schloemann merchant mills	Schloemann rail mills Schloemann structural mills	—	—
Zaporozhe	U.S. equipment in cold mill	—	—	U.S. 66″, United Engineering	U.S. 66″, United Engineering; Demag skin pass mills
Dzherzhinsk	—	—	—	Universal mill, Krupp-Grusonwerk A-G	—
Dnepropetstal	Tube Reducing Co., Mannesman	—	—	—	—
Nikopol	Tube Reducing Co., Brown-Boveri Co. (Vienna)	—	—	—	—
Lend-Lease (unknown)					
Location I	—	18″ merchant mill	—	—	—
Location II	Seamless pipe mill	—	—	—	—
Location III	Seamless pipe mill	—	—	—	—
Location IV	—	—	Rail mill, structural mill	—	—

Sources: American Iron and Steel Institute, *Steel in the Soviet Union* (New York: 1959).
U.S. State Dept. Decimal File, 861.60/325 and 861.6511/34.
U.S. State Dept., *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945).
Iron and Steel Industry, June 1937, pp. 475–7.

technologies to the U.S.S.R.[30] and included a $3-million equipment order and $1 million for technical assistance. The contract also provided for installation of a complete electrically driven rolling mill at Zaporozhe. Part of this mill was to be built at Kramatorsk according to United drawings and with technical assistance provided by that company.[31] The mill installation, complete with a blooming mill, was similar to one already completed by United Engineering at the Ford River Rouge plant with an annual capacity of 600,000 metric tons of 60-inch hot and cold strip. At the same time an agreement was signed with American Standard Corporation for $3 million worth of rolling-mill equipment.[32]

There is in the State Department files an excellent and objective interview of T. W. Jenkins, Chief Engineer for United Engineering in the Soviet Union, concerning the problems of installing the mill at Zaporozhe. The interview took place on February 2, 1937, some two years after signature of the agreement.

Jenkins had arrived in the U.S.S.R. in August 1936. Under the contract some of the equipment was to be built at the Kramatorsk plant. Jenkins and three other American engineers were to spend one year in the U.S.S.R. to install the United equipment, supervise construction in Soviet plants, and train Soviet engineers. One American engineer was stationed at Kramatorsk to ensure the quality of equipment being built there; this apparently presented some difficulties and Jenkins made arrangements, as could be done under the contract, for all Soviet equipment to be approved by the United engineer before shipment to Zaporozhe:

> One of the main difficulties experienced in this connection has been that the Soviet mechanics and engineers do not appreciate or understand the necessity for exact and precise work in connection with the construction of machinery. They do not keep within the allowances specified on the drawings. It is for this reason that many of the parts in the rolling mill which was operated in December did not stand up during the test.[33]

Jenkins suggested that installation might be completed by the end of 1937.

By January 1939 the hot-strip mill was installed and operating at about 30 to 35 percent of capacity.[34] By the end of 1940 the mill was producing about

[30] See chap. 9. For a detailed description of the design and equipment of the Zaporozhe strip mill supplied by United Engineering and Foundry Co. see M. Stone, 'Continuous Wide Strip Mill Now Being Built in Russia,' *Steel*, December 9, 1935, pp. 32–5, 57. Stone was an engineer with United Engineering and Foundry. Also see U.S. State Dept. Decimal File, 861.64/17 and 861.6511/34, Moscow Embassy, 1937.

[31] U.S. State Dept. Decimal File, 861.6511/34; *New York Times*, February 26, 1935, p. 27.

[32] U.S. State Dept. Decimal File, 861.6511/34.

[33] *Ibid.*

[34] U.S. State Dept. Decimal File, 861.6511/42, Report No. 2008, Moscow Embassy, January 17, 1939.

1,500 tons of steel sheets per day.[35]

Steel tube mills relied exclusively on American (Tube Reducing Company) and German (Pilger, Mannesman) processes. In 1939 Howard Kenworthy, Assistant Chief Engineer for the Tube Reducing Company of New Jersey, stayed for six months at the Nikopol tube plant supervising installation of seven machines for the manufacture of carbon-steel and stainless-steel tubes. Two similar machines were supplied by the Tube Reducing Company for installation by Soviet engineers at the Dnepropetrovski plant. The total contract to supply the 'most modern' tube-manufacturing equipment was estimated to be worth between $750,000 and $1 million.[36]

Several other complete modern steel mills were supplied under the U.S. Lend-Lease program.[37] An 18-inch merchant mill valued at $3.5 million was completed and shipped by February 1945. Two pipe-fabrication mills for production of seamless pipe valued at a total of $1.2 million were shipped in May 1945. Another project valued at $15 million included a blooming mill, rail mill, structural mill, railroad tie and fishplate mill, and soaking pits, and was also exported during 1945 under the Lend-Lease program.

In addition to these complete installations, orders for $13.2 million worth of auxiliary steel-mill equipment (with the potential of increasing Soviet steel output by 2.5 million tons per year) were shipped under the program.[38]

CONSTRUCTION OF THE MAGNITOGORSK COMPLEX BY McKEE CORPORATION[39]

Planned as the largest steel complex in the world, Magnitogorsk is a replica of the United States Steel plant at Gary, Indiana, with an annual capacity of

[35] *Ibid.*, 861.6511/46, Report No. 978, Moscow Embassy, December 4, 1940.

[36] *Ibid.*, 861.60/325, Report No. 2154, Moscow Embassy, March 7, 1939. The electrical equipment for the Nikopol tube mills was built by the Brown-Boveri Co. in Vienna. This equipment comprised: two 900-kilowatt motors for the boring mills, two 600-kilowatt motors for the forming mills, and four 180-kilowatt motors for the tube-finishing mills. Two other motors were supplied for the reversing rollers in the forming mills (180-kilowatt). In addition two 2000-kilowatt motor generators were supplied for the rolling mill together with the necessary switchboards and circuit breakers. See *Brown-Boveri Review*, January/February 1934, p. 10.

[37] U.S. State Dept., *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945), p. 17.

[38] *Ibid.* This discussion has concerned only some of the major iron and steel units. There is a complete detailed listing of 150 or so iron and steel plants dated 1944. (See Report No. 68 of Gmelin Institute, *Eisenhüttenindustrie*, National Archives Microcopy T 84–127–1428293 *et seq.*) This list included numerous installations not mentioned here; for example, a Davy mill in Leningrad, a Thomas Trio at Sormovo, a Bliss mill at Krasnyi Etna, several Lauta trios, a number of Universal mills, and numerous other foreign units. The writer has not found any evidence of a Soviet-designed mill in the period 1930–45.

[39] *Berliner Tageblatt*, August 4, 1931. In addition to references cited in this section, see: Fred N. Hays, '5 Great Power Plants Rise at Magnitogorsk,' *Power*, August

2.46 million tons of finished steel products. The Soviets started to build the plant with their own resources and then, after almost two years of fruitless effort and a competitive battle between McKee and Siemens of Germany for the contract, handed planning and design over to the McKee Corporation. *Pravda* reported that construction started in early 1928 with plans to expend 84 million rubles by September 30, 1930;[40] in fact, only 20 million was expended and a large proportion of that was for the McKee design work. 'The principal cause of delay,' said *Pravda*, 'is the lazy work of political and professional leaders.'[41]

R. W. Stuck, American superintendent in charge of Magnitogorsk construction for the McKee Corporation, arrived at the site late May 1930 and found that the Soviets had started work on Blast Furnace No. 1. Stuck photographed preliminary excavation work on the No. 1 furnace site and also on the No. 2 site when he had gotten it to a similar stage.[42] At the peak of plant construction in late 1931 there were 250 Americans, as well as a large number of German and other foreign technicians, at Magnitogorsk.[43] Blast-furnace construction alone required 27 U.S. engineers, stationed by Stuck at the most strategic points of the project. The greatest single problem was to restrain Soviet engineers (known among the Americans as '90-day wonders'), who were convinced that a hastily devised three-month training program and revolutionary ardor were adequate substitutes for capitalist engineering experience. According to Stuck, Russian blast-furnace construction techniques were 50 to 75 years out of date, and attempted improvements by Russian engineers reduced, rather than enhanced, efficiency. Another problem was the creation of construction schedules for propaganda, irrespective of engineering feasibility. The Communist Party required start-up of Blast Furnace No. 1 on January 31, 1932: however, at that time the furnace was only three-quarters completed. As Stuck said, 'It was put into operation against our insistent demands not to do such a foolish and rash thing as the furnace was not ready and would be destroyed. . . .'[44]

1932, pp. 79–80, for German power station equipment: W. A. Haven, 'The Magnitogorski Mines and Metallurgical Plant,' *Blast Furnace and Steel Plant*, January 1931. Haven was Vice President of McKee Corp. and includes a layout diagram of the plant. E. C. Kreutzberg, 'Filling Equipment for Blast Furnace Steps-up Output," *Steel*, March 26, 1934, reviews Otis Elevator equipment and skips for Magnitogorsk blast furnaces. Also see W. A. Haven, 'Some Comments on the Design and Construction of a Mining and Metallurgical Plant for the U.S.S.R.,' *Mechanical Engineering*, XLV, 1932, pp. 461–6, 497.

40 *Pravda*, August 16, 1930.

41 *Ibid.*

42 The reader is referred to these comparative photographs: they illustrate the disorder of the Soviet attempt at excavation. See R. W. Stuck, 'First-Hand Impressions of Soviet Russia,' *Case Alumnus*, November 1932.

43 *La Vie Economique des Soviets*, No. 114, April 20, 1930, p. 15.

44 *American Engineers in Russia*, Stuck MSS, p. 41.

Attempts were also made, absurd as it may appear, to carry out construction according to pictorial rather than engineering objectives. According to Stuck, open-hearth stacks were built first, 'as these were very tall and made a nice picture. . . .'[45] There is support for Stuck's assertions: a close examination of early propaganda photographs of the Magnitogorsk plant indicates the absence of certain major components.[46]

Ultimate success in handling this political interference depended on personality. Ferguson, in charge of blast-furnace construction at Kuznetsk, had similar problems, laid down flat directives, and got away with them, while Stuck was rarely able to outwit or beat down the Party propagandists in their battle against engineering logic. Stuck outlined his construction problems at length and was particularly caustic in comments on Soviet planning and engineering practice. The contract provided that Magnitogorsk was to be designed and constructed 'according to the best and most modern metallurgical practice. . . .' There was, according to Stuck, dispute over where the best designs could be obtained; some Soviet engineers contending that 'German, French, British and their own methods were just as good and in most instances better than those prevalent in the United States.' On the contrary, Stuck estimated Russian practice at that time as being 'from half to three-quarters of a century behind the rest of the world.' Soviet engineering practice hardly impressed him; he noted, for example, the following:

> Even the anchor bolts for the building steel were not in line. They were never checked in spite of our pointing out . . . that serious results were bound to occur if the bolts did not line up properly. The steel was erected and the inevitable happened. The steel would not fit, the crane girder rails would not meet by four inches, yet the erectors started riveting the steel together and no one could stop them. The bricklayers started the brickwork around the columns even though they, as well as everyone else, knew that the steel was not set properly. Finally after an effort that almost took armed force to carry out I succeeded in having the work stopped and an attempt made to rectify the mistakes.[47]

Soviet purchasing commissions abroad buying equipment for Magnitogorsk were equally independent. For example:

> In connection with the gas cleaning system, the design called for disintegrators, which are large rotating drums driven at high speeds, causing the gas and water to be in more intimate contact and resulting in better cleaning of the gas. The design of the machines and their capacity were such that they would handle the greatest amount of gas the furnaces would ever produce. The design was approved by the Commission work-

[45] *Ibid.*, p. 42.

[46] See various issues of *U.S.S.R. in Construction.*

[47] R. W. Stuck, 'First Hand Impressions of Soviet Russia,' *Case Alumnus*, XII, No. 2, November 1932, p. 10.

> ing with our company, and the specifications sent to the Russian buyer in Germany, since the machines to be purchased were built in Germany. The Russian who was doing the buying felt that since he had not been consulted the design was certainly not correct, and that no one except he knew what they were doing. Therefore he, without consulting anyone else, bought machines of larger capacity. Consider for a moment what this meant. All piping connections, size of water lines, foundations of machines, buildings for the machines, in fact, all details of the design and installation were voided by his action in buying contrary to specification. . . . Of course, we were not let into the secret until the machines were purchased and on their way to the site.[48]

Both gas holders at Magnitogorsk were also imported from Germany and erected by German technicians at a cost of two and a half million gold rubles. Although erected in 1934, they were idle until 1940: operation was guaranteed only to $-15^{\circ}C$ and the Plan did not allocate money for conversion, so for six years the combinat operated without a gas reserve.[49]

The General Electric Company, however, under its 1928 technical-assistance agreement, made an 'outstanding engineering contribution' by sending a 'special group of highly trained General Electric steel mill specialists who formed the nucleus of a steel mill electrical designing bureau . . . (at) Electroprom.'[50] This group supervised the electrical layout design for Magnitogorsk and other iron and steel plants. General Electric concluded, 'As a result of this co-operation, a large number of Soviet electrical engineers learned and obtained firsthand intimate knowledge of General Electric engineering methods as applied to the rolling mill industry.'[51]

CONSTRUCTION OF THE KUZNETSK COMPLEX BY THE FREYN ENGINEERING COMPANY[52]

Kuznetsk (known as Stalinsk after 1932) was designed and built by the Freyn Engineering Corporation of Chicago. The Freyn contract covered the entire Kuznetsk plant except the by-product coke plant and the chemical plants, which were the responsibility of a French company (Disticoque S.A.)

48 *Ibid.*, pp. 8–9.

49 Scott, *op. cit.*, pp. 182–3.

50 *The Monogram*, November 1943, p. 19.

51 *Ibid.*

52 Based on *American Engineers in Russia*, 'Statement of J. S. Ferguson Covering Personal Experiences in Russia over a Period of Eighteen Months,' April 30, 1933, pp. 2–3. Ferguson was superintendent of blast-furnace construction at Kuznetsk. Also see E. P. Everhard, 'Kuznetsk Steel Plant in U.S.S.R.,' *Blast Furnace and Steel Plant*, December 1932, pp. 889–93, and M. J. Wohlgemuth, 'Building a Steel Plant in Soviet Russia,' *The Electric Journal*, February 1934, pp. 62–7. Wohlgemuth was Assistant Chief Electrical Engineer for Freyn at Kuznetsk, and his article has excellent data on the electrical equipment at the mill.

under contract to Kokstroi (Coke Industry Construction Trust). Freyn also supervised modernization of all tsarist plants scheduled for reconstruction elsewhere in Russia under the First Five-Year Plan. The only iron and steel plant not covered by the Freyn contract was the Magnitogorsk complex, under contract to McKee Corporation and Demag A-G. The rolling mills were built and installed by two German companies: Demag A-G and Schloemann A-G. Individual equipment items were purchased from the supplier offering the best terms and technical specifications, and were selected initially by Freyn, subject to approval by a Soviet commission. The company had contractual responsibility for equipment acceptance and operations during the initial six months. The 115,000-cubic-foot-per-minute capacity turbo-blowers were supplied by Brown-Boveri of Switzerland; the disintegrators were Zschocke. Freyn designed, built and installed the automatic ore-hoppers, the pressure burners and stock-line recorders. Demag A-G built the ore bridge cranes and Pollock-type hot-metal ladles as well as the rolling mills. Charging cars were by Orr, skip and bell hoists by Otis, clay guns by Brossius, stock distributors by McKee, and the automatic hot-blast controls by Bristol: all were manufactured in the United States. The only items for Kuznetsk manufactured in the Soviet Union were Dewhurst slag ladles.

The service units at the Kuznetsk plant were supplied from Europe. A refractories plant (for fire-clay and silica-brick products for the furnaces) utilized German equipment and was built by German engineers. In power plant No. 6, the generator (of the standard type) was made in the U.S.S.R., probably by the Elektrosila plant in Leningrad. The condenser equipment was from Wumag (Germany) and the turbine drives from Rateau (France).

Between 1929 and December 1932, construction of the first section of Kuznetsk was under general supervision of E. P. Everhard, who had 70 U.S. engineers working for him. They supervised construction and initial operation of the plant in December 1932, and when they left, the plant had achieved an annual rate of 450,000 tons, compared to the control figure of 330,000 tons.[53] The director of Kuznetsk while it was under construction was Sergei Mironovitch Frankfurt,[54] a former textile mill operator, while I. P. Bardin, a well-known Russian metallurgist, was Frankfurt's chief engineer. Assistants to Frankfurt were Party men with little knowledge of iron and steel plants. Everhard, senior American engineer on site, apparently had effective control while construction was under way. For example, Everhard comments (with reference to Frankfurt and Bardin):

> I made it a hard and fast rule that no Russian, not even the Red Director or technical superintendent could authorize the changing of the

[53] *American Engineers in Russia*, Folder 4, Report 9.

[54] S. Frankfurt, *op. cit.*

burden or temperature and volume of the blast. This precaution saved us trouble many times later on. . . .[55]

The rolling mills for the first section of Kuznetsk (construction of which was supervised by Americans) had been imported. The blooming mill was a 45-inch Demag with drive and control equipment by General Electric. The rail mill, the 24-inch structural mill, the 70-inch plate mill, and two merchant mills for rods, rounds, bars, sections, and agricultural shapes were made and installed by Schloemann A-G of Germany. All mill cranes were either from Germany or the United States, and all mill motors of over 25 horsepower were imported and mainly of General Electric design. The only Soviet-made equipment in the first section of the Kuznetsk rolling mills were mill motors of less than 25 horsepower made to General Electric design; these powered the 'live rollers.'[56]

The second section of Kuznetsk was begun immediately but with a significant difference. Construction was now under Soviet supervision; foreign participation was limited to the installation and operation of imported equipment, which consisted mainly of rolling mills. An article in *Za Industrializatsiiu* (Moscow) for March 24, 1933, reports on progress of this second section. The Soviet-built equipment consisted of the sixth turbo-generator, boilers number 5, 6, and 7, and 900-millimeter rolling mill, and the model 210 crane. The second unit of Kuznetsk included blast furnaces No. 3 and 4 of the standard type,[57] the last five open hearths, two section mills, a sheet mill, and coke-oven batteries No. 3 and 4. This second section included imported equipment and a larger proportion of Soviet duplicates of foreign equipment made with foreign technical assistance.

CONCLUSIONS

Iron and steel plant construction and reconstruction in the period from 1928 through 1932 was of American design and was built under the supervision of American and some German engineers, utilizing imported equipment from either the United States or Germany but usually manufactured to American design.

Gipromez, the metallurgical design bureau, was charged in 1928 with the transfer of American technology, and for this purpose a number of American engineers took over key positions. Its function was to compare foreign

[55] E. P. Everhard, *op. cit.*, p. 25. (See fn. 52 above.)

[56] *American Engineers in Russia*, 'Statement of J. S. Ferguson Covering Personal Experiences in Russia over a Period of Eighteen Months,' April 30, 1933, p. 3.

[57] Blast furnaces Nos. 1 and 2 had capacities of 1,164 cubic meters, and Nos. 3 and 4 had capacities of 1,163 cubic meters.

technologies, select the most suitable, and develop this as a Soviet standard; this standard design was duplicated during the period 1932 to 1945 with U.S. and German engineering assistance.

The standard blast furnaces were initially of Freyn design. The McKee design was not duplicated. The second standard was a 1300-cubic-meter design produced by Gipromez without assistance by 1938, but not widely utilized. The standard open-hearth furnace was a Freyn 150-ton design. The standard hot and cold continuous wide-strip mills were of United Engineering design. Product and merchant rolling mills were of the U.S. type, although originally made in Germany and then duplicated by Soviet machine-building plants. Demag slabbing and blooming mills were also adopted.[58]

Thus between 1928 and 1945 there was complete diffusion of iron and steel technology from capitalist countries (primarily the U.S. and Germany) to the Soviet Union; the Soviets utilized proven foreign designs and adapted them, with foreign help for their standards. No reverse diffusion from the Soviet Union to the U.S. has been found; neither has any indigenous Soviet innovation, apart from the Gipromez 1300-cubic-meter second standard design and several larger open-hearth furnace designs.

[58] Tube mills will be considered in Volume III. There were in Russia in this period Mannesman and Pilger mills and a Tube Reducing Co. mill (at Nikopol).

CHAPTER SIX

Technical Assistance to the Fuel Industries

'MISTER GRAVER, WHO BECAME COMRADE GRAVER'[1]

IN 1930 the Soviet Union had a refinery capacity of about 95 million barrels per year in shell still units which were built before 1917 and yielded kerosene and oils rather than gasoline. Volume I briefly outlines extensive construction of new shell still and pipe still units during the period 1927–30 by German companies (Borman, Pintsch, and Wilke), and then British (Vickers) and American companies (Graver, Badger, Foster-Wheeler, Max Miller, Winkler-Koch, and Alco Products).[2] This first construction phase (which ended in 1932–3 with the departure of American engineers, although some Germans remained on individual ruble contracts) added a refinery capacity of about 96 million barrels, including lubricating and Winkler-Koch cracking units, not previously known in Russia.

Even the propaganda magazine of the First Five-Year Plan acknowledged this enormous debt to American technology. Under the title, 'Mister Graver, Who Became Comrade Graver' this acquisition was described:

> Baku and Grozny adopted Graver—an American; following in Graver's footsteps came 'Badger'—a kerosene and oil still; then came 'Foster' and then a cracking still of the 'Winkler, Cokh & Jenkins' [sic] system. This year another foreign child adopted by the Soviet petroleum workers —the 'Max Miller' still which produces high-grade cylinder oils, will be put into operation.[3]

In 1932–3 the Soviets started to build their own refinery equipment, based on imported designs. Machine shops at Baku, Grozny, Podolsk and other locations were assigned to the oil industry for this purpose. Little progress

[1] *U.S.S.R. in Construction*, No. 12, 1931.
[2] Sutton, *Western Technology . . ., 1917 to 1930*, pp. 35–40.
[3] *U.S.S.R. in Construction*, No. 12, 1931.

was made, as both the shops and the personnel were unsuited to the heavy work involved in refinery construction.

THE RETURN OF U.S. FIRMS FOR CONSTRUCTION OF THE 'SECOND BAKU'

In 1936 American refinery construction companies were called back and remained in the Soviet Union until 1945. Badger, Alco Products, Universal Oil Products, Winkler-Koch, McKee, Petroleum Engineering, Lummus Company of New York, and Max Miller expanded older locations at Baku, Grozny, and Batum and built the refineries at the 'Second Baku.'

On July 10, 1936 a contract was signed by the Petroleum Engineering Company of Tulsa, Oklahoma and by the McKee Corporation for expansion of the Baku petroleum refinery.[4] Technical assistance, drawings, material, and equipment were sold for a total of $178,780 to build an absorption plant, crude stabilizer, gasoline-stabilizing units, butane-fractionating unit, and propane-fractionating unit. Capacity of the complex was 5,000 barrels per day with an input of 24 million cubic feet per day of natural gas. The Brown Instrument Company supplied the control equipment.[5] By 1939, however, the complex was reported only 80 percent complete.[6] It is a reasonable inference that similar contracts were let and units built at Batum. An Embassy official toured the Batum complex in 1938 and reported that it had four Winkler-Koch, four Jenkins, and four Foster-Wheeler stills.[7] This is a greater number than had been built in the period 1928–31. Since no Soviet construction has been reported, it is a reasonable inference that six units were built by American companies between 1932 and 1938. In the late 1930s the Universal Oil Products Company installed high-octane gasoline plants at both Grozny and Saratov. These were polymerization units about equal in size, and they were about 60 percent complete in 1940 when the American engineers were withdrawn.[8]

However, the major focus of American refinery-construction effort after 1936 was not in the Baku-Batum-Grozny region, but farther north, along the Volga River in the 'Second Baku.'

In 1938 another contract was made with the Universal Oil Products Company for installation of a hydrogenation and iso-octane plant (see figure 6–1)

[4] U.S. State Dept. Decimal File, 861.602/299, Report No. 1419, Moscow Embassy, June 27, 1938.

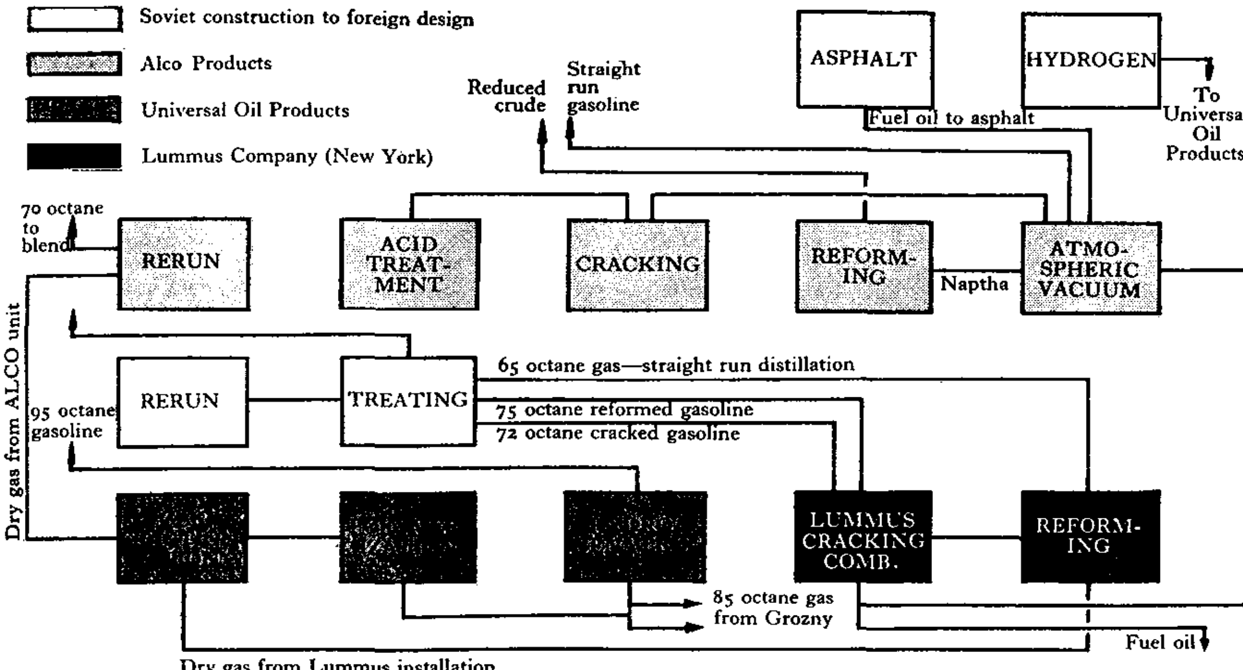
[5] *Ibid.*, 861.6363/345. These were original Brown control units, not copies made under the company's technical-assistance agreement. (See p. 165.)

[6] *Ibid.*, 861.6363/351, Report No. 2024, Moscow Embassy, January 19, 1939.

[7] *Ibid.*, 861.6363/341, Report No. 1327, Moscow Embassy, June 1, 1938. This is a lengthy but rather vague report; no other technical details are included.

[8] *Ibid.*, 861.6363/370, Report No. 263, Moscow Embassy, January 18, 1940.

Figure 6–1 FOREIGN AND SOVIET CONSTRUCTION OF THE UFA PETROLEUM REFINERY COMPLEX, 1938–40



Source: U.S. State Dept. Decimal File, 861.602/285.

at Chernikova, 35 kilometers from Ufa, in the 'Second Baku.'[9] This was the first installation of its type in the Soviet Union and of some importance, since to this time the Soviets had been unable to make 87 or 94 octane gasoline for aviation use. The hydrogenation units built by Universal Oil Products received 85 octane gasoline from Saratov and Grozny and polymerization charge stock from the Alco and Lummus units, and converted this into 95 octane aviation gasoline.[10]

The refinery at Ufa was built by Alco Products (the oil-refining division of American Locomotive) and consisted of an atmospheric vacuum unit, reformer, cracking plant, rerun unit, and acid-treating plant.[11] The value of the equipment supplied was $1 million, 50 percent payable when the equipment was delivered to the dock in New York and 50 percent when the plant was completely in operation. Alco provided supervision of construction and technical assistance, and supervised initial operation of the refinery. Until the plant began to produce in 1937, the Alco Company kept five engineers on the Ufa site to supervise construction and train Russian workers in operation. It was reported by Alco engineers that the OGPU was in 'absolute control.'[12] The total cost of the Alco Products contract, including services, was $2.5 million.

The third part of the Ufa complex was built by the Lummus Corporation of New York and consisted of cracking and reforming units to produce 500,000 tons of 66 octane gasoline per year, to feed into the rerun and treating units.[13]

In April 1939 only four of the six units under construction were actually in operation.[14]

There were numerous problems at Ufa; one reported by several engineers concerned attempts by Soviet engineers to change the original designs. Meredith commented, 'I was surprised to learn upon my arrival that the preliminary work already done by Soviet engineers had changed the original design and line-up of equipment as provided for in the plans.'[15] Soviet engineers had decided to discard the centrifugal refining process and 'to install in its stead a new chemical process which had recently been developed by a firm in Kansas.' Meredith suggested that this process was still in the experimental stage and not well-adapted to the type of crude oil intended to be run through the Ufa refinery. Later he added that 'during my entire stay in Ufa I

[9] *Ibid.*, 861.6363/340, Report No. 1292, Moscow Embassy, May 20, 1938.
[10] *Ibid.*, 861.6363/370, Enclosure to Report No. 263, January 18, 1940.
[11] *Ibid.*, 861.6363/348, Report No. 1651, Moscow Embassy, September 15, 1938. Also see 861.602/285, Report No. 2203, Moscow Embassy, January 16, 1937. For Soviet attitudes toward Alco Products and E. B. Badger and Sons during negotiations, see pp. 264–6 and U.S. State Dept. Decimal File, 861.602/263.
[12] *Ibid.*, 861.6363/348.
[13] *Ibid.*, 861.6363/340, Report No. 1292, Moscow Embassy, May 20, 1938.
[14] *Ibid.*, 861.6363/353, Report No. 2240, Moscow Embassy, April 10, 1939.
[15] *Ibid.*, 861.602/285.

was continually obliged to insist that the Soviet engineers construct the plant according to plan and not try to put in so-called improvements.' Meredith indicated to the Soviets that if the plant was not constructed exactly according to the plans as provided for in the contract, Alco would take no responsibility for the final results.

Crude oil for the Ufa plant came from fields about 200 kilometers to the southeast; Soviet organizations had nearly completed construction of the pipelines while the refinery was being built. From partial examination of the lines and from reports from other engineers, Meredith concluded that there would be considerable difficulty in maintaining the lines; there were no boosting stations anywhere along the 200-kilometer length and, despite the extreme Russian climate, no provision had been made for expansion joints, 'so that there will undoubtedly be continuous leaks and breakdown.'[16] The Alco Company was not able to acquire samples of the crude oil for analysis, but Meredith suggested that if it had the high sulphur and water content rumored, it would be 'extremely difficult to refine it by the chemical process which has been adopted.'[17]

That great value was attached by the highest political authorities to the work of these American engineers and the installations supplied by these firms was demonstrated in 1939, when the Soviets refused to allow the employees of the Max B. Miller Company to travel from Grozny to the U.S. Embassy in Moscow to have their passports renewed. The Soviets apparently thought the Americans were planning to leave the Soviet Union.[18]

Mashinoimport telegraphed the Miller Company in the United States, stating 'that the Company's engineers for "unknown causes" insist upon leaving and request[ed] the Company to instruct them to continue their work until the plant is in operation.'[19] In the meantime the Soviet authorities, according to the U.S. Embassy, stalled the engineers, first promising them transportation, then insisting it was not available, and finally stating that the trip to Moscow was not necessary, as 'arrangements' had been made with the U.S. Embassy. The Embassy commented that 'this misrepresentation could only have been made for the purpose of misleading the engineers into believing the trip to Moscow to be unnecessary.'[20]

16 *Ibid.*

17 *Ibid.* It appears extraordinary that the Alco Products Company would have received a contract to design a refining unit without samples of the crude oil to be used. It would be possible to do this from the Russian specifications but certainly not in the best interests of efficient operation. This is an example of the deep-seated Soviet distrust of foreign organizations: a completely unfounded distrust, as there is no question that the American firms were providing excellent equipment.

18 U.S. State Dept. Decimal File, 361.11 Employees/360, December 28, 1939.

19 *Ibid.*

20 *Ibid.*

Later, after some negotiation, the Russians acquiesced to the principle that American citizens had freedom to travel to Moscow to renew passports but expressed concern over the departure of Rodman, Rasmussen (in charge of construction at Grozny for a Universal Oil Products polymerization unit), Miller, Hanson, and Owens:

> Potemkin [the Russian ambassador] expressed great concern over the serious effect which their withdrawal would have on the large investment of the Soviet Union in the respective plants the construction of which they have been supervising and particularly emphasised the urgent desire of the Soviet Government to retain the services of Rasmussen whose work appears to be most vital until the period specified under his contract shall have expired.[21]

Table 6–1 PERCENTAGE OF SOVIET REFINERY AND CRACKING CAPACITY WITH FOREIGN DESIGN AND CONSTRUCTION, 1932 AND 1945

	Foreign Design and Construction		*Soviet Construction Using Foreign Design*	
	*1932**	*1945***	*1932**	*1945***
Refineries	77.5%	n.a.	22.5%	n.a.
Lubricating oil plants	96.4%	99.3%	3.6%	0.7%
Cracking plants	91.6%	94.7%	8.4%	5.3%

Sources: 1932 data calculated from *The Petroleum Times*, February 13, 1932, p. 173. 1945 data calculated from data in U.S. State Dept. files.

* The data used were incomplete. This was by far the most difficult industrial sector to reconstruct, because of numerous name changes of individual refineries and the almost complete lack of usable Soviet data. Although these percentages do cross-check, for example, with the unpublished 1935 plan for refinery construction in the Smolensk archives, they are not presented as definitive. The general order of magnitude is, however, quite acceptable.

** Excludes tsarist construction.

These units were supplemented by four complete refineries supplied under Lend-Lease and shipped during 1943. A total of 100,000 tons of equipment comprised these four units.[22] In early 1944 the Soviets approached seven United States manufacturers of refinery equipment concerning equipment deliveries in the postwar period,[23] and equipment deliveries were made under the 1945 pipeline agreement.[24] In late 1944, when Soviet troops entered Rumania they dismantled large quantities of refinery equipment (including Romana Americana and Astra Romana refineries) from the Rumanian oil fields and shipped it to the U.S.S.R. It is interesting to note, in light of continuing U.S. and British Lend-Lease assistance and the alliance against Nazi Germany, that

[21] U.S. State Dept. Decimal File, 700.00116 M.E./24, Telegram, December 29, 1939.
[22] *Ibid.*, 861.24/1473, Telegram, Moscow to Washington, D.C., May 24, 1943.
[23] *Ibid.*, 861.50/2944, Memorandum, WEA to AA (State Dept.), May 29, 1944.
[24] To be covered in Volume III.

'removal of equipment [was] limited to companies owned by Americans and British and others have not yet been disturbed.'[25]

LUBRICATING-OIL UNITS BY MILLER AND ALCO PRODUCTS

At the end of 1931 the Soviets had about 11 million barrels per year of lubricating-oil capacity, one-half of which had been built before 1917 and the other half by German and U.S. companies at the end of the 1920s. The largest single unit added between 1932 and 1945 was a Max Miller bright-stock plant at Baku, designed to produce almost 3 million barrels per year of high-grade lubricating oils.[26] This was supplemented by a 700,000-barrel Russian-built Pengu-Gurevitch vacuum unit.

The Max Miller unit at Baku was erected under the supervision of Miller Company Chief Engineer Werner Hofmann. Twice during its construction Hofmann left the Soviet Union and was interviewed on the progress of his work. In December 1931 he reported problems with refinery construction; for example, on one job, he said that there were 'one thousand leaks where there should not have been more than ten or twenty.'[27]

In November 1932, leaving for the last time, he was more caustic in his comments on the Soviet Union in general and the Max Miller plant in particular. After dismissing the Soviet Union with the statement that 'the entire present regime is one big lie,'[28] he said that the Miller plant had cost $5 million but that only $25 worth of maintenance tools were available, adding that one shop had a half million dollars invested in one type of machine but that he couldn't get rags to wipe off the oil. Hofmann himself bought cloth in the foreigners' store to make wiping rags, but the workers took it to make children's clothes. These workers, he added, had neither protective clothing nor work clothes.[29]

Another lubricating-oil unit, with a capacity of 1.4 million barrels, was built at Batum by Foster-Wheeler. Three other units were built at Grozny (another Foster-Wheeler 1.4-million-barrel unit and two Alco Products units: one in 1933 and one in 1938–9), with an aggregate capacity of about 3.8 million barrels. In 1939 it was reported that the Max Miller Company had another lubricating-oil unit under construction at Grozny.[30]

25 U.S. State Dept. Decimal File, 871.6363/11–244, Telegram 1106, November 2, 1944. Reparations as a development mechanism will be explored in Volume III.

26 *World Petroleum*, May 1932.

27 U.S. State Dept. Decimal File, 861.5017—Living Conditions/389, Report No. 755, Vienna, December 12, 1931.

28 U.S. State Dept. Decimal File, 861.5017—Living Conditions/389, Report of November 9, 1932.

29 *Ibid.*

30 *Ibid.*, 861.6363/351, Report No. 2024, Moscow Embassy, January 19, 1939.

WINKLER-KOCH GASOLINE-CRACKING TECHNOLOGY

The Soviet Union continued to be dependent on Western technology (primarily American) for cracking petroleum into light gasoline fractions. Lend-Lease equipment deliveries were sufficient to bring the output of aviation gasoline from only 110,000 metric tons per year in 1941 to 1.67 million metric tons in 1944, despite the fact that several Lend-Lease cracking units were not delivered until after the end of the war.

In 1931–2 the Winkler-Koch Engineering Corporation of Wichita designed and furnished to the Soviets 15 cracking units to produce gasoline from fuel oil and gas oil derived from Russian crudes; these units comprised about 85 percent of the total cracking capacity in the U.S.S.R. in the 1930s.[31] *The Petroleum Times* reported: 'These units were erected by Russian labour and Russian engineers supervised by Winkler-Koch construction engineers. The operation and instructions to the Russian operators during the test runs of the units were in charge of Winkler-Koch operators.'[32]

This cracking capacity of almost 20 million barrels a year was erected in only two years; 'only 14 months elapsed from the time the first unit was completed and put on stream until the last of the 15 units was erected, tested out and fully accepted with all guarantees fulfilled.'[33]

Three Vickers (United Kingdom) units were erected at Baku and Grozny in 1928–9. It was apparently from the Vickers cracking system that the Soviets derived their own standard system. An article by Professor Andreyev in *The Petroleum Times* stated that 'the ability to conduct liquid-phase cracking—a technical process new to the U.S.S.R.—was in the main acquired at the Vickers refinery, the first industrial cracking plant to appear in the Soviet Union.'[34] This process was then called the Shukov-Kapelyushnikov system and was used to build two cracking units in 1931 at Baku with a total capacity of 2.1 million barrels a year. No further units were built to this system.

Winkler-Koch and Alco Products systems were used for those units built in the middle and late 1930s, at which time the Houdry catalytic plants were received under Lend-Lease; this certainly suggests that the 'Soviet-Vickers' process was not as effective as either the Winkler-Koch or the Alco Products system.

The U.S. responded in 1939 to the Soviet attack on Finland and decided that 'there should be no further delivery to certain countries of plans, plants, manufacturing rights, or technical information required for the production of

[31] *The Petroleum Times*, February 13, 1932, p. 173.
[32] *Ibid.*, p. 174.
[33] *Ibid.*
[34] December 29, 1934, p. 700.

Table 6–2 CRACKING UNITS BUILT IN SOVIET UNION, 1932–45

Location	Built 1930–32[1, 2] (Units)	Capacity (Barrels/Day)	Built 1932–41[3, 4] (Units)	Capacity (Barrels/Day)	Built 1941–5[5] (Units)	Capacity (Barrels/Day)
Batum	4 Winkler-Koch 2 Jenkins	14,000	Universal Oil Products*			
Baku	4 Winkler-Koch 2 Vickers 2 Kapelushnikov	14,000	Petroleum Engineering Co.* McKee Corp.*			
Grozny	6 Winkler-Koch 1 Jenkins 1 Vickers	21,000	Alco Products[3]* Max Miller[7]* Universal Oil Products[9]*			
Tuapse	4 Winkler-Koch	7,000				
Yaroslavl	1 Winkler-Koch	2,000	1 Winkler-Koch	6,000		
Konstaninovka	1 Winkler-Koch	3,500 (estimate)[1]				
Khabarovsk	—		2 Winkler-Koch	7,000[1]		
Saratov	—		Universal Oil Products[9]	6,000[1]		
Cherson	—		1 Winkler-Koch	2,800[4]		
Berdyansk	—		1 Winkler-Koch	2,800[4]		
Ufa	—		Alco Products, Inc.[6]* Universal Oil Products* Lummus Company[8]*			
Syzran	—				4 units Lend-Lease	7,000 each

Sources: [1] *World Petroleum*, May 1932, pp. 200–1; July 1931, p. 436. [2] *The Petroleum Times*, February 13, 1932, p. 173.

[3] Generalstab des Heeres. Microcopy T-78, Roll 491, Frame 6477382–759.

[4] Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, *Erdölfund-und Erdölverar im Kaukasischen R* (incomplete title in original).

[5] U.S. State Dept., *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945), p. 16. An additional seven refinery and cracking units were supplied to the Soviet Union under U.S. Lend-Lease. As these were shipped after the end of World War II and did not come on-stream until the late 1940s and 1950s, they will be treated in Vol. III.

[6] U.S. State Dept. Decimal File, 861.602/285 (January 16, 1937). [7] *Ibid.*, 361.11 Employees/360, December 28, 1939.

[8] *Ibid.*, 861.6363/310. [9] *Ibid.*, 861.6363/370.

* Exact numbers of units unknown.

high quality aviation gasoline.'[35] This left the Soviets unprepared for the demands of World War II, so that one-quarter of all aviation gasoline had to be imported under Lend-Lease, together with four complete Houdry catalytic cracking and alkylation plants, totaling some three million metric tons of capacity.[36]

As part of Lend-Lease assistance, and at the request of 'government agencies,' the Standard Oil Company of New York was said either to have supplied or to be preparing to supply the Soviet Union with technical information, plant designs, and pilot manufacturing plants for the following processes: sulfuric acid alkylation for production of 100 octane gasoline, 'voltolization' of fatty oils for production of aviation lubricating oils, the manufacture of hydrogen from methane, the production of alcohol from refinery gases, and the production of Buna-S.[37]

The assistance in production of Buna-S is interesting in that the Soviets, as will be described later, had had an initial advantage in synthetic-rubber production by building on tsarist-era research and by establishing manufacturing facilities predating those in the West. Their requirement for foreign Buna-S technology would suggest that in the conversion from laboratory production to practical manufacture the system had failed in some respects.

WESTERN ASSISTANCE FOR MECHANIZATION OF COAL MINES

The first technical-assistance agreements concluded in 1926 were with U.S. and German engineering consultant firms for the coal-mining industry. Agreements with Stuart, James and Cooke, Roberts & Schaefer, and Allen & Garcia in the United States were renewed in the early 1930s,[38] so that these three companies operated continuously in the Soviet Union for at least five to six years, reorganizing and expanding coal mines in the Donbas and the Urals. Up to 1930–1 almost all equipment used in coal mines was imported, but in that year a few domestic machines based on Western designs and produced under technical-assistance contracts were first used in Russian coal mines.

Stuart, James and Cooke, Inc., made its first agreement, with Donugol (Don Coal Trust), in October 1926 and started work on March 25, 1927.[39] This agreement was for schematic projects for two mines in the Donbas. The work accomplished must have been acceptable, as the company was given a

[35] U.S. State Dept. Decimal File, 861.796/98a, Telegram, December 24, 1939.
[36] U.S. State Dept., *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945).
[37] U.S. State Dept. Decimal File, 861.6363/439, Letter: Standard Oil of New York to State Department, April 5, 1943.
[38] See Sutton, *Western Technology . . ., 1917 to 1930*, chap. 3.
[39] Amtorg, *op. cit.*, VI, No. 6 (March 15, 1931), pp. 135–8.

more extensive contract to make schematic projects for the Yugostal (Southern Steel Trust) coal mines and five mines for Moskvugol (State Association for Coal Industry in the Moscow Region Basin). This contract was followed by another three-year contract for technical assistance to Donugol, Moskvugol, and Uralugol. Ten company engineers were assigned to this contract, which expired in November 1931. Other Stuart contracts in the coal industry (there was one for the iron-ore mines as well) included a two-year agreement with Donugol, signed March 24, 1930, for five additional engineers to rehabilitate Donbas coal mines, a contract with Shakhtostroi (Shaft-Sinking Trust) for five key technical men to plan coal mines west of the River Volga, and a contract for an additional five engineers to give technical aid to coal mines of the Vostokugol (Far East Coal Trust), east of the Volga. In all, the company had 11 separate contracts for technical assistance to the coal mines of the Soviet Union between 1926 and early 1931.[40]

The Allen & Garcia Company had two forces in Russia: 20 engineers at Kharkov and 15 at Tomsk. This company had previously built the largest mine in the world: the Orient, at Franklin, Illinois,[41] and in 1929 signed a second contract for technical assistance in the design and construction of new shafts in the Donbas and in Siberia.

One function of Allen & Garcia was to design coal-cleaning plants, but this work apparently was ignored by the Soviet planners. According to J. A. Garcia, writing in 1934:

> We made a good many designs for coal cleaning plants both in the Don Basin and Siberia, but none of them were built, and the other American engineering firms had the same experience from 1926 to date. However, the Germans did build one large cleaning plant for them in the Don Basin at Gorlovka, and Mr. Appleyard of England built a dry cleaning plant of about 100 tons per hour in 1933. Outside of these two plants our fellows know of no cleaning plants built in the entire Soviet Union since we started working with them in 1927.[42]

As a result of this planning decision, the Soviet Union transported two million tons of ash and dirt attached to coal in 1931 alone.

The use of individual foreign technical personnel (as distinct from those imported by formal agreement with foreign firms) in the coal mines probably peaked about 1931,—at least until German occupation of the Don. In 1931 there were about 2,000 foreign specialists in the Don coal mines, about 80 percent of them German.[43] In 1931 some German personnel started to return home as a result of bad working conditions, but other reports suggest that

[40] *Ibid.*

[41] *Ibid.*, IV, No. 18 (September 15, 1929), p. 302.

[42] *American Engineers in Russia*, Letter, J. A. Garcia to H. H. Fisher, March 28, 1934.

[43] U.S. State Dept. Decimal File, 861.6362/48.

a large number did remain throughout the 1930s, and even while some German miners were reported leaving the Donbas, American miners—perhaps as many as 1,500—were reported arriving in the Leninsk mines in Siberia. Five groups arrived by August 1931 and others were expected to follow.[44] Also, Isaac Goldfein, a chemical engineer at the Kemerovo coke plant for 10 years, reported that in late 1932 a group of 50 German engineers and technicians were sinking new shafts for an 800,000-ton-per-year coal mine in Kemerovo.

> The Russians sank the first shafts themselves, but they had difficulty in preventing the flow of water from underground water courses, and by following their own methods permitted large portions of the mine to fill with water. German engineers are engaged in damming up the flow of water by a freezing method.[45]

It was the larger mines that were designed and brought into production by American consultant firms between 1928 and 1933 and operated by German technicians after about 1931. The largest of these was the OGPU mine in the Shakhty district, with an investment of eight million rubles, closely followed by the Amerikanka, also with an investment of eight million rubles. Others were the Nikitovka, Lutiaino, and Karl No. 7–8. While not as large in initial development, these were far larger than existing operations. They all became the show mines for visiting Communists and foreign tourists. Astute observers, however, noted that women still comprised 50 percent of the underground labor force[46] and that 'prisoner-engineers' were used.[47] In the Kuznetsk Basin, the largest mine was the Capital Coke Mine, started in 1929 with a capacity of one million tons of coking coal per year; J. W. Powell was consulting engineer.[48]

The emphasis on concentrating existing coal mines into fewer large shafts (designed by the United States firms) while at the same time opening up new areas behind the Urals was continued from 1930 until 1945.[49] The concentration in the Donbas areas is shown in table 6–3.

There were no shafts producing in excess of 500,000 tons per year before 1928, while in 1941 more than 17 percent came from such large-capacity shafts; almost 83 percent of output came from shafts producing more than 100,000 tons per year in 1941, compared to only 31 percent in 1928–9.

Foreign technical assistance in coal mining expired before that in any other industry, and by 1932–3 Soviet industry was on its own, although still

44 *Ibid.*, 861.6362/50.
45 *Ibid.*, 861.5017—Living Conditions/536, Riga, September 28, 1932.
46 K. Legay, *Un Mineur Français chez les Russes* (Paris: Editions Pierre Tisne, 1937), p. 58.
47 E. G. Grady, *Seeing Red* (New York: Brewer, Warren and Putnam, Inc., 1931), pp. 50–1.
48 Amtorg, *op. cit.*, IV, No. 10 (May 15, 1929), p. 201.
49 See Sutton, *Western Technology . . ., 1917 to 1930*, p. 56.

receiving substantial quantities of imported equipment. The reorganization underway since 1926 under these contracts began to pay off. Whereas the average annual increase in labor productivity was 6.3 percent between 1928 and 1932, it rose to 10.7 percent between 1932 and 1937, although it subsequently dropped to 4.4 percent in the purge years 1937–40. In the same manner the capital-labor ratio changed dramatically as the mines were mechanized; from a base of 100 in 1928 the ratio rose to 205 in 1932 (a doubling in four years) and 409 in 1940 (a further doubling in eight years).[50]

Table 6–3 CONCENTRATION OF COAL MINING IN THE DONBAS, 1928–41

Annual Production of Shaft (Thousands of Tons)	*1928–9*	*1933*	*1941*
	(Percentage of Total Output)		
Under 10	4	3	0
10–50	33	18	—
50–100	31.6	31	17.4
100–200	20	26	20.2
200–500	11	19	45.1
Over 500	0.4	3	17.3

Source: I. M. Budnitskii, *Ugol'naya Prom'shlennost'* (Moscow: 1958), p. 7.

However, some doubt is thrown on such official claims by the comments of engineers working for American consulting firms. For example, William von Meding, of the Allen & Garcia Tomsk group, suggested that while the coal industry did show an increase in the early 1930s 'it was not nearly in proportion to the increase in capital investment or in the number of workers.' Von Meding specifically pointed to transportation deficiencies.[51]

Similarly, although Soviet plants started to produce coal cutters and mine equipment in the early 1930s under the Goodman and Casablancas technical-assistance agreements, they were still using large quantities of imported equipment in the middle and late 1930s. We have precise figures for the Kisel mines, producing 4.5 million tons of coal per year; in 1936 the Kisel district mines employed 54 coal cutters. Of these, 12 were of German make (Eickhoff), 24 were American, and 18 were the Soviet DTK-2.[52] The DTK-2 cutters

[50] Figures from C. E. Butler, *Productivity in Soviet Coal Mining, 1928–64* (Harvard University Economics Dept.: 1965–6), unpublished Ph.D. thesis, p. 478. The Butler thesis, by far the most comprehensive work on the Soviet coal industry generally available in the West, notes the increase in Soviet output and productivity, and concludes that 'part of the Soviet advantage in growth rates was due to great initial technological backwardness and the opportunity to borrow technology from other countries.' (P. 385.)

[51] *American Engineers in Russia*, Folder 3.

[52] Gmelin Institute, *Russland: Die Kohlenlagerstatten des Urals*, Bericht No. 66c; National Archives Microcopy T 84, Roll 127 (about 1940).

were copies of the Sullivan Machinery model,[53] and other coal-cutting equipment was made under the Goodman assistance agreement at the Gorlovka plant.

Thus the years between 1930 and 1941 witnessed the development of large-scale coal mines designed by American coal-mining consultants and the phasing out of small mines. These new mines were highly mechanized, at first with imported equipment and then after 1931–2 increasingly with Soviet-made equipment based on the most suitable of Western models. However, even by 1940 a large proportion of underground equipment was still imported. No indications of indigenous Soviet development have been found, either in coal-mine development or in mine equipment.

This American assistance was apparently well appreciated: in January 1944, upon an inquiry by Averell Harriman concerning postwar construction plans, Molotov indicated nothing specific except to inquire concerning the possibility of sending a U.S. expert for the Don Basin coal mines.[54]

THE RAMZIN 'ONCE-THROUGH' BOILER: AN INDIGENOUS DEVELOPMENT

In boiler construction we find an example of an indigenous Soviet development—the 'once-through' high-pressure boiler—adopted in 1936 for the bulk of the new construction program.

In 1936 there were four high-pressure boilers operating in the U.S.S.R.: two Czech Loeffler boilers with a capacity of 330,000 pounds per hour working at a pressure of 1,850 pounds per square inch,[55] and two once-through boilers—the experimental Ramzin boiler of 1931 and the commercial model of the Ramzin built in 1933 with a capacity of 440,000 pounds per hour at 2,000 pounds per square inch.[56]

Numerous other foreign high-pressure boilers, including the La Mont, Velox, Babcock and Wilcox, Ladd-Lakeside, Hanomag, and Borsig-Ilse No. 3, had been tested and data had been developed,[57] but the adoption of the

[53] U.S. State Dept. Decimal File, 861.797/35, Report No. 165, Moscow Embassy, September 7, 1934.

[54] *Ibid.*, 861.51/3019, Harriman to Hopkins, January 7, 1944.

[55] Built by Wiklowitzer Bergbau und Eisenhütten Gewerschaft of Czechoslovakia. Technical details are in Browlie, 'The Löeffler Boilers at Moscow,' *The Steam Engineer*, XXI, No. 5 (February 1933), pp. 216–8.

[56] The experimental Ramzin is described in *The Steam Engineer*, VII, No. 73 (October 1937), pp. 26–8. The commercial version is described in No. 76 (January 1938), pp. 160–1 and 168, and in T. Saur, 'The Ramzin Once-Through Boiler,' *Combustion*, X, No. 1 (July 1938), pp. 35–6. For a report on operating experience with a 'once-through' boiler after several years, see P. G. Kaufmann, 'Operating Experience with a Pulverised Fuel-Fired "Once-Through" Boiler,' *The Steam Engineer*, XIII, No. 156 (September 1944), pp. 358–64.

[57] *Genie Civile*, CIII, No. 25 (December 16, 1933).

Ramzin was advantageous, although it required extensive development of heat-resistant steels, high-pressure fittings, and automatic regulating instruments, as it avoided the heavy cost of the drums which for high-pressure use required expensive and complicated steel-working equipment.

Table 6–4 gives the weight of raw material inputs for several types of contemporary boilers and suggests a real savings advantage in terms of material for the Ramzin over the two-drum TKZ and single-drum TKZ, both based on Western designs.[58]

Table 6–4 COMPARATIVE MATERIAL INPUTS FOR VARIOUS SOVIET BOILERS, 1936

Input Material	*Boiler Type* Two-Drum TKZ (Based on Western Design) (tons)	Single-Drum TKZ (Based on Western Design) (tons)	Ramzin 'Once-Through' (Soviet Design) (tons)
Rolled steel	362	232	158
Tubes and headers	139	88	140
Boiler plates	30	16	9.5
Cast iron	26	5	15
Heat-resistant steel	—	—	14
Other materials	33	5	3
Total	590	346	339.5
Steam generating capacity: specific weight per lb./hr.	3.98	2.31	2.21

Source: The Steam Engineer, XIV, No. 167 (August 1945), p. 332.

However, in spite of concentration of design effort in the C.K.K.B. (Central Boiler Design Institute), development of a standard boiler, and introduction of the successful Ramzin 'once-through' boiler, Soviet development achievements by 1945 were limited. The position has been summarized by Paul G. Kaufmann in an article in the August 1945 issue of *The Steam Engineer* and based on Soviet source material: 'With regard to small boilers . . . there is no appreciable development evident in the Soviet technical literature. Nor was there any development in high pressure steam engineering before the war, apart from the introduction of the "once-through" boiler.'[59]

[58] P. G. Kaufmann, 'Development of Steam Boiler Design in Russia,' *The Steam Engineer*, XIV, No. 166 (July 1945), p. 292.

[59] P. G. Kaufmann, 'Development of Steam Boiler Design in Russia—II,' *The Steam Engineer*, XIV, No. 167 (August 1945), p. 333. There is also some evidence that the Soviets had boiler fabrication difficulties; for example, in mid-1938 the Republic Steel Company sold a quantity of welded seamless boiler tubes to the U.S.S.R. (See U.S. State Dept. Decimal File, 861.602/298, Report No. 1446, Moscow Embassy, June 6, 1938.)

CONCLUSIONS

This chapter has examined technical development of two natural fuels and the boilers used to convert fuel into energy.

In petroleum refining we find an extraordinary degree of dependence on American technology right through to 1945. Not only was almost all the Soviet capacity actually built by American firms but, even as late as 1940, duplication of this technology by the Soviets was not successful. This is confirmed by the diplomatic appeal, at the highest levels, to retain a single American engineer—Rasmussen—in the Soviet Union to complete a single cracking plant.

On the other hand, in coal production, also an early recipient of technical assistance, we find Soviet-built equipment in operation. The three U.S. consulting companies had left by 1933, and by 1934–5 Russian mines began receiving Soviet-made equipment—duplicates of foreign equipment already in use, perhaps, but still Soviet-made. By 1942–3 probably half of the equipment in Soviet coal mines had been domestically manufactured to foreign design. There are no signs of indigenous technical advance before 1945.

The third sector—boilers—suggests greater, albeit unsuccessful, technical advance. Although in 1945 there had been no appreciable advances in either small-, medium-, or high-pressure boilers, there had been—in the Ramzin 'once-through' boiler—an example of a purely indigenous Soviet development. This was put into operation but then discarded. It must be presumed that the Ramzin boiler was not used further because Western design effort was more satisfactory.

In brief, the three sectors provide somewhat different conclusions. Although all three were essentially dependent on the West, we find in petroleum refining no indigenous development and in coal mining a degree of success at copying Western equipment but no indigenous development. In the boiler industry we find that the Soviets copied Western designs and also produced an original design, adopted it, and finally discarded it as unusable.

CHAPTER SEVEN

Technical Assistance to the Chemical Combinats[1]

THE Soviet Union, normally secretive about its industrial structure, is unusually secretive concerning development of the chemical and allied industries. This has posed problems in tracing the use of Western technology. Two approaches have been used to help overcome the paucity of accurate data. First, the structure of several large combinats based on comparatively small tsarist plants and expanded between 1930 and 1945 is examined. Second, major chemical processes are examined for the origin of Soviet technology in these combinats. Cross-checking processes against the industrial structure provides additional information.

Construction of chemical combinats was irregular and progress was directly related to Western assistance. For example, the Berezniki combinat had extensive Western assistance and equipment in all units. In full operation by the mid-1930s, it was by 1941 the largest Soviet chemical complex, employing 25,000 persons and producing large quantities of explosives and military chemicals.[2] Similarly, Shostka, where Du Pont built a nitric-acid plant, employed 13,750 by 1936.[3] On the other hand, although much equipment at Bobriki (Stalinogorsk) was imported, greater reliance was placed on Soviet technical cadres and domestically produced duplicates of Western apparatus,

[1] This chapter is based on Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, National Archives Microcopy T 84–122, supplemented by U.S. State Dept. reports from returning engineers, articles in the Western engineering literature, Alcan Hirsch's *Industrialized Russia* (New York: Chemical Catalog Co., 1934), B. S. Blinkov's *Khimicheskaya promyshlennost' SSSR* (Moscow: 1933), and *Bolshaya Sovietskaya Entsiklopediya* (Moscow: 1945).

[2] Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, National Archives Microcopy T 84–122.

[3] *Ibid.*

and progress was very slow. We know that efforts were made in 1931 to build Bobriki on a 24-hour 'crash' basis, but by 1937 only about 1,500 operating workers were employed in the combinat.

The Berezniki-Solikamsk project was by far the largest chemical project attempted between 1930 and 1945. The basic project for Berezniki, a synthetic-ammonia plant, was designed, supervised, and initially operated by the Nitrogen Engineering Corporation of New York under its President, Colonel Frederick Pope. The agreements between Nitrogen Engineering, Du Pont and Westvaco Chlorine and the Soviets are considered below in detail, and the construction of the more important chemical combinats is then examined.

THE NITROGEN ENGINEERING CORPORATION AGREEMENTS OF 1928 AND 1931[4]

The first agreement between Nitrogen Engineering and Khimstroi (Chemical Industry Construction Trust) was signed on November 11, 1928. The main provision covered

> . . . the erection and putting into operation, under NITROGEN'S technical advice and direction, of a plant or plants for producing synthetic ammonia within the territory of U.S.S.R., and the grant to KHIMSTROI by NITROGEN of the right to use within such territory the methods, principles and processes of NITROGEN for the construction and operation of such plants.

The first project under this agreement was a synthetic ammonia plant at Berezniki.

The 1928 agreement was extended and modified by a second contract, dated June 29, 1931. (See Appendix B.) Exhibit C of this 1931 agreement specified in detail the project contribution to be made by Nitrogen Engineering, and was quite similar to specifications contained in other technical-assistance agreements.[5] A project, according to Exhibit C, consisted of two parts: a preliminary and a final section.

The preliminary section was to contain a general plan drawn on a scale of not less than 1:1000, with a 'schematic indication of sewage, steam, water and gas pipes, electric lines, transport lines and sidings.' Drawings for buildings with equipment locations and foundations, economic and technical calculations

[4] A copy of the second (1931) contract is reproduced as Appendix B. The original is in the State Dept. files, together with a memorandum of discussion between Col. Pope and officials at the U.S. Embassy in Moscow in 1934. (See U.S. State Dept. Decimal File, 861.602/259, October 3, 1934. The first page has been removed; otherwise the documents appear to be intact, except for missing appendix containing a list of equipment supplied under the contract.)

[5] For example, the Douglas Aircraft agreement, p. 232.

for the various energy components with variations and calculations of costs and inputs, descriptions of processes (with calculations and methods of estimating energy and heat-power requirements), specifications and cost of equipment, labor requirements, and cost-of-production figures were also required.

The final section required a series of drawings on a scale of 1:50 or 1:100, covering the boiler house, gas plant, conversion plant, compression plant, purification plant, synthesis plant, catalyst plant, and general piping layout; detailed working drawings of the equipment 'of such scale and detail reasonably necessary to enable a first-class shop to manufacture the same'; and, in addition, detail drawings of piping, loads, apparatus, and the electrical layout, as well as detailed calculations concerning economic balance, raw material inputs, heat balance, and design assumptions.[6]

The June 1931 agreement extended this assistance to 1936 and also attempted, according to Colonel Pope, President of the company, to give Nitrogen engineers more protection while working in the Soviet Union. Under the 1931 agreement Vsekhimprom (All-Union Trust for the Chemical Industry) was granted 'in perpetuity' exclusive rights to 'build, extend, operate and transfer' chemical plants for the manufacture of synthetic ammonia according to Nitrogen Engineering (NEC) processes. All NEC patents had to be transferred to the U.S.S.R. for five years. Under Clause IV, consulting, technical, and engineering services were to be provided and NEC was to maintain a staff of engineers in the U.S.S.R., provide drawings and data on improvements, and give assistance in transferring technology. For five years the Soviet Union also had the right to send its engineers into any NEC factory in the United States. Further, NEC had to send 'detailed written instructions for the use of its technical staff in starting and operating the synthetic ammonia plants and all departments thereof constructed by Vsekhimprom.'

Disagreements arose between the Soviets and Nitrogen Engineering, and these were the subject of discussion between Colonel Pope and members of the U.S. Embassy in Moscow in mid-October 1934.[7] Colonel Pope pointed out that in the six years since the first agreement there had been numerous organizational changes in the chemical industry and 'new Soviet officials appear to consider it incumbent upon themselves to criticize the acts of their predecessors.'[8] Difficulties mounted as the Soviets 'began to copy our machines and patented apparatus.'[9] Pope negotiated the second agreement, hoping to alleviate these problems by providing for Swedish arbitration and

[6] See Appendix B.

[7] U.S. State Dept. Decimal File, 861.602/259, October 3, 1934.

[8] *Ibid.*

[9] *Ibid.*

> . . . since the Soviet Government was already copying equipment patented by NITROGEN and adopting various processes worked out by NITROGEN and since, in view of the peculiar nature of Soviet patent laws, no effective steps could be taken to prevent them from so doing, I assented to a provision in this contract which gave the Soviet Government the right to employ the processes of NITROGEN and to use its patents for a period of five years.

By 1934 the Soviets had become obligated to NEC to the extent of $1 million and refused a payment of $60,000 then due. Vsekhimprom 'gave a number of frivolous reasons for its refusal,' and this brought Pope to Moscow, where he was met by yet another board of directors who 'have resorted in their dealings with me to all of those small artifices generally practiced by dealers in second-hand clothes.' Colonel Pope indicated he had no intention to discuss the $60,000 but would refer it to arbitration. Vsekhimprom suggested that arbitration would cost $10,000 and 'I might find it preferable merely to reduce my bill by that amount.' When this was refused it was suggested that NEC give Vsekhimprom 'as a token of goodwill an instrument or two which was difficult to procure in the Soviet Union and which they sorely needed.' A list was drawn up containing $15,000 worth of instruments 'which they insisted should be donated to them by NITROGEN.' Vsekhimprom finally agreed to a donation of $8,000.

The Colonel added that he refused to discuss (with another trust) a further technical-assistance agreement and concluded as follows to the Embassy officials: 'I am disgusted with Soviet business and do not intend to waste my time and ruin my temper in engaging in other transactions with Soviet agencies.'[10]

THE DU PONT NITRIC-ACID CONTRACTS

The Du Pont Company built two nitric-acid plants in the Soviet Union under its 1929 agreement. These were at the Kalinin combinat and at Shostka in the Ukraine. Not very much information about these units is recorded except in reports from two Du Pont engineers after their return from the U.S.S.R.[11] One, J. K. Jenney, worked first at Kalinin and then, from August 1930 to February 1932, at the Shostka installation. His concluding comment was: 'After putting the plants into operation, one was conducted to what promised to be early ruin. The second was operated and maintained excel-

[10] Presumably the Soviets then paid the $60,000 overdue and met another commitment of $60,000 due in June 1935. This tactic of refusing to pay bills while attempting to get something else of value, or reduce the amount owed, was not confined to Nitrogen Engineering. See: Douglas Aircraft, page 235, for another example.

[11] *American Engineers in Russia*, Fisher, Folder 3, Item 22. See also U.S. State Dept. Decimal File, 861.5107—Living Conditions/241, Report No. 240, April 17, 1931, Berlin.

lently.'[12] Jenney also commented that there were no delays in construction because of transportation problems; this coincided with the priority given to chemical industry construction.[13]

Another Du Pont engineer, F. H. McDonald, also worked at both nitric-acid plants but added very little to this except that one unit was of 50-ton and the other of 20-ton capacity. However, McDonald did indicate that the technical director of one unit (not specified) was a Russian about 25 years old who had spent four to five months in the United States, was currently writing books on chemical problems, and, he suggested, had little knowledge of chemical engineering.

In 1932 negotiations were conducted for construction of a gigantic nitric-acid plant with a capacity of 1,000 tons per day, enormous when compared to previous plant capacities of 20 and 40 tons per day. This approximates 350,000 tons annually; 25 years later, in 1957, the largest Du Pont process nitric-acid plant in the United States at Hopewell had an annual capacity of 425,000 tons. Under its earlier contract Du Pont was obliged to supply such technical assistance to the U.S.S.R. for a period of five years and consequently inquired of the State Department whether this plant of 'excessively large capacity'[14] would meet with objection from the U.S. Government.

The State Department position is summarized in a memorandum dated April 6, 1932[15] which reviewed the matter of the export of military shipments to the Soviet Union and concluded that the Department would have no objection to construction of such a large nitric-acid plant.[16]

THE VSEKHIMPROM-WESTVACO CHLORINE PRODUCTS, INC., TECHNICAL-ASSISTANCE AGREEMENT

During the early twentieth century the production of caustic soda by the ammonia-soda process was replaced by a process utilizing the electrolysis of salt brine solution; this process yields chlorine and hydrogen in addition to caustic soda.

In February 1930 a technical-assistance agreement was concluded between Vsekhimprom and Westvaco Chlorine Products, Inc., of Virginia for technical assistance 'in the production of liquid chlorine and the manufacture in the Soviet Union of Vorce chlorine cells for salt brine electrolysis.'[17] The Soviets chose well; the Vorce cell, heart of the electrolytic method, is one of several

12 *American Engineers in Russia*, Fisher, Folder 3, Item 22.
13 *Ibid.*
14 U.S. State Dept. Decimal File, 861.659—DU PONT DE NEMOURS & CO/5.
15 *Ibid.*, 861.659—DU PONT DE NEMOURS & CO/9.
16 *Ibid.*, 861.659—DU PONT DE NEMOURS & CO/9 to /11. See also chap. 15.
17 Amtorg, *op. cit.*, V, No. 5 (March 1, 1930), p. 81.

methods of producing chlorine and caustic soda by electrolysis. The Vorce design, however, is compact, efficient, simple, and accessible, and utilizes strong, inexpensive construction of steel and cement with inexpensive anodes.[18]

The agreement provided for use of Westvaco patents on the Vorce cell. American engineers were sent to the U.S.S.R. and Soviet engineers studied cell production methods at Westvaco plants. It was anticipated that 'the first chlorine plant of the several to be constructed in the U.S.S.R. is to be completed in about six months.'[19]

THE BEREZNIKI-SOLIKAMSK CHEMICAL COMBINAT

The major construction effort in the chemical industry between 1930 and 1945, and also the focal point of the Nitrogen Engineering and other technical-assistance agreements, was this chemical combine, located behind the Urals comprising 10 integrated units and requiring an expenditure in excess of 100 million rubles.

The raw materials for the Berezniki complex came in part from the extensive Solikamsk potash deposits. These were the largest potash mines in the world, with a capacity some two and one half times that of the largest German mine. They were developed by the German firm Deilmann Bergbau und Tiefbau in the late 1920s.[20] In partial operation by September 1931, the Solikamsk mines were completely mechanized, to a great extent with Demag A-G equipment.[21] Coal was obtained from the Kisel fields to the south.

The site for the chemical combinat itself (to the south of Solikamsk) was the Luibimoff-Solvay soda plant, built in 1883. To this early enterprise were added plants to produce intermediate products—chlorine, synthetic ammonia, nitric acid, catalysts, and finally fertilizers and explosives. Power was supplied from a power station of 80,000 kilowatts' capacity, itself requiring an expenditure of 60 million rubles.[22] The water reservoir supplied 26,000 cubic meters per hour—twice the quantity supplied to the city of Moscow.[23]

Construction of the Berezniki chemical complex got under way in fall of 1929. By May 1930 foundations were completed, and in the fall of 1930 the walls of the first units were up. As will be seen in table 7–1, construction of this complex was a completely Western undertaking. The basic unit was a

[18] C. L. Mantell, *Industrial Electrochemistry* (New York: McGraw-Hill, 1950, third ed.), pp. 430–6.

[19] Amtorg, *op. cit.*, V, No. 5 (March 1, 1930), p. 81.

[20] Sutton, *Western Technology . . ., 1917 to 1930*, pp. 215–7. Also see Amtorg, *op. cit.*, VI, No. 18 (September 13, 1931), p. 145.

[21] Amtorg, *op. cit.*, IX, No. 11 (October 1934), p. 233.

[22] *Ibid.*, VII, No. 3 (February 1, 1932), p. 57.

[23] *La Vie Economique des Soviets*, VII, No. 143 (October 5, 1931).

Table 7–1 WESTERN TECHNICAL ASSISTANCE TO THE BEREZNIKI-SOLIKAMSK COMPLEX

Product or Production Unit	*Source of Technology or Construction*
Soda	Tsarist Luibimoff-Solvay process
Chlorine	Westvaco Chlorine Products, Inc.
Synthetic ammonia	Nitrogen Engineering Corp., under supervision of Col. Pope
Catalyst	Nitrogen Engineering Corp., under supervision of C. O. Brown
Nitric acid	Du Pont (not confirmed)
Boiler house for complex	German and U.K. boilers
Gas generator plant	Power-Gas Corp., Ltd. (United Kingdom)
Caustic soda II	Westvaco Chlorine Products, Inc.
Caustic soda III	Siemens-Billiter
Sulfuric acid	Petersen (tower system)

Sources: U.S. State Dept. Decimal File, 861.5017—Living Conditions/653, May 10, 1933; and 861.602/259, October 3, 1934.
U.S.S.R. in Construction, No. 5, 1932.
Alcan Hirsh, *Industrialized Russia* (New York: Chemical Catalog Co., 1934).

synthetic-ammonia plant built by Nitrogen Engineering. The 90-ton-per-day plant was designed, erected, and put into operation under Colonel Pope. The catalyst plant was designed, erected, and put into operation by the same company under supervision of Dr. C. O. Brown. Most of the ammonia was shipped to Perm for fertilizer and explosive manufacture; the balance was retained at Berezniki for the manufacture of nitric acid and ammonium nitrate. The nitric-acid unit, with a capacity of about 75 tons per day, was probably built according to Du Pont designs, while the ammonium-nitrate plant had a capacity of about 20 to 25 tons per day. The sulfuric-acid department, using the 'latest type of tower system' process was the first of the new units, opening in December 1932.

THE BOBRIKI CHEMICAL COMBINAT

The Bobriki (Stalinogorsk) chemical combinat was established 200 kilometers south of Moscow and comprised a group of plants somewhat similar to those at Berezniki, but larger and more varied in chemical production.[24]

The history of its construction is intriguing. Excavation was under way on a 'crash' basis in 1931; later that year a Linde oxygen process plant was in operation, and imported equipment for a silicate-ceramics plant and gas-generator station had been assembled.[25] In 1933 work was started on a

[24] U.S. State Dept. Decimal File, 861.5017—Living Conditions/653, Riga, May 10, 1933, Interview with Atherton Hastings, employed by Vsekhimstroi.

[25] Amtorg, *op. cit.*, VII, No. 3 (February 1, 1932), p. 65.

synthetic-ammonia plant and on units for production of nitrogenous fertilizers, sulfuric acid, nitric acid, and sodium nitrate.[26] In January 1934 it was indicated that the turbines would soon be in operation, and in September the synthetic methanol plant—the first in the U.S.S.R.—was reported in operation.[27]

However, troubles were reported by several sources.[28] The Oberkommando der Wehrmacht also records that in 1937 less than 2,000 workers were employed at Stalinogorsk: less than 10 percent of the Berezniki employment figure.[29] From this low employment figure and the paucity of output statistics it is inferred that Soviet construction organizations ran into considerable trouble after the erection of imported equipment or parts copied from foreign models in the Stalinogorsk chemical equipment manufacturing department.

The feature distinguishing Bobriki from Berezniki is that the former depended far more (although by no means completely) on Soviet technical resources than Berezniki, and was probably intended as a training ground for chemical construction and operating technicians.

Table 7–2 WESTERN TECHNICAL ASSISTANCE TO THE BOBRIKI (STALINOGORSK) CHEMICAL COMBINAT

Product	*Western Technology*
Synthetic ammonia	Nitrogen Engineering Corp.
Nitric acid	Most equipment from Germany and U.K.; some U.S. Probably assembled by Soviet organizations.
Sulfuric acid	Most equipment from Germany and U.K.; some U.S. Probably assembled by Soviet organizations.
Nitrogen fertilizers	Most equipment from Germany and U.K.; some U.S. Probably assembled by Soviet organizations.
Silicate ceramics	Foreign equipment assembled by Soviets.
Methanol	Probably Hastings (U.S.) design.
Chlorine	Westvaco Chlorine Products design; possibly Soviet-manufactured.
Oxygen	Linde process.
Chemical equipment manufacturing plant	Equipped with German, American, and English machinery.
Power station	Origin probably Western; assembled by Soviet organizations.

Sources: See text.

[26] *Ibid.*, IX, No. 1 (January 1934), p. 18.

[27] *Ibid.*, No. 11 (November 1934), p. 241.

[28] Alcan Hirsch, *op. cit.*, and U.S. State Dept. Decimal File, 861.5017—Living Conditions/653. Interview with Atherton Hastings, employed by Vsekhimstroi.

[29] Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, National Archives Microcopy T 84–122.

Atherton Hastings, who worked at both combinats in the early 1930s, makes the point that although mistakes were made in construction and operation of Bobriki, great progress was made by learning from experience and the plant was producing a nucleus of chemical industry workers.

Another distinguishing feature of Bobriki was its chemical equipment manufacturing plant, the first in the U.S.S.R., for construction of heavy chemical machinery. This, according to Hastings, was efficient: 'It is equipped with German, American and English machinery and constructs heavy machinery not only for Bobriki plant but for all Russian chemical plants. . . .'[30]

Most of the equipment for Bobriki was, however, imported. For example, in reference to the gas generator station, Amtorg comments: 'The assembling of the equipment for the station was accomplished by Soviet engineers and workers alone.'[31] The same article also makes reference to 'assembling' the ceramic plant. If the equipment had been *manufactured* in the Soviet Union, it is almost certain that reference would have been made to this point.

This observation is confirmed by Alcan Hirsch, Chief Consulting Engineer to the chemical industry in the early 1930s, who states: 'Some of the equipment at Stalinogorsk has been imported from the United States, but most of it came from Germany and England.'[32]

THE KALININ CHEMICAL COMBINAT[33]

The Kalinin chemical combinat was based on the prerevolutionary Raspiapino lime and sulfuric-acid plants. The Tenteleev-process sulfuric-acid plant was entirely rebuilt, expanded, and fitted with new equipment. With the addition of Gay-Lussac and Glover tower units, it produced 40,000 tons per year, including fuming acid, by 1944.[34]

The synthetic-ammonia plant bought from Casale in Italy[35] utilized a water-gas process with a capacity of 16,500 short tons of nitrogen per year. There was also some direct American engineering assistance to the combinat, as it was reported in 1938 that an American engineer had been employed there since 1935.[36]

[30] U.S. State Dept. Decimal File, 861.5017—Living Conditions/653, Riga, May 10, 1933, Interview with Atherton Hastings, employed by Vsekhimstroi.

[31] Amtorg, *op. cit.*, VII, No. 3 (February 1, 1932), p. 65.

[32] Alcan Hirsch, *op. cit.*, p. 85.

[33] Formerly Raspiapino, also called Dzherzhinsky or Chernoreznitsky at Nizhni-Novgorod (Gorki).

[34] Wirtschaftsgruppe Chemische Industrie, *Die Schwefelsäureindustrie in der Sowjet-Union*, January 1944, National Archives Microcopy T 84–122–1421980.

[35] Sutton, *Western Technology . . ., 1917 to 1930*, p. 214.

[36] U.S. State Dept. Decimal File, 861.659—CHEMICALS/10, Report No. 883 from Moscow Embassy, January 21, 1938.

At Karakliss, in Armenia, a plant was finished in October 1931 to produce 10,000 tons of cyanamide a year, and later, when power was received from the new Leninakhan power station, output was raised to 20,000 tons of cyanamides and 4,000 tons of carbonates, with oxygen as a by-product. The complex was built with technical assistance from the Swedish company Stockholms Superfosfat Fabriks Aktiebolaget.[37]

Table 7–3 WESTERN TECHNICAL ASSISTANCE TO THE KALININ CHEMICAL COMBINAT

Plant	*Origin*
Lime plant	Tsarist plant
Sulfuric acid	Tsarist plant; Russian Tenteleev process plus Western tower units (Gay-Lussac and Glover)
Synthetic ammonia	Casale (Italy)
Nitric acid	Du Pont design and supervision with German equipment
Chlorine	Westvaco Chlorine Products (probable)
Calcium carbide	Stockholms Superfosfat Fabriks Aktiebolaget
Cyanamide	Stockholms Superfosfat Fabriks Aktiebolaget
Liquid oxygen	Linde process
Superphosphate	Stockholms Superfosfat Fabriks Aktiebolaget

Sources: V. I. Ipatieff, *Life of a Chemist* (Stanford: Stanford University Press, 1946), p. 413.
Die Chemische Fabrik, No. 9, (1928), p. 107.
Amtorg, *op. cit.*, 1930–3.
Vneshtorgizdat, *Economic Conditions in the U.S.S.R.* (Moscow: 1931), p. 22.

At Konstantinovka a chemical complex was built based on roaster gases from the zinc smelter. The sulfuric-acid plant comprised a Tenteleev contact system[38] and a tower system with a capacity of 25,000 tons. Arsenic was also produced. The superphosphate plant at Konstantinovka was started in 1927, but for some unknown reason construction was delayed for two years and probably completed sometime in the mid-1930s.[39]

One apparent exception to the rule of heavy Western assistance was the tsarist Moscow plant of Dorogomilov; five departments were added to the original unit and 'all formulae for the chemicals produced were developed by Soviet specialists, the construction work was supervised entirely by Soviet engineers, and over 90 per cent of the equipment installed was produced in Soviet plants.'[40] The plant probably used prisoner engineers and certainly produced poison gases.[41]

37 Vneshtorgizdat, *Economic Conditions in the U.S.S.R.* (Moscow: 1931), p. 22.
38 *Die Chemische Fabrik*, II, No. 25 (June 19, 1929), p. 304.
39 Amtorg, *op. cit.*, IV, No. 10 (May 15, 1929), p. 202.
40 *Ibid.*, VII, No. 1 (January 1, 1932), p. 20.
41 V. I. Ipatieff, *Life of a Chemist* (Stanford: Stanford University Press, 1946).

The Gorlovka coke-chemical combinat was the first coke by-product plant to be put into operation. The first part, Ordzhonikidze Works I, consisted of two batteries of coke ovens (14½ tons capacity per oven) built by Koppers A-G, and equipment to produce by-products (benzol, sulfate, and tar) from the gas. Coal was supplied from several old coal mines and one modern mine known as '8-bis,' which delivered coal right into the coal-washing plant. The latter was built by a German company and was the first coal-washing plant in the Soviet Union.[42]

The Soviets then added Works II, comprising another two coke-oven batteries with by-products departments. It was a copy of the first installation, and in this book is called 'Soviet Koppers.' Simultaneously a complete synthetic-ammonia plant using the Fauser process was built to use the H_2 in the coke-oven gas and nitrogen from the air to make NH_3. Sulfuric-acid and nitric-acid plants laid the base for combining the NH_3 in the manufacture of either fertilizer or explosives. The synthetic-ammonia and related plants were put into operation in 1935 and demolished in 1941 at the time of the German invasion.[43]

We have accurate data on the Magnitogorsk by-product coke-chemical plant, as John Scott (now Senior Editor of TIME magazine) was in 1935–6 operator of the Magnitogorsk benzol department.[44] The by-product coke-oven installation, the largest in Europe, was a Koppers-Becker system installed by the Koppers A-G, although, as Scott points out, the design was developed partly by the McKee Corporation and several Soviet organizations. As finally built it was not nearly as large as originally planned. No departments came into production before the mid-1930s.

In 1936 the plant consisted of a condensation department with four German exhausters and a sulfate department with three imported saturators giving a maximum of 60 tons of ammonium sulfate per day. The benzol department had four stills producing 60 tons a day and a benzol rectification unit (opened in 1936) producing benzol, tuluol, and naphthalene. As John Scott says, 'All pumps and most of the apparatus of the benzol department were imported.'

Another combinat in Moscow was the Voskressensk, of which the sulfuric-acid plant (the largest in the world) had an annual capacity of 160,000 tons with possible expansion to 240,000 tons per year. The Benker-Milberg system was used[45] for production of phosphates and superphosphates.[46] Much of the

[42] *American Engineers in Russia*, Folder 4, No. 16.
[43] *Fortune*, October 1949, p. 117.
[44] John Scott, *op. cit.*, p. 155.
[45] *Die Chemische Fabrik*, 1928, p. 454. The mechanical furnace section was the Nichols Engineering and Research Corp. design, called VKhZ and manufactured and widely distributed in the U.S.S.R. [*Bolshaya Sovietskaya Entsiklopediya* (Moscow: 1945), LI, col. 14.]
[46] Hirsch, *op. cit.*, p. 83.

equipment was bought from Germany.[47]

The Grozny Chemical Combinat No. 22 had a butanol-acetone plant, utilizing an adaptation of the Weizmann fermentation process,[48] and a synthetic methanol plant, probably designed by Hastings.

Thus an examination of the Soviet chemical combinats built between 1930 and 1941 suggests a great amount of Western design assistance and equipment at locations of earlier tsarist enterprises. No evidence of significant practical Soviet contribution to chemical engineering is found in this period.[49]

TECHNOLOGY IN ALKALI PRODUCTION

Alkalis form the basis of many other chemical products; production of soda ash (sodium carbonate) and of caustic soda (sodium hydroxide), with or without chlorine as a by-product, are the most important sectors.

Table 7–4 METHODS OF ALKALI PRODUCTION IN THE SOVIET UNION, 1930–44

Plant	*Process Used*	*Capacity (Tons per Day)*	*Note*
SODA ASH			
Donsoda[1]	Solvay	270	Restarted February 1944[2]
Slaviansk[2]			
Old plant	Henningman	50	Restarted February 1944[2]
New Plant I	Solvay	210	Open 1937–41, restarted November 1946[2]
New Plant II	Solvay	210	
Berezniki[1]	Solvay	90	Expansion of old plant (1890?)
Karabugaz[2]	Le Blanc	150	Expansion of old plant (1897)
Zapadonosibirsk[1]	Le Blanc	100	Expansion of Luibimoff-Solvay works (1898)
CAUSTIC SODA			
Donsoda[1]	'Levig' (Löwig)		
Slaviansk	Wet lime		
Berezniki	'Levig' (Löwig)		

Sources: [1] B. S. Blinkov, *Khimicheskaya promyshlennost' SSSR* (Moscow: 1933), p. 196.
[2] G. E. Lury, *50 let sovetskaya khimicheskaya nauka i promyshlennost'* (Moscow: 1967), pp. 158–62.

[47] *Die Chemische Fabrik*, 1931, pp. 2–38.

[48] Hirsch, *op. cit.*, p. 86.

[49] See chap. 18. Under the technical-assistance contract with the French firm Société Electrométallurgique de Montricher, nine furnaces were installed at Donoi-Postroi (each of 10,000-kilowatt capacity) to produce calcium carbide according to the Miguet system. Three copies of these furnaces were later built by the Soviets and installed in Leningrad. The 10,000-kilowatt capacity was the largest economical size for this process and gave the Soviets an estimated 250,000-ton capacity for the production of calcium carbide. W. G. McBurney, *et al.*, *German Carbide, Cyanamide and Cyanide Industry*, C.I.O.S. Report No. XXVII-92, p. 28.

Soda ash was produced in three plants in tsarist Russia, using the Solvay and Henningman processes. In the 1930s these plants were re-equipped and considerably expanded, and two new Le Blanc plants were added at Karabugaz and Zapadonosibirsk. (See table 7–4.) The process used at the Le Blanc plants is of interest. The Le Blanc soda process, although never used in the United States is historically most important. It was succeeded in about 1870 by the Solvay ammonia-soda process in Europe as well as Russia. However, in the new Soviet plants a return was made to the Le Blanc process,[50] which was no longer in use elsewhere in the world.

In caustic-soda manufacture we find the same use of an obsolete process. The Löwig process, originating in nineteenth-century Germany and not used in the West in the twentieth century, was the process selected for caustic-soda plants.[51]

THE RUSSIAN TENTELEEV PROCESS FOR SULFURIC-ACID PRODUCTION

The Soviet Union does not offer, even 50 years after the Revolution, an example of an indigenous technology utilized on a world-wide basis. However, tsarist Russia does offer an excellent example: the Tenteleev contact process for production of sulfuric acid. Developed in the Tenteleev St. Petersburg works (now called the Krasnyi Khimik), it was used in more than half the sulfuric-acid plants of prerevolutionary Russia, patented in Russia and throughout the West, and used in a number of Western countries.

Of the more than 40 Russian sulfuric-acid plants in existence before 1917, over 20 units utilized the Tenteleev process,[52] while the others used the Grillo-Schroder and Mannheim systems. In 1913 the Tenteleev process was used in the United States (by the Boston-Merrimac Chemical Company in

[50] B. S. Blinkov, *op. cit.*, p. 202. Whether the explanation lies in factor resource patterns occurring in Russia and not elsewhere, faulty planning decisions, or a static technology has not been explored. The writer hopes to re-examine this problem in a later study.

It should be noted that the use of a long-established process is not, of itself, an indication of inefficiency, at least in the chemical industry. There are many examples in the West in which an old process has been improved, redesigned or adapted to take advantage of new equipment, and so has competed successfully with newer methods. For example, in the acid-pickling process for removing scale from steel, the only change in centuries has been in the design of larger continuous units and improved equipment; the basic principle remains the same.

[51] M. B. Zelikin, *Proizvodstvo kauticheskoi sody khimicheskimi sposobami* (Moscow: Goskhimizdat, 1961), p. 14.

[52] An excellent summary of the Russian sulfuric-acid industry in 1917 is given in *Chemical and Metallurgical Engineering*, XXX (1924), pp. 384–8. The position in 1944 is described in Wirtschaftsgruppe Chemische Industrie, *Die Schwefelsäureindustrie in der Sowjet-Union*, January 1944, National Archives Microcopy T 84–122–1421980.

New York and by the General Chemical Company), Germany (by Dynamite Nobel in Hamburg), and the United Kingdom (by the Dynamite Trust in London), as well as in other Western countries. In all, 24 Tenteleev units were at work in Germany, Rumania, Sweden, the United States, and Japan at the end of 1911.[53]

By 1945 the Soviet sulfuric-acid industry was operating either on tsarist processes or standard Western processes. Reference to *Bolshaya Sovietskaya Entsiklopediya* for 1945 supports this statement. Seven pages are devoted to a discussion of sulfuric-acid production. Standard Western equipment (the Nichols-Herreshoff mechanical furnaces—called VKhZ designs—at Voskressensk[54] and the Lurgi revolving furnace) and standard chamber, tower, and contact methods are indicated on the diagrams. The contact method described in most detail is the German Herreshoff-Bauer method.

THE CHAMBER PROCESS FOR PRODUCING SULFURIC ACID

This process utilizes Glover towers, used throughout the world since 1859, to concentrate acid and remove nitrogen oxides. Gay-Lussac towers, also utilized, are arranged in series to recover nitrogen oxides from the spent gases.

Figure 7–1 SOVIET CHAMBER SYSTEM FOR MANUFACTURE OF SULFURIC ACID, 1945

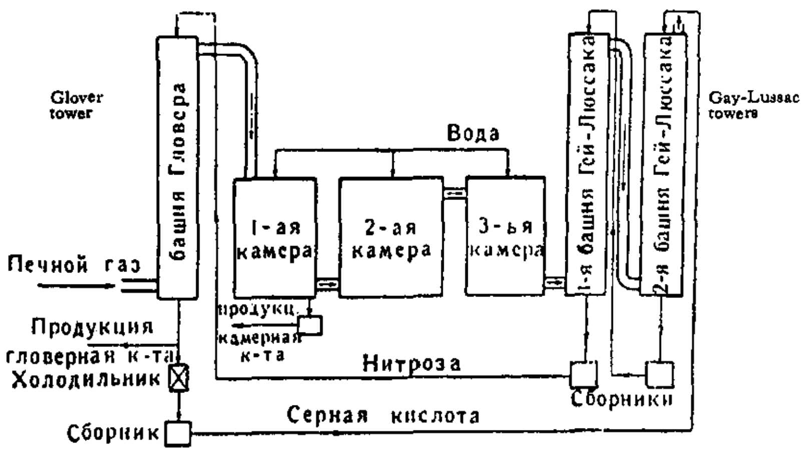


Diagram of Chamber System

Source: Bolshaya Sovietskaya Entsiklopediya (Moscow: 1945), LI, col. 18.

[53] George Lunge, *The Manufacture of Sulphuric Acid and Alkali*, I, Part iii (London: Gurney & Jackson, 1913), p. 1359.

[54] See *Bolshaya Sovietskaya Entsiklopediya* (Moscow, 1945), pp. 7–14.

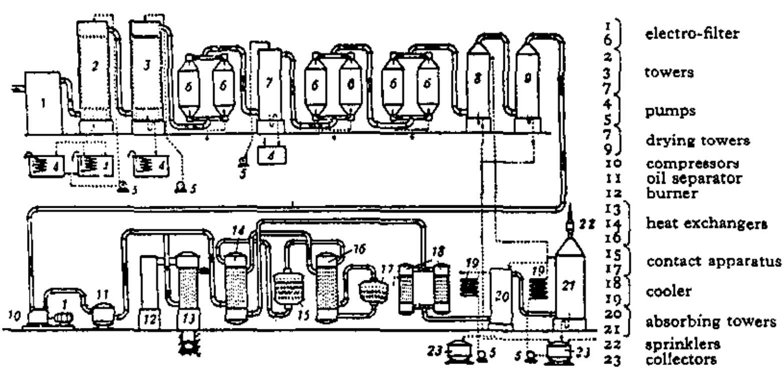
They are similar to Glover towers but taller and of smaller diameter. The many variations of this process in use throughout the world include Mills-Packard, Gaillard-Parrish, Opl, Petersen, and Kachkaroff-Guareschi (French).

This method was utilized in the U.S.S.R. between 1930 and 1945 in its varying forms, including the Gaillard-Parrish for two units in the Urals[55] and the Petersen at a large new plant at the Krasnyi Khimik in Leningrad.[56] In 1944 more than one-fifth of all sulfuric acid was being made by some variation of this chamber process.[57]

THE CONTACT PROCESS FOR THE MANUFACTURE OF SULFURIC ACID

Two basic processes used in Russia have been sulfur-burning contact system for converting SO_2 to SO_3 and for the manufacture of sulfuric acid based on utilization of roaster gases from metallurgical plants and coupled with use of towers. It is reported that in 1937 about 8 percent of Soviet sulfuric acid was obtained from the roaster gases of metallurgical plants,[58] leaving a balance of about 70 percent (allowing 20 percent for chamber processes) produced by contact processes using sulfur and pyrites.

Figure 7–2 SOVIET HERRESHOFF-BAUER CONTACT SYSTEM FOR SULFURIC ACID PRODUCTION, 1945



Source: Bolshaya Sovietskaya Entsiklopediya (Moscow: 1945), LI, col. 22.

[55] *Chemical and Metallurgical Engineering*, CXXXVII, No. 8 (August 1930), p. 472.

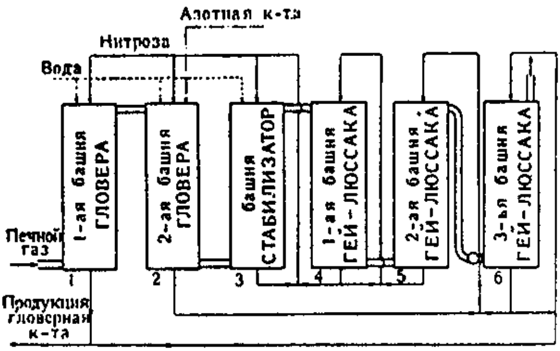
[56] *Die Chemische Fabrik*, II, No. 40 (October 2, 1929) p. 442.

[57] Calculated from Wirtschaftsgruppe Chemische Industrie. This is a minimum; incomplete data prevents more accurate calculation.

[58] *Chemical Age*, July 28, 1945, p. 81. These figures are very approximate and are subject to revision.

Units for production of sulfuric acid from roaster gases were located at the Ridder lead-zinc smelter (using an adapted Glover process), in several Herreshoff-Bauer systems, at a Lurgi plant at Baku, and in the Benker-Milberg system at the Moskhimkombinat, and in other similar systems.

Figure 7–3 SOVIET SIX-TOWER SYSTEM



Tower 1—Glover
Tower 2—Glover
Tower 3—Stabilizer
Tower 4—Gay-Lussac
Tower 5—Gay-Lussac
Tower 6—Gay-Lussac

Source: Bolshaya Sovietskaya Entsiklopediya (Moscow: 1945), LI, col. 19.

PRODUCTION OF CHEMICALS FOR MILITARY USE[59]

The large production of explosives and 'war chemicals' in the Soviet Union at this time supports the argument that the nation had a war-oriented economy. Oberkommando der Wehrmacht Intelligence listed 52 chemical plants, including many old, small units manufacturing explosives and allied chemicals in 1936–9 for war use. The largest of these plants was the Okhtinsky chemical combinat in Leningrad, employing 14,000 workers in 1938, with the Du Pont-built plant at Shostka following closely with approximately 13,750 employees in 1936. The Nitrogen-Engineering-designed complex at Berezniki employed 25,000 workers in 1937 and manufactured thermit, powder, and nitroglycerin. In aggregate the Soviets probably had a quarter of a million workers in plants producing explosives and war chemicals in the years 1936–8.[60] The larger of these plants had been built by Western companies nominally for the manufacture of fertilizers; but conversion to explosives is a comparatively

[59] Based on Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, National Archives Microcopy T 84, Roll 122, Frames 1421291–6, Pulver und Sprengstoffwerke.

[60] Based on figures for the 24 works where employment was known; figures for the remaining 28 works are not given.

straightforward procedure, and the facts were suspected by the companies involved and the State Department.[61]

The Olgin chemical works in Moscow was fully equipped for production of poison gases during World War I. After the Revolution it was shut down until 1928, when it was re-equipped with imported German Hoffer compressors and an autoclave for high-pressure experiments, together with other equipment for gas production.[62] The plant was then operated by prisoner engineers, including Kravets, head of the Glavkhim planning department, at least until 1941 for the production of arsenic and cyanide compounds.[63]

Several sources reported great interest in poison gases and noted that absolute priority had been given to production of arsenic, an ingredient of poison gas. One excellent source is E. G. Brown, a metallurgical engineer and the only foreigner employed in the Tsvetmetzoloto laboratories which made analyses of ore specimens and designed reduction processes. The Soviet chemists made the analyses and Brown determined the reduction process to be used. He reported that every effort was made to increase the production of arsenic. For example, in the case of complex ores (containing, for instance, lead-silver and arsenic) he was ordered to design a plant to free the maximum amount of arsenic even if that meant losing other by-products.[64]

TECHNICAL ASSISTANCE FOR MINOR CHEMICAL AND PHARMACEUTICAL PRODUCTION

Chemical products required only in comparatively small quantities also received foreign assistance.

An ultramarine plant was built in Rostov with a capacity of 1,000 tons per year, utilizing foreign equipment and technical assistance.[65] A carbon disulfide plant with a seven-ton-per-day capacity was built by the Berlin firm of Zahn, utilizing the company's patents.[66] In 1930 the major British chemical producer, Imperial Chemical Industries, Ltd., agreed to sell 30 million rubles worth of chemicals to the Soviet Union on a credit basis; 'the agreement also provided for technical-assistance to the Soviet chemical industry in the

[61] U.S. State Dept. Decimal File, 861.659—DU PONT DE NEMOURS & CO./5, Du Pont to Secretary of State Stimson, February 19, 1932, which states: '. . . while we have no knowledge of the purpose of the proposed plant, yet the excessively large capacity contemplated leads us to believe that the purpose may be a military one.'

[62] Ipatieff, *op. cit.*, pp. 469, 487.

[63] Oberkommando der Wehrmacht, *op. cit.*, Plant No. 321.

[64] U.S. State Dept. Decimal File, 861.5017—Living Conditions/415, Riga, January 19, 1932. In a similar report, Steffenson indicated the emphasis on arsenic.

[65] *Die Chemische Fabrik*, II, No. 25 (June 19, 1929), p. 304.

[66] *Ibid.*, II, No. 42 (October 16, 1929), p. 461.

production of commodities manufactured by the British concern. . . .'[67] It was reported by Amtorg in the same year that 'several technical-assistance agreements have been concluded with large French construction firms, especially for the building of chemical enterprises. . . .'[68]

Technical assistance was also provided by I. G. Farben[69] and other German firms: Dürkopp-Werke, Charlottenburger Wasser und Industriewerke and Lenz. American firms providing technical assistance included Parke, Davis in pharmaceuticals, Moren and Company, and Chain-Belt;[70] also under contract were the Dutch firm Electro and the French firm Cellulose de Bourges.[71] H. D. Gibbs (U.S.) furnished plans and supervised the installation and initial operation of a small chemical plant in 1934 to manufacture phthalic anhydride, aluminum chloride, and antraquinone.[72]

CONCLUSIONS

The largest production complex (Berezniki) and the most important technologies (synthetic-ammonia, nitric-acid, and, to a lesser extent, sulfuric-acid and alkali production) originated in the West. Reproduction of foreign equipment for part of the Bobriki combine was coupled with imports but does not appear to have been immediately successful, although it no doubt provided useful training for technical cadres.

Findings on the Soviet chemical industry suggest that a great effort has been made to withhold details of this development from the outside world. This was essentially a military sector which reflected intense Soviet interest in chemical warfare and military preparations in general. The combination of technical backwardness and military necessity ensured that great efforts would be made to obscure both the development of individual plants and the processes utilized. However, despite military pressures, by 1945 the Soviet chemical industries provided no examples of indigenous Soviet technology.

67 Amtorg, *op. cit.*, V, No. 11 (June 1, 1930), p. 226.
68 *Ibid.*, V, No. 12 (June 30, 1930), p. 226.
69 *Ibid.*, III, No. 19 (October 1, 1928) pp. 331–2.
70 *Die Chemische Fabrik*, II, 1929, p. 47.
71 *Ibid.*
72 *American Engineers in Russia*, Fisher, Folder 1, Letter from Gibbs to Fisher.

CHAPTER EIGHT

Technical Assistance to the Coke-Oven, Synthetic-Rubber, Cement, Alcohol, and Wood-Distillation Sectors

KOPPERS-BECKER DESIGNS IN THE COKE-CHEMICAL INDUSTRY

COKE, derived from coking-quality coals, is an essential input for metallurgical industries. Russian coking capacity in the mid-1920s consisted chiefly of tsarist-era French and Belgian Coppe and Piette ovens; there were no modern vertical pusher ovens (also known as by-product ovens) of the Koppers or Koppers-Becker type which enabled by-products of the coking process to be utilized for chemical production. The United States had developed several types of efficient by-product ovens: the Wilputte, Hemet-Solvay, Cambria, and Simon-Carves, but by the 1920s Koppers and Koppers-Becker had the dominant position and their ovens were being installed in three-quarters of new plants in the United States. These designs were adopted by the Soviet Union. Almost all iron and steel plants built between 1928 and 1932, including the gigantic Magnitogorsk and Kuznetsk complexes, received imported Koppers-built by-product vertical pusher ovens; plants built since 1932 have used either 'Soviet Koppers' or 'NKVD Koppers' systems.

A complete list of these coke-chemical plants was compiled by merging data given in *Fortune* of October 1949 by Louis Ernst, a former engineer at Soviet coke-chemical plants (he lists 27 plants in operation in 1941 and others under construction by the NKVD), with data from the OKW files (which contain a list, dated March 1941, of 25 plants, some of which do not appear on the Ernst list.)[1]

'Soviet Koppers' designs are defined by Ernst in the *Fortune* article as 'built under Soviet supervision, according to Soviet design based on Koppers

[1] Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, National Archives Microcopy T 84–122–1421229.

original designs with equipment partly imported, partly increasingly manufactured by Soviet factories.' The NKVD Koppers designs were Soviet Koppers ovens produced and installed under NKVD supervision by forced labor. These ovens were usually also operated by the NKVD using forced labor.

CONSTRUCTION OF COKE-OVEN BATTERIES AT MAGNITOGORSK AND KUZNETSK

The largest coke-oven and by-products installation built in the period 1930–45 was at the Magnitogorsk iron and steel complex. This plant was planned to contain eight batteries, each consisting of 69 ovens, with a late-1931 completion date. The Koppers Corporation of Pittsburgh won the contract for installation and at the end of 1930 sent 16 American engineers, together with a number of German Koppers A-G engineers, to Magnitogorsk. Only one battery of 61 ovens was completed by late 1931; another was completed in mid-1932, and two others in 1933. By November 1932 only one American and five or six German Koppers engineers were left at the Magnitogorsk coke plant.

Louis Gerhardt, the Koppers Chief Construction Engineer in the U.S.S.R., has described the organization of the construction effort and the utilization of foreign engineers and their place in coke-oven construction. Gerhardt was in charge of Koppers construction and had four American construction engineers working directly under him. Each American was teamed with one Soviet engineer and two Russian foremen. Each foreman supervised four subforemen, each of whom in turn supervised a gang of about 30 to 50 laborers.[2]

The greater part of the machinery and piping, and 13,000 tons of firebrick, came from Germany. Special castings came from the United States. Only the structural steel work was manufactured in the Soviet Union.

Although Magnitogorsk was initially projected to have eight batteries of Becker ovens, all with Koppers by-product recovery plants, and a four-battery complex was erected by Koppers under its technical-aid contract, only the original four batteries were in operation in 1945. The remaining four batteries planned were not built.

The Koppers engineers were very pessimistic about the future of the batteries constructed. They were designed to last 20 years, but it was considered doubtful that they would last four to five years, owing to inefficient operation by unskilled labor. Louis Gerhardt mentioned to a State Department

[2] U.S. State Dept. Decimal File, 861.5017—Living Conditions/569.

official that the ovens were already about '12 years old' after operating only a few months.

The chemical plant, based on coke-oven by-products, was allowed to lag in construction. It has been described by John Scott as 'shoddily projected but [having] a fairly good condensation department with four German exhausters.'[3] The sulfate department went into operation in 1935 and had three saturators producing 60 tons daily of ammonium sulfate. The benzol department, with four imported stills, went into operation in 1936, producing 60 tons daily of tar, benzol, tuluol, naphthalene, and other chemical products.[4]

The coke-oven batteries at the Kuznetsk iron and steel plant, the second giant of 'socialist construction,' were erected by French engineers working for Distocoque S.A. (the Koppers French licensee). They designed two batteries, each with fifty-five 17-inch ovens of the Koppers type.[5] About 20 French engineers under Chief Engineer Louis completed the first battery by March 1932 and put it into operation. At this point continuing friction between the French and Russian engineers came to a head, and sometime later in March, 'after a heated interview with the administration, Chief Engineer Louis returned to the foreign engineers' quarters, gathered together all the plans for the coking plant, and burnt them in the stove.'[6] The French engineers were ordered to leave and the second battery was completed by the Soviets with assistance from German engineers.[7]

CHANGES IN COKE-OVEN TECHNOLOGY

The technological structure of Soviet coke ovens changed completely between 1928 and 1947. In 1928 more than one-half of Russian coke was produced in tsarist-era ovens with little chemical by-products capacity. The balance of the capacity was German- and French-built, on Koppers, Otto, and Distocoque systems. During the period from 1928 to 1932, a decision was made to standardize on the basis of the Koppers system. By 1932 tsarist ovens accounted for less than one quarter of an output which had more than doubled (3.2 to 7.1 million tons). The balance of the capacity was split between Soviet Koppers ovens and Koppers systems imported and installed by the American, German, and French Koppers companies.

[3] Scott, *op. cit.*, p. 154.

[4] *Ibid.*

[5] U.S. State Dept. Decimal File, 861.5017—Living Conditions/434, March 4, 1932, interview with Aaron J. Winetz, coke oven engineer at Kuznetsk.

[6] U.S. State Dept. Decimal File, 861.5017—Living Conditions/454, Report No. 291, Riga Consulate, April 22, 1932, p. 8, interview with T. A. Hoffmeyer, Freyn Co. construction engineer at Kuznetsk.

[7] U.S. State Dept. Decimal File, 861.5017—Living Conditions/434, March 4, 1932.

By 1940 coke output had again tripled—to 23 million tons, of which more than 60 percent was now produced from Soviet Koppers ovens. The tsarist ovens were closed down and no systems were built after 1933 by foreign construction companies. Also by 1940 the NKVD was building Koppers ovens in more remote northern regions, using forced labor. The German invasion of the Ukraine in 1941 temporarily changed this pattern, but in 1947 almost 60 percent of the output was again being produced in Soviet Koppers systems. In addition, there was a significant increase in NKVD Koppers capacity.

We may therefore conclude that in the 20 years from 1928 to 1947 the Soviets increased coke-oven capacity by a factor of eight and replaced the small-scale prewar ovens almost completely with Koppers systems at first imported (as at Magnitogorsk and Kuznetsk) and then duplicated and built in the Soviet Union.

COKE-OVEN BY-PRODUCT TECHNOLOGY AND THE KOPPERS CORPORATION

The Soviet claim that 'in the years of Soviet power, the Soviet Union developed a new technique of coking through its own efforts'[8] does not stand up under investigation. As we have seen, there was a significant increase in coke-oven capacity, and an even more significant increase in chemical by-products capacity between 1928 and World War II, but both were wholly based on Koppers technology transferred to the Soviet Union.

It is also suggested by the Soviets that 'the experience which was acquired in the process of rebuilding and redesigning old plants was not sufficient for the construction of new plants on a high engineering level,' and that 'the coke-chemical industry which developed in the period of the First Five-Year Plan was on an engineering level which exceeded that of Europe.'[9] Soviet coke capacity was based on Koppers designs and built by Koppers until such time as the Soviets could duplicate the Koppers system in their own machine-building plants at Kramatorsk and Slaviansk and later at Orsk.'[10]

This combination of imported Koppers systems and domestic duplication to a single standardized design enabled the Soviets to acquire a large coking capacity in a short space of time. From 1931 to 1946 the standard Soviet coke oven was the 17-inch Koppers. Apart from one experimental design (the PVR-39, with paired vertical valves and recycling of combustion products)

[8] 'Koksokhimicheskaya promyshlennost' SSSR,' in *Metallurgiya SSSR (1917–1957)*, ed. I. P. Bardin (Moscow: 1957), p. 77.

[9] *Ibid.*

[10] See chap. 9 for U.S. assistance in the machine-building industry. See also I. L. Nepomnyashchii, *Koksovye mashiny, ikh konstruktsii i raschety* (Moscow: 1963).

tried at the Kharkov Coke-Chemical Plant in 1940, no attempt at indigenous innovation can be traced. Other types (Evans-Cope, Becker, and Otto) were purchased and installed but not standardized. By 1945 the Soviets had added very little of technical value, if anything, to this transfer; their whole effort had been spent on mastering and reproducing the most effective of foreign designs. The significant rates of growth in the coke industry[11] are explainable in terms of this transfer.

DANISH AND GERMAN EQUIPMENT IN THE CEMENT INDUSTRY

By 1929 all 31 of the tsarist-era cement plants were back in production (after being re-equipped with imported machinery) and were able to produce 13 million barrels of cement that year. All these plants had been expanded and modernized by several German firms and one Danish firm (F. L. Smidth and Company A/S of Copenhagen); the largest project was at Novorossisk in the Caucasus and had been undertaken by Friedrich-Krupp Grusonwerk A-G and designed to produce 400,000 tons of cement a year.[12] Also in 1929 a technical-assistance agreement was concluded with the American firm of

Table 8–1 ORIGIN OF CEMENT PLANTS IN THE SOVIET UNION, 1938

Revolving kilns		*Shaft kilns* *Ordinary*		*Shaft kilns* *Automatic*		*Total of all types*
Manufacturer	*No.*	*Manufacturer*	*No.*	*Manufacturer*	*No.*	
Allis-Chalmers	1	Candlo	5	Graber	1	225 foreign*
Amme-Gieseke	7	Dietch	34	Krupp	10	
Feollner	1	Schneider	73	Lundstedt	12	
Krupp	5			Tiele	1	
Miag	4					
Pfeiffer	12					
Polysius	13					
Smidth	46					
Russian	21					21 domestic
Total	110		112		24	246

Source: I. Ershler and S. Stoliarov, 'The Cement Industry in the U.S.S.R.,' *Pit and Quarry*, XXX, No. 8 (February 1938), pp. 61–4.

* Percentage of foreign installations (based on 246 known makes, not including 24 periodic kilns of unknown origin): 91.5 percent.

[11] G. Warren Nutter, *The Growth of Industrial Production in the Soviet Union* (Princeton: Princeton University Press, 1962), p. 96. The average annual growth rate in the coke industry for the period 1928–55 is given as 9.1 percent.

[12] *Die Chemische Fabrik*, I, No. 44 (October 31, 1928), p. 640.

MacDonald,[13] and between 1930 and World War II some 16 large Portland Cement plants were added. Table 8–1 summarizes the origin of Soviet kilns (the most important components of a cement plant)—in use in 1938.

In 1927 the Soviets organized a bureau for design and construction of cement plants and from about 1930 onwards some basic equipment (kilns, mills, crushers, etc.) was built in the U.S.S.R., probably at the Leningrad Shipbuilding Works.[14] By 1938 some 21 kilns (of a total of 246, or 8.5 percent) were of Soviet construction to foreign design. Almost 50 percent of the revolving kilns were built by one Danish company—Smidth, manufacturers of the Unidan and Unax designs.[15] However, even the 21 mills built by Soviet organizations contained a great amount of imported equipment. Table 8–2 illustrates this for the Novo Spassk, the largest cement plant in the U.S.S.R. in 1938–9.

It is unlikely that, during the period under consideration, the Soviets availed themselves of the latest advances in American cement technology. This conclusion is gleaned from an article by one of the hired engineering consultants, who, after pointing out that the expectation of American cement engineers going to the Soviet Union had been that recent improvements in equipment would be adopted, was surprised to find an 'extreme conservatism' evident in all designs finally accepted for building.[16]

> The American engineers were closely questioned on all improvements in machinery and process, but very few of these new developments were incorporated into the plants actually built. The tendency to follow the older European types of design was very strong. On the high councils many of those who enjoyed authority showed a practical familiarity with this older type of cement plant and expressed extreme doubt as to the practicability of adopting modern American designs.[17]

The writer then pointed out that American engineers' plans were criticized in 'great detail' by these councils and changed many times, and that foreign engineers were expected to have 'great masses of detail' to prove every design point.

This argument regarding the negligible transfer of American technique is supported by the data in tables 8–1 and 8–2. In 1938 Soviet kilns were dependent on European, rather than American, design. Further, an article by two Soviet engineers,[18] while confirming that only 21 of the 110 revolving kilns

[13] *Ibid.*, II, No. 47 (November 20, 1929), p. 501.
[14] Amtorg, *op. cit.*, V, No. 18–19 (October 1, 1930), p. 373.
[15] See table 8–3.
[16] 'Facts about Russian Cement Plants Told by American Engineers,' *Concrete*, XXXIX, No. 5 (November 1931), pp. 53–5.
[17] *Ibid.*
[18] *Pit and Quarry*, February 1938, p. 61.

in 1938 were built in the Soviet Union, limited its claims concerning the Soviet-built kilns to the following statement: 'Several large new factories have been equipped mainly with equipment made in the country.'[19] Nowhere do the Soviet engineers claim provision of a cement mill with all Soviet-built equipment.

On the other hand, the Soviet cement mill design bureau was in 1938 undertaking design work for cement plants and mill equipment for delivery to Turkey, Iran, and the Mongolian People's Republic. The rationale behind constructing cement plants for export while importing equipment for domestic cement plants lies in the relative quality of imported versus domestic equipment. Soviet-built equipment was acceptable, even if less efficient, in barter deals with underdeveloped areas. It also provided a training ground for mill construction. The mistakes fell elsewhere, and at the same time provided an acceptable propaganda package: the U.S.S.R. exports cement mills and *therefore* has the ability to supply its own cement mill requirements.

Table 8–2 ORIGIN OF EQUIPMENT AT THE NOVO SPASSK CEMENT PLANT, 1938

Department	*Equipment Item*	*Soviet-Made, to Foreign Designs*	*Foreign-Made (Firm)*
Limestone Crushing Dept.			
	Preliminary crusher	—	Smidth A/S
	Hammer mill	—	Smidth A/S
Clay-Crushing Dept.			
	Toothed roll crusher	—	Smidth A/S
Raw Material Storage			
	Traveling crane	—	Babcock & Wilcox
Raw Materials Drying Dept.			
	Limestone driers*	Soviet-made	—
	Pulverized coal burners*	—	Peabody
	Pumps	—	Fuller-Kinyon
Raw Materials Grinding Dept.			
	4-compartment mills*	—	Smidth A/S
	Dish plate feeders*	—	Smidth A/S
	Speed-reducers (in mills)*	—	Wuelfel
	3-compartment mills*	Soviet-made	—
	Filters	—	Beta
Mixing Silos Dept.			
	Pumps*	—	Fuller-Kinyon (made by Claudius Peters)
	Filters*	—	Beta
Rotary Kiln Dept.			
	Kilns and coolers*	Soviet-made	—
	Speed-reducers*	—	Wuelfel
	Pumps	—	Fuller-Kinyon
Clinker Storage			
	Traveling crane	—	Babcock & Wilcox

[19] *Ibid.*, p. 64.

Table 8–2 (Continued)

Department	*Equipment Item*	*Soviet-Made, to Foreign Designs*	*Foreign-Made (Firm)*
Cement Mill House	4-compartment mills*	—	Unidan (Smidth)
	Plate feeders*	—	Smidth A/S
	Speed-reducers*	—	Wuelfel
	3-compartment mill	Soviet-made	—
	Pumps*	—	Fuller-Kinyon
Gypsum Storage	Tubular drier	Soviet-made	—
Fuel Preparation Plant	Roll crushers*	Soviet-made	—
	Tubular driers*	Soviet-made	—
	Pumps*	—	Fuller-Kinyon
	2-compartment mills*	—	Smidth A/S
	Plate feeders*	—	Smidth A/S
	Coal mills*	Soviet-made	—
Central Compression Plant	2-stage vertical compressors*	—	Five-Lille (France)
	Pumps*	—	Fuller-Kinyon
Power Plant	3,000-kilowatt steam turbines*	Soviet-made	—
	3,300-volt alternators*	Soviet-made	—
	Vertical Garbe boiler	Soviet-made	—
	Pulverized fuel furnace	—	Babcock & Wilcox
	2 boilers (750 square meters each)	Soviet-made	—

Source: Pit and Quarry, October 1938, pp. 55–64.
* Exact number unknown.

SOVIET DEVELOPMENT OF SYNTHETIC RUBBER

The Soviets can rightfully claim indigenous progress in development and initial production of synthetic rubber. The Russian chemist I. I. Ostromislensky worked on synthetic rubbers before the Revolution and in 1915 announced the first organic vulcanizing agents: symmetrical trinitrobenzene, m-dinitrobenzene, and benzoyl peroxide, as well as several agents not using elemental sulphur. Butadiene was produced in Russia in 1915 according to Ostromislensky's method, using a catalytic process starting from ethyl alcohol. Although Ostromislensky later went to work for the U.S. Rubber Company, his work was continued in the Soviet Union by B. V. Buizov, who in 1921 announced the vulcanizing properties of diazoaminobenzene, and by S. V. Lebedev, who in 1928 developed a process for producing butadiene from alcohol 'using a catalyst of magnesium hydroxide, with small proportions of kaolin and hydrous silica and much smaller proportions of iron, titanium and zinc oxides at a temperature of about 385°C.'[20] This pioneering Russian work was preceded only by an English patent (No. 24,790 of 1910) using sodium as the

[20] Harry L. Fisher, *Chemistry of Natural and Synthetic Rubbers* (New York: Reinhold, 1957), p. 85.

catalytic polymerizing agent in production of butadiene synthetic rubber and by a small German production effort using similar methods during World War I.

Commercial production and marketing of synthetic rubber began in 1929 with Thiokol in the U.S.; by 1940 there were a dozen synthetic rubbers in production in the United States and Germany, in addition to Lebedev's SKB, the sodium-butadiene type, in the Soviet Union.[21] During the 1930s the Soviets made some progress with SKB. Production time was halved, and in 1935 'rodless' polymerization was achieved by using disseminated sodium in large trays; by 1939 production reached 90,000 tons per year. However, Soviet synthetic rubber had a low tensile strength of only about 2,000 psi, compared to 4,500 psi for natural rubber and 4,000 psi for Neoprene (the Du Pont chlorophrene synthetic introduced in 1931). In the United States synthetic rubbers with low tensile strengths of this order, such as the U.S. Rubber Company Type AXF, were not introduced onto the market.

Table 8–3 SOVIET SYNTHETIC RUBBER PRODUCTION, 1939 AND 1945

1939: Types Produced		*1945: Types Produced*
1. SKB in three plants (butadiene polymerized with metallic sodium): tsarist research plus Soviet development		1. SKB 2. Resinit (Thiokol)
2. Resinit (Thiokol polysulphide elastomers): U.S. development	Supplied under Lend-Lease	3. Du Pont Neoprene (Sovprene): 2 plants, 40,000 tons each (polymerization of acetylene) 4. Houdry butadiene method: 1 plant, 40,000 tons 5. Houdry catalyst plant 6. Dow Chemical Styrene plant

Capacity at 1939		*Capacity at 1945*	
SKB	90,000 tons	SKB	90,000 tons
Resinit	Very small	Neoprene (Sovprene)	80,000 tons
		Houdry	40,000 tons
		Dow	(?)
		Total	210,000 tons (plus)

Sources: U.S. State Dept., *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945).
George Racey Jordan, *From Major Jordan's Diaries* (New York: Harcourt, Brace and Co. 1952), pp. 138–9.

[21] However, even this Soviet product was developed with U.S. technical assistance. In 1930 a Soviet rubber delegation went to the United States; Soviet rubber engineers were sent for training, three 'foreign specialists' were employed by Resinotrest (Rubber Trust), and four contracts for technical assistance were made with U.S. firms. See *Za Industrializatsiiu*, February 22, 1930.

Thus in 1941–2, when the U.S.S.R. was in urgent need of high-tensile strength synthetic rubber for military purposes, domestic production was small, of mediocre quality, and lacking in the oil-resistant and light-resistant qualities necessary for military use. Only two types were being produced: the original SKB (sodium butadiene) and Resinit (the Soviet version of the Thiokol product, made from ethylene chloride and sodium tetrasulfide).

The Soviet rubber position at 1941 is therefore interesting. The Russians had done early work of great significance on synthetic rubbers, and Ostromislensky's research had certainly placed Russia at least on a par with Western countries during World War I, and perhaps even ahead in theoretical work. This development work was successfully continued in the Soviet Union by his associates and finally led to the sodium-butadiene type, SKB. Thus at the end of the 1920s there had been little Western influence on Soviet synthetic rubber development apart from the usual exchange of theoretical knowledge among scientists. A plant was subsequently built on the basis of this internally generated research and by 1939 was successfully producing 90,000 tons a year. However, there was no technological progress from the original butadiene concept except in the slight improvement of manufacturing methods. While Germany produced and abandoned the numbered Bunas (85 and 115) and the U.S. brought out and replaced a dozen synthetic rubbers with varying properties, the Soviets stayed with SKB plus the adopted Thiokol product, Resinit.

The Baruch Committee on Russia recommended during World War II that the United States investigate Soviet experience with Buna rubbers. In the final analysis very little information was forthcoming and the results of this attempted exchange were slow and disappointing. It was found that the Soviets were producing only the original Buna-S (butadiene polymerized by sodium) and had no experience with improved Buna-S or emulsion polymerization methods. However, the Office of Rubber Administration did send a special mission headed by Ernest W. Pittman, President of the Inter-Chemical Company, to the Soviet Union. There is, in the State Department files, an interesting memorandum of conversation in which Colonel Dewey, Deputy Rubber Director, commented on this attempted exchange of information.[22] As synthetic rubber was the only sector in which the Soviets had undertaken technological development on their own on the bases of extensive tsarist-era research, it is worth quoting:

[22] Dept. of State, Memorandum of Conversation, 861.645/17, April 1, 1943. Participants were: Col. Dewey, Deputy Rubber Director; Dr. Gilliland, Assistant Deputy Rubber Director; Major General Wesson, Office of Lend-Lease Administration; Mr. John Hazard, Office of Lend-Lease Administration; Mr. Dean Acheson, Assistant Secretary of State; and Mr. Loy Henderson, Assistant Chief, Division of European Affairs.

In response to a suggestion which had been made last year by the Soviet authorities for an exchange of information with regard to the manufacture of rubber, the Office of Rubber Administration had sent to the Soviet Union a mission composed of four of the outstanding experts in the United States on the production of rubber. These men spent six weeks before their departure collecting data relating to American manufacturing processes to take with them. They left the United States in December 1943. When they arrived in Moscow they called immediately upon the appropriate Soviet authorities and had a discussion with them regarding the scope and method of the exchange of information. The Soviet authorities apparently were pleased at the ideas expressed by the members of the mission during this discussion and suggested that these ideas be reduced to writing.

Dr. Pittman, the Chief of the American mission, assisted by the other three members, thereupon prepared a proposal outlining the method of exchange of information and the scope of the exchange. This proposal was handed in the latter part of January to the appropriate Soviet authorities in the form of a letter. No reply to this letter was ever received. The Soviet authorities proceeded for a period of more than two months, however, to engage in sporadic conversation relating to the rubber industry and on two occasions went so far as to take the mission through rubber producing plants. The information which they furnished the mission was of too superficial a character to be of any practical use, and the members of the mission were hurried through the plants at such a fast pace that they derived no technical benefit from their visit.

In the meantime the Soviet Government sent a committee of highly qualified rubber experts to the United States in order to obtain information regarding American processes of rubber manufacture. This commission arrived a number of weeks ago. In view of the manner in which the American rubber mission was being treated, Colonel Dewey gave orders that no information of any practical value should be given to it until he had assurances that the American mission was being given information of value or until the return to the United States of the American mission. The Soviet Government now proposes, Mr. Dewey continues, in a letter to Mr. Stettinius that a formal agreement be drawn up providing for the exchange between the United States and the U.S.S.R. of information with regard to rubber. This proposal was of a more far reaching nature than that made by Mr. Pittman in January. It provided that the Soviet Government should furnish certain technical information to the American Government; that the American Government would furnish technical information to the Soviet Government not only regarding the processes with regard to which Mr. Pittman had suggested an exchange but also with regard to other processes which were in various stages of development in the United States; that for a period of several years the American Government should furnish the Soviet Government full details regarding any new processes or improvements in processes for manufacturing rubber which might be worked out; that the American Government should furnish the Soviet Government with machinery and technical personnel

> to enable it to build during 1943 and 1944 large rubber producing factories in the Soviet Union.
>
> Colonel Dewey said that a good deal of the information which the Soviet Government demanded could not possibly be put to practical use during the war; that the Russians were asking for some extremely complicated, technical secrets of American manufacturers the utilization of which would require elaborate machinery and equipment which could not be manufactured during the war period without interfering with other important war production; that it would be impossible to set up and begin operating plants containing such machinery and equipment during war time; that, furthermore, the production of this equipment and the explanation of its use to the Soviet authorities would require much time of numerous American technicians whose services are urgently required in the war production field.

On balance then, the Soviets gained far more than the United States in the World War II technical exchange in synthetic rubber, although this was the single area where the Soviets were presumed to be more advanced.

Gaps in Soviet synthetic rubber-manufacturing facilities were filled by Lend-Lease. Two complete plants were acquired for the manufacture of Neoprene by polymerization of acetylene, with a capacity of 40,000 tons each per year.[23] The U.S. also shipped a Houdry-method butadiene plant, a Houdry catalyst plant, and a Dow Chemical Company styrene plant. Table 8–3 summarizes this acquisition of U.S. synthetic rubber manufacturing facilities by the Soviet Union. The Du Pont Company, at the request of the State Department, supplied its Neoprenc process, as well as two plants,[24] to the Soviet Union with the right to use patents and processes. Russian engineers visited Du Pont plants and were granted access to technical data. Du Pont engineers erected the plants in the Soviet Union.[25]

Several agreements to transfer allied U.S. technologies were negotiated with the assistance of the State Department. One agreement was with the Standard Oil Company for a process producing synthetic ethyl alcohol from petroleum gases. The Standard Oil agreement gave the Soviets special advantages (apart from designs, specifications, and operating instructions); for example, an inspection party was allowed to inspect the Baton Rouge plant. At first the party, headed by P. S. Makeev, was denied entrance on security grounds, but inspection was later allowed.[26]

[23] Now called Narit, in the U.S.S.R.

[24] *New York Times*, July 3, 1944, p. 24, col. 3.

[25] *Ibid.* Very large shipments of Lend-Lease synthetic rubbers confirm the shortages. Some \$36 million worth of manufactured rubber goods, 1½ million pounds of synthetic rubber, and more than \$115 million worth of tire casings, as well as camelback and rubber cements, were shipped. (Jordan, *op. cit.*, pp. 158–9.)

[26] Frank A. Howard, *Buna Rubber* (New York: Von Nostrand, 1947), p. 241.

RECLAIMED RUBBER TECHNOLOGY[27]

In the early 1930s the proportion of reclaimed rubber to total consumption was about one-half and increasing. Thus reclaim processing was as important as original manufacture. Up to 1932 there were two tsarist plants in Moscow and Leningrad processing reclaim from rubber footwear by the acid process. The Leningrad plant was reconstructed during the First Five-Year Plan and supplemented by a new and much larger plant at Yaroslavl which produced 23 tons of reclaim per day from rubber tires by the alkali process.

The technology used in the new Yaroslavl plant was completely American, and used equipment made in the United States and in the United Kingdom to American design. It was the equal of the most modern plants under construction and the technology was significantly in advance of current European practice. The grinding operation, for example, utilized a 2.5- to 4-ton capacity chopper 'used at the best American plants but little known in Europe, though its capacity is very considerable.'[28] The devulcanizing room was of American layout, using two Louisville presses and three Sargent conveyor dryers. The washing process utilized Anderson moisture-expellers. The recuperating unit utilized a Dorr thickener and an Oliver vacuum filter. The mill room was of American layout but much of the equipment was supplied by the United Kingdom.[29]

CARBON BLACK MANUFACTURE

Carbon black is an important raw material in the manufacture of tires, about five pounds being required for each 10 pounds of synthetic rubber. The Soviets acquired carbon-black technology from three sources before 1945. First, a small, crude plant to manufacture carbon black from gas was designed and built by the Marietta Manufacturing Company in 1930. Then during World War II Soviet engineers acquired a good deal of technical information from United States plants. After World War II the Soviets took as reparations the largest of the German plants manufacturing carbon black from crude anthracene residue.[30]

E. B. BADGER WOOD-DISTILLATION AND CONTINUOUS ALCOHOL UNITS

Two specialized plants for production of chemicals from wood products were erected by the E. B. Badger and Sons Company of Boston. In 1931–2

[27] Partly based on M. I. Farberov and V. N. Komarov, 'Russia's Reclaiming Process,' *The India-Rubber Journal*, CLXXXVII, June 23, 1934.

[28] *Ibid.*, p. 699.

[29] *Ibid.* See p. 699, for details of these units.

[30] U.S. Senate Foreign Relations Committee, *East-West Trade* (Washington, D.C.: November 1964), p. 51.

the Nadezhdinsk and the Ashinsky plants, near Sverdlovsk, were entirely designed by the Badger Company, and according to Alcan Hirsch, Chief Chemical Consultant to the Soviet Union 'closely resemble[d] the great plant they built for the Ford Motor Co. at Iron Mountain, Michigan.'[31] These were the most modern wood-distillation units and, as the Soviets have claimed, the largest in the world outside the United States. They produced 80 percent glacial acetic acid and C. P. Methanol grade wood alcohol, both using Badger Company processes. Alcan Hirsch described the equipment of the Ashinsky as follows:

> The still house is equipped with the latest type triple effect evaporators; acetic acid fractionating and concentrating apparatus, and wood alcohol and methyl-acetone refining equipment of the most modern, continuous type. The equipment is provided with heat exchangers and automatic temperature, pressure and flow regulators, and with the latest type controls and accessories for continuous production.

After stating that it was designed with emphasis on economy, Hirsch added that 'upward of a million dollars was spent on equipment being imported from this country.'[32]

In December 1935 a further agreement was made under which E. B. Badger and Sons agreed to build three complete continuous 97-percent alcohol-distillation and refining units, three complete 99.8-percent anhydrous alcohol units, three complete benzol-refining units, and three 'calandria for heating crude alcohol.'[33] These were completed in 1937 and 1938. The Soviets obviously continued to lag in alcohol technology in 1941, as in that year the Kellogg Corporation advised Amtorg that it was unable to supply an ethyl alcohol plant.[34]

CONCLUSIONS

This chapter has considered eight major chemical or allied industries.

The development of coke ovens—particularly by-product coke ovens—was based wholly on Koppers and Koppers-Becker designs, at first built by the Koppers Corporation or its licensees and then gradually by the Soviets themselves.

[31] Hirsch, *op. cit.*, p. 82. For a description of the Ford Iron Mountain wood-distillation plant, see W. G. Nelson, 'Waste-Wood Distillation by the Badger-Stafford Process,' *Industrial and Engineering Chemistry*, XXII, No. 4 (April 1930), pp. 312–5. The process was 'a radical departure from established procedure' and the plant was 'probably the cleanest wood distillation plant in the world.' A pilot plant had been built in 1924 after extensive investigation. The Soviets were able to acquire the Badger-Stafford process within one to two years after the Ford Motor Co.

[32] Hirsch, *op. cit.*, p. 83.

[33] U.S. State Dept. Decimal File, 861.602/284, Report No. 2209, Moscow Embassy, January 16, 1937.

[34] U.S. State Dept. Decimal File, 861.659/17, January 16, 1941.

The cement industry was almost completely of European origin; 91.5 percent of the kilns operating in 1938 were of foreign manufacture—chiefly Danish. Those of Soviet manufacture contained a great amount of foreign equipment and were built to foreign design.

Synthetic rubber is of considerable interest as the Soviets started with an initial advantage in the form of tsarist research. SKB rubber was a purely Soviet development, but by World War II Soviet development had slipped behind Western development and this necessitated imports of Neoprene, Houdry, and Styrene processes and equipment for manufacture of special rubbers. Reclaimed rubber technology was wholly American and carbon-black technology was American and German in origin.

Wood-distillation plants were built by E. B. Badger and Sons of the U.S. in 1931–2, and the same company built three continuous alcohol-distillation units in 1936–7.

Thus in these major chemical industries, seven technologies (coke-chemicals, carbon black, cement, high-tensile-strength synthetic rubber, reclaimed rubber, wood distillation, and alcohol distillation) were transferred from the West with no indigenous Soviet development. The eighth technology, synthetic rubber from butadiene, was one in which the Soviets had an initial research advantage; however, the Soviet industry did not develop as rapidly as that in capitalist countries, and in 1941 technology for more advanced synthetic rubbers was imported under the Lend-Lease program.

CHAPTER NINE

Technical Assistance to the Machine Building and Allied Industries[1]

Two plants, Uralmash and Kramatorsk, were of major significance in Soviet development between 1933 and 1945. These plants built machinery for heavy industry, including the iron and steel and non-ferrous smelting and rolling sectors. Both were equipped with the finest obtainable Western equipment and produced standard adaptations of Western designs, enabling multiple production of heavy equipment and machinery of known and reliable capability without investment in research and development.

The key to Soviet development is mass production for capital industries of heavy equipment (furnaces, kilns, compressors, etc.) of a standard type based on a proven Western design. This principle has three essential components: first, flow or multiple-unit rather than single-unit production; second, standardization to avoid the cost of customizing for a particular location and market; and third, avoidance of research and development costs by adaptation of a proven design.

EXPANSION OF THE FITZNER & HAMPNER MACHINE-BUILDING PLANT AT KRAMATORSK

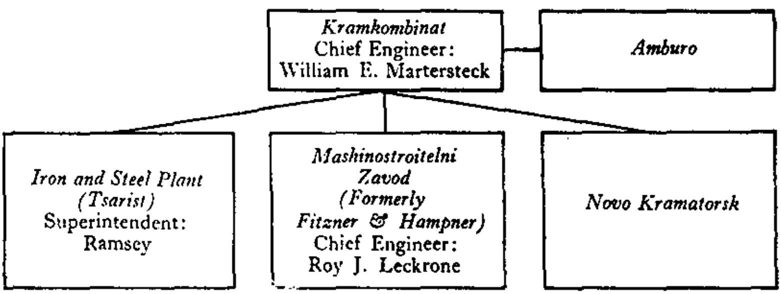
The Fitzner & Hampner plant founded in 1896 at Kramatorsk, about 225 kilometers southeast of Kharkov, manufactured general mining and metallurgical equipment (including cranes, ladles, and slag cars), using iron and steel products made in four small blast furnaces and rolled in mills associated with

[1] Sources for this chapter include the U.S. State Dept. Decimal File; Oberkommando der Wehrmacht records in the National Archives; articles in the U.S. trade press for the machine tool industry; L. A. Aisenshtadt's *Ocherki po istorii stankostroeniya SSSR* (Moscow: 1957); and an informative article by Joseph Gwyer, 'Soviet Machine Tools,' in *Ordnance*, November–December 1958. For a different argument, see David Granick, *Soviet Metal-Fabricating and Economic Development* (Madison: University of Wisconsin, 1967). Granick's study is based wholly on Soviet source material.

the plant. This plant was little used by the Soviets until the early 1930s. Then enormous capital investments in the newly formed Kramatorsky combine (Kramkombinat) turned the old plant into the largest machine-building unit in the Soviet Union, with three main sections: the original iron and steel mills at Kramatorsk, the Fitzner & Hampner machine works (both considerably expanded with new imported equipment), and a gigantic new enterprise, Novo Kramatorsk, far larger than the early plant. The latter was opened in sections beginning in 1931.

The first new unit of Novo Kramatorsk was a steel construction shop to manufacture structural steel work for the Dniepr Dam and the Magnitogorsk and Kuznetsk iron and steel plants. A large forge shop followed, 'equipped with modern machinery imported from abroad and partly produced in Soviet factories'[2] to produce forgings of up to one and a half tons. In addition there were two iron foundries: one of 27,700 square meters for large and medium castings and one of 17,000 square meters for small castings. A 60,000-square-meter steel foundry—the largest in Europe—was added. It was supplied by four open-hearth and four electric furnaces.

Figure 9–1 STRUCTURE OF KRAMKOMBINAT, 1930–2



Source: Construction from data in U.S. State Dept. Decimal File, 861.5017—Living Conditions/568, /553.

Later extensions comprised three mechanical shops (A, B, C). Shop A produced rolling-mill equipment; Shop B blast-furnace equipment, open-hearth furnaces, and coke ovens; and Shop C vacuum drums, cylinders, generator shafts, pinions, and turbine rotors. More than 600 machines of the finest Western make were installed in these three shops. The first group of departments opened in 1932. By August 1934 the plant had 13 large departments operating. The balance came into operation by 1936–7.

[2] *U.S.S.R. in Construction*, No. 7 (July 1932). The Soviet machines were the simplest types of lathes and drilling machines, as the machine-tool plants were not producing modern units. All the heavy presses and forges were imported.

Technical assistance supplied to Kramkombinat began on an informal basis; i.e., it was unrelated to specific Western firms, and comprised groups of both American and German engineering designers and specialists. After 1936 it was supplied by contract with United Engineering and Foundry, and possibly by Demag A-G.

The American contribution began with a conversation sometime in 1929 between Meshlauk (in charge of heavy industry) and William Martersteck, a member of the Freyn Engineering Company staff in the U.S.S.R. Martersteck was an experienced steel-rolling-mill designer and suggested to Meshlauk that the Soviet Union should make its own rolling-mill equipment rather than import it. It was suggested that this would provide training for Soviet engineers and in any event help solve the eventual problem of repairing imported equipment. Meshlauk was impressed. He sent Martersteck back to the United States, where, independently of the Freyn Corporation, he gathered a party of 20 U.S. engineers and designers. They returned in December 1930 to the Kramatorsk plant.[3]

Martersteck was Chief Engineer of a group consisting of five machine-shop designers, three foundry experts, one pattern-shop expert, one open-hearth expert, one expeditor for the planning department, two crane designers, five steel-mill machinery designers, and one steel-mill operator. All were employed on a two-year contract payable in U.S. dollars plus rubles. Total wages for the group were $14,350 and 10,600 rubles per month.

After several months spent working on small projects, the group was requested to design a rolling mill: the standard blooming mill later produced at Kramatorsk. In February 1932, concurrently with Soviet financial difficulties, the group was informed that the contract would be terminated March 1, 1932 and replaced with another contract employing only Martersteck, seven designers, and Ramsey, the steel-mill operator—with a 50 percent pay cut. One of the crane designers refused and returned to the U.S.[4] By the end of 1933 only one designer, Puttman, remained in the Soviet Union.

The Martersteck group formed, for about 18 months, a mill-design bureau. Individual American and German engineers were also employed in both the

[3] U.S. State Dept. Decimal File, 861.5017—Living Conditions/568, Riga Consulate, November 22, 1932, interview with Karl E. Martersteck (his son); and 861.5017/553, Riga Consulate Report No. 892, November 4, 1932, interview with Miriam Martersteck, Russian wife of Karl.

[4] As the group had a two-year contract, this was a clear breach of contract by the Soviets. A somewhat harsher view is given in a letter written by E. G. Puttman, a blooming-mill specialist. Puttman says that half the group was dismissed on 'trumped-up charges' and a month later the others had their dollar allowances cut. After bargaining for 5 months, Puttman was given the Soviet terms: accept or face termination. He accepted and a simple rider covering the changes was added to the contract. He was unable to obtain a copy of this 'voluntary agreement.' (See U.S. State Dept. Decimal File, 861.602/254.)

old and new Kramatorsk plants. The Chief Engineer of Mashinostroitelni Zavod was Roy J. Leckrone,[5] who reported that 26,000 Russian workers were fabricating steel for the Dniepr Dam and making iron and steel plant machinery and 400 gun limbers.

Although Martersteck and Leckrone stayed on until 1933, most American designers and engineers left at the time of the valuta crisis and were replaced with Germans—some 500 at Kramatorsk alone—willing to work for rubles without foreign currency.[6]

The machine-shop equipment at Kramatorsk was evidently British and German. Sir Walter Citrine, General Secretary of the Trades Union Congress of Great Britain, reported in 1936 after a lengthy tour of Kramatorsk, 'I saw many machines by English makers, amongst them Craven, Asquith, Herbert, Igranic and Richards, and these and German machines dominated the shops. . . .'[7]

In 1936 the United Engineering and Foundry Company of Pittsburgh signed an agreement with the Soviet Union to design, construct, and install both hot and cold steel-strip mills. These reflected the very latest in American steel technology. Such wide-strip mills were essential for production of automobile body sheets. The contract included special designs in millimeter measurements and technical assistance to the Kramatorsk works to build such mills. Soviet engineer P. Perepelitsa spent two years in the United States at United Engineering plants and American engineers in turn worked at the Kramatorsk plant. On his return to the U.S.S.R. in 1937, Perepelitsa wrote an objective comparison of work at the United plants and at Kramatorsk[8] and quite clearly had greatly benefited from his lengthy exposure to American production methods.

Preparations for installing the strip mill in the U.S.S.R. were supervised at Kramatorsk by T. W. Jenkins,[9] who summarized the Russian engineering position at that time as follows: 'Soviet engineers are not yet able to execute American blueprints which require great precision and . . . the lack of highly skilled workmen for the execution of such work is a great handicap to Soviet plants.'[10] Even casting for the strip mills required skilled workmen from

[5] U.S. State Dept. Decimal File, 861.5017—Living Conditions/542, Istanbul Consulate, October 5, 1932.

[6] *Ibid.*, 861.5017—Living Conditions/553. The Germans were treated as Russians and paid 150 rubles per month, whereas the American designers had been earning up to $1,000 plus 500 to 600 rubles per month.

[7] W. Citrine, *I Search for Truth in Russia* (London: Routledge, 1936), p. 222.

[8] *Za Industrializatsiiu*, No. 10, January 12, 1937.

[9] U.S. State Dept. Decimal File, 861.6511/35, Report No. 19, Moscow, February 3, 1937.

[10] *Ibid.*

the United States.[11] It is interesting to note that the Perepelitsa article is reasonably consistent with Jenkins' criticisms and, coming at the time of the purges, is a remarkably frank commentary.

On the other hand, some progress in learning was undoubtedly being made in the U.S.S.R. In 1936 Kramatorsk turned out the first Soviet coking machine, a copy of a Koppers model, which, while not of the same order of construction complexity as a strip mill, still represented a considerable advance from the 1930–2 period.[12]

During the German occupation, Kramatorsk was turned over by the German occupation authorities to Berg und Hüttenwerke-Gesellschaft Ost m.b.H., which repaired the buildings, plant, and existing machinery, and assembled raw materials. Initial work consisted of the repair of mining machinery.[13] Early in 1943 Alfred Krupp requested a special report on Kramatorsk, submitted on August 13, 1943 by Dr. Hedstueck, deputy plant manager. This report resulted in an order to all Krupp departments in Germany to render all necessary assistance to the renamed Neue Maschinenfabrik Kramatorsk, 'especially as regards placing at their disposal the material and manpower

Table 9–1 ANNUAL CAPACITY OF SOVIET HEAVY-MACHINE-BUILDING PLANTS

Non-Military Heavy Equipment	*Kramatorsk**	*Uralmash**	*Expanded Tsarist Plants***
Standard blast furnaces	6 per year	4 per year	4 per year
Standard (150-ton) open hearths	30 per year	20 per year	20 per year
Standard blooming mills	3 per year	2 per year	2 per year
Other blooming mills	13 per year	10 per year	12 per year
Gas generators	150 per year	50 per year	50 per year
Heavy forgings	24,000 tons	20,000 tons	—
Mining equipment	—	17,000 tons	—
Non-ferrous metallurgical equipment	—	5,000 tons	—
Heavy presses	—	5,000 tons	—

* Output for Uralmash includes all important items. Kramatorsk also produced turning lathes, 125-ton cranes, heavy hoists and gas-blowing machines. Kramatorsk output includes that for the Fitzner & Hampner plant established in 1896 and incorporated into the new Kramatorsk plant next door. Both plants had a considerable military capacity.

** Output estimated.

Sources: American-Russian Chamber of Commerce, *Handbook of the Soviet Union* (New York: John Day Co., 1936), p. 152.
U.S.S.R. in Construction, No. 7 (July 1932).

11 *Ibid.*

12 I. L. Nepomnyashchii, *op. cit.*, p. 5.

13 *Report on Russian Foundries*, April 14, 1943, Nazi Industry Reports, No. 4332 (at Hoover Institution).

urgently required for starting production in the tank maintenance plant which is of vital importance to the fighting troops.'[14]

By August 1943 there were 2,000 Russian workers at Kramatorsk, working mainly on tank and military equipment repairs and producing small tools such as shovels, hammers, and wheelbarrows. Very little complex equipment was manufactured, although one order was for 1,000 cylinder-boring and grinding sets for the Wehrmacht.[15]

THE URALMASH PLANT AT SVERDLOVSK

Uralmash was another giant plant, only slightly smaller than the expanded Kramatorsk complex. Designed to build equipment for the mining and metallurgical industry, Uralmash also produced large quantities of military goods.

Uralmash opened July 15, 1933, but as late as 1936 was working at only 60 percent capacity. The complex contained numerous shops and departments handling production procedures all the way from raw-material conversion through steel manufacture to the production of finished heavy equipment. By 1936 Uralmash could produce prefabricated submarines.

Table 9–2 REPRESENTATIVE LIST OF GERMAN EQUIPMENT SUPPLIED TO URALMASH

Description	*Cost (Millions of Marks)*	*Supplier*
Generator plant (peat)	1.25	'Machine factory in Berlin'
Boiler plant (550 square meters)	0.75	'West German' plant
Steam turbines	—	'Silesian machine plant'
Cranes	2.0	Several German plants
Tilting furnaces	0.5	'West Germany'
Roll-turning machines	0.6	'West German plant'
Forge ovens	0.4	'Middle Germany factory'
Forge shop cranes	0.7	'Rhineland machine plant'
Forging press and installations	0.8	'Rhineland machine factory'
Drilling banks	1.0	'Berlin tool plant'
Drilling machines, lathes, etc.	3.0	'Rhineland machine factory'

Source: Sowjetwirtschaft und Aussenhandel, Handelsvertretung der UdSSR in Deutschland, Berlin SW., IX–XII, 1930–3.

Construction required some 12,000 workers; 'about 150 foreign specialists and workers were engaged to help in the construction and operation of the

[14] *Report on Neue Maschinfabrik Kramatorsk,* in Nazi Industry Reports, No. 2959 (at Hoover Institution).

[15] *Ibid.*

factory.'[16] The construction and design of several key departments, such as the foundry, were American in concept, and American engineers were hired to design layouts and develop methods of reinforcing concrete for the plant.[17] The complex included foundries, hammer and press shops, forge shops, heat-treating shops, two mechanical departments, and machine fabrication and assembly shops. The equipment came largely but not completely from Germany.

Scott received a conducted tour of the plant in 1935–6 and wrote an enthusiastic description:

> It is one of the best-looking plants I have ever seen. The first mechanical department was a beautiful piece of work. A building a quarter of a mile long was filled with the best American, British and German machines. It was better equipped than any single shop in the General Electric Works in Schenectady. There were two immense lathes not yet in operation. Later I found out that they were used for turning gun barrels.[18]

CHANGES IN THE SOVIET DEMAND FOR IMPORTED MACHINE TOOLS

The Kramatorsk and Uralmash plants were primarily intended for construction of heavy equipment, although they did manufacture heavy machine tools such as presses and forges. Machine tools—lathes, shapers, grinders, broachers, and similar tools—were manufactured in large, specialized plants, some of which were expanded tsarist plants and some completely new Soviet enterprises.

This construction and expansion of giant specialized tool plants did not, as has been suggested by some observers, reduce the total Soviet demand for foreign equipment in the 1930s,[19] although it did change slightly the structure of that demand. In 1931 most American, United Kingdom, and German machine-tool exports in all categories were going to the Soviet Union. (See table 9–3.)

[16] *Factory and Industrial Management*, LXXX, No. 2 (1931), p. 637.

[17] Amtorg, *op. cit.*, IX, No. 10 (October 1934), p. 198.

[18] Scott, *op. cit.*, p. 103.

[19] For example, see Harry Schwartz, *Russia's Soviet Economy* (New York: Prentice Hall, 1950): 'But as Soviet machine tool and machinery factories increased their output as Soviet engineers mastered advanced foreign technology, the U.S.S.R.'s imports of machinery and technicians from abroad could be and were reduced.' (P. 241.) On the other hand American engineers working in Russia correctly foretold the need to continue machine tool imports. For example, see A. M. Wasbauer, 'Machine Tools for the Soviets,' *American Machinist*, v. 78, February 1934, pp. 147–9. In 1933–4 Wasbauer was on the Design Commission in charge of heavy-machine-tool design.

Table 9–3 PERCENT OF U.S. MACHINERY EXPORTS GOING TO SOVIET UNION, 1930–1

Equipment Item	*1930 (Percent)*	*1931 (Percent)*
Drilling machines	51.79	78.05
Foundry and molding equipment	57.56	73.81
Milling machines	42.01	70.26
Forging machinery	51.92	67.54
Vertical boring mills	36.25	65.68
Lathes	50.73	65.61
Planers and shapers	36.61	64.60
Other metal machines	35.98	59.98
Grinding machines	29.56	57.90
Sheet and plate metal working machines	30.93	53.91
Other metal working machines	36.79	35.82

Source: Amtorg, *op. cit.*, VII–VIII, No. 10 (May 15, 1932), p. 223.

In the case of the United Kingdom, the impact of Soviet purchases was almost complete; in 1932 the Soviet Union took no less than 90 percent of all United Kingdom machinery exports.[20] In some machinery categories the Soviets took almost all United Kingdom exports: £161,000 worth of presses were exported, of which £157,000 worth (98.1 percent) went to the Soviet Union. In the same year the U.K. exported £382,000 worth of planers, of which £365,000 worth (95.5 percent) went to the Soviet Union. Of other machine tools such as lathes, drilling machines, and grinders, 90 percent of U.K. exports went to the U.S.S.R.[21]

By 1935–6 production of engine lathes, semi-automatic and single-spindle automatic lathes, planers, and some pneumatic tools had been 'mastered' by the Russians, but objectives for the following year still included such machine tools as axle-turning lathes, six-spindle automatics, internal grinding machines, and radial drills, and many other types.[22]

At the end of the 1930s, the Soviet Union was still importing significant quantities of machine tools, and its trade agreements were negotiated with this as a primary objective. The 1939 trade agreement between Germany and the Soviet Union placed great emphasis on machine tools. After indicating that Germany would grant a 200-million-Reichmark credit, a 'Strictly Confidential' German Foreign Office memorandum adds:

> The credit will be used to finance Soviet orders in Germany. The Soviet Union will make use of it to order the industrial products listed in schedule

[20] *Engineering*, July 27, 1934, p. 86.

[21] *Ibid.*

[22] 'Machine Tool Building in Russia,' *Machinery*, v. 42, October 1935, p. 107.

> A of the agreement. They consist of machinery and industrial installations. Machine tools up to the very largest dimensions form a considerable part of the deliveries. And armaments in the broader sense (such as optical supplies, armor plate and the like) will, subject to examination of every single item, be supplied in smaller proportion.[23]

Soviet requests and delivery schedules under the agreement reflect a primary interest in large, specialized machine tools.[24] It appears that German-occupied Czechoslovakia also played an important role in supply of machine tools. Between March 1939 and August 1940, more than 85 percent of Czech exports to the Soviet Union consisted of machines and apparatus of various kinds, and much of the remaining 15 percent consisted of iron and steel products.[25]

Soviet stripping of Manchurian industry in late 1945 confirms their overriding interest in machine tools; so many machine tools were removed that the productive capacity of the considerable Manchurian metal working industry was reduced by some 80 percent. For example, the Manchurian Machine Tool Company plant at Mukden was completely removed to the Soviet Union. An American engineer from the Pauley Mission visited the plant in June 1946 and reported, 'There was very little to observe in this factory except the absence of equipment. Everything of value was removed.'[26]

Between September and October of 1945, 120 Soviet officers and men had been billeted in the plant; in 40 days, with the help of 200 Japanese employees, they 'stripped the equipment listed, crated it individually and completely, and shipped it out by rail.' This plant produced small lathes, automatic lathes, drilling machines, and milling machines. Similarly, the Manchu Machine Works was stripped of 90 percent of its equipment, and half a dozen similar large plants, each with several thousand machine tools, were removed to the U.S.S.R.[27]

[23] Raymond J. Sontag and James S. Beddie, *Nazi-Soviet Relations, 1939–1941* (Dept. of State, Washington, D.C., 1948), p. 83. (Translation of Foreign Office Memorandum, August 29, 1939.) See also the negotiations between Germany and the U.S.S.R., 1939 to 1941, in the Hauptarchiv, Hoover Institution, Boxes 1137 and 1138.

[24] Hoover Institution, Hauptarchiv, Box 1138. For example, see Documents 324623–29.

[25] Hoover Institution, Hauptarchiv, Box 1137, *Ausfuhr-Warenverkehr des Protektorate Böhmen und Mühren mit der U.d.S.S.R. vom 16.3.1939 bis 31.8.1940*. See Tariff Classes 38, 40, and 41.

[26] Edwin W. Pauley, *Report on Japanese Assets in Manchuria to the President of the United States, July, 1946* (Washington, D.C.: 1946), Appendix 7, 'Plant Inspection Report 1-J-3.' The question of reparations will be covered in Vol. III.

[27] *Ibid., Appendix 7*, 'Plant Inspection Report 1-J-7.' The Northeast Economic Commission says the plant was 100-percent stripped; the U.S. inspecting engineer says the figure was closer to 90 percent.

A continuing interest in machine tools is also suggested by the recommendations of the Pauley Mission on Japanese reparations,[28] the machine tool section of which was written by Owen Lattimore.[29] 'Although I do not believe that the U.S.S.R. should assert a substantial claim for reparations from Japan, nevertheless certain plants and machine tools may well be made available to the U.S.S.R.'[30]

The reason given was that low levels of economic development in the Far East would make absorption of this industrial capacity by other countries 'difficult' and that China and the Philippines were not technically ready to receive such reparations.[31] Lattimore presented the topic to the Reparations Committee on January 12, 1946 and suggested that after war damage was taken into account Japan might have 850,000 machine tools available for reparations. As China and the Philippines had already been ruled out on the grounds they were economically backward and therefore had no need for such equipment, the obvious recipient would be the Soviet Union. China had already lost its share of reparations by quick Soviet action in Manchuria, where the machine tools taken by the Soviets were actually a charge against Chinese reparations claims.[32]

This continued Soviet demand for certain important categories of machine tools is supported by tabulations compiled by Joseph Gwyer.[33] Between 1932 and 1945 approximately one-half of the steadily increasing machine-tool

Table 9–4 COMPOSITION OF SOVIET MACHINE TOOL PRODUCTION, 1932–45

Tools Produced	*1932*	*1940*	*1945*
Total machine tools produced	19,978	58,437	38,419
Group A: lathes (not turret or semi-automatic)	7,145	11,523	13,063
Group B: vertical drilling machines	6,838	15,251	7,168
Groups A and B as percent of total	72.8%	45.8%	52.7%

Source: Adapted from Joseph Gwyer, 'Soviet Machine Tools,' *Ordnance*, XLIII, No. 231, November-December 1958, pp. 415–9.

28 Edwin W. Pauley, *Report on Japanese Reparations to the President of the United States, November 1945 to April 1946* (Washington: April 1, 1946).

29 For background of Owen Lattimore, see Anthony Kubek, *How the Far East Was Lost* (Chicago: Regnery, 1963), pp. 263–4.

30 Pauley, *Report on Japanese Reparations . . . 1946*, p. 13.

31 *Ibid.*

32 *Ibid.*, pp. 18–9.

33 Joseph A. Gwyer, 'Soviet Machine Tools,' *Ordnance*, November–December 1958.

production was comprised of just two elementary types: simple lathes (excluding turret and semi-automatic lathes) and vertical drilling machines. (See table 9–4.)

If we analyze Soviet production in complex machine-tool categories, we find that by 1945 the Soviets were hardly beyond the prototype stage. In 1932 no broaching machines were made, and in 1945 only five. In 1932 only 46 slotters were made; this declined to 20 in 1945. No radial drilling machines were made in 1932 and only 43 in 1945. Some 233 planers were made in 1932, but only five in 1945. Finally, only 42 machines described as 'large, heavy, unique' were made in 1945.[34]

Thus the structure of Soviet machine-tool production in 1945 is quite clear. Output was concentrated on producing very large numbers of very simple machine tools. Even tools of moderate complexity (radial drills, broachers, and slotters) were imported. Thus the dependence of the Soviet Union on the West was almost as great in 1945, as far as machine tools were concerned, as in 1932. Only two groups of fairly simple machine tools had been mastered with any degree of certainty by 1945, and this circumstance was brought about only by Western technical assistance to individual machine-tool plants.

TECHNICAL ASSISTANCE TO MACHINE-TOOL PLANTS

The Podolsk plant, about 24 miles from Moscow, employed some 2,000 workers on the production of turret lathes. This plant had a technical-assistance agreement with Frank D. Chase, Inc., and was subsequently reorganized on American lines by John W. Lundin, who installed a large refinery and metal casting plant.[35] The Frank D. Chase consulting organization also undertook three other large foundry projects. The first, in 1929, was for production of sewing-machine castings; for this purpose the company brought back Soviet engineers to the United States and 'made the design, drawings, specification and purchase of equipment in this country.'[36] The very large foundry at the Stalingrad Tractor Plant was built under a Frank Chase contract, as was the foundry at the Putilovets plant; in these, Chase also supervised construction, installation of equipment, and initial operation. The Putilovets plant was

[34] *Ibid.* It could be argued quite accurately that Lend-Lease was supplying Soviet imports of more complex tools. However, if the Soviet Union had the production capability for these tools it is likely that requests would have been for other urgently needed equipment. Lend-Lease was not a bottomless barrel, and the Soviet Union was required, even though the Administration gave first priority to the Soviets, to establish priorities and make choices.

[35] U.S. State Dept. Decimal File, 861.5017—Living Conditions/274 and /482. See also Sutton, *Western Technology . . ., 1917 to 1930*, p. 72.

[36] *American Engineers in Russia*, C. R. Cody folder.

'the first modern mechanically equipped foundry completed in Russia [and] also one of the early projects of the Five Year Plan. . . .'[37]

The Prisposoblenie plant of Orgametal in Moscow was stocked in the early 1930s with 'the very latest in American machine tools—rows of milling machines and other machine tools of the most approved design.'[38] This was in addition to a sprinkling of German millers, shapers and lathes. According to Walter Wells,[39] Prisposoblenie had the responsibility of establishing standards, and dies and jigs were built at Prisposoblenie for Soviet tool-manufacturing plants.

The Krasny Proletariat plant in Moscow was an expanded tsarist plant previously known as Bromley Brothers, making small diesels with German technical assistance in the late 1920s and then lathes. The first lathe models produced in 1929–30 were cone pulley types, replaced in 1932 by the new Soviet standard lathe 'which follow[ed] very closely the design of the German standard machine' and was produced in three sizes—150, 200, and 300 millimeters (center height).[40] In 1932, 20 were produced and in 1933 only 550, although 6,000 were planned.[41] By 1937 the plant employed some 7,500 workers, still producing standard lathes.

Another very large Moscow plant was the Ordzhonikidze (Works No. 28), built in 1930–2 and by 1940 employing 5,000 in three shifts. Production started with 65-millimeter turret lathes 'which were direct copies of a Warner & Swasey machine.'[42] In 1934 the Plan added production of a semi-automatic multi-tool lathe: 'a copy of the Fay automatic.'[43] In 1937 another model was added—the first multi-spindle automatic built in the Soviet Union: 'a copy of the Cone machine.'[44] *American Machinist* commented, 'With these machines as the base, Ordzhonikidze built-up experience in the shops and the design office. These were the only three types of machines made until the beginning of World War II when Russia modernized and improved tooling. . . .'[45]

The Leningrad Ilytch works concluded a technical-assistance agreement in 1928 to run for three years with the firm Vereinigte Carborundum und Elektritwerke A-G of Neu-Betanek in Czechoslovakia.[46] This plant was

[37] *Ibid.*

[38] Walter Wells, 'An American Toolmaker in Russia,' *American Machinist*, LXXV, November 26, 1931, p. 816.

[39] *Ibid.*

[40] L. A. Aisenshtadt, *Ocherki po istorii stankostroeniya SSSR* (Moscow: 1957), pp. 171–3.

[41] *Machinery*, September 1931, p. 54. Included is an outline drawing of the lathe.

[42] *American Machinist*, November 19, 1956. (See also chap. 18.)

[43] *Ibid.*

[44] *Ibid.*

[45] *Ibid.*

[46] *Die Chemische Fabrik*, I, No. 18 (May 2, 1928), p. 256.

Table 9–5 SELECTED SOVIET MACHINE TOOLS AND WESTERN ORIGINS, 1930–50

Class of Equipment	*Models* (basic model in *italics*)	*Years Produced*	*Western Origin of Basic Model*	*Specialist Plant in the U.S.S.R.*	*1941 Plan Output*
Gear-cutting machine	*Pfauter*, 532, (750 mm)	1931—after 1950	Pfauter (Germany)	Komsomolets (founded 1909)	70
Boring machine	*R-80*, A-80, (80 mm)	1930—after 1950	Union		
Cylindrical grinding machine	*Fortuna*, 316, 316 M (250 mm)	1930—after 1950	Fortuna	Zlatoyet	1,647
Centerless grinder	*3180*, (5–75 mm)	1945—after 1950	Cincinnati		105
Shaper	*Sheping*, 7S35, 735 (500 mm)	1926—after 1950	Pre-World War I model	Samotochka (founded 1898)	
Bench lathe (150 mm)	*Chemnitz*, 162 SP, 1615, 1615 M	1930—after 1950	Chemnitz (Germany)	TZ-K	4,638
Bench lathe (200 mm)	*Standard DIP series*, 1D62, 1D62M, 1A62	1932?	Standard German model (replaced Tn series)		5,387
Gear-cutting lathe			Krause (Austrian)		95
Turret lathe (65 mm)	*136*, 1M36	1935—after 1945	Warner & Swasey Model 2A		1,600

Sources: L. Aizenshtadt, *Ocherki po istorii stankostroeniya, SSSR* (Moscow: 1957)
L. Turgeon, *Prices of Metalworking Equipment in the Soviet Union, 1928–1951* (Santa Monica: RAND Corp., 1953), Research Memorandum RM 1112.

expanded after 1934, by an expenditure of more than 30 million rubles, to include production of two models of the German Stock tool grinders (after expropriation of the Stock concession); the plant also produced in 1934 its first Cincinnati universal tool grinder, 'fully equal to the American product.'[47]

Similarly the Frunze plant was reported as 'preparing to produce the German automatic lathe, Index, of the firm Hahn and Kolb, Stuttgart and . . . to produce 45 units in this year [1934] and 500 units up to 1938.'[48]

SPECIALIZED AND AUTOMATIC EQUIPMENT

While the expanded tsarist and new machine-tool plants concentrated on producing large quantities of single models based on Western designs, there remained an unfilled need for specialized equipment of a sophistication far beyond Soviet capability. As each machine model was produced, imports were halted even if the Soviet version was decidedly below the import in quality; machine imports from the early 1930s to the present time have been concentrated in specialized equipment not produced in Soviet plants.

Given the Soviet concentration on mass production of standardized products, automatic machinery was a prime requirement. Such machines came primarily from the United States. One such order was for a shipment of 47 Fay automatic lathes[49] for machining the motor cylinders, pistons, and sprocket shafts of the No. 60 Caterpillar tractor being built at Chelyabinsk.

The use of imports to supplement limited internal production capabilities is well exemplified in the case of gear-cutting machines. In 1933–4 the only gear-hobbing machine produced was the Pfauter model at the Komsomolets plant in Yegorievsk, near Moscow, an old tsarist plant founded in 1909 and specializing in production of this single German machine model. The Pfauter had very limited capacity. Specialized equipment was therefore needed to produce, for example, the high-quality gears used in high-speed rolling mills. For this purpose an engineering delegation was sent to the U.S. in 1934 to investigate available types of gear-cutting equipment. An order was placed with Farrel-Birmingham Co., Inc., of Buffalo, New York for two 'huge Sykes machines.' Although of design similar to others in Farrel-Birmingham's own plant, they were 'considerably larger, the one intended for the Kramatorsk plant having capacity for cutting gears up to 8 meters. . . .'[50] These machines,

[47] *American Machinist*, March 14, 1934.

[48] *Ibid.*

[49] Ralph E. Miller, 'American Automatic Machinery Aids Soviet Reconstruction,' *The Iron Age*, CXXXI, No. 4 (January 26, 1933), pp. 16–24. Miller describes these machines, shipped in 1932, in detail. A comparison of the Fay (in Aisenshtadt) with Miller's description of the machines produced supports the estimate of American and Soviet capabilities.

[50] 'Large Farrel-Sykes Gear Generators for Soviet Russia,' *Machinery*, XLIII, November 1936, pp. 211–2.

weighing 130 tons each, could cut gears weighing up to 50 tons each. One Sykes machine was for Uralmash and one for Kramatorsk.[51] Design of the Sykes machines occupied eight engineers and draftsmen for more than one year and actual manufacture about 15 months. They were probably the largest such machines in the world.

In the field of rolling-mill equipment, a large gear drive was made by the United Kingdom firm of David Brown and Sons (Huddersfield), Ltd., from castings supplied by the English Electric Corporation. This gear drive weighed 24 tons, was designed to encounter peak loads of 10,800 horsepower and was described as 'probably the largest gear wheel of its kind ever cast in one piece.'[52]

Other special designs, supplied by the British firm of Davy Brothers, Ltd., of Sheffield, were for large forging manipulators ranging from 5 to 15 tons capacity. Known as the Davy-Alliance models, they were the result of a special Davy study of forging manipulators.[53] The same company also supplied a 6,000-ton Davy patented forging press for the Stalingrad tractor works.[54]

Similar equipment for steel works was supplied by Craven Brothers (Manchester), Ltd., of Reddish, who in the early 1930s supplied a double 50-inch center lathe with a 112-foot by 9-foot 9-inch bed and 8-foot face plates.[55] German firms supplied similar large specialized equipment; for example, Maschinenfabrik Augsburg-Nürnburg A-G (MAN) supplied a 300-ton overhead traveling crane to serve a 15,000-ton forging press.[56]

Thus for the whole period under consideration the Soviets depended entirely on more advanced countries for imports of machine tools beyond the two simplest types.

THE ACQUISITION OF BALL- AND ROLLER-BEARING TECHNOLOGY

The Swedish SKF Company established a ball-bearing manufacturing plant in Moscow in 1917. After the October Revolution the company was given a concession agreement to continue operation of the original plant and build new facilities for the manufacture of complete ball and roller assemblies.[57] The new plant was opened in 1929. Although the basic agreement was for

51 See p. 130 *et seq.*
52 *Engineering*, CXL, July 26, 1935, p. 99.
53 *The Engineer*, CLII, July 1931.
54 *Ibid.*
55 *Ibid.*, CLIV, 1932, p. 253.
56 *Engineering*, April 27, 1934, pp. 482–3.
57 Sutton, *Western Technology . . ., 1917 to 1930*, pp. 177–8.

40 years, both SKF plants were taken over in 1930 and renamed Moscow Ball-Bearing Plant No. 2.

Yearly production for the ex-Swedish SKF plants was three million ball and roller bearings. By 1937, under the management of 10 ex-SKF engineers, including the chief engineer (they all remained under individual ruble work contracts), production reached eight million bearings per year. The plant employed 15,000 workers in three shifts.

Table 9–6 TECHNICAL ASSISTANCE TO BALL- AND ROLLER-BEARING PLANTS

Location	*Technical Assistance*	*Production*
Moscow, Plant No. 1 (Kaganovitch)	RIV (Italy)	1938: 18 million ball and roller bearings
Moscow, Plant No. 2	Former SKF (Sweden) concession	1937: 8 million ball and roller bearings
Saratov, Plant No. 3	Imported U.S. equipment	Started about 1941 to produce 22 million ball bearings per year

Source: Oberkommando der Wehrmacht, National Archives Microcopy T 84–122–1421222/3.

Construction of Moscow Ball-Bearing Plant No. 1, the Kaganovitch, exemplifies Soviet economic development during the years 1930–45. The only completely new ball- and roller-bearing plant, with a full product range, to be constructed between 1930 and 1941, it covered an area of 1.5 million square feet under one roof. Whereas in 1931 all European anti-friction bearing plants together produced 120,000 pieces per day, the Kaganovitch alone was scheduled to produce 100,000. With an ultimate capacity of 40 million bearings annually, Kaganovitch could have equalled one-third of 1931 world production and one-half the United States production.

The plant cost 116 million rubles, including 35 million for 5,000 imported machines. It was conservatively described by Amtorg as 'one of the largest and most up to date of its kind in the world,'[58] with an output destined to provide all bearings necessary for production of the Amo (Fiat) 3-ton truck, the Yaroslavl (Hercules) 5-ton truck and bus, the Ford Models Gaz A and Gaz AA, the Fordson tractor, two models of the International Harvester tractor (produced at Kharkov and Stalingrad), the Caterpillar 60-horsepower tractor (produced at Chelyabinsk), and the Velo motorcycle and bicycle plant (Birmingham Small Arms Company). The Kaganovitch plant was a vital unit in Soviet industrialization.

[58] Amtorg, *op. cit.*, 'The Moscow Ball Bearing Factory,' VII, No. 9 (May 1, 1932), pp. 197–200.

The history of the Kaganovitch plant began in 1928 when Orgametal attempted to develop a construction plan.[59] In 1929 the plan was sent to Berlin, where a prominent German expert was employed as a consultant. Later in the year a Soviet Bearing Commission went to the U.S. and retained another engineer as consultant. Then followed a complex series of international expeditions, consultations, designs, and redesigns; 'finally a total of five bureaus in four countries, with three working simultaneously, were required to present a final plan. . . .'[60]

The technical-assistance picture was equally complicated. The Italian firm RIV (Officine Villar-Perosa of Turin) signed a technical-assistance contract to 'supervise the job complete from project to finished plant in operation.'[61] The company also accepted a 'large number' of Soviet workers and technicians in its plants for training.[62] RIV was a subsidiary of Fiat, which was partly American-owned; this provided a funnel for the transmission of American bearing technology, which U.S. manufacturers had been reluctant to provide directly. Albert Kahn, Inc., of Detroit designed the buildings.[63] In August 1930 Sharikopodshipnikstroi (Ball-Bearing Construction Trust) was transferred from the Machine-Building Trust to VATO (All-Union Automobile and Tractor Trust) and a number of top-flight U.S. engineers were sent to work in both Sharikopodshipnikstroi and the Kaganovitch plant itself. See table 9–7 for the organizational structure.

The Kaganovitch production program included 120 sizes of bearings: i.e., ball bearings (53 sizes, from E12 to 318), tapered roller bearings (35 sizes, from 40 to 200 millimeters outside diameter), helical roller bearings (20 sizes), cylindrical roller bearings (9 sizes, including the Hoffman type, from 40 to 160 millimeters), and simple ball retainer assemblies.[64]

The specifications and tolerances were based on the International Standard, somewhat more rigorous than the Society of Automotive Engineers standards used in the United States. Specifications also reflected foreign practice in the products using bearings. For example, in helical roller bearings, 'the final

[59] A series of five articles entitled 'Bearings for the Soviets,' by Frank Schubert, appeared in *American Machinist* in early 1933 and describes in detail the planning, construction, and output of the Kaganovitch plant. See *American Machinist*, LXXVII: April 12, 1933, pp. 229–32; April 26, 1933, pp. 273–6; May 10, 1933, pp. 296–9; May 24, 1933, pp. 334–7; and June 7, 1933, pp. 369–73.

[60] Schubert, *op. cit.*, *American Machinist*, LXXVII, April 12, 1933, p. 230. These countries were the United States, Germany, Italy, and the United Kingdom. Sweden, foremost in ball-bearing technology, was not a candidate, as the Soviets were in the process of expropriating the Swedish SKF ball-bearing concession.

[61] *Ibid.*, p. 232.

[62] Amtorg, *op. cit.*, V, No. 18–19 (October 1930), p. 386.

[63] Schubert, *op. cit.*, *American Machinist*, LXXVII, April 12, 1933, p. 231.

[64] *Ibid.*, April 26, 1933, p. 273.

Table 9–7 ORGANIZATION OF THE BALL-BEARING INDUSTRY, 1932

VATO
(Sharikopodshipnikstroi)
Chief Consulting Engineer:
H. S. Trecartin

Plant No. 1 (Kaganovitch)	Plant No. 2 (ex-SKF concession)
Director: H. J. Miller	Director: (Swedish engineer)
U.S. engineers in charge of:	
Tapered roller-bearing division	
Ball-bearing division	
Helical-bearing division	
Cylindrical-bearing division	
Russian engineers with U.S. assistants in:	
Stores dept.	Technical management under ten Swedish engineers
Forge shop	
Turning shop	
Heat-treating shop	
Grinding shop	
Ball-making shop	
Roller-making shop	
Press operations	
Assembling and packing	
Tool and die shop	
Repair and maintenance shop	

Sources: H. S. Trecartin, *Iron Age*, October 13, 1932.
F. Schubert, *op. cit.*

decision was based on Ford practice for bearings to be used in Ford type units and on the largest available commercial bearings for those to be used in other units.'[65]

Hoffman specification bearings were used on Yaroslavl 5-ton trucks and buses and International Harvester specifications for tractors produced at Stalingrad and Kharkov.

When the processes and specifications had been decided upon, the task became one of selection, purchase, and installation of equipment. Schubert comments: 'After the general technological processes had been laid out here, in America, the selection of machines became the making of a decision between

[65] *Ibid.*, p. 275.

two (or perhaps three, if available) different makes of machines for each operation.'[66]

Two Soviet buying commissions were appointed: one for Italy and Germany, and another for the United States and the United Kingdom. A buying plan was established which apportioned equipment purchases as follows:

United States: 185 grinding machines (a key component) valued at over $1 million, together with some helical roller winders[67]

Italy: electric furnaces, ball-making equipment, some ring-grinding equipment, roll-lapping machines, and polishing machines

United Kingdom: grinding machines

Germany: forging equipment, automatic screw machines, chucking machines, presses, gaging, and laboratory equipment

These were unusually large purchases; indeed, some German orders were transferred elsewhere as the firms were unable to handle such large quantities. For example, in Germany the initial 1931 order alone comprised 100 single-spindle chucking machines, 80 multiple-spindle chucking machines, 80 internal grinders, 120 oscillating grinders, and 30 ball grinders.

Altogether, about $30 million worth of equipment for Kaganovitch was made, installed, and initially operated by Western firms.[68] The Soviet machine-building plants, just getting into production, supplied the simpler tools: 'many lathes, some milling machines and some grinders. . . .'[69] Indeed, one of the first machines installed was a simple cylindrical grinder built in the Leningrad Karl Marx factory, a copy of the German model, Fortune. The special steel required was supplied by Elektrostal in Moscow and Zlatoust in the Urals; both plants had Western technical assistance.

For a plant of this size and complexity, construction was remarkably swift. Some site-grading was in progress in November 1930, and the plant was almost complete by September 1931. By January 1932 the first trial batch of bearings had been produced, and by March 1,000 machines were installed. The second

[66] *Ibid.*, May 10, 1933, p. 299.

[67] It is a reasonable deduction that a great deal of this equipment—particularly the grinding machines—came from the Bryant Chucking Grinder Company of Springfield, Va. (now part of the Ex-Cello Corp.). In 1931 Bryant shipped 32.2 percent of its output to the U.S.S.R., and in 1934 55.3 percent of its output. Then there were no shipments until 1938, when the Soviets again bought one-quarter of Bryant's annual output. Major shipments were made under Lend-Lease. After that there were none. In 1959 Bryant was prevented by Congressional action from shipping 46 Centalign-B machines for the manufacture of miniature ball bearings, mainly used in missiles. (U.S. Senate, Committee on the Judiciary, 87th Congress, 1st session, *Export of Ball Bearings Machines to Russia* [Washington, 1961], I, p. 41.) These shipments, from 1931 to 1959, coincide with the Soviet construction of ball-bearing plants.

[68] *Ibid.*, p. 299.

[69] *Ibid.*

section was opened in November 1933 and in that year the plant produced about 50 types of ball and roller bearings.

Understandably, such an enormous plant had its teething problems.[70] Planned to produce 24 million bearings in 1934, it achieved an annual rate of only 18 million by 1938. The SKF concession (renamed Plant No. 2), planned to produce only 3 million in 1933, was producing 8 million bearings per year by 1937 under its Swedish engineers, despite the severe problems after expropriation, when production fell 50 percent and the rejection rate increased from 2 to 14 percent.[71]

The large imports of ball and roller bearings under Lend-Lease suggest that the Soviets had problems assimilating bearing technology. In 1945 alone, $6 million worth of ball and roller bearings and their parts as well as manufacturing equipment were shipped under U.S. Lend-Lease.[72]

PLANS FOR THE MANUFACTURE OF DIESEL ENGINES

Before the October Revolution diesel engines were manufactured at the Nobel works in Petrograd and at the Kolomna works.[73] Both manufactured engines under license from Diesel. These arrangements ceased with the October Revolution and were replaced in 1927 with a license and technical-assistance agreement to manufacture MAN diesels at the old Nobel works (renamed Russky Diesel) and the Kolomna plant.[74]

During the late 1920s, production of diesels was expanded to occupy four plants: the Kolomna, Sormovo, Russky Diesel, and Krasny Proletariat; and about 20 million rubles was spent between 1926–7 and 1930 on these efforts to expand. Kolomna 'mastered' production of diesels (for the second time) in 1930, and was scheduled to produce two-thirds of Soviet diesels by 1932–3. The other three plants, together with the Dvigateli Revolutsii plant, the

[70] Walter Citrine, General Secretary of the Trades Union Council (United Kingdom), toured Kaganovitch in 1935 and was not impressed with plant construction, maintenance or working conditions: 'Not a single door fitted properly, the concrete floor was full of holes and rolled up and down, like the waves of the sea. . . .' (*Op. cit.*, p. 85.)

[71] H. S. Trecartin, 'Industrial Russia,' *The Iron Age*, October 13, 1932.

[72] U.S. State Dept., *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945).

[73] 'The L. Nobel plant in St. Petersburg . . . was founded in 1862. The first diesel of 20 hp. was made in the plant in 1898. . . . In the period 1903–1910 the plant built marine diesels with a total capacity of 54,850 hp.' [E. M. Penova, ed., *Podvodnoe Korablestroenie v Rossii (1900–1917)*, (Sudostroenie: 1965), p. 356.] See also A Cyril Yeates, 'Nobel's Contribution to the Early Development of the Diesel Engine,' *Gas and Oil Power*, XXXII, No. 385 (October 1937), p. 255.

[74] *U.S. Naval Institute Proceedings*, 77, No. 3 (March 1951), p. 273.

Table 9–8 PLANNED MANUFACTURE OF DIESEL ENGINES: 1928–41

Soviet Plant	*Sulzer System*	*Nobel System*	*MAN System*	*Otto Deutz System*
Russky Diesel (tsarist Nobel Plant)	Marine diesels (1,400–2,700 hp.) Stationary diesels (1,500–3,000 hp.) Compressorless diesels (100–300 hp.)	Small diesels with compressors (150–1,000 hp.)*	—	—
Kharkov locomotive works (tsarist plant)	Marine diesels (100–465 hp.) Marine diesels Type S-47 (800–1,200 hp.) Stationary diesels (1,000–2,700 hp.)	—	—	—
Nikolaevsky im. Marti (tsarist shipyards)	Marine diesels (1,400–2,700 hp.)	—	—	—
Kolomna (tsarist plant)	—	—	Double action MAN (2,250–4,500 hp.) MAN system (165–1,575 hp.) including locomotive engines	—
Sormovo (tsarist plant)	—	—	MAN system (120–2,970 hp.)	—
Krasny Proletariat (formerly Bromley Brothers)	—	—	—	Small Deutz system diesel engines (10–200 hp.)
Dvigateli Revolutsii (Gorki)	—	—	MAN system BK-38 (70–150 hp.), unknown 'B' series with compressors	—

Source: Izvestia Vsesoyuznogo Teplotekhnicheskogo Instituta, No. 5, 1930, pp. 84–5.

* The tsarist plant had a Nobel license to manufacture diesel engines.

Komitern plant at Kharkov, and the Nikolaevsky shipbuilding yards, were planned to handle the building of the remaining one-third.[75]

At the same time, plans were made to expand production of Sulzer and Deutz diesel engine systems, each plant specializing in one foreign system with a limited range of end uses. The Sulzer agreement made in 1927 gave Lenmashstroi (Leningrad Machine-Building Trust) the right to make Sulzer diesels, the firm sending its own engineers and blueprints to assist in the process.[76]

The Kolomna works produced a variety of MAN-system diesels without compressors ('G' series) and with compressors ('B' series), in a range of horsepowers from 165 to 1,575. All were four-cycle engines. Production was scheduled to include locomotive engines for the E el-9 diesel electric locomotives and double-action marine diesels of 2,250 to 4,500 horsepower. The main productive effort in both large-horsepower and specialized models was expended at the Kolomna works on the German MAN system.

The Russky Diesel works specialized in heavy marine diesels and stationary diesels produced on the Sulzer system, together with smaller diesels on the Nobel system (R.D. construction). The Kharkov locomotive works concentrated on medium-size engines for ships and stationary use. The Nikolaevsky Shipyards (im. Marti) handled repair and construction of large marine diesels of between 1,400 and 2,700 horsepower on the Sulzer system. The Sormovo works, a very large tsarist plant, produced small and medium-sized marine diesels on the MAN system. Krasny Proletariat (formerly Bromley Brothers) specialized in small diesels (10–200 horsepower) on the Deutz system. Dvigateli Revolutsii at Gorki produced small and medium horsepower stationary diesels on the MAN system.[77]

Thus, each of the seven Soviet diesel engine plants produced a well-defined, narrow line of engines based on a single Western system. These domestically produced diesels were supplemented throughout by specialized imported engines. For example, the Krasny Oktiabr' electricity-generating plant at Stalingrad was equipped with three MAN 2,230-horsepower engines coupled to AEG 1,610-kilowatt a.c. generators.[78] A large order for 100 marine diesel engines for fishing boats with 96 to 104 horsepower was placed in 1932 with Ruston & Hornsby, Ltd., of England.[79] Even at the end of the 1930s large diesels were still imported; in 1938, for example, National-British Thomson

[75] *Izvestia Vsesoyuznogo Teplotekhnicheskogo Instituta*, No. 5, 1930, p. 78.

[76] Kassell, Lt. Cdr. Bernard M., '1,000 Submarines—Fact or Fiction,' *U.S. Naval Institute Proceedings*, LXXVII, No. 3 (March 1951), pp. 267–75.

[77] *Ibid.*

[78] *Izvestia Vsesoyuznogo Teplotekhnicheskogo Instituta*, No. 1, 1931, pp. 10–28.

[79] *Far Eastern Review*, March 1932, pp. 124–6.

Houston engines of 4,032 horsepower were made in the United Kingdom for Soviet power stations.[80]

The practice of producing Soviet diesels to standard well-known foreign designs, supplemented by selective imports, continued through the 1930s while Soviet research organizations experimented and tested different types, including those for tractor and road use.[81] In 1940, according to a German source, there was still only a limited range of diesel and gasoline motors produced in the U.S.S.R.[82]

[80] *Oil Engine*, No. 1, January 5, 1938, p. 283.

[81] See, for example, *Diesel Power*, II, No. 2 (November 1933), pp. 702–5; and *The Automobile Engineer*, XXV, No. 336 (September 1935), pp. 333–6.

[82] 'Motorenbau in Sowjet-Russland,' *Brennstoff-und Wärmewirtschaft*, January 22, 1940, pp. 7–10.

CHAPTER TEN

Technical Assistance for Electrical-Equipment Manufacture and Power-Station Construction

MANUFACTURE of electrical equipment, including transformers, switchgear, lamps, and motors, was concentrated in the VEO (All-Union Electrical Trust) with 34 plants: 14 in Moscow, 14 in Leningrad, and the rest in the Ukraine and Urals. This trust included all the tsarist electrical plants as well as several large units constructed after 1930; its principal works were Elektrosila (Leningrad, electrical machinery), Elektrozavod (Moscow, electrical machinery and switchgear), Dynamo (Moscow, traction motors and equipment), and Elektroapparat (Leningrad, switchgear). Technical-assistance agreements were concluded with numerous foreign companies, the most important of which were International General Electric (1929, extended through 1944), Metropolitan-Vickers (extended from the early 1920s to 1935)[1] and Radio Corporation of America (1927, extended to April 1941). These agreements were of enormous benefit to the U.S.S.R.; in 1932–3, for example, a proposal was made to build 150 new types of electrical apparatus under the General Electric and Metropolitan-Vickers agreements alone.[2]

As electrical-equipment manufacture was concentrated in a few plants of great size, the industry can be effectively considered on a plant-by-plant basis.

GENERAL ELECTRIC ASSISTANCE TO THE KHEMZ TURBINE PLANT AT KHARKOV

The second largest unit constructed under the Second Five-Year Plan[3] was a giant new turbine-manufacturing plant located in Kharkov. Begun in 1930,

[1] Metropolitan-Vickers engineers were expelled from the Soviet Union in 1933; the agreement may have continued for several years, but not beyond 1935.

[2] *The Electrical Review*, April 15, 1932, p. 555.

[3] Gosplan, *Vtoroi piatiletnii plan razvitiia narodnogo khoziaistva SSSR (1933–1937 gg)* (Moscow, 1934) I, p. 587.

partially opened in 1933, and completed in 1935, it absorbed a planned investment of over 87 million rubles. With an aggregate annual capacity of 2.3 million kilowatts of finished equipment, it had a productive capacity more than twice that of General Electric, which until that time had been the largest producer of turbines in the world.[4] Such a plant was urgently needed to produce large steam-turbine generators for the GOELRO (State Commission for the Electrification of Russia) program; up to 1933 these had all been imported.

VEO contracted with the International General Electric Company and Metropolitan-Vickers for design, construction, and technical assistance to KHEMZ. General Electric was the world's largest builder of steam-turbine generators, and prepared in Schenectady 'the complete architectural and engineering design for this new turbine manufacturing plant in which steam turbine generators of General Electric type in capacities of 50,000 kW and over were built.'[5]

General Electric engineers went to Kharkov to erect the plant and supervise installation of German equipment, and many Soviet engineers went to Schenectady for training. General Electric engineers also became members of Soviet commissions to purchase foreign equipment and tools for installation at KHEMZ. Solomon Trone, a General Electric engineer at KHEMZ, stated that 'the Kharkov plant is equipped with German machinery, but is, as far as possible, modelled after similar American plants.'[6]

The impact of KHEMZ was immediate and significant. Whereas before 1935 all generators and most turbines had been imported, after this date only one turbine was imported—an advanced design for the Union Heat Engineering Institute in Moscow.

The other turbine-manufacturing plant was the Putilovets plant in Leningrad, also a producer of locomotives, tractors, and automobiles. The Putilovets turbine shop had technical assistance from Metropolitan-Vickers, and the turbine shop was completely refitted with British machine tools in 1930–3 under the supervision of British engineers.[7]

[4] 'Kharkov Turbo-Generator Works,' *Metallurgia*, October 1932, pp. 187–8.

[5] *The Monogram*, November 1943, p. 19.

[6] U.S. State Dept. Decimal File, 861.5017—Living Conditions/616. Detailed information on General Electric work in the U.S.S.R. is scarce, as the company instructed its large force of engineers and workers not to discuss its work in the U.S.S.R. This instruction was interpreted by some of these personnel to include discussion with the U.S. State Dept.

[7] U.S. State Dept. Decimal File, 861.5017—Living Conditions/635, March 29, 1933. 861.5017—Living Conditions/617 records Metropolitan-Vickers assistance at the KHEMZ plant.

MOSCOW ELEKTROZAVOD[8]

The Moscow Elektrozavod plant employed more than 25,000 in 1941 and produced about one-fifth of Russian electrical equipment; the plant concentrated on transformers, rectifiers, electrical equipment, and accessories for the automotive and tractor industries, including electric light bulbs and special-purpose bulbs.

The transformer shop was stocked with Western equipment during the late 1920s and early 1930s, mostly from Siemens and A.E.G. in Germany. The A.T.E. shop produced electrical equipment, including magnetos and generators, for automobiles and tractors. The bulb shop was established by a group of eight German technicians between 1930 and 1935. There was a searchlight department with technical assistance from Sperry Gyroscope Company of the United States, and possibly there were other military production units. These shops were supplemented by a tool-making shop.

Elektrozavod was a heavy employer of German technicians—especially skilled toolmakers, almost all of whom came from the Berlin area, and were administered under a Foreign Bureau headed by Swassman. In December 1930 there were more than 100 Germans in the plant as heads of departments and in similar key positions. Pose also comments that a 'considerable number of foreign workers were placed in responsible posts.'[9] In the transformer department, German foremen included Müller, Schwartz, Drause, and Heinz, and the inspector was Schippel. In the A.T.E. department, Baument and Lampe were foremen. Horn was head of the bulb department repair shop, and Pose himself was in charge of the 14 imported machines in the rotor workshop.[10]

Not only were Germans scattered among the lower management levels but all-German and mixed German-Russian shock brigades and individual udarniks were created. Socialist competition was developed among German workers at Elektrozavod and at other electrical-equipment plants, such as Elektroapparat and Svetlana, both in Leningrad.[11] There was also General Electric technical assistance at Elektrozavod. Manufacture was begun on 220,000-volt transformers, at first for the Svir system, and then for other electric projects. These were G. E. designs, produced with the technical assistance of General Electric.[12]

[8] Details are from F. Pose, *German Workers in a Moscow Factory* (Moscow: 1933).

[9] *Ibid.*, p. 50.

[10] *Ibid.*, pp. 50–1.

[11] For an American view of Electrozavod, see U.S. State Dept. Decimal File, 861.5017—Living Conditions/775, Report No. 399 from Moscow Embassy, February 19, 1935, an interview with Andrew Smith who worked at the plant. Also see Andrew Smith, *I Was a Soviet Worker* (New York: E. P. Dutton, 1936) for a full-length description of life at Elektrozavod.

[12] *The Monogram*, November 1943.

THE UTILIZATION OF HEROULT AND DETROIT ELECTRIC-FURNACE DESIGNS BY ELEKTROZAVOD

The Technical Director of the electric furnace department of Elektrozavod was an American, C. H. vom Bauer, under whom the production of standard electric furnaces at the rate of 100 per year was attained. By the end of 1933 the Soviet Union had about 450 electric furnaces in operation, accounting for about 2 percent of its total steel output. By comparison, electric furnaces produced 1½ percent in the United States and 1 percent in Germany.

Electric furnaces are used in both ferrous and non-ferrous metallurgical industries where cheap electricity is available and high-quality metals are required. Great emphasis was placed by Soviet planners on electric-furnace steel manufacture and, fortunately, we have precise data for the years 1928 to 1943.[13]

Until 1928 all Russian electric furnaces were imported. The Soviets hired C. H. vom Bauer, a well-known New York consultant on electric furnaces, who became Technical Director of the newly formed electric furnace department of Elektrozavod in Moscow, as noted above. Vom Bauer remained in this post until 1932, instituted electric-furnace manufacture, and, after returning to the United States, presented data on his achievements at the Sixty-Third General Meeting of the Electrochemical Society in Montreal. He estimated that between 1914 and 1932 some 149 foreign electric furnaces had been imported into Russia, including 76 Heroult, 26 Detroit, 10 Ajax-Wyatt, and 30 high-frequency furnaces, and three Miguets and a few other special types.[14]

Production under vom Bauer concentrated on three main series: Heroult, Detroit and Ajax-Wyatt, 'all built according to the author's [i.e., vom Bauer's] specifications. The operation of these furnaces was superintended by the author during the years 1931 and 1932.'[15]

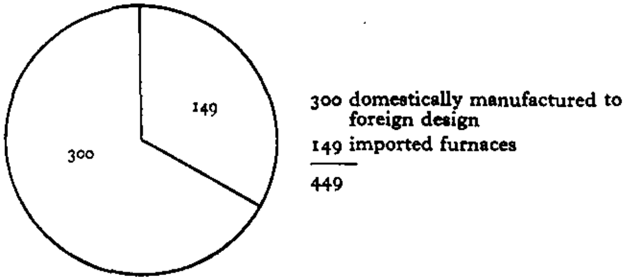
Most furnaces, both imported and newly built, were Heroults and were used in the iron and steel industry. The 'Soviet Heroult' was so close to the regular Heroult that vom Bauer does not bother to distinguish between Soviet-made and imported furnaces. After 1933 only large-capacity Heroults were imported. The greater number of new installations were 'Soviet Heroults,' almost all of 3-ton or 5-ton capacity. By the early 1940s the U.S.S.R. had

[13] C. H. vom Bauer, 'The Electric Furnace and Its Products in the U.S.S.R.,' *Electrochemical Society: Transactions*, LXIII, 1933, pp. 305–8. The vom Bauer data is supplemented by the detailed equipment lists of Soviet steel plants in Bericht No. 68, from the Geheim-Archiv of the Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), prepared by the Gmelin Institute (National Archives Microcopy T 84–127–1428132).

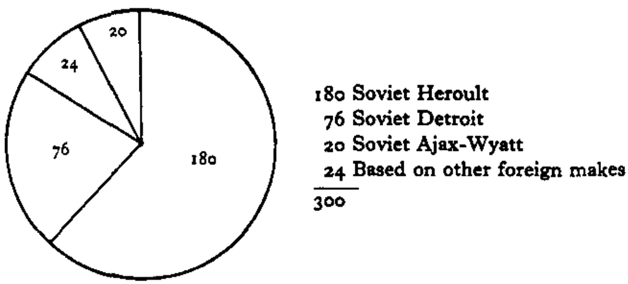
[14] Vom Bauer, *op. cit.*

[15] *Ibid.*, p. 305.

Figure 10–1 ORIGIN OF ELECTRIC FURNACES IN THE U.S.S.R., 1934



Distribution between imported and domestic electric furnaces



Design origins of Soviet domestically manufactured electric furnaces

more than 300 Heroult furnaces, of which only about 76, or one-quarter, had been imported.

The standard smaller furnace (less than one ton per heat) was the Detroit. Of these, 26 were imported between 1914 and 1932 and about 50 'Soviet Detroits' made between 1928 and 1933 under vom Bauer's supervision.[16]

The third standard type was the Ajax-Wyatt Type 1–3. Ten were imported between 1914 and 1932; the Soviets made an additional 20 between 1928 and 1931, also under vom Bauer's supervision. Apparently none were built after 1932. While Heroult and Detroit furnaces were manufactured, special types continued to be imported.[17]

16 We cannot estimate construction after 1933, as the OKW lists only steel plants in Bericht No. 68 and use of this type of small furnace is concentrated in non-ferrous plants.

17 *Ibid.* The OKW records state that several large 10- to 35-ton Heroults were installed in 1935–6.

Electric-furnace manufacture typifies Soviet development during this period. In 1928 all such furnaces were imported. The Soviet Union hired, for a period of four years, one of the top-ranking foreign experts in the field, and vom Bauer organized production of Western models. The Soviet continued this production by concentrating on the two standard foreign models (Heroult and Detroit) most suited to their conditions.

THE DYNAMO (KIROV) PLANT

This was a large prewar plant employing about 10,000 in 1937 and manufacturing electric locomotives, mine locomotives, electric motors, dynamos, generators, and war equipment. The factory started manufacture of the General Electric 3,000-volt d.c. main line electric locomotives based on the G. E. Suram locomotive.[18] These locomotives, eight of which were supplied by the General Electric Company, were of the 125-metric-ton C-C type designed for multiple-unit operation for both passenger and freight work. The first two locomotives were constructed in the U.S. and shipped complete. The balance of six were shipped complete except for the motors, which were manufactured at the Dynamo plant from G.E. drawings under supervision of G.E. engineers.[19] The Dynamo engine became the pattern for further manufacture.

SPERRY GYROSCOPE COMPANY AND THE LENINGRAD ELEKTROPRIBOR PLANT

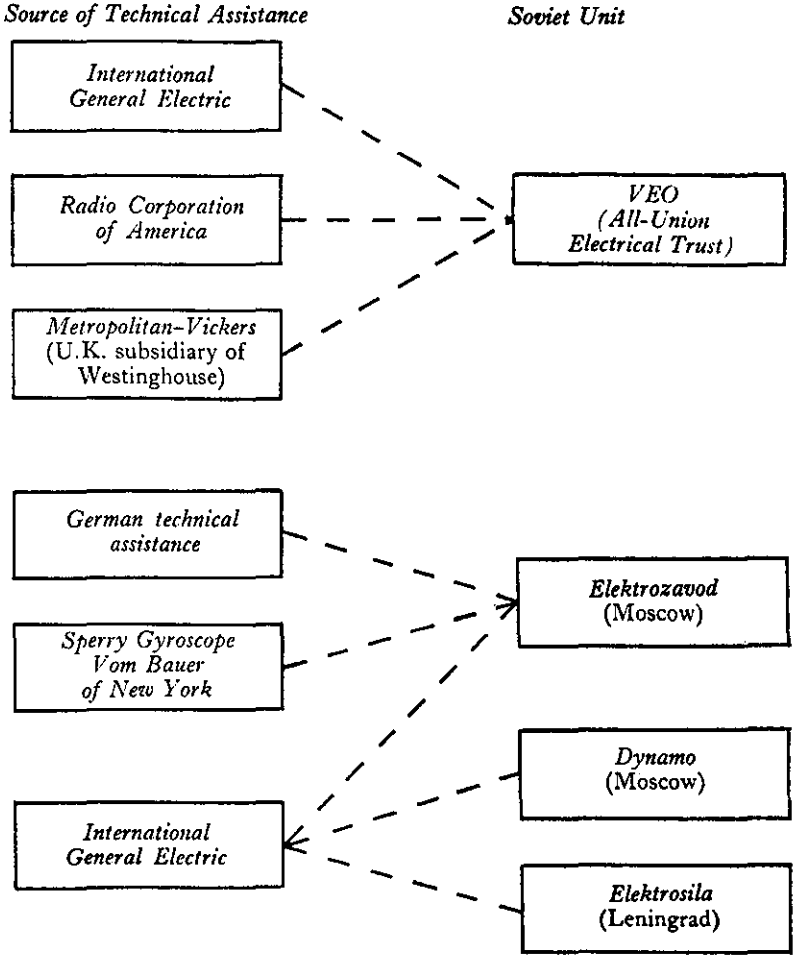
The Elektropribor was a tsarist-era plant, expanded and modernized under the Soviets, by agreement with Sperry Gyroscope Company of the United States, to manufacture electrical equipment (light bulbs, radios, voltmeters, ampere meters, and batteries). The plant had a separate division for the manufacture of army and navy instruments.

In the fall of 1931 the Sperry Company sent Mr. 'A,'[20] an American mechanical engineer, to the Elektropribor plant with instructions to supervise the assembly of machinery supplied by Sperry and to 'instruct in copying and designing such machines.'[21] Mr. 'A' worked for two years at Elektropribor and then went to the U.S. Consulate in Riga to renew his passport. The interviewing officer commented that 'he was a pathetic figure. He seemed frightened, uneasy and his attitude was one of humility and servility which is unusual in the average American.'

[18] *Ibid.*
[19] *General Electric Review*, XXXVIII, May 1935, pp. 220–1.
[20] Name withheld by author in view of the State Dept. comments quoted.
[21] U.S. State Dept. Decimal File, 861.5017—Living Conditions/680.

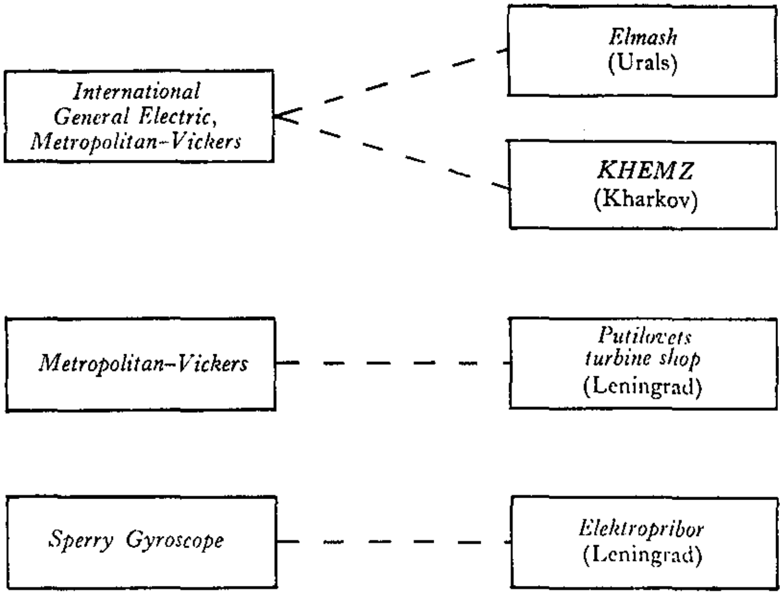
Although Mr. 'A' supplied information to the Riga Consulate, he was concerned as to whether it would be treated confidentially; the OGPU had attempted to get him to 'supply . . . secret American military information.' He had refused to do this and put his refusal in writing.

Figure 10–2 FOREIGN TECHNICAL ASSISTANCE TO PRINCIPAL PLANTS UNDER VEO (ALL-UNION ELECTRICAL TRUST), 1930–45*



* Not all agreements extend for the full period.

Figure 10–2 (Continued)



Sources: see text.

Later, after a senior Sperry official had visited the U.S.S.R., the OGPU came back to Mr. 'A' demanding information on bomb sights which the Soviets had begun to import from the Sperry Company. Just before leaving the U.S.S.R., he was again approached by the OGPU, which suggested that there were Sperry products which the company would not sell the U.S.S.R. and that the Russians 'would be pleased to have plans and specifications of these.'[22] Interest was also indicated in questions posed by the 'American Secret Service.' This placed Mr. 'A' in something of a dilemma and no doubt accounted for the attitude noted by the Riga Consulate, particularly as Mr. 'A' was 'sure' that the 'agents of the GPU at the present time [are] in the employ of the company' (i.e., Sperry in the U.S.).

THE URALS ELEKTROMASH COMBINAT

Urals Elektromash has been claimed, probably with accuracy, as the largest electrical-equipment building plant in the world. As planned, it comprised 14 separate but integrated factories with an aggregate annual output value of 2 billion rubles, seven times greater than that of all existant Soviet electrical

[22] *Ibid.*

equipment manufacturing plants. Employment was over 100,000, with about 12,500 engineers and technicians. The combine had its own city of 300,000 inhabitants.[23]

Two of the main shops at Urals Elektromash were the turbo-generator shop, with an annual production of 38 large steam generators of 50,000 to 160,000 kilowatts, and a machine-building shop for production of large modern mechanical equipment for mining and heavy industry, such as rolling-mill motors and generators. The transformer shop specialized in production of equipment in excess of 200,000 volts. A general apparatus shop produced oil switches, circuit breakers, electrical switchgear, crane and motor control apparatus, and similar units. A cable shop produced cable for other shops of the combinat.[24]

Amtorg summarized Western assistance as follows: 'Prominent American and British specialists are participating as consulting engineers in designing the plant. . . . The combine will employ the most modern machinery and technique.'[25]

THE RADIO CORPORATION OF AMERICA AGREEMENTS, 1927–41

In 1927 the Radio Corporation of America concluded an agreement with the Soviet Union for extensive provision of technical assistance and equipment in the radio communications field.[26] RCA was 'frequently consulted by the Soviets in the construction of radio stations' and the Soviet Radio Delegation to the U.S. in 1930 was able to visit a number of American radio stations 'under the auspices of the Radio Corporation of America.'[27]

In 1935 the VEO proposed another general agreement[28] whereby RCA would furnish 'engineering, technical and manufacturing information in those portions of the radio field in which RCA is or may be engaged.'[29] On September 30, 1935, RCA concluded an agreement[30] and approached the State Depart-

[23] Amtorg, *op. cit.*, VI, No. 18 (September 15, 1931), p. 426.

[24] 'Der Plan des Elektromaschinenwerks im Ural,' *Sowjetwirtschaft und Aussenhandel*, 1931, pp. 34–6.

[25] The American and British specialists were almost certainly from General Electric and Metropolitan-Vickers (the Westinghouse subsidiary), but the writer has no firm evidence at this point concerning their work at Elektromash in the Urals. Both General Electric and Metropolitan-Vickers are very reticent concerning their work in the U.S.S.R.

[26] See Sutton, *Western Technology . . ., 1917 to 1930*, pp. 250–2.

[27] Amtorg, *op. cit.*, V, No. 21 (November 1, 1930), p. 435.

[28] U.S. State Dept. Decimal File, 861.74 RADIO CORPORATION OF AMERICA/19–20.

[29] *Ibid.*, 861.74 RADIO CORPORATION OF AMERICA/20.

[30] A copy of the agreement is in U.S. State Dept. Decimal File, 861.74 RADIO CORPORATION OF AMERICA/30 and in 811.20161/52.

ment for permission, with the argument that if the agreement was not made with RCA then VEO would go to its European competitors. The Departmental reply indicated the 'proposed agreement will not be contrary to any policy of our government.'[31]

The extensive contract emphasized technical assistance and included 'the entire field of manufacturing and experimental activities of RCA and its subsidiaries. . . .'[32] The fields of technology to be transferred included both radio and television transmission and reception, electro-vacuum apparatus, sound recording, sound motion picture equipment, measuring apparatus, and remote control apparatus. RCA made a related agreement with Glavesprom (People's Commissariat of Heavy Industry), and Soviet personnel were sent to the United States for training.[33] A payment of $2.9 million was made to RCA and it was further agreed that the Soviets would purchase quantities of equipment from the company.

In 1938 eight RCA engineers were in the U.S.S.R. supervising installation of this equipment. In exchange for the purchase of $230,000 worth of RCA television equipment and $825,000 worth of related equipment, including some for military use, RCA also supervised erection of a television station.[34] The RCA Chief Engineer, L. F. Jones, was unable to complete installation, however, as Soviet construction organizations had not completed the building and materials supplied by Soviet plants were not delivered in time to complete the project by the agreed date of January 1, 1938.[35]

In particular, work was delayed on the station antenna. Jones did not want to report this to the Soviet authorities for fear the Soviet engineer on the job would be arrested as a 'wrecker.' Previous delays had been reported, however, and the Soviet engineer—not in any way to blame—was arrested a few days later on charges of wrecking activities. This delayed the work even further, as a second Russian engineer had to be trained. Thus in this instance RCA negotiated an extension of this section of the general agreement to avoid repetition of the accusation of wrecking and further delays.[36]

In 1939 the RCA agreement was extended to September 30, 1941,[37] but in

[31] U.S. State Dept. Decimal File, 861.74 RADIO CORPORATION OF AMERICA/21.

[32] *Ibid.*, 861.74 RADIO CORPORATION OF AMERICA/30, November 26, 1940.

[33] *Ibid.*, p. 6.

[34] U.S. State Dept. Decimal File, 861.74 RADIO CORPORATION OF AMERICA/26, Report No. 1283, Moscow Embassy, May 14, 1938.

[35] *Ibid.*, 861.74 RADIO CORPORATION OF AMERICA/25, Report No. 707, Moscow Embassy, November 10, 1937.

[36] *Ibid.*, Attachment to Report No. 707, Moscow Embassy, November 10, 1937, Memorandum of Statements. See also Metropolitan-Vickers below, p. 171.

[37] U.S. State Dept. Decimal File, 861.74 RADIO CORPORATION OF AMERICA/28, Memorandum, Division of Controls, August 3, 1939.

April 1941 this extension was modified and limited to May 31, 1941.[38] The annual charge for technical assistance had been $120,000; this figure was reduced to $77,777 on July 27, 1939. A further request by Kalinin, a Soviet leader, in April 1941 for a reduction of the fee was turned down by RCA.[39]

THE INTERNATIONAL GENERAL ELECTRIC COMPANY TECHNICAL-ASSISTANCE AGREEMENT OF 1929

On May 24, 1929 the Soviet Union ratified an agreement signed by Amtorg and International General Electric Company—by far the most important single agreement in the development of the Soviet electrical equipment industries.

The contract provided for a 'broad exchange of patents as well as exchange of designing, engineering and manufacturing information' for a period of 10 years. In practice the 'exchange' was a one-way transfer; this is clear from the second and third paragraphs of the formal announcement. The second paragraph stated that:

> American engineers will be sent to the Soviet Union to assist the Soviet Electrotechnical Trust in carrying out its plans of expansion of the electrical industry, in all its phases. The engineering assistance to be rendered by the International General Electric Company will involve the construction of electrical apparatus and machinery for use in electric lighting. . . . Soviet engineers will visit this country to study American methods employed in the manufacture of electrical equipment and its application to industry.[40]

The diffusion of General Electric technology within the Soviet Union from 1929 until the end of World War II was extraordinarily extensive. The following summary lists plants where this technology was transferred directly, i.e., with the help of General Electric engineers; it does not include those plants and industries benefiting from an indirect infusion of equipment made in plants with General Electric technical assistance.[41]

According to General Electric engineers then working in the Soviet Union, the Soviets had 'full rights to all patents and working drawings of the American

[38] *Ibid.*, 861.74 RADIO CORPORATION OF AMERICA/38, Letter, RCA to State Dept., April 30, 1941.

[39] *Ibid.*, Letter, RCA to Kalinin.

[40] Amtorg, *op. cit.*, IV, No. 11 (June 1, 1929). This contract was in addition to a previous contract concluded in 1928 which covered purchase of $26 million worth of General Electric equipment over a period of several years with credit terms of five years granted by General Electric. See Sutton, *Western Technology . . ., 1917 to 1930*, p. 198.

[41] This supply of equipment was considerable. For example, in the case of the Dniepr Dam, General Electric supplied enough oil circuit breakers to occupy 50 railroad cars. [Amtorg, *op. cit.*, VI, No. 20 (October 15, 1931), p. 465.]

concern.'[42] Although the equipment had been designed by Americans, most of it came from Siemens in Germany and some from British and French manufacturers. At the time, Amtorg noted that 'much of the American equipment purchased in past years is used by the Soviets as models for the construction of similar machinery in their own plants.'[43]

Table 10–1 PARTIAL LIST OF PLANTS AND ACTIVITIES BENEFITING FROM DIRECT INTERNATIONAL GENERAL ELECTRIC TECHNICAL ASSISTANCE*

Magnitogorsk Iron and Steel Combine	VEO
Kazakhstan Copper Combine	Elektrozavod (Moscow)
Leningrad Electro-Technical Institute	Izolit Insulation Plant
Glavenergo (Leningrad)	Electric Welding Equipment Plant
Stalin Automobile Plant (Moscow)	Elektroapparat Plant
Elektrosila Plant (Leningrad)	KHEMZ Turbine Works
Grozneft oil fields	Elektroprom
Ukraine coal mines	Kuznetsk Steel Combine
Lena gold mines	Azov Steel Mill
Balakhna Paper Combine	Tomsky Steel Mill
Zaporozhstal Works	Dzherzhinsky Steel Mill
Baku oil refineries and oil fields	Orsk Benzine Cracking Plant
Suram Pass section of Transcaucasian Railroad	Zaporozhe Aluminum Plant
Dynamo Electric Locomotive Plant (Moscow)	Elektrik
	Dniepr Dam

Source: The Monogram, November 1943.
* Excluding power stations.

Unfortunately the General Electric Company instructed its engineers not to discuss conditions in the U.S.S.R. with State Dept. officers, and corporate files covering work in the U.S.S.R. have been destroyed.[44] Thus the only record is from those engineers who, when interviewed by State Dept. officials, 'forgot' their instructions and gave details of their work. For these reasons our knowledge is fragmented.

42 *Ibid.*
43 *Ibid.*
44 U.S. State Dept. Decimal File, 861.5017—Living Conditions/428. Unfortunately, General Electric engineers mostly abided by this corporate injunction. For example, H. H. Fisher contacted (for his 1934 Hoover Institution study) a number of General Electric engineers, but only two replied; O. B. Bemis said that he had worked for G.E. on the Dniepr Dam (see Folder 1) and C. Thomson, G. E. chief erector, in a 1934 letter indicated that he had worked on the Stalingrad stations and at Dnieprstroi, adding that he might have to return, so that 'tact plus the danger of involving my Company in an unpleasant situation bars me from making any statements.' A subsequent letter, January 9, 1936, added nothing new to the 1934 letter. (See correspondence folder.)

We do know that one group of seven engineers worked at VEO offices in in Moscow designing steel mill equipment for location in the Urals and Siberia. The equipment itself was supplied by General Electric and Siemens Schukert.[45]

The General Electric adviser on transfer of electric welding technology, particularly important in shipbuilding and submarines, was E. J. O'Connell.[46] With the assistance of the company, a number of new welders were developed: multi-operator machines of 1,500-ampere capacity, automatic welders, spot welders, butt welders, and roller welders. Expanded in the early 1930s, the Elektrik Plant (Moscow) became the principal supplier of welding machines. Electric welding was then used extensively in shipbuilding, submarine construction, steel construction, machine-building, and boiler manufacturing.

One consulting General Electric power plant engineer, Solomon Trone, spent about six months of every year from 1927 to 1933 in the U.S.S.R. and claimed that in his work he visited 'nearly every important electrical project.'[47] The inference that General Electric equipment became the Soviet standard throughout the country is not unbelievable. It is supported by the fact that the writer has found no evidence of indigenous Soviet development in the electrical-equipment field.

It is also a reasonable inference that General Electric transferred the latest technology under its various assistance agreements. For example, in 1938–9 the General Electric Company was negotiating the sale of $500,000 worth of General Electric equipment 'including high power transmission lines of a higher voltage capacity than any in use in the United States except on the Boulder Dam project,'[48] and in 1944–5 the General Electric Company made a second set of generators for the Dniepr Dam, but more advanced and of greater capacity than generators supplied by the company more than a decade previously.[49]

THE BROWN INSTRUMENT COMPANY TECHNICAL-ASSISTANCE AGREEMENT

Problems in developing instrument-manufacturing technology noted by Mr. 'A' and others[50] led to a second agreement with an American manufacturer

[45] U.S. State Dept. Decimal File, 861.5017—Living Conditions/515.
[46] *Ibid.*, 861.5017—Living Conditions/421. In accordance with Company instruction O'Connell would not discuss technical aspects of his work with the State Dept. officer.
[47] *Ibid.*, 861.5017—Living Conditions/616.
[48] *Ibid.*, 861.6463/68.
[49] See p. 168. The interested reader should also see the November 1943 issue of *The Monogram* (published by the General Electric Company), which supports these arguments in great detail. The *General Electric Review* also published a few articles in the 1930s which give support.
[50] See p. 150.

of recording instruments, but only after the Soviets had tried unsuccessfully to copy the company's instruments.

The technical-assistance contract with the Brown Instrument Company was signed in January 1936 for three years and included 'furnishing measuring instruments and instruction to the Soviet heavy industries.'[51] Instruction was given to Soviet engineers in the U.S. plants of the company and in Soviet plants. In the words of M. Mark Watkins, Brown Export Division Sales Manager, instruction was for 'learning the intricacies of making recording instruments. . . .' The purchase of at least $500,000 worth of instruments was contingent upon provision of this instruction. Watkins noted that there was a considerable demand for such instruments in the steel and oil industries but that the Soviets were not yet technically equipped to make them. This observation was based on

> . . . the fact that during his travels in the Soviet Union for the last month he has seen many copies of the Brown instruments made in this country and they were so poorly constructed and were working so inefficiently that he was convinced that the Soviet authorities had signed the technical aid contract with his firm since they had been unable to copy their instruments satisfactorily. . . .[52]

Another contract, rather similar to the Brown contract, was made by J. J. Higgins, an engineer with patents in the field of electrical equipment. This contract with GET (State Electro-Technical Trust) and the Moscow lamp works required Higgins to provide technical assistance in the manufacture of incandescent lamps and radio tubes and to undertake the design work for these products. Higgins, having spent 20 years with the Westinghouse Company in the United States, was well qualified for such work.[53]

THE GREAT NORTHERN COMPANY TELEGRAPH CONCESSION[54]

Maintaining one of the very few foreign concession operations to survive the 1920s, Great Northern Telegraph operated its international telegraph concession from 1919 until the late 1930s. This Danish company was given the 'exclusive concession for an indefinite period to provide service from all points in the Union of Soviet Socialist Republics to all foreign countries except Finland.'[55] The agreement was revocable by either party on six months' notice. The company handled about eight million words a year in the 1930s, all in international messages.

[51] U.S. State Dept. Decimal File, 861.602/278.
[52] *Ibid.*
[53] *American Engineers in Russia*, Fisher material.
[54] See Sutton, *Western Technology . . ., 1917 to 1930*, pp. 249–50.
[55] U.S. State Dept. Decimal File, 861.72/13.

Great Northern had numerous offices in the Soviet Union, each under a Danish manager, with a total employment of about 200; the Moscow office employed 23, including 10 Danes. There was an even larger staff in Leningrad. In 1935 it was reported that there was no real friction between the Soviets and the company, although the Soviet Government did operate its own radio and land lines for most government messages, thus infringing on the agreed concession monopoly. However, the company's relative efficiency operated to its advantage; Great Northern handled messages from London to Moscow in five to six minutes, whereas the Government transmissions 'usually require hours'; Moscow-New York was handled by the company in one hour, but by the Soviet offices in two to ten hours.

Accordingly, the commercial, diplomatic, and even official Soviet traffic went Great Northern, and the Government was not seen as a serious competitor. It was 'an interesting fact that official government messages written in illegible longhand and those containing texts difficult to transmit, frequently are given to the Company although not intended for Company transmission by the sender.'[56]

AMERICAN, BRITISH, AND CANADIAN LEND-LEASE SHIPMENTS

Shipments under United States Lend-Lease were considerably greater than either British or Canadian shipments of electrical generating stations. George Jordan notes that 17 stationary steam stations and three hydroelectric power stations were sent with a value in excess of one-quarter billion dollars.[57]

According to the State Department, power plants were supplied both for the reconstruction of damaged plants in recaptured areas and for new plants behind the Urals. Up to September 1945, $135 million worth of equipment was shipped, with another $32 million worth following under the agreement of October 15, 1945. A more revealing way of looking at this is in terms of physical capacity; the total capacity supplied was 1,457,274 kilowatts, divided as follows:[58]

Stationary steam plants	631,939 kilowatts
Stationary diesel plants	327,498 kilowatts
Railroad power trains, steam	267,500 kilowatts

[56] *Ibid.*

[57] Jordan, *op. cit.*, p. 51. He gives the figures as $263,289,000; the State Department as $178,000,000. There were additional shipments under the October 15, 1945 'pipeline agreement' to be covered in Sutton, *Western Technology and Soviet Economic Development, 1945 to 1965.*

[58] U.S. State Dept. *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945), p. 16.

Trailer-mounted diesel plants	72,945 kilowatts
Railroad power cars, diesel	103,000 kilowatts
Hydroelectric stations	54,392 kilowatts

In 1944 the General Electric Company received a contract to build another nine hydroelectric turbogenerators to fit the same foundations at the Dniepr Dam as the original General Electric installation in 1931; however, as designed, the generators produced 15 percent more energy and the systems were re-engineered by General Electric to incorporate the 15 years of technical advances since 1930.[59] There is no question that this assistance was vitally needed; the Moscow Embassy reported in 1943 that the 'extreme importance attached to delivery of equipment for Soviet hydro-electric stations was the subject of special request by Mikoyan.'[60]

Altogether about two million kilowatts of generating capacity was supplied before the end of 1945 under the U.S., Canadian, and British Lend-Lease programs to the Soviet Union. The capacity lost in German-occupied areas was fully replaced.

Although a large number of power stations were sent under U.S. and British Lend-Lease, there is no record of their final location in the Soviet Union. We can deduce some possible end-uses from a comment by the British Thomson-Houston Company of the United Kingdom:

> . . . normal peace-time products of the B.T.H. Company were urgently required for war production purposes. . . . Equipment for five complete power stations was sent to Russia, as well as a large number of 500 kW transportable turbo-generators, which were used for supplying electricity to damaged towns as they were re-taken from the enemy. . . .[61]

Altogether, 40 of these transportable turbogenerators, each suitable for supplying a complete town with electricity, were supplied.

Up to mid-1944, Canadian companies supplied equipment valued at $25 million for eight or nine hydroelectric power stations[62] under Lend-Lease. The United Kingdom also supplied equipment valued at about $30 million for about a dozen power stations.[63]

[59] *Electrical World*, October 21, 1944, p. 6. The original General Electric turbines had been removed in 1941 and relocated east of the Urals.

[60] U.S. State Dept., 861.24/1564, Telegram 809, Moscow to Washington D.C., July 6, 1943.

[61] H. A. Price-Hughes, *B.T.H. Reminiscences: Sixty Years of Progress* (B.T.H. Ltd.: 1946), p. 111–2.

[62] *Electrical Review*, June 23, 1944, p. 887. There is an unsubstantiated report that the U.S.S.R. established a purchasing agency in Canada in 1944 for H.E.P. equipment. See U.S. State Dept. Decimal File, 861.24/1775a, April 22, 1944.

[63] *Electrical Review*, May 19, 1944, p. 690. This question will be taken up in Sutton, *Western Technology and Soviet Economic Development, 1945 to 1965*.

FOREIGN EQUIPMENT AND SUPERVISION FOR CONSTRUCTION OF LARGE POWER STATIONS

In 1933 the Soviet Union had 10 power stations operating with generating capacity in excess of 100,000 kilowatts; these were Kashira, Shterovka, Shatura, Krasnyi Oktiabr' in Leningrad, Moges in Moscow, Zuevka, Dniepr, Nivges at Gorki, Chelyabinsk, and Krasnya Zvesda at Baku. Table 10–2 illustrates the extensive, if not complete, utilization of Western equipment installed under foreign supervision.

Table 10–2 FOREIGN EQUIPMENT IN LARGE POWER STATIONS OPERATING IN 1933*

Power Station	*Capacity (Kilowatts)*	*Western Equipment*
Kashira	186,000	Babcock & Wilcox boilers (enlargement of tsarist station)
Shatura	136,000	Metropolitan-Vickers,[9] Brown-Boveri turbo-generators[10]
Moscow (Moges)	107,000	Metropolitan-Vickers turbines[1]
Krasnyi Oktiabr' (Leningrad)	111,000	Metropolitan-Vickers turbines and boilers,[4] German and Swedish transformers and circuit breakers,[4] U.S. insulators on high tension lines[4]
Shterovka	157,000	Metropolitan-Vickers (2 turbo-generators), Brown-Boveri (2 turbo-generators), Siemens-Schukert (2 turbo-generators)[6]
Zuevka	150,000	Metropolitan-Vickers turbines[1]
Dniepr	310,000	Newport News turbines[3]
Gorki	158,000	Metropolitan-Vickers turbo-alternators,[7] AEG[8]
Chelyabinsk	110,000	Metropolitan-Vickers turbines[1]
Baku	109,000	Siemens-Schukert turbines,[2] Metropolitan-Vickers generators[9]

Sources: Stations in operation: *Pravda*, No. 13, January 13, 1933.

Western origins:

[1] Great Britain, *Correspondence Relating to the arrest . . .*, Command Paper 4286 (London, 1933).

[2] *U.S.S.R. in Construction*, No. 3, March 1932.

[3] Sutton, *Western Technology . . ., 1917 to 1930*, p. 204.

[4] *The Electrician*, April 11, 1930, p. 464.

[5] Sergei Koptewski, *The Costs of Construction of New Metallurgical Plants in the U.S.S.R.* (New York: East European Fund, Inc., 1952).

[6] Allan Monkhouse, *Moscow 1911–1933* (Boston: Little, Brown & Co., 1934).

[7] Amtorg, *op. cit.*, V, No. 11 (June 1, 1930), p. 224.

[8] *Ibid.*, VII, No. 7 (April 1, 1932), p. 164.

[9] *Ibid.*, V, No. 20 (October 15, 1930), p. 400.

[10] *Ibid.*, No. 18–19 (October 1, 1930), p. 365; VI, No. 8 (April 15, 1931), p. 178.

* Includes all stations over 100,000 kW.

It is from Allan Monkhouse, Metropolitan-Vickers Chief Engineer in the U.S.S.R., that we derive information concerning skilled engineering and operating labor for power stations. Monkhouse suggested in 1935 that the prewar 'technical intelligentsia' in electrical power generation was not 'decimated' (as in other sectors) and that from 1923 onwards electrification plans were put into effect by those who had held similar responsible positions before the Revolution. In addition, by this time the Soviets had 'turned out many thousands of young men trained in the rudimentary theories of electrical engineering.' Monkhouse makes an interesting comment:

> With regard to skilled workmen, this has not been as serious a difficulty in the building and operation of power stations as might be generally thought because during the constructional periods the main responsibility for skilled workmanship fell upon the erectors sent to the U.S.S.R. by foreign contractors; and of course, once the stations are complete there is not a great deal of work about a power station which necessitates employing highly skilled workmen.[64]

If the reader combines the Monkhouse statement above with data in table 10–2 on the origin of power station equipment, he will readily envisage the primary role of Western contractors in Soviet power-station construction.

The Metropolitan-Vickers Company of the United Kingdom was probably the most important single foreign firm in the electrification of the Soviet Union.[65] Between 1921 and 1939 the company handled about $25 million worth of contracts in the U.S.S.R. involving installation of one million kilowatts of electrical generating capacity as well as other electrical equipment and the provision of technical assistance in the construction of steam turbines, generators, and other types of electrical equipment.[66] The company, according to its own history, trained 'large numbers of Russian engineers' at its works in the United Kingdom.[67] The importance of Metropolitan-Vickers may be gleaned from a series of articles in the London *Times* relating to the arrest of Metropolitan-Vickers engineers in Moscow in 1933 on charges of espionage:

> The Metropolitan-Vickers Company has been continuously engaged in Russia since 1923 and to a greater extent than any other British firm has worked on the electrification of that country. Over a period of ten years about 350 British subjects have from time to time been employed by the Company there, and the plant it has installed in Russia is said to be equivalent to one-sixth of the total generating plant of all kinds in Great Britain. . . .[68]

[64] Allan Monkhouse, 'Electrical Development in the U.S.S.R.,' *Proceedings of the Institute of Electrical Engineers* (London), LXXVI, No. 462 (June 1935), p. 641.

[65] See Sutton, *Western Technology . . ., 1917 to 1930*, pp. 199–200.

[66] J. Dummelow, *1899–1949* (Manchester: Metropolitan-Vickers Electrical Co., Ltd., 1949).

[67] *Ibid.*, p. 121.

[68] 'The Moscow Trial, New Light on the Case of 1933,' reprinted from the *Times* (London) of May 22, 23, 24, 25, 1933.

The company certainly had its share of problems. After the company had worked for ten years on Soviet electrical projects, its engineers were arrested in 1933 in a raid reminiscent of the 1930 Lena Goldfields raids by the OGPU. The arrests were part of a widespread purge of 'wreckers' although the technical problems reported in the British press appear to have been similar to the usual 'teething problems' of all new plants, as the *Times* noted.

There is some confusion concerning the 1933 Metropolitan-Vickers case, unlikely to be solved until the British Foreign Office records are examined.[69] There is no question that Metropolitan-Vickers, like other foreign firms and engineers working in the Soviet Union, tried to protect Russian engineers, insofar as they could, from absurd charges of sabotage and wrecking. Russian engineers were taking the blame for the ineptitudes and failures of central planning. In this regard,

> the Metropolitan-Vickers Company habitually took the blame for such defects as occurred and made a practice of replacing parts long after the maintenance period had expired, irrespective of whether the defects were the fault of the Company or, as was more frequently the case, were due to the inefficiency of the customers operating staff. . . .[70]

It was the pressure from the Party to rush installation and operate equipment far beyond its safety limits that was leading to breakdown. The British installation engineer, Gregory, for example, regarding the outdoor switchgear and the 12 oil circuit breakers of 165 kilovolts each for Dnieprstroi, says, 'These switches are the largest switches that have ever been made by our Company. The largest switches erected in Russia. . . .'[71] Given all the known difficulties in installing such new and major equipment of this type, the Soviets still blamed Gregory for faulty installation, after themselves attempting to rush the job. Gregory pointed out in his defense that the oil filters were very difficult to obtain and that there was a lot of work to be done.

> So it really amounted to this, that in spite of the delays there were three switches completed in 48 days. These switches were 45 tons each. So now I will leave that to the technical experts to judge whether those switches were done in good time, and whether if done in a shorter time, they would be done properly. . . .[72]

[69] The British Government records became available after this book went to press. Extensive information is listed in *Index to the Correspondence of the Foreign Office for the Year 1933* (Kraus-Thomson, Nendeln/Liechtenstein, 1969) and *Index to "Green" or Secret Papers* (Kraus-Thomson, Nendeln/Liechtenstein, 1969), under both Metropolitan-Vickers, Ltd., and names of individual company engineers.

[70] 'The Moscow Final, New Light on the Case of 1933,' reprinted from the *Times* (London) of May 22, 23, 24, 25, 1933, p. 12.

[71] Dummelow, *op. cit.*, p. 150.

[72] State Law Publishing House, *Wrecking Activities at Power Stations in the Soviet Union*, II, p. 111.

Table 10–3 MAIN PLANTS MANUFACTURING ELECTRICAL EQUIPMENT IN COMMISSARIAT OF HEAVY INDUSTRY, 1933

Name of Plant	*Product*	*Western Technical Assistance (1929–33)*
Leningrad District		
Stalin Metal works	Steam boilers Steam turbines	Babcock & Wilcox Metropolitan-Vickers
Elektrosila works	Turbo-alternators Generators Rolling-mill motors Mercury-arc rectifiers Marine equipment	International General Electric
Elektrik	Electric welding equipment Induction furnaces	International General Electric
Elektroapparat	Heavy switchgear	International General Electric
Elektropribor	Switchboards Instruments (industrial) Sperry gyroscopes	Brown Instrument Co. Sperry Gyroscope Co.
Radio works	Radio equipment X-ray apparatus	Compagnie de TSF
Svetlana works	Rectifiers Radio receiving valves	AEG (Germany) Siemens-Schukert
Krasnyi Zoria telephone works	Telephone equipment	Ericsson (Sweden)
Moscow District		
ATE works	Electrical equipment for automobiles and tractors	AEG
Transformer works	Transformers	Siemens-Schukert Sperry Gyroscope
Lamp works	Lamps Neon-tube advertising signs Sodium lamps	International General Electric
Electric furnace shop	Electric arc furnaces	Vom Bauer
Dynamo works	Traction equipment Locomotives	International General Electric
Projector and domestic equipment works	Projectors	W. Coffman & Co.
Isolator works	Electrical porcelain Electrical insulating materials	Vakander International General Electric
Moscow Röntgen works	X-ray equipment	Compagnie de TSF
Elektrougli	Brushes Batteries	Ex-AGA concession
Electric lamp works	Electric lamps Valves	J. J. Higgins (U.S.)

Table 10-3 (Continued)

Name of Plant	*Product*	*Western Technical Assistance (1929–33)*
Other Districts		
Revtrud works	Train-lighting sets Locomotive head lamps	 Not known
KHEMZ	Large motor generators Industrial motors Industrial switchgear and control gear Relays Meters Steam turbine	General Electric General Electric Metropolitan-Vickers General Electric
Volta Works	Motors Industrial equipment	 Not known
Uralmash	Electrical equipment	See text

Sources: Plants and products: Monkhouse, *op. cit.*
Technical assistance: see text.

Metropolitan-Vickers was the major influence in almost all power projects besides the Dniepr Dam (a General Electric-Newport News project). However, there were also a few foreign engineers on individual contracts for design and supervision of dam construction. B. E. Torpen worked on hydroelectric design and construction in the Don Basin for about three years.[73] Major G. R. Olberg was requested to supervise construction of the Mingechaur Dam in Azerbaidjan, as large as the Coolidge Dam in the United States. This contract was apparently terminated during the valuta crisis.[74] Two governments supplied advice and aid: four Swedish experts from the Stockholm Hydraulic Bureau came to assist construction of the Svir Dam,[75] and the United States Government supplied 'drawings, photostats and specifications of machinery' used on the Fort Peck and Sardis Dams in the U.S.[76]

Space precludes a thorough examination of smaller power stations, but some examples will suggest the number of such stations receiving foreign equipment; figure 10–3 also illustrates the impact of foreign equipment for one grid area, Leningrad. The Kusnetsk Iron and Steel Plant had two 6,000-kilowatt Rateau turbines and four 24,000-kilowatt Wumag main turbines. The condenser equipment was German but the generators were Soviet-built, probably at Elektrosila.[77] The Krasnyi Oktiabr' metallurgical plant at Stalin-

[73] *American Engineers in Russia*, Folder 3, Item 7.

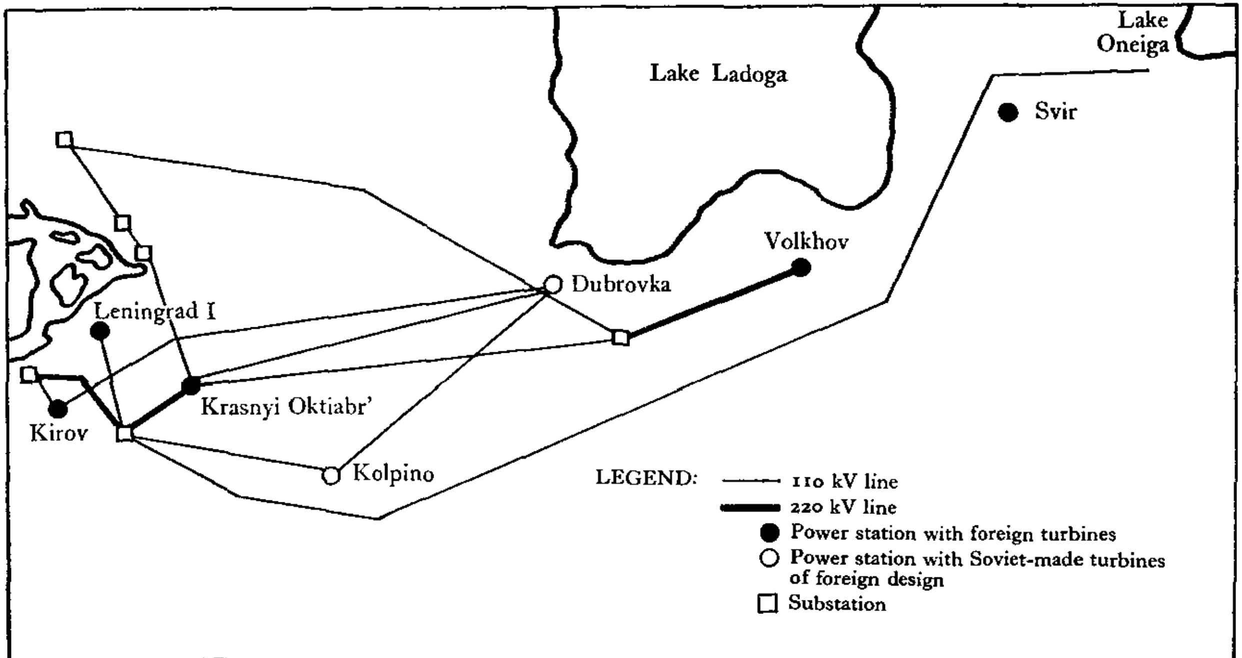
[74] *Ibid.*, Item 14: see also U.S. State Dept. Decimal File, 861.5017—Living Conditions/602.

[75] U.S. State Dept. Decimal File, 861.6463/44.

[76] *Ibid.*, 711.00111 Armament Control/1525.

[77] *Far Eastern Review*, January 1933.

Figure 10–3 ORIGIN OF STEAM AND HYDRAULIC TURBINES IN THE LENINGRAD GRID SYSTEM, 1930–44



Source: Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), *Schema des 220 und 110 kV Leitungsnetz von Leningrad: Karte II*, National Archives Microcopy T 84–122.

grad had three 2,230 MAN diesel engines coupled with AEG 1,610-kilowatt a.c. generators.[78] The Leningrad metal works had Metropolitan-Vickers turbines.[79] Plant 1 at Leningrad had five German 15,000-kilowatt turbines and one English turbine.[80] Plant 5 (Krasnyi Oktiabr') at Leningrad had Metropolitan-Vickers equipment.[81] The Svir hydroelectric station had four vertical Kaplan turbines: three from Sweden and one made by Lenmash.[82] The Volkhov plant had eight Swedish Francis vertical turbines coupled to four Swedish and four Soviet generators.[83] The Magnitogorsk Iron and Steel Plant power stations had two Bergman and one AEG turbine coupled with a Soviet-built turbine.[84] The Kalinin station had two Brown-Boveri turbines coupled with two from Elektrosila.[85] The Orechevo-Suchevo station near Moscow had Metropolitan-Vickers turbines.[86]

After about 1933, power stations began to receive Soviet-built standard turbines and generators based on foreign designs and built in the U.S.S.R., at first with foreign technical assistance and then completely as Soviet undertakings. These were of standardized sizes.[87]

Much of the Don Basin equipment was destroyed or evacuated in 1941 and the Germans were not completely successful in restoring the electric power generation industry in the occupied areas. According to one report, probably written in July and August of 1943, the Germans had restored about one-fifth of electric power capacity in the occupied territories, or about 500,000 kilowatts of operating capacity (against an original installation of 2.5 million kilowatts).[88]

78 *Izvestia Vsesoyuznogo Teplotechnicheskogo Instituta*, No. 1, 1931, p. 10.
79 Monkhouse, *op. cit.*, p. 185.
80 Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Plant No. 21, National Archives Microcopy T 84–122–1421674/749.
81 *Electrician*, April 11, 1930.
82 Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Plant No. 44, National Archives Microcopy T 84–122–1421674/749.
83 Monkhouse, *op. cit.*, pp. 138–41.
84 Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Plant No. 313.
85 *Ibid.*, Plant No. 50.
86 State Law Publishing House, *op. cit.*, p. 62.
87 See p. 154.
88 Breakdown of the figures does not indicate any particular preference for restoration of industrial, mine, armament, or town electrical power supply systems. Restoration was accomplished as follows:

District power supply	21.8 percent of original installation
Local power supply	15.9 percent of original installation
Mines (original plant very small)	0 percent of original installation
Foundries	21.5 percent of original installation
Iron and steel works	23.3 percent of original installation
Industry	16.4 percent of original installation

Source: Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, National Archives Microcopy T 84–122–1421745.

CONCLUSIONS

There was a considerable manufacturing of electrical equipment in tsarist Russia; the facilities were later re-equipped and expanded and then supplemented by several giant new manufacturing plants. This program was undertaken in close cooperation with internationally known companies, including International General Electric, Metropolitan-Vickers, and RCA. Two plants, the KHEMZ and the Urals Elektromash, were truly gigantic—much larger than the main home plants of General Electric and Metropolitan-Vickers. Agreements with RCA, Sperry Gyroscope, Brown Instrument Company, and others provided assistance in specialized areas.

The 10 largest power stations built by 1933, in addition to numerous smaller stations, had Western equipment; later stations received equipment that was Soviet-made to standardized Western designs.

It is not an exaggeration to say that by 1945 Soviet electrical equipment was completely based on Western (mainly General Electric) models. This is one sector where a truly remarkable pattern comprising thousands of transfers can be precisely identified.

CHAPTER ELEVEN

Technical Assistance to the Automobile and Tractor Industries

DEVELOPMENT OF AN AUTOMOBILE INDUSTRY

THE Soviet automobile industry before 1930 was limited to production of the prerevolutionary Fiat light truck, utilizing imported parts. After 1930 the industry relied completely on American technical assistance. One completely new plant, the Gorki, was built under Ford Motor Company supervision in the early 1930s[1] and two tsarist plants in Moscow and Yaroslavl were expanded and completely re-equipped with up-to-date American machine tools. These three plants, together with a smaller Moscow assembly plant which opened in 1940, constituted the Soviet automobile industry before World War II.

THE AMO PLANT IN MOSCOW

This tsarist plant, owned by Ryabushinski and Kuznetsov before the Revolution, was still producing a few 1912-model Fiats (the original model) in early 1929. In mid-1929 the A. J. Brandt Company of Detroit undertook an extensive two-year reorganization and expansion of Amo, which was then renamed Automobile Works No. 2 (Stalin), and is today known as the ZIL (plant im. I. A. Likhachev). This plant produced 50,000 medium-sized trucks per year, in addition to large automobiles and buses. The early Amo-Fiat models were hand-built. The reconstructed plant mass-produced the ZIS 5 and ZIS 6 trucks (i.e., the Autocar 2½-ton truck) until 1944 and the heavy ZIS 101 and ZIS 102 automobiles until 1941. Both were based on U.S. designs and specifications.[2]

[1] The important Ford Motor Company agreement of 1929 to build the Gorki plant is described in Sutton, *Western Technology . . . 1917 to 1930*, pp. 243–9: the equally important Fiat agreement of 1966, which transfers mainly U.S. (not Italian) machine tools, will be covered in Sutton, *Western Technology . . . 1945 to 1965*.

[2] Alexander Barmine, *One Who Survived* (New York: G. P. Putnam, 1945), p. 237.

This Brandt-built plant was described by Carver, a skilled American observer, as 'by far the largest and best-equipped plant in the world devoted solely to the manufacture of trucks and buses. Basically, the equipment is the last word in American practice.'[3]

A similar comment was made by C. P. Weeks, Vice-President of Hercules Motor Corporation (Canton, Ohio). After a four-hour tour of the expanded Amo, Weeks commented that it was superior to both the Mack and White plants and was 'the best-equipped plant in the world.'[4] Amo was further described by Carver as follows:

> From the forge shop, which is equipped with batteries of steam and board drop hammers, forging machines and furnace equipment, and the foundry with its bull ring, continuous pouring floor, sand conditioners, etc., through to final assembly and finishing department, no detail has been missed. The press room is a dead ringer for some of ours. . . .'[5]

The production equipment was entirely American and German.[6] In late 1929 Amtorg placed an order on behalf of Amo with the Toledo Machine and Tool Company for $600,000 of cold-stamping presses.[7] In 1932 an order was placed with Greenless Company of Rockford, Illinois for multi-cylinder lathes.[8]

In 1936 a second technical-assistance agreement was concluded for Amo with the Budd Manufacturing Company of Philadelphia and the Hamilton Foundry and Machine Company of Ohio to produce 210,000 chassis and bodies per year for a new ZIS-model automobile.[9]

The Budd Company sent engineer R. L. Adams and two shop men to supervise installation of $1 million worth of dies made by the company for ZIS production. One feature of the contract which intrigued the Budd Company was a requirement that 100 finished sets of body stampings were to be made from the dies *in the United States* and shipped with the dies. These were to be used to build 100 ZIS automobiles under the supervision of Budd engineers in the Soviet Union to celebrate the 1936 anniversary of the October Revolution. The Hamilton Foundry supplied the presses required for follow-on fabrication of sheet metal for bodies and chassis in the Soviet Union.

In spite of this assistance, troubles were encountered in producing the Autocar model, although blueprints and technical advice had been freely

3 W. L. Carver, 'AMO and Nizhni-Novogorod Plants Lead Soviet Plans,' *Automotive Industries*, LXVI (March 12, 1932), pp. 418–9.

4 U.S. State Dept. Decimal File, 861.5017—Living Conditions/307.

5 Carver, *op. cit.*, pp. 418–21.

6 Amtorg, *op. cit.*, VI, No. 21 (November 1, 1931), p. 489.

7 *Ibid.*, IV, No. 20 (October 15, 1929), p. 372.

8 *Ibid.*, VII, No. 8 (April 15, 1932), p. 176.

9 U.S. State Dept. Decimal File, 861.60/288.

given. For example, Weeks commented that 200 castings had been made of one part but that not one was usable, because of inaccuracies in dimensions and faulty materials.

In late 1937 neither the Ford-built Gorki (discussed below) nor the Brandt-built Amo plant was fulfilling production schedules, because of 'tremendous disorders.'[10] The truck conveyor at the Amo plant was idle 23 percent of the time, and the M-1 model conveyor at Gorki was idle 35 percent of the time. Serious technical difficulties were encountered in production of both the M-1 model and the ZIS. Parts were not supplied on schedule.[11] The U.S. Moscow Embassy concluded from various reports that the Soviet automobile industry was 'in sore need of further assistance.'[12]

These problems were overcome at least in part, and 1938 production, as reported by the Oberkommando der Wehrmacht intelligence, was not unsatisfactory, although raw output figures tell us nothing about quality. Production of the Amo plant in 1938 was given as follows:

ZIS Model 5 (2½ tons, Autocar)	59,724 units
ZIS Model 6 (4 tons, unknown model)	3,169 units
ZIS Models 101 and 102 (Budd design)	3,900 units
Buses (Autocar chassis)	1,335 units[13]

Some 40,000 workers were employed in this plant in 1940.

HERCULES MOTOR CORPORATION RECONSTRUCTION OF THE YAROSLAVL PLANT

In 1929 the Hercules Motor Corporation, of Canton, Ohio, received a contract similar to that of A. J. Brandt to expand and reconstruct on American lines the Yaroslavl Automobile Works No. 3, known previous to the Revolution as Akt Obs Vozdukhoplavanie. In 1915 the plant had been equipped to produce 1,500 Crossley and Wolsey automobiles per year. Although intact after the Revolution, the plant was used only as a repair shop from 1918 to 1931, producing a few trucks with imported engines.

The agreement with Hercules Motor Corporation was signed in August 1929, and Amtorg indicated that:

> The Hercules Company will supply the Soviet Automobile Trust with the necessary drawings and other technical data and will send engineers to the U.S.S.R. to assist in designing and manufacturing the engines. In addition, Soviet engineers will study the various phases of production of motors in the Hercules plant. . . .[14]

10 *Ibid.*
11 *Pravda*, No. 267, September 27, 1937.
12 U.S. State Dept. Decimal File, 861.60/289.
13 Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, National Archives Microcopy T 84-122.
14 Amtorg, *op. cit.*, IV, No. 18 (September 1929), p. 279.

Table 11-1 WESTERN ORIGIN OF SOVIET AUTOMOBILES AND TRUCKS, 1930–45

Soviet Automobile or Truck Model	*Description*	*Western Model of Origin*	*Western Technical Assistance*
Amo-F-15	1.5-ton flatbed truck	Fiat 15 (1912 model)	Fiat S.p.a. engineering assistance, 1929.
GAZ A	Pickup truck	Ford Model A	Ford Motor Co. (new plant).
GAZ AA (also GAZ MM, and GAZ 63)	1.5-ton flatbed truck	Ford Model A (MM had Ford Model B engine)	Ford Motor Co. (new plant).
GAZ 410	1.5-ton dump truck	Ford Model A	Ford Motor Co. (new plant).
GAZ AA	Fire engine	Ford	Ford Motor Co. (new plant).
GAZ M-1 (and M-20)	Passenger automobile	Ford 1934 model	Ford Motor Co. (new plant).
ZIS 5	2½-ton flatbed truck	Autocar Model S.A.	Ryabushinski-Kuznetsov Co. plant (tsarist) re-equipped and expanded by A. J. Brandt.
ZIS 6	4-ton flatbed truck	Unknown; probably Autocar Model S.A.	Ryabushinski-Kuznetsov Co. plant (tsarist) re-equipped and expanded by A. J. Brandt.
ZIS 101	Heavy passenger automobile	Budd Co.*	Ryabushinski-Kuznetsov Co. plant (tsarist) re-equipped by A. J. Brandt (1929–30) and Budd Co. (1936).
ZIS 21, 21A	Gas generator truck	—	Ryabushinski-Kuznetsov Co. plant (tsarist) re-equipped and expanded by A. J. Brandt, Budd Co. and Hamilton Foundry.
YaZ 3	3-ton flatbed truck	Fiat S.p.a.	Fiat S.p.a. (pre-1929).
YaZ 6	5-ton flatbed truck, bus	Hercules Motor Co.	Akt. Obs. Vozdukhoplavanie plant (tsarist) re-equipped and expanded by Hercules Motor Co.
YaZ 10	8-ton dump truck	Hercules Motor Co.	Akt. Obs. Vozdukhoplavanie plant (tsarist) re-equipped and expanded by Hercules Motor Co.
L.K. 1	Trolleybus	Hercules Motor Co.	Akt. Obs. Vozdukhoplavanie plant (tsarist) re-equipped and expanded by Hercules Motor Co. (after 1933).

Sources: See text.

* Budd supplied body dies to Ford specifications.

The basic vehicle design used at Yaroslavl was American except that the engines were 'bored somewhat larger, the frames reinforced and special heavy axles . . . fitted.'[15] That is to say, a heavy truck specification was used.

In 1932 Yaroslavl was again expanded, in order to produce 4,000 heavy trucks per year, although even by 1938 production had only reached a total of 2,377 YaZ 5-ton trucks and buses.[16] This 1938 output, requiring about 15,000 workers, was distributed as follows:

YaZ 3 (3-ton truck)	826
YaG 6 (5-ton truck)	1,289
YaG 10 (8-ton truck)	27
L. K. 1 (trolleybus, chassis)	235[17]

As noted, this was also the Soviet bus-building plant, the chassis being made at Yaroslavl and the bodies in Leningrad and Moscow. The single-deck four-wheel trolleybus, known as the L.K. 1, had a Yaroslavl chassis and traction equipment made at the Dynamo plant in Moscow.[18]

THE CONSTRUCTION OF OTHER AUTOMOBILE PLANTS

Construction of a large new automobile plant (modeled after the River Rouge plant) at Gorki by the Ford Motor Company has been described in Volume I.[19] This plant started operation on January 1, 1932, but in 1936–7 it still had major operating problems. In 1937 S. S. Dybets, Director of the Gorki plant, former mechanic, and reputed active member of the I.W.W. in the United States, was removed from office. The charges included Menshevik associations and Bukharinist tendencies.

As built, the plant had a capacity to produce 140,000 vehicles per year. In 1938 it was reported operating at about 85 percent capacity, producing the following:

GAZ AA (light truck)	84,288
GAZ M (automobile)	23,256
Gas generator vehicle (M chassis)	1,738

15 Carver, *op. cit.*, p. 419.

16 Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, National Archives Microcopy T 84–122.

17 *Ibid.*

18 No technical-assistance agreement was traced for these buses. The specification given by W. Konovaloff ('The First Trolley Buses in Moscow,' *The Electric Railway, Bus and Tram Journal*, June 15, 1934, pp. 286–8), however, would have been too advanced for Soviet capabilities in the early 1930s—so presumably some agreement was made. The exterior is rather similar to some German models. See also U.S. State Dept. Decimal File, 861.5017—Living Conditions/688.

19 Sutton, *Western Technology . . . 1917 to 1930*, pp. 246–9.

GAZ AAA (2-ton truck)	6,314
S, 193, M55 (buses)	1,796[20]

This represented some improvement over 1937, when the M-1 conveyor line had been reported idle 35 percent of the time.[21] Further improvements were registered after the invasion of the Soviet Union by the Nazis and after Lend-Lease equipment assistance.

Two assembly plants were supplied with parts for assembly manufactured at Gorki. One was the Gudok Oktiabr' (with an annual assembly capacity of 6,000 automobiles), which merged with the main Gorki plant in 1932. The other was Automobile Assembly Plant No. 2 (the KIM, in Moscow), with an assembly capacity of 24,000 automobiles. This plant had been erected with Ford technical assistance in 1930–1. Employment was reported at 10,000 in 1940, with a probable output of 50,000 vehicles in 1941.[22]

UNITED STATES AND SWISS ASSISTANCE IN THE MANUFACTURE OF AUTOMOBILE PARTS

Construction of truck and automobile production plants required the establishment of a series of smaller industries supplying parts. In the United States these are partly supplied to the major automobile producers on a subcontract basis; in the U.S.S.R. such parts had previously been imported.

For the manufacture of automobile springs, bumper bars, and similar components, VATO made an agreement with the Gogan Machine Company of Cleveland, who sold them the necessary equipment and sent an engineer and two mechanics to the Soviet Union to supervise equipment installation and initial production operations. Emil Lutzweiler, the Gogan engineer, and the two mechanics were sent first to the Moscow truck plant (Amo) and then to the Ford plant at Gorki.[23]

Amtorg reported in late 1930 that a former samovar factory—the Kirjanov—was being rebuilt with 'the assistance of German and American specialists' to produce Ford headlights: the 'first of its kind in the U.S.S.R.'[24]

Automobile glass was produced in a Moscow plant of Steklofarfor (Glass and Ceramics Trust), with C. E. Alder as supervisor of some 300 Russian workers. The plant used imported American machinery.[25]

20 Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, Microcopy T 84–122.

21 U.S. State Dept. Decimal File, 861.60/288.

22 Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941. Miscellaneous German Records, National Archives Microcopy T 84–122.

23 U.S. State Dept. Decimal File, 861.5017—Living Conditions/441, Report No. 615, Stuttgart, March 16, 1932.

24 Amtorg, *op. cit.*, V, No. 24 (December 15, 1930), p. 494.

25 U.S. State Dept. Decimal File, 861.5017—Living Conditions/287, Report No. 889, Stockholm, June 27, 1931.

Electrical equipment for automobiles, trucks, and tractors was the subject of an agreement between VEO and the Electric Auto-Lite Company of Toledo, Ohio. The company prepared 'a detailed layout and working project for a plant to manufacture complete electrical units for automobiles and tractors.'[26] This plant, the only one of its kind in the U.S.S.R., had the capacity to produce 450,000 complete electrical units per year for automobiles and 270,000 electrical units for tractors. The agreement called for furnishing manufacturing information, providing American engineers to work in the U.S.S.R.,[27] and training Soviet engineers in the United States.[28] The agreement was implemented in the Soviet Union by M. Buchenberd, Vice-President of the Electric Auto-Lite Company. Magnetos (Bosch design) and spark plugs (design unknown, but possibly Champion) were produced in a Moscow electric-apparatus factory where 'German and Swiss machinery is used almost exclusively and it is all new.'[29]

The Swiss company Scintilla A-G had a technical-assistance contract similar to those of Ford and Hercules Motors to erect and start up a plant for the manufacture of ignition equipment.[30]

The rapidity with which the Soviets were able to acquire even closely guarded Western processes is little short of amazing. The manufacture of carburetors provides a good example. In 1928 the Holley Permanent Mould Machine Company in the United States developed a mechanized metal-casting process for producing carburetors to replace the previous slow-earth-moulds technique. The new technique was much quicker and required much less labor. The secret was in the composition of the heat-resistent lining of the moulds. The Holley Company sold only two sets of equipment: one to Ford in the United States and one to Siemens-Schukert in Germany. Then the Soviets announced that they too had the 'Kholley' carburetor manufacturing process and were going to put it to use.[31] The Samara carburetor and motor plant was sub-

[26] Amtorg, *op. cit.*, V, No. 6 (March 15, 1930), p. 106.

[27] *Ibid.* See also U.S. State Dept. Decimal File, 861.6463/46. The Electric Auto-Lite employees raised the question of their status and rights if they became employees of the Soviet Government. Clearly they preferred to remain employees of Electric Auto-Lite.

[28] U.S. Congress, *Investigation of Communist Propaganda* (71st Congress, 2nd session, Special Committee to Investigate Communist Activities in the United States), Part 3, Vol. 3 (Washington, D.C.: 1930).

[29] U.S. State Dept. Decimal File, 861.5017—Living Conditions/417.

[30] *Automotive Industries*, LXI, No. 17 (October 26, 1929).

[31] *Pravda* (Leningrad), No. 24, October 15, 1932. The 'advantage of coming late,' even with the carburetor, may be suggested by the observation that, in Great Britain alone, some 28 different carburetor models were developed between 1889 and 1933. [See *Motor Cars Handbook of the Collection*, Part II (London: H.M.S.O., 1959).]

sequently developed to supply the entire automobile, tractor, and airplane industries with carburetors.[32]

In early 1932 the 'first automobile repair station of a standard type' was opened in Moscow; it was 'equipped with American machinery.'[33]

At this time a large plant for the manufacture of rubber and asbestos parts for automobiles and tires for automobiles, bicycles, and motorcycles—'one of the largest in the world'—was erected at Yaroslavl. Designed to employ 22,000, the plant came into production at the end of 1932 and cost more than $100 million. Technical assistance for the rubber-tire plant was supplied by the Seiberling Rubber Company of Akron, Ohio, which supervised initial operations and trained Soviet engineers and foremen at Akron. Amtorg stated that the Seiberling Company 'will prepare all the designs, plans and specifications for the construction. . . .'[34] The automobile-tire-producing capacity was 3,100 per day, in addition to 9,000 bicycle and 480 motorcycle tires.[35] Some 35 different asbestos parts, including brake linings and clutch facings, were also made.[36] Technical assistance to the asbestos unit was supplied by the Multibestos Company of Walpole, Massachussetts, and a number of American engineers were hired on individual contract.[37]

Another rubber-tire plant was supplied by the United States under Lend-Lease: this was the Ford Motor Company tire plant, capable of producing one million automobile tires per year. It was dismantled and shipped complete to the U.S.S.R.[38] There were some problems in re-erection of this tire plant in Moscow, as the Soviet Union was not able to duplicate the basement and sublevel features 'which were part of the Detroit plan.'[39] By February 1944, 75 percent of the plant equipment was on site and another 15 percent en route. A request was then made for installation drawings for Goodrich-type tire-building machines from the National Rubber Company and for two American engineers to handle the erection of the Farrel-Birmingham calendars; given these, the Russians expected that production would start in June 1944.[40]

In the allied field of highway construction, the Seabrook Construction Company provided technical assistance for road construction in the Moscow

[32] Amtorg, *op. cit.*, VI, No. 23 (December 1, 1931), p. 533.
[33] *Ibid.*, VII, No. 2 (January 15, 1932), p. 43.
[34] *Ibid.*, IV, No. 16–17 (September 1, 1929), p. 279.
[35] *Automotive Industries*, LXI, No. 17 (October 26, 1929).
[36] U.S. State Dept. Decimal File, 861.659—ASBESTOS, Report No. 623, Riga, August 11, 1932.
[37] *Ibid.*
[38] U.S. State Dept. Decimal File, 861.24/1567.
[39] *Ibid.*, Telegram 810, Moscow to Washington, D.C., July 6, 1943.
[40] U.S. State Dept. Decimal File, 861.654/19, Telegram 451, Moscow to Washington D.C., February 10, 1944.

area and had road-building contracts in Turkmenistan and possibly in the Caucasus.[41] Technical assistance for bridge construction was provided by a highly qualified consultant, Leon S. Moisseiff, Consulting Engineer to the Port of New York Authority.[42]

THE ORIGIN OF THE STALINGRAD TRACTOR PLANT

Site selection and staking out for the Stalingrad Tractor Plant were reported in 1926.[43] Little else was done for three years. In March 1929 a delegation of 13 Soviet engineers arrived in the United States and in co-operation with several American companies outlined a plan for a plant to produce 50,000 Caterpillar-type tractors (of 15 to 30 horsepower) per year.[44] The Stalingrad Tractor Plant, largest in Europe, was a packaged plant built in the United States, dismantled, shipped to the U.S.S.R., and re-erected at Stalingrad under supervision of American engineers. All equipment was manufactured in the United States by some 80 firms; the plant produced the International Harvester 15/30 model.

The original Gosplan request had been for a plant to manufacture only 10,000 tractors per year. The Russian planners estimated a construction time of four or five years even for a U.S. construction company.[45] Work on a 50,000-tractor-per-year plant actually started in June 1929. The framework was completed December 23, 1929[46] and the structure roofed and walled by February 15, 1930.[47] Three months later 20 percent of the equipment in the machine shops and assembly departments, 75 percent of the forge-shop equipment, and 40 percent of the casting-shop equipment had been installed.[48] In the following month the balance of the equipment was received and installation of the foundry completed.[49]

The Stalingrad Tractor Plant was the first of three massive plants for the production of tractors in peace and tanks in war. It was built in every sense

41 Amtorg, *op. cit.*, IV, No. 12–13 (July 1, 1929), p. 232.

42 *Ibid.*, No. 18 (September 15, 1929), p. 306.

43 Report of the Ford Delegation to Russia and the U.S.S.R., April–August 1926 (Detroit, 1926), Ford Motor Company Archives Accession No. 49.

44 'While preliminary work on the site of the Stalingrad Tractor Plant had been conducted for some time, the actual work on the construction of the principal departments started only in June when the plans arrived from the United States.' [Amtorg, *op. cit.*, V, No. 7 (April 1, 1930), p. 135.] 'The entire designing of the Stalingrad . . . tractor plant, which is to produce annually 40,000 wheel tractors of 15–30 h.p. was carried out in the United States.' [Amtorg, *op. cit.*, IV, No. 19 (October 1, 1929), p. 336.]

45 Amtorg, *op. cit.*, V, No. 7 (April 1, 1930), p. 135.

46 *Ibid.* See photograph on p. 134.

47 *Ibid.* See photograph on p. 135.

48 Amtorg, *op. cit.*, V, No. 13 (July 1, 1930), p. 287.

49 *Ibid.*

of the word in the United States and reassembled by 570 Americans and 50 Germans in Stalingrad. The plant was delivered in component parts, and installed in a building supplied by McClintock and Marshall and erected under John Calder of the Austin Company. *Za Industrializatsiiu* pointed out that 'it is very important to note that the work of the American specialists . . . was not that of consulting but of actually superintending the entire construction and the various operations involved.'[50]

Each item of construction and equipment was the responsibility of a major U.S. firm. This effort is summarized in table 11–2.

Table 11–2 DESIGN AND CONSTRUCTION OF THE STALINGRAD TRACTOR PLANT

Operation or Supply	*U.S. Firm*
Design of plant	Albert Kahn, Inc.
Design of forge shop	R. Smith, Inc.
Design of foundry	Frank D. Chase, Inc.
Equipment for cold-stamping department	Niagara, Bliss
Equipment for heat-treating shops	Rockwell
Equipment for power station	Seper
Equipment for power-station equipment	Westinghouse
Equipment for chain-belting, conveyor system	Chain Belt Co.
Supply of buildings	McClintock & Marshall
Superintendent of construction	John Calder

Sources: *Za Industrializatsiiu*, July 5, 1930.
Amtorg, *op. cit.*, V, No. 7 (April 1, 1930), p. 135.
Norton T. Dodge, 'Trends in Labor Productivity in the Soviet Tractor Industry,' Ph.D. Dissertation, Harvard University, Economics Department (February 1960).

The American chief engineer had no administrative chores. These were handled by Russian and American assistants. All technical problems were settled by American engineers on the spot. The Stalingrad Tractor Plant, therefore, was American in concept, design, construction, equipment, and operation. It could just as easily have been located outside Chicago, except for the placards claiming 'socialist progress.'

It is worthwhile to recall that the contemporary Soviet press was reasonably open about this U.S. assistance. For example, an article in *Za Industrializatsiiu*[51]

[50] *Za Industrializatsiiu*, July 5, 1930. The original Gipromez plant was significantly changed by the American construction companies and equipment suppliers. The floor area of the forge shop was decreased from 12,600 to 7,200 square meters and the forge shop work force from 655 to 335 men.

[51] *Ibid.*

drew three conclusions: first, that the preparation of the plans for the Stalingrad plant by American engineers with 'participation' of Soviet engineers made completion of the plant possible within a 'very short time'; second, that work and training by Soviet engineers in the United States resulted in a 'considerable improvement in engineering processes' and the application of American standards; and third, that work in the United States gave the Soviets a first-hand opportunity to study American tractor plants and verify data on operation of American machine tools. Even though this article understated the amount of American assistance, it constituted altogether a quite remarkable admission.

THE KHARKOV TRACTOR PLANT

Kharkov was identical to the Stalingrad plant. By using the steel-work dimensions given in the Stalingrad blueprints, the Soviets anticipated saving 440,000 rubles in the purchase of fabricated structural steel in the United States. A *Pravda* article[52] noted this and questioned whether the assembly shop trusses, doors, and windows should be bought in 'knocked-down' form from the United States (as in the Stalingrad plant) or built and assembled by Soviet plants and engineers. Finally much of the structural steel was bought in Czechoslovakia.

Although the original intention was to build Kharkov as an all-Soviet undertaking, American engineers were called in at a very early point. Leon A. Swajian, for example, became Chief Construction Engineer and was subsequently awarded the Order of Lenin for his work at Kharkov.[53] A fairly large number of foreign specialists were invited in; a booklet of 80 pages (including 74 illustrations) is devoted to the activities of foreign workers at the Kharkov Tractor Plant.[54]

To Leon Swajian we owe the observation that these tractor plants were built very much more quickly in the U.S.S.R. than in the U.S.A. although the same supervising engineers and equipment were used. After commenting that no other construction job had required so much work in a single year, Swajian added that in the U.S. giant plants are not built all at once; we build a few departments, subcontract, and buy spares outside, so that:

> Ford's River Rouge plant was more than a dozen years in building. When I took charge it was already partly built; I worked there six or seven years and when I left construction was still in progress. But in the U.S.S.R. with government financing and no other plants from which to buy spare parts, with the plant dependent on itself—down to the smallest operation

[52] June 5, 1930.

[53] F. E. Beal, *Foreign Workers in a Soviet Tractor Plant* (Moscow: Co-operative Publishing Society of Foreign Workers in the U.S.S.R., 1933), p. 9.

[54] *Ibid.*

> on the basic raw material—the whole plant must be built at once. And very swiftly too, if it is not to tie up capital too long. The Kharkov job was pushed to completion more swiftly than any job I have ever had to do with.[55]

Even in mid-1933, when the plant was in operation, there were still 25 Americans at Kharkov, including the Foundry Maintenance Superintendent, the Assistant Maintenance Superintendent, and the engineer in charge of pyrometer equipment.[56]

As at Stalingrad and Chelyabinsk, the equipment was almost all foreign—'either German or U.S.—if German then patterned after American makes';[57] in fact no equipment at the Kharkov plant has been identified precisely as Soviet. The forge shop had $403,000 worth of American forging machines and dies;[58] and the heat-treating equipment, automatic furnace-temperature controls, and similar equipment were supplied by Leeds and Northrup of Philadelphia.[59]

Kharkov produced the International Harvester 15/30 model until 1937, when it changed over to the Russian NATI model. After World War II the plant went back to production of the original International Harvester 15/30.

THE CHELYABINSK TRACTOR PLANT

The Chelyabinsk plant was started in 1930 without foreign technical assistance as another duplicate of the Stalingrad Tractor Plant. One year later, in March 1931, a letter to the Soviet press signed by 35 Chelyabinsk Tractor Plant engineers and economists charged that the plant was 'on the verge of total collapse.'[60] The letter explained that planning had begun early in 1930 and construction in April. Supposedly the building had been completed in September of that year. Although operation had begun on November 6, 1930, no usable tractors had been produced as of March 1931. The first 'tractors' were built of 'junk,' there were 'freaks' in the design of the metal stamps, there was no hoisting gear in the mechanical and assembly shops (the walls were not strong enough to bear the weight), the compressor shop

[55] Amtorg, *op. cit.*, VI, No. 18 (September 15, 1931), pp. 413–5.

[56] U.S. State Dept. Decimal File, 861.5017—Living Conditions/677, Report No. 155, Riga, June 14, 1933.

[57] *Ibid.*

[58] Amtorg, *op. cit.*, V, No. 22–23 (December 1, 1930), p. 462.

[59] L. M. Herman, 'Revival of Russia's Tractor Industry,' *Foreign Commerce Weekly*, XXI, No. 2 (October 6, 1945), p. 12.

[60] 'The Chelyabinsk Experimental Tractor Plant on the Verge of Collapse,' *Za Industrializatsiiu*, No. 77, March 19, 1931, p. 3. Subsequent articles indicate further delays and problems. See *Izvestia*, March 22, 1931, and *Za Industrializatsiiu*, April 18, 1931.

was not working, and the boilers received from Germany had not been installed. So ran some of the complaints in the letter.

American engineers, including John Calder, the expert trouble-shooter, were then called in to take over reconstruction of the plant and operating responsibility. A pilot plant was established and operated by John Thane and an American assistant, both former employees of the Caterpillar Company.[61] The Chief Consulting Engineer from 1931 to 1933 was Edward J. Terry. An interview with Terry by a State Department official[62] provides information on the fate of the plant in the next two years. Even by early 1933 'very little had actually been completed'; the foundry and the forge were not finished, nor were the conveyors nor the sand-handling equipment for castings.

One puzzling point concerning Chelyabinsk is the extent of the assistance rendered by the Caterpillar Company, of Peoria, Illinois. In 1968 company officials did not have a technical-assistance agreement on file nor could any current official recall an agreement. However, the Stalinets S-60 tractor was an exact copy[63] of the Caterpillar 1925–31 model. Ex-Caterpillar engineers supervised operations, and one of these stated 'that he had seen at the works American specifications and drawings and also standard drawings belonging

Table 11-3 SUMMARY OF SOVIET TRACTOR PRODUCTION AND WESTERN MODELS, 1930–45

Soviet Model	*Years Produced*	*Soviet Plant*	*Western Origin*
Wheeled Tractors			
FP 10/20	1928–33	Putilovets (Kirov)	Fordson
International 15/30	1930 after 1948	Kharkov, Stalingrad	International Harvester
Universal 10/20	1934–7, after 1945	Kirov, Vladimir	International Harvester Farmall
Track-Laying Tractors			
NATI	1937–41 1944–9	Kharkov Stalingrad	No data on origin of the NATI
Stalinets S-60	1931–7	Chelyabinsk	Caterpillar
Stalinets S-65	1937–41	Chelyabinsk	Diesel version of Caterpillar 60

Sources: See text.

[61] *Factory and Industrial Management*, LXXXII, 1931, p. 804.
[62] U.S. State Dept. Decimal File, 861.5017—Living Conditions/663, May 27, 1933.
[63] U.S. State Dept. Decimal File, 861.659/TRACTORS/5, October 26, 1933.

to the American company.'[64] Moscow *Pravda*[65] agreed that negotiations with Caterpillar were inconclusive. The Soviet representative at the Chelyabinsk Detroit office then reportedly purchased a Caterpillar tractor, took it to pieces in his Detroit office, and proceeded to design the plant.[66] This is rather an unlikely way to design a tractor plant and would certainly account for construction problems at Chelyabinsk.

In May 1933 'practically all the machine tools and production equipment in the plant was [*sic*] either American, English or German of the highest quality and the most modern for that time. . . .'[67]

German equipment installed at the Chelyabinsk Tractor Plant included oil breaker switches (700,000 marks' worth),[68] various drop hammers (about half a million marks' worth),[69] a wheel lathe (300,000 marks),[70] a compression unit (200,000 marks),[71] forging machines (1¾ million marks' worth),[72] 15 gear-cutting machines (200,000 marks),[73] a mold for the iron foundry (400,000 marks),[74] a Universal milling machine (200,000 marks),[75] grinding machines (350,000 marks' worth),[76] and heavy presses (1 million marks' worth).[77]

By 1937 the plant employed about 25,000 workers. The only model produced between 1933 and 1937 was the Stalinets (Caterpillar) S-60; a 50-horsepower (drawbar) model of the crawler type. About 6,460 were produced in 1937:[78] a long way from the planned 50,000 per year. In 1937 the production model was changed to the Stalinets S-65, which was a Caterpillar 60 with slightly increased horsepower and a diesel engine. A total of just over 3,000 were produced, including another model with a gas generator.

64 *Ibid.*

65 No. 146, May 29, 1933. *Za Industrializatsiiu*, No. 125, June 1, 1933, says that the company rejected a technical-assistance contract.

66 *Za Industrializatsiiu*, No. 125, June 1, 1933.

67 Norton T. Dodge, 'Trends in Labor Productivity in the Soviet Tractor Industry,' Ph.D. Dissertation, Harvard University, Economics Department (February 1960).

68 *Sowjetwirtschaft und Aussenhandel*, Handelsvertretung der UdSSR in Deutschland, Berlin SW, X, No. 17 (1931), p. 30.

69 *Ibid.*, XI, No. 6 (1932), p. 15.

70 *Ibid.*, XI, No. 7 (1932), p. 18.

71 *Ibid.*, XI, No. 10 (1932), p. 21.

72 *Ibid.*, XI, No. 6 (1932), p. 14.

73 *Ibid.*, XI, No. 16 (1932), p. 23.

74 *Ibid.*, XI, No. 10 (1932), p. 21.

75 *Ibid.*, XI, No. 8 (1932), p. 31.

76 *Ibid.*, XI, No. 15 (1932), p. 22.

77 *Ibid.*, XI, No. 10 (1932), p. 21.

78 Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, National Archives Microcopy T 84–122.

THE PUTILOVETS (KIROV) TRACTOR PLANT IN LENINGRAD

The Putilovets, oldest engineering plant in Russia, attempted to produce copies of the Fordson tractor in the late 1920s.[79] This was unsuccessful and the plant was rebuilt and greatly expanded in 1929–31 under the supervision of Ford Motor Company engineers to produce the Fordson-Putilovets (FP) tractor.[80] Thus by 1931 the plant was organized along American lines with completely new American and German equipment. An American engineer, Bowers, was running the two foundry shops;[81] Karl Holgdund, an American citizen, was superintendent of the drop hammer shop;[82] and the modern forge shop was also under American management. According to one observer, the design, drawings, specifications, and equipment were all American.[83]

The first Soviet motor for combines, the Viskhom-2, was a modified Fordson tractor motor. Production started in March 1932.[84] In the spring of 1934 the tractor model was changed from the Fordson, found to be too light for Russian conditions, to the International Harvester Farmall tractor, known in the U.S.S.R. as the Universal. The changeover may in part have been brought about by what C. P. Weeks, Vice-President of Hercules Motor Corporation, calls the 'acknowledged failure' of the FP in workmanship and engineering detail.[85] The Farmall was the standard row-crop steel-wheeled tractor even after World War II, when it was produced at the Vladimir Tractor Plant, opened in 1944.

Another tractor plant added in World War II was the Altai (Robtovsk), opened in 1943 with equipment evacuated from the Kharkov Tractor Plant.

AGRICULTURAL COMBINE PLANTS

Of five agricultural combine plants, four produced copies of the Holt machine, although, according to the J. I. Case Company representative in the U.S.S.R. 'they do not stand even a modest comparison with our products. . . .'[86]

The first 'Soviet Holt' combine harvesters were supplied with engines by the Hercules Corporation in the United States, although, according to Vice-President Weeks, these were not ordered until the machines were completed.[87]

[79] Sutton, *Western Technology . . ., 1917 to 1930*, p. 140–1.
[80] U.S. State Dept. Decimal File, 861.50—FIVE YEAR PLAN/60, p. 5 of attached report.
[81] U.S. State Dept. Decimal File, 861.5017—Living Conditions/689.
[82] *Ibid.*,
[83] *American Engineers in Russia*, Folder 4, Item 2, G. R. Cody.
[84] Amtorg, *op. cit.*, VII, No. 6 (March 15, 1932), p. 140.
[85] U.S. State Dept. Decimal File, 861.5017—Living Conditions/307.
[86] *Ibid.*, 861.5017—Living Conditions/517.
[87] *Ibid.*, 861.5017—Living Conditions/307.

The Selmash (All-Russian Syndicate of Agricultural Machines and Implements) Agricultural Equipment Plant, located at Rostov on Don, was a large new plant equipped with 2,802 new imported machine tools.[88] A short published list of these machines included a milling machine,[89] a steam turbine,[90] and a gas producer.[91] Twenty-eight American and German technicians instructed technical personnel and workers to operate the imported equipment; construction at Selmash was supervised by U.S. engineers. Production was planned at 100,000 each of wagons, plows, and hay mowers per year, in addition to 30,000 drills and 40,000 binders.[92] A separate combine harvester plant to produce 5,000 'Soviet Holt' combines per year was also erected.

Table 11–4 AGRICULTURAL COMBINE PLANTS, 1930–45

Name of Plant	*Annual Capacity*	*Origin of Technology and Assistance*
Selmash	15,000 combines	Holt combine
Kommunar (Zaporozhe)	10,000 combines	Holt combine
Saratov	25,000 combines	Soviet motorless combine
	13,000 pickups	—
	15,000 windrowers	—
Novosibirsk	25,000 combines	Holt combine
Krasny Aksai	Combines (number not known)	Holt combine
	Corn harvesters (number not known)	New Idea corn harvester

Source: U.S. State Dept. Decimal File, 861.5017—Living Conditions/517, Gloeckler Report, p. 12.

Increases in the production of corn, beans, sugar beets, and sunflowers required special equipment such as the row-crop tractor, first introduced into the United States in 1925.[93] The first Soviet row-crop tractor, produced in 1935, and called the Universal, was a steel-wheeled reproduction of the International Harvester Farmall tractor. But this hardly worried the J. I. Case Company sales representative in the U.S.S.R., who commented:

> 'That insignificant plant Krasny Aksai . . . is an old plant not fit for mass production. They are copying . . . the New Idea Corn Picker. Our corn harvester showed better results in the test contracted last year in the Caucasus than the New Idea or any other of our competitors [*sic*] machines.'[94]

[88] Amtorg, *op. cit.*, V, No. 9 (May 1, 1930), p. 187. (The size of the plant is illustrated on pp. 180–1.)
[89] *Sowjetwirtschaft und Aussenhandel*, IX, No. 6 (1930), p. 18.
[90] *Ibid.*, IX, No. 20 (1930), p. 38.
[91] *Ibid.*, IX, No. 11 (1930), p. 44.
[92] Amtorg, *op. cit.*, V, No. 9 (May 1, 1930), p. 187.
[93] Naum Jasny, *The Socialized Agriculture of the U.S.S.R.* (Stanford: Stanford University Press, 1949), p. 462.
[94] U.S. State Dept. Decimal File, 861.5017—Living Conditions/517, Gloeckler Report, p. 12.

Similarly, the Novosibirsk combine plant, expanded from the old International Harvester plant, had 10,000 workers producing about 40 'Soviet Holt' combines per day. This plant had four Americans and one German technician to help start production.[95]

This close relationship between the United States and development of a modern Soviet agricultural equipment industry was recognized in the Soviet press. For example, the following comment was made in reference to the start of manufacture of the Holt combine at the Kommunar plant in Zaporozhe:

> It is quite obvious that carrying out this huge program within such a short time would be impossible without utilizing the technical experience of capitalist countries. America is the leading source of modern engineering practice. Some things can be learned from Germany, but in the agricultural machine building industry the United States must be taken as a model. . . .[96]

Izvestia pointed out[97] that the Krasny Aksai works was building combines according to a U.S. model.

In August of 1930, however, it was announced that the Saratov Combine Plant was to produce 15,000 combines per year; this combine was to be a type 'not popular in the United States,' i.e., a five-meter motorless combine with a power take-off from the tractor. Said *Pravda*, 'The preparation of these models was done without foreign technical assistance . . . because foreigners could not be helpful in designing a machine entirely unknown to them. . . .'[98] The article added that a group of American and European engineers skilled in conveyor methods of production was to be hired.[99] The plant utilized German press equipment.[100]

CONCLUSIONS

The building of the new Ford Gorki plant, the reconstruction of the Moscow and Yaroslavl auto plants, and the construction of three giant tractor plants were all undertaken between 1929 and 1934. The second half of the decade was generally occupied in bringing these enormous plants into operation, although several new automobile-assembly plants were also started. Both automobile and tractor capacities were the same in 1941 as in 1933; the reported increase in production came by utilizing the capacity built in the early 1930s to its fullest extent.

[95] U.S. State Dept. Decimal File, 861.5017—Living Conditions/537, Interview with A. D. Korn. Mr. Korn's contract is attached to the report.

[96] *Torgovo-Promyshlennaya Gazeta*, LXX, No. 1771 (December 10, 1929).

[97] *Izvestia*, April 18, 1930.

[98] *Pravda*, August 11, 1930.

[99] *Ibid.*

[100] Amtorg, *op. cit.*, VII, No. 13–14 (July 15, 1932), p. 295.

The automobile and tractor industries were completely dependent on foreign (primarily American) technology for design, construction, and equipment, as well as initial operation. There was a German contribution, but this mainly consisted of supplying equipment manufactured to U.S. designs.

The product of these gigantic plants were Fords, a specially designed Budd Company model with a Hercules engine, Caterpillar and International Harvester tractors, and Holt and Farmall agricultural machines. No indigenous Soviet technology has been traced, with the exception of the five-meter motorless combine produced at Saratov. Indeed, the Soviets had enormous problems just assimilating transferred U.S. technology; and this objective itself was not achieved until about 1941.

At the time of the German invasion in 1941, the Soviet Union had one completely new automobile plant (the Ford Gorki unit) and two greatly expanded and reconstructed units for trucks at Moscow (the Amo) and Yaroslavl. The Rostov plant was probably not in production in 1941; other units were assembly plants only. At the same time tractor production was concentrated in three new very large plants at Stalingrad, Kharkov, and Chelyabinsk, together with the expanded and rebuilt Putilovets at Leningrad. The Altai (Robtovsk) plant, added in 1943, and the Vladimir plant, added in 1944, both produced Western models.

CHAPTER TWELVE

Technical Assistance to the Railroad System

THE DEVELOPMENT OF A MODERN RAILROAD SYSTEM

In February 1930 a delegation of 34 Soviet railroad engineers arrived in the United States to make a study of Pennsylvania Railroad operations. As D. E. Sulimov, First Vice-Commissar of the Commissariat of Transportation, noted, 'This is the first Soviet railway delegation to make a comprehensive study of American railway systems, the technical achievements of which have aroused the greatest interest in the Soviet Union. . . .'[1]

The commission was interested, he added, in studying American rolling stock and hoped to accomplish much with 'the co-operation of American engineering and industry.'[2] The delegation traveled more than 16,000 miles examining United States railroads[3] and concluded that adoption of the American railroad system was essential for Soviet economic progress:

> . . . we realize well that we shall not be able to carry through this program in the most effective manner unless we avail ourselves of the great fund of experience accumulated by the most technically advanced countries, particularly the United States.[4]

This implied a comparison to the lightweight European rails then utilized in Russia which limited train loads, speed, and equipment utilization.

Sulimov added that the delegation was interested in making arrangements with American firms to further this technical transfer and that they would negotiate agreements for designing locomotives, freight cars, and gondolas, and were interested in technical assistance for production in the Soviet Union.

[1] Amtorg, *op. cit.*, V, No. 5 (March 1, 1930), p. 74.
[2] *Ibid.*
[3] Amtorg, *op. cit.*, V, No. 8 (April 15, 1930), p. 147.
[4] *Ibid.*

In conclusion, thanks was given to the Pennsylvania Railroad, Great Northern Railroad, American Locomotive Company, and the Baldwin Locomotive Company for their assistance.

An agreement was concluded immediately with Ralph Budd, President of Great Northern Railroad, to visit the U.S.S.R. and present a plan for reorganization of the industry along American lines.[5] Budd returned with Sulimov and the delegation to Russia.[6]

On returning to the United States at the end of 1930, Budd released public statements which glossed over the many problems of Soviet railroading,[7] but the official report which he submitted to the Soviet Government left no doubt as to the backwardness of their railroads.[8] The objective of his trip was reported as follows:

> [In 1930] they [the Russians] were undecided as to whether they should modernize to the so-called transcontinental railway plant or change to the American system and standards. It was for the purpose of reporting on this question that I spent the summer of 1930 in that country. . . .[9]

To achieve such modernization, it was suggested that grade reduction was one means to increase capacity; a reduction from the prevailing 0.6 to 0.8 percent to the United States standard of 0.3 to 0.4 percent would be an effective means of increasing capacity and avoiding double tracking. After listing grade practices that should be halted, such as level tracking across bridges and frequent changes of gradient, Budd recommended extensive grade reductions and studies toward that end. Practically all sidings were on level gradients, whereas in good railroad practice 'sidings are not allowed to determine gradient but the location of sidings is influenced by gradient. . . .' Budd noted that main line tracks varied from alignment, that clearances were insufficient, that ballast had been neglected, that ties were not satisfactory (Budd provided repair specifications), and that existant rails should be replaced with 110-pound rails (Budd gave U.S. rail specifications), among other technical considerations.

Budd's recommendations are an excellent indicator of the state of railroad conditions in 1930 and provide a standard with which to measure progress in the following decade. In order to acquire the best transportation system at the lowest cost, according to Budd, Soviet railroads would have to:

5 Amtorg, *op. cit.*, V, No. 9 (May 1, 1930), p. 188.

6 *Ibid.*, No. 12 (June 15, 1930), p. 257.

7 *Ibid.*, No. 22–23 (December 1, 1930), p. 464.

8 Ralph Budd, *Report on Railways of the U.S.S.R. 1930*. The Soviets, of course, did not publish the report, but a copy of Vol. I is in the National Archives and another copy is in the Hoover Institution.

9 *American Engineers in Russia*, Letter from Ralph Budd to H. Fisher, February 7, 1934.

(1) Adopt automatic couplings on all cars and locomotives
(2) Adopt air brakes throughout
(3) Strengthen the track, particularly with more and heavier ties and improved ballast
(4) Improve track standards, with better rail sections, bolts, and tie plates
(5) Carry out extensive track realignment
(6) Reduce main line gradients
(7) Adopt the train order system of handling
(8) Use larger modern cars
(9) Use larger modern locomotives
(10) Use heavier rail sections
(11) Use passing sidings and yard tracks for longer trains
(12) Build engine houses and terminals for larger locomotives
(13) Adopt automatic block signals
(14) Modernize repair shops
(15) Adopt a consolidation program to reduce number of lines
(16) Undertake a campaign for safety, cleanliness, and better care of material[10]

Budd further noted that climate and topography were quite similar to those in the United States and that, except for Moscow and Leningrad suburbs, electrification was not justified 'to any considerable extent.'

Brief extracts from the diary of W. Robert Wood,[11] who also made a long official inspection of the complete Soviet railroad system, illustrate the magnitude of the problem then facing Soviet railroad authorities and pointed out by Budd.

> June 11, 1930 Today we inspected round houses and shops, and I must say it looks rather hopeless as the workers seem to do about as they please. . . . Their day's output is eleven freight cars repaired and three or four passenger cars; with many less men at our St. Cloud shops we could turn out nearly that number *new* freight cars besides the repaired cars of twenty or thirty per day [*sic*]. . . .

[10] The reader is directed to two excellent reports published by the Association of American Railroads which are indicators of the considerable progress made in Russia between 1930 and the 1960s: Association of American Railroads, *Railroads of the U.S.S.R.* (Washington, D.C., n.d.), and *A Report on Diesel Locomotive Design and Maintenance on Soviet Railways* (Chicago: AAR Research Center, 1966).

[11] *American Engineers in Russia*, 'Trip to Russia,' Folder 7. Numerous comments similar to those of Budd were made. Wood noted, for example, that the Russians were using untreated pine ties with a life expectancy of only four to five years and said no larch was available in the U.S.S.R. However, larch is a common soft wood in the Soviet Union and was noted by American engineers as being found 'in abundance and not used.' (P. 14.)

> July 18, 1930 [At Penza] . . . walked over the yard where they have made a problem by building four bridges right in the terminal.
> August 5, 1930 Arrived at 8 a.m. at a tunnel that presents a problem. It is wet and ice forms in the winter. It also is caving in. Tunnel is about 1½ kilometers long and at east end has a reverse curve due, they told us, to missing their alignment when constructing. This is probably the only tunnel in the world with three curves in it. The Engineer must have missed connecting by twelve feet. . . .
> August 5, 1930 [At Sverdlovsk] The station layout and yard layout is the worst we have ever seen . . . the project was most fantastic.
> August 6, 1930 . . . there are reverse curves at every station and between stations put in for no apparent reason. . . .

Thus in 1930 the problems observed by Budd and Wood were undeniably substantial. A decision was made to overcome them by adopting American railroad practice and specifications. American operating personnel were hired, including a large group from the Baltimore and Ohio Railroad. C. A. Gill, formerly with the Reading Railroad, was made Chief Consulting Engineer of the Soviet railroads.[12]

However, the track reforms instituted in the early 1930s were several years coming to fruition, and this particularly limited the use of American-sized engines, which were too heavy for the weak track. Five locomotive types were put on trial, including two of unusual design. Three types were standard: the FD, which was Soviet-made, embodying many U.S. features; the U.S. 2–10–2; and the U.S. 2–10–4. In addition an articulated Beyer-Garrett was bought from the United Kingdom and a Soviet-built 4–14–4 was also placed under test; these last two engines were the results of an attempt to overcome the weak-track problem by lowering the load per wheel: i.e., spreading the weight over a greater number of wheels. This effort was not, however, successful, and concentration was placed on standard tsarist and American locomotives.

Between 1935 and 1945 many American recommendations were implemented. The decade was marked by reconstruction, double-tracking of key routes, installation of automatic block signals, and new siding and loop construction. This, coupled with the extensive reorganization of railroad operations, led to major improvements: increased loads, greater average speeds and faster turn-around times.

World War II did not affect the railroad system as adversely as might be expected. Railroad mileage by 1943 had been reduced by one-third,[13] and most of this had to be rebuilt after recapture. Lend-Lease provided an ample supply of railroad materials for this purpose. The locomotive stock fared even better. Locomotives were moved back behind the lines in 1941. Only about 15

[12] *Ibid.*, Folder 1.

[13] J. N. Westwood, *Soviet Railways Today* (New York: Citadel Press, 1964), p. 17.

percent fell to the German armies,[14] and these were of the older types. Lend-Lease supply of 2,600 new locomotives (see table 12–1) placed the Soviets in a better position by 1943–4 than before the German invasion.

Table 12–1 ORIGIN OF SOVIET STEAM LOCOMOTIVES, 1930–45

Soviet Locomotive Class	*Years Made*	*Wheel Arrangement*	*Number Produced or Purchased*	*Origin of Locomotive Class*
B	1929	2–10–2 tank	6	Skodawerke Pilsen (Czechoslovakia)
K	1931	0–6–0	'Batch'	Henschel and Sohn (Germany)
Ta	1931	2–10–4	5	American Locomotive Co. (U.S.)
Tb	1931	2–10–2	5	Baldwin Locomotive Co. (U.S.)
FD	1931–41	2–10–2	3,220	Based on U.S. 2–10–2 (U.S.), manufactured at Voroshilovgrad (Lugansk)
Ja	1932	4–8–2 and 2–8–4	1	Beyer-Peacock (U.K.)
Is	1933–41	2–8–4	650	Based on U.S. 2–10–2 (U.S.), manufactured at Kolomna (passenger version of FD type)
C	1933	0–6–0 tank	'Batch'	Beyer-Peacock (U.K.)
B	1933	0–4–0 tank	'Batch'	Beyer-Peacock (U.K.)
So	1936–54	2–10–0	5,000	Bryansk (tsarist E 0–10–0)
AA	1936	4–14–4	1	Voroshilovgrad (Lugansk)
Su	1940 1926–51 (all classes)	2–6–2	2,830	Tsarist Class S (Kolomna, Sormovo)
Sh, a	1943	2–8–0	200	Standard U.S. Army type
E	1943	0–10–0	9,500	Prerevolutionary Class E (Kuibyshev and other works)
—	1943	2–10–0	2,400 (?)	Baldwin Locomotive, American Locomotive (U.S. Lend-Lease)

Sources: H. M. Le Fleming and J. H. Price, *Russian Steam Locomotives* (London: Marshbank, 1960).
Neue Zürcher Zeitung, July 26, 1944.

THE DESIGN OF RUSSIAN STEAM LOCOMOTIVES

The Vladikavkaz steam locomotive, first produced in 1910, became in its several versions the basic Soviet steam locomotive until the end of World War II. Westwood estimates that it was the most numerous class of steam locomotive in the world, accounting as late as 1960 for about one-third of the Soviet locomotive stock.[15] Another type—the FD—was placed in production

[14] *Ibid.*

[15] J. N. Westwood, *History of Russian Railways* (London: George Allen & Unwin, 1964), p. 87.

in 1933 at Voroshilovgrad (the old Lugansk works), and is described by Westwood as 'a Soviet 2–10–2 design embodying many American features.'[16] In 1935 series production started of a similar but smaller locomotive, the SO 2–10–0.

During World War II some 2,000 American 2–10–2 engines were received by the Soviets under Lend-Lease (forming the Ea class). Some features of this engine were incorporated into the L class which first appeared in 1945 from the Kolomna works. Other numerous classes of locomotives are the TE and TL series, formed from German locomotives captured in World War II. Table 12–1 summarizes by class the origin of Soviet steam locomotives (both prototype and production) between 1930 and 1945.

SOVIET ELECTRIC LOCOMOTIVES

The first Soviet electric locomotives were made by the General Electric Company and were to form the basis of Soviet-designed and built locomotives. General Electric supplied eight locomotives, of which two were complete and six provided with engines manufactured at the Dynamo works in Moscow with General Electric technical assistance. With a total weight of 124 tons, each had an axle weight of 22 tons. The traction motors had an hourly rating of 340 kilowatts and developed 2,760 horsepower.[17] These were called the Ss class and between 1932 and 1934 some 21 were built at the Kolomna locomotive works with electrical equipment from the Dynamo works.

The General Electric locomotive design was not produced between 1934 and 1938. Seven similar engines were bought from the Brown-Boveri Company of Italy.[18] These had dimensions similar to those of the General Electric but were not developed further.

In addition to these purchases of foreign electric locomotives, the Soviets developed the VL 19, the prototype of which was tested in late 1932. This locomotive had an axle weight of 19 tons with 340-kilowatt traction motors. Westwood notes that about 150 were built between 1932 and 1938. The VL 19 was a Soviet design, although it used a 340-kilovolt General Electric motor. It was made the production standard. However, mechanical and other weaknesses led to abandonment of the standard VL 19 and a return to the General Electric design. The first of these was produced in 1938 and designated VL 22; a more powerful 400-kilowatt unit replaced the earlier engine in 1941 and this model became the postwar standard.[19]

[16] *Ibid.*, p. 88.

[17] *General Electric Review*, XXXVIII.

[18] Westwood, *Soviet Railways Today*, p. 46.

[19] *Ibid.* Westwood notes on p. 47 of *Soviet Railways Today* that other prototypes (the SK and the PB) were built but not multiplied. An experimental high-voltage

Electrification of suburban services began at Baku in 1926 with German equipment, withdrawn in 1940. Moscow suburban electrification was based on the Sv class using Vickers electrical equipment and operated until replacement by the Sd class in 1939. The Sd equipment built in the Moscow Dynamo plant was similar to the Vickers with a 170-kilowatt motor.[20]

Attempts to develop diesel electric locomotives provide an example of the ineffective transfer of foreign technology, ending in abandonment of the dieselization program in 1937. A number of diesel electric locomotives were built for the Soviets before 1930 in Germany. The first was Lomonossoff's 1-Eo-1 model of 1924–5, with a MAN 1,200-brake-horsepower engine. This was followed in 1927 by another with a Krupp gear box and the same MAN engine. Several other oil-engine locomotives were built as prototypes between 1928 and 1933, all, except one, utilizing MAN engines with horsepower ranging up to 3,000 in twin units.

The exception was a prototype built by the Hohenzollern works of Krupp with two Sulzer engines and Brown-Boveri traction motors.[21] This Krupp prototype was copied by the Kolomna works near Moscow and after encouraging trials was put into series production and became the Soviet Class E el 12. A motor was built for the unit at Kolomna on the MAN diesel system.

The locomotives worked well enough around Moscow but when sent to the arid areas of Turkestan their performance deteriorated. Westwood comments on the problem as follows:

> . . . the work of the diesel locomotives was quite unsatisfactory, and did not match the results achieved on trials. . . . Not only design faults, but also poor quality manufacturing and assembly began to be revealed in day-to-day operation. Fuel pumps failed, cylinders developed cracks, bearings overheated, there were transmission failures, crews were sometimes driven from the cab by smoke and smouldering lubricants. These troubles were aggravated by lack of spare parts and the unavailability of skilled technicians. . . .[22]

Construction of diesel electric locomotives was halted in 1937 and effort was concentrated on steam locomotive production.[23] The significance of this failure in the light of expectations may be judged from the Second Five-Year

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locomotive, based on the G.E. Ss class, was designed, and a prototype was built in 1938, tested for three years, and then abandoned (p. 54). Another, built at the Dynamo works was similar to the German Höllentalbahn locomotives, except for the cab structure. Technical details are in *Electric Railway Traction*, December 8, 1939, pp. 139–41.

20 Westwood, *Soviet Railways Today*, p. 60.

21 See 'Dieselelektrische Lokomotive für Russland,' *Zeitschrift des Vereines Deutscher Ingenieure*, September 16, 1933, for technical details.

22 Westwood, *Soviet Railways Today*, p. 69.

23 *Ibid.*, p. 70. Postwar diesels were based on General Electric/Alco Products technology. This will be covered in the concluding volume.

Plan estimates that by 1937 Kolomna would have an annual capacity of 100 diesel locomotives and Orsk a capacity of 540.[24]

CAR, WAGON, AND AXLE MANUFACTURE

Until 1933 axles for railroad wagons and cars were manufactured on a small scale in the old tsarist locomotive plants. In 1933 'an interesting plant for machining railway carriage and wagon axles on a vast scale' was bought from Craven Brothers (Manchester), Ltd., in the United Kingdom.[25] This enormous plant, comprised of numerous special machines (such as four-axle parting, ending, centering, and shouldering machines), was designed to produce 270,000 axles per year of a standard type—a capacity equal to total railroad axle requirements projected through 1945. The equipment was specially designed 'in order that the machines [could] be operated by semi-skilled or possibly by unskilled workpeople.'[26]

Considerable amounts of new railroad rolling stock were supplied under the Lend-Lease program. By 1945 the following had arrived in the U.S.S.R.: 1,900 steam locomotives, 66 diesel electric locomotives, 9,920 flat cars, 1,000 dump cars, 120 tank cars, and 35 heavy-machinery cars.[27]

Car repair work was developed along lines adopted from the Japanese flow repair system; for example, it was announced that the Dzerzhinsky locomotive repair plant at Voronezh had adopted a new method of locomotive repair 'which is a combination of American and Japanese methods.'[28]

THE BEGINNING OF RAILROAD ELECTRIFICATION

The Suram Pass section of the Transcaucasian Railroad was selected for the initial installation of a 3000-volt d.c. electrified railroad system. The initial project was a 40-mile stretch with a maximum grade of 3 percent—not only the most difficult on the Baku-Batum railroad but possibly in all of the Soviet Union. A little over one-half the mileage consists of curved track, with a 2½ mile tunnel at the summit.

Both General Electric Company and Westinghouse drew up plans for electrification of this section.[29] General Electric obtained the contract. Three substations were installed and the 1500-kilowatt motor-generator sets were manufactured by Italian General Electric of Milan, which also built the high-

24 Gosplan, *op. cit.*, I, pp. 579–80.

25 *The Engineer*, CLVI, October 1933, pp. 331–4. This article describes the technical characteristics of the equipment supplied.

26 *Ibid.*

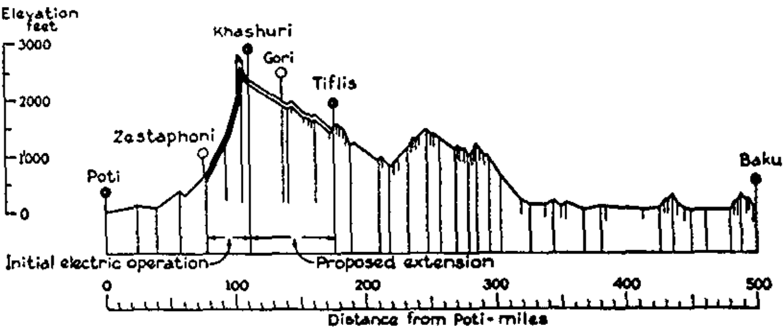
27 U.S. State Dept., *Report on War Aid Furnished by the United States to the U.S.S.R.*, p. 20.

28 Amtorg, *op. cit.*, VI, No. 7 (April 1, 1931), p. 165.

29 U.S. State Dept. Decimal File, 861.64/4.

speed circuit breakers and d.c. lightning arrester. Auxiliary apparatus and secondary distribution material was manufactured in the U.S.S.R.[30]

Figure 12–1 PROFILE OF THE TRANSCAUCASIAN RAILWAY, GIVING ELEVATIONS AND GRADE OF THE ELECTRIFIED ZONE, 1930



At about the same time, a Soviet commission visited most of the 3000-volt electrification systems in the U.S. and Mexico and selected the General Electric C-C locomotive weighing 133 tons for Suram Pass operations. Eight of these were supplied by the company.[31] Erection and placing in service were under supervision of two General Electric engineers, who also trained operative and maintenance personnel. For the next stage of Suram Pass electrification (the easy downward gradient towards Tiflis), the Soviets utilized their own resources.

THE MOSCOW SUBWAY

The lavish Moscow subway was originally intended as a foreign concession. In early 1929 the Rosoff Subway Construction Company of New York concluded an agreement for construction of a 12-mile belt subway and a 120-million-gallon waterworks in Moscow. It was suggested in the *Engineering News Record* that the agreement would not be ratified by the Soviets until 'the company [had] succeeded in negotiations to obtain the required capital from outside sources.'[32] This concessionary arrangement was not implemented.

Construction was begun, therefore, in 1932, with Soviet material resources and advisers from the London, New York, Paris, and Berlin subway systems and utilized layout plans originally drafted by the Russians in 1908.[33] John Morgan, an American, acted as consultant to Mosstroi (Moscow State

[30] *General Electric Review*, XXXVIII, May 1935, p. 220.

[31] *Ibid.*

[32] *Engineering News Record*, CII, June 13, 1929, p. 967–8.

[33] U.S. State Dept. Decimal File, 861.5017—Living Conditions/780.

Table 12–2 PRODUCTION AND ORIGIN OF LOCOMOTIVES IN THE U.S.S.R., 1938

Type (Model)	*Diesel Locomotives*	*Electric Locomotives* *VL-22*	*SO*	*E*	*Steam Locomotives* *FD*	*SU*	*Armored Locomotives*	*All Types*
Western Influence	*Krupp Design Mann A-G Motor Lomonosoff*	*General Electric Design*	*U.S. 2–10–0 Design*	*German, Swedish Design*	*Soviet 2–10–2 Design Plus U.S. 2–10–2 Design Features*	*Tsarist Russian Design (1910)*	*None*	
Plant								
Komintern works (Kharkov)	—	—	6	112	87	—	36	241
October Revolution (Voroshilovgrad, ex-Lugansk works)	—	57	—	—	215	128	77	477
Novocherkast works	—	—	—	4	—	—	14	18
Sormovo (Gorki)	—	—	32	—	86	96	—	214
Kolomna (Moscow)	Production abandoned 1937	80	—	200	86	105	52	523
Stalin (Orsk)	—	—	—	—	134	98	—	232
Ulan Ude works	—	—	16	84	—	—	—	100
Total	—	137	54	400	608	427	179	1,805

Source: Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, March 1941, National Archives Microcopy T 84–122.

Construction and Installation Trust).[34] A German engineer, M. Schmidt, who had been with the Berlin subway, worked on the plans of the Moscow system.[35] An extensive study of foreign systems was made in both the United States and Europe.[36] A Soviet subway commission visited Berlin, and Amtorg commented that:

> . . . Berlin authorities have given the commission every facility for studying the trolleys and subways, street lighting, sewage systems, etc., of Berlin. The commission is authorized to order machinery and equipment for public utilities.[37]

Skilled workers were drawn from all over Europe. Skilled underground laborers came from Vienna.[38] Underground workers and technicians were hired in Great Britain, Germany, France, and the United States.[39] In addition, all known tunneling methods were tried before the British shield method was chosen. Amtorg noted that 'practically all known construction methods were tried out.' They included the British shield system, the French caisson system, the Belgian double passage, artificial freezing (a German method) and the American 'flying arch.'[40]

As finally built, the Moscow system was very much like that of the London Underground, and Westwood points out that 'Soviet engineers made a careful study of the Underground before embarking on their own project, which to some extent represents a significant improvement on the London system.'[41] The escalators, however, were probably of Otis design.[42]

The first section, Sokolniki-Gorki Park, 7½ miles in length, was opened in May 1935.[43]

THE INSTALLATION OF AUTOMATIC BLOCK SIGNALS[44]

The installation of automatic block signals is a good example of the Soviet approach to foreign technology: buying as little as necessary and then duplicating without regard to patent rights.

34 *Izvestia*, January 14, 1935.
35 Amtorg, *op. cit.*, VI, No. 24 (December 15, 1931), p. 575.
36 *Ibid.*, IX, No. 4 (April 1934), p. 92.
37 *Ibid.*, VII, No. 1 (January 1, 1932), p. 22.
38 *Ibid.*, V, No. 20 (October 15, 1932), p. 417.
39 *Ibid.*, X, No. 3 (March–April 1935), p. 92.
40 *Ibid.*
41 Westwood, *Soviet Railways Today*, p. 65.
42 See chapter 16 for the adventures of an Otis Company engineer who attempted to take Otis company blueprints out of the U.S.S.R.
43 *Izvestia*, January 14, 1935.
44 Based on U.S. State Dept. Decimal File, 861.5017—Living Conditions/409, Report No. 8424, January 22, 1932, Riga Consulate.

In 1930 there was only one automatic-signal railroad section in the Soviet Union: it was on the Northern Railroad for 30 kilometers north and east of Moscow. This was installed by German engineers in the late 1920s and comprised all-German equipment.

In 1928 the Union Switch and Signal Company, a division of Westinghouse Electric, sold the Soviet Government about $500,000 worth of apparatus for automatic block signals. This order was on five-year-credit terms and at a 25-percent discount from Union Switch's previous lowest prices. This discount was apparently in anticipation of further large orders.

The equipment was shipped late in 1928 and intended for a section of the Moscow-Sebesh Railroad. Soviet engineers attempted to install the equipment, were unsuccessful, and requested assistance from Union Switch. The company sent an engineer—John M. Pelikan—who was placed in charge of the 17 Russian engineers and 450 workers making the installation. While supervising this installation, Pelikan was approached by the Soviet authorities, who, according to a contemporary Riga Consulate report,

> . . . offered him $100 per month more than he receives from his company if he will resign from it and enter into a personal contract with them for five years. His work would be the same—that of superintending the installation of signal equipment anywhere in the Soviet Union.[45]

This is in itself, of course, both usual and quite acceptable, but the report added that Pelikan 'had seen exact duplicates of the American apparatus which have been manufactured by hand in Soviet Russia. This apparatus, he believes, will operate as efficiently as the American originals.'[46] The apparatus was covered by patents which the Soviets ignored and infringed upon without compensation to Union Switch.

This *modus operandi* was also found, for example, in the field of excavating machinery. The Soviets duplicated without license agreement, company permission, or patent rights, and then approached company engineers in the Soviet Union installing *imported* equipment, offering them a higher rate of pay to supervise installation of the Soviet-duplicated equipment.[47]

Lend-Lease provided automatic signal-operating equipment, also supplied by Union Switch, for a further 3,000 kilometers of railroad track in 1944 and 1945 in a project valued at $10.9 million and designed to increase capacity of existing rail facilities without increasing the amount of rolling stock.[48]

[45] *Ibid.*

[46] *Ibid.*, p. 5.

[47] *Ibid.*

[48] U.S. State Dept., *Report on War Aid* . . . , p. 17.

CHAPTER THIRTEEN

Technical Assistance to the Shipbuilding Industry and the Red Fleet

THE TSARIST SHIPBUILDING LEGACY

ALMOST all of the Imperial Russian Navy, which included comparatively large warships, was built in Russian shipyards. Just before World War I four battleships of 23,000 tons' displacement were launched: the *Petropavlovsk*, *Sevastopol*, *Gangout*, and *Poltava*, built in the Baltic and the Admiralty yards in St. Petersburg.[1] In addition to construction of such large battleships, there was also a remarkable Russian submarine-development program before and during World War I.[2]

These same yards were utilized by the Soviets to build the Red Fleet; once again the concentration was on submarine construction. The Soviet merchant marine, on the other hand, was mainly built in foreign shipyards. As of 1941 only one Soviet destroyer—the *Tashkent*—had been built abroad, while three-quarters of the Soviet merchant marine had been built in foreign shipyards. In general, however, the Soviets had not reached even by 1940 a level of shipbuilding activity equal to that of the private Russian yards in the first decade of the twentieth century.

Analysis of the Red Fleet at the beginning of World War II indicates that one-quarter consisted of ex-tsarist warships and the other three-quarters had been built in modernized tsarist shipyards. By 1939 the largest warships completed under the Soviets were in the 8,000-ton *Kirov* class, very much smaller than the 23,000-ton battleships built in 1910–3 in the same shipyards under the tsar. Consequently the naval assistance forthcoming to the Soviet Union under the Nazi-Soviet pact of 1939 and from American and British

[1] H. P. Kennard, *Russian Year Book for 1912* (London: Macmillan, 1912), pp. 63–7.

[2] E. M. Penova, *Podvodnoe korablestroennie v Rossii (1900–1917)* (Leningrad: Sudostroennie, 1965).

Lend-Lease was very welcome and formed, from the Soviet viewpoint, the key component of each agreement.

In 1941 the Soviet merchant fleet, unlike the Red Fleet, had very few tsarist-era vessels. Only 11 ships, all below 5,000 gross tonnage, have been traced.[3] Most of these had been built at the Nevsky yards or at the long-established Sormovo works. One incidental feature is worth noting; the *Yalta*, a small 600-tonner built at Kolomensky, had an Italian hull coupled with a *Russian* engine, reflecting the early start in diesel-engine manufacture in tsarist Russia. Since 1917 it has been more common to import engines rather than hulls.

These tsarist-era yards then, their names suitably proletarianized, formed the basic structure of the Soviet shipbuilding industry.

Table 13–1 MAJOR RUSSIAN SHIPBUILDING YARDS, 1930–45

Tsarist Name	*Soviet Name*	*Employment (1937–40)*
Leningrad Yards		
Putilov	Severny yard, Zhdanov (part of Kirov Works)	1938: 40,000 in three shifts
Baltic	Ordzhonikidze	1940: 10,000 in one shift
Société Franco-Russe	Andre Marti	1938: 11,000 in three shifts
Admiralty	Sudomekh	1938: 7,000 in three shifts
Black Sea Yards		
Nikolaev Works Co.	Andre Marti, at Nikolaev	1938: 20,000
	Kolomna, at Kuibyshev	1938: 20,000
	Yard 61	1938: 7,000
	Andre Marti, at Odessa	1940: 1,200
Sommer	Sevastopol	1940: 12,000 in three shifts
Inland Yards		
Sormovo	Krasnoye Sormovo (Yard 92)	1937: 27,000 in three shifts
	Komsomolsk, at Khabarovsk	1938: 5,000
Far East		
—	Voroshilovsk, Vladivostok	1938: 5,000

Sources: Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi) March 1941. Miscellaneous German Records, National Archives Microcopy T 84–122.
M. G. Saunders, ed., *The Soviet Navy* (London: Weidenfeld and Nicolson, 1958)

[3] Calculated from data in *Lloyd's Register of Shipping, 1941* (London, 1942). This chapter is based in the main on three sources: *Lloyd's Register of Shipping, Jane's Fighting Ships* (New York: Macmillan, 1942), and the Oberkommando der Wehrmacht archives. *Lloyd's Register* for 1941 reported a Soviet mercantile fleet of 716 ships (gross tonnage 1.3 million tons) in 1939 and include construction details of most ships built to this date.

SHIPBUILDING TECHNOLOGY

Shipbuilding consists of two distinct technologies: design and construction of the hull, and design and construction of the propulsive units. A third supporting category is shipbuilding yard equipment: gantries, welding facilities, and machine shops ancillary to construction slips.

There were several technical-assistance agreements and extensive transfers in each category of shipbuilding technology. Veritas Cie., a French company, supervised construction of tankers at the Odessa Marti yards and the Nikolaev yards in the early 1930s; M. Richard was the French engineer in charge of this work.[4]

Persistent efforts were made in 1937–9 to purchase a 45,000-ton battleship, two destroyers, submarines, and other naval equipment in the United States. These efforts, including the construction of a 45,000-ton battleship (which would have been above current international size and weight standards) had the support of President Roosevelt, the Department of State and Admiral Leahy. However, little came of the effort; it is surmised that officers in the Navy Department may have been at least partly responsible.[5] Assistance to the Leningrad yards was forthcoming from Germany under the Nazi-Soviet pact of 1939. Lend-Lease provided American and British skills and techniques, including vast amounts of shipbuilding equipment.[6]

THE SOVIET MERCANTILE FLEET IN 1941

About three-fourths of the Soviet mercantile fleet of the 1930–45 period was built in foreign yards.[7] The United Kingdom was by far the most important foreign supplier. More than 28 percent of Soviet hulls and almost 32 percent of Soviet merchant marine engines added between 1917 and 1941 were built in British shipyards. Germany was next, represented by almost 20 percent of the tonnage and 12 percent of the engine capacity. Holland was third, with almost 10 percent of the tonnage and more than 6 percent of the engine horsepower. The United States contributed 8 percent of both tonnage and engine capacity. In sum, between 1917 and 1941, 72 percent of Soviet merchant marine hulls and 77 percent of marine engine capacity were built in foreign shipyards and engine plants.

Construction of diesel marine engines inside the U.S.S.R. was concentrated on two systems (MAN and Sulzer) built in eight prerevolutionary plants. The

[4] Amtorg, *op. cit.*, V, No. 16–17 (September 1, 1930), p. 360.

[5] For further details, see U.S. State Dept. Decimal File, 711.00111, Armament Control.

[6] U.S. State Dept., *Report on War Aid Furnished by the United States to the U.S.S.R.*, p. 21.

[7] Calculated from *Lloyd's Register of Shipping, 1941*.

Russky diesel works, an expanded tsarist plant and the largest supplier of marine diesels, supplied the Severney yards with 13 four- and six-cylinder marine diesels of between 500 and 750 horsepower and supplied another dozen four- and twelve-cylinder marine engines to the Baltic and Andre Marti yards in Leningrad and the Nikolaev Yard 61 on the Black Sea.

The Kharkov locomotive works, a tsarist plant, built four types of marine diesel engines of between 350 and 475 horsepower in both six- and eight-cylinder versions for the Sevastopol yards. The Kolomensky engine works in Moscow concentrated on 12-cylinder diesels for the Black Sea yards (Sevastopol and Odessa). Six MAN-type 200-horsepower 12-cylinder marine diesels were built for Sevastopol, and five of the same type and two MAN-type 100-horsepower diesels for Odessa.

The Leningrad engine works supplied 237 standard 62-horsepower four-cylinder diesels for use in the Severney yard fishing-boat construction program. In addition to receiving marine engines from engine plants, the shipyards themselves produced a range of engines; for example, the Severney yard produced three standard 62-horsepower units for fishing boats.

SOVIET NAVAL CONSTRUCTION[8]

Soviet-built naval ships were heavily influenced by foreign design and technology.

Only one new battleship was built before World War II—the *Tretii International (Third International)*, laid down on July 15, 1939 in the Leningrad yards. This was a 35,000-ton battleship; the guns, turrets, armor, and boilers were purchased in the United States and Germany, but the ship was probably not completed by 1947.[9] The other Soviet battleships—the *Marat*, *Kommuna*, and *Oktyabrskaya Revolutsia*—were ex-tsarist vessels reconditioned and refitted. Attempts to build three battleships of the Italian *Vittorio Venuto* class came to nothing. One, the *Krasnaya Ukraina*, was 'captured half-completed by the Germans at Nicolaiev in 1941.' The machinery had been ordered in Switzerland, but was bought by the British Government as a pre-emptive purchase in case the Germans tried to complete the vessel 'and it remains in packing cases in Switzerland to this day,' according to a 1965 report.[10] The other two were not started.

Three aircraft carriers were undergoing construction by the end of the 1930s; the *Stalin* (formerly called the *Admiral Kornilov*) was a 9,000-ton ship built in 1914, redesigned in 1929 and completed in 1939 as an aircraft carrier.

[8] Based on *Jane's Fighting Ships, 1941*, and M. G. Saunders, *op. cit.*, pp. 57–8.

[9] Saunders, *op. cit.*, pp. 57–8.

[10] David Woodward, *The Russians at Sea* (London: William Kimber, 1965), p. 205.

Two other carriers of 12,000 tons each were built 'on the besis of American blueprints':[11] the *Krasnoye Znamye* and the *Voroshilov*, both laid down at Leningrad in 1939 and 1940.

Several cruisers were refitted tsarist-era vessels, including the *Krasni Kavkaz* (formerly the *Admiral Lazarov*, built in 1916 at Nikolaev), the *Profintern* (formerly the *Svetlana*, built in 1915 at Reval and refitted in 1937), and the *Chevonagy Ukraina* (formerly the *Admiral Nakhimov*, built in 1915). The first Soviet attempt at cruiser construction was the *Kirov* class of 8,800 tons. Three ships were laid down in 1934–5. These ships had engines made by Tosi in Italy and were built according to Italian drawings at Putilovets (the *Kirov* and *Maxim Gorki*) and at the Marti at Nikolaev (the *Kuibyshev*) under the technical direction of Ansaldo.[12]

There were three categories of destroyers. First, there were 14 tsarist vessels —four in the *Petrovski* class (built in 1917–8), nine in the *Uritski* class (built in 1914–5), and one ex-*Novik* (built in 1911). Secondly, new classes of destroyers were built under the Soviets, to French and Italian designs.[13] Between 1935 and 1939, 15 destroyers (based on French drawings) of 2,900 tons each were built in the *Leningrad* class: six in the Leningrad yards, eight on the Black Sea, and one at Vladivostok. The first units, supervised by French engineers, were quite similar to the French contretorpilleurs (motor torpedo boats).

The *Stemitelnie* was the largest class; 35 were built between 1936 and 1939. These were 1,800-ton ships mostly built in Leningrad and Black Sea yards to an Italian Odero-Terni-Orlando design, under Italian supervision with some British machinery; most engines were Tosi 50,000-shaft-horsepower geared turbines.[14] In addition, the *Tashkent*, another Odero-Terni-Orlando design, was built in Italy—the only Soviet naval surface vessel ordered abroad in the 1930s.[15]

In January 1939 the firm of Gibbs and Cox, naval architects, was approached with a request to design two destroyers in addition to the 45,000-ton battleship already under design for the Soviet Union.[16] In July of the same year General

[11] Saunders, *op. cit.*, pp. 57–8.

[12] However, according to Woodward, *op. cit.*, p. 205, some machinery was built in the United Kingdom, 'the manufacturers being supplied with blank plans of the ships, showing only the dimensions of the machinery spaces and a 'torpedo compartment.'

[13] Saunders, *op. cit.*, pp. 57–8.

[14] Woodward, *op. cit.*, p. 203.

[15] *Ibid.* Woodward comments: 'The fact that the Communist and Fascist regimes were working hand in hand on this project is, to this day, somewhat piquant, as is the fact that when the Italian-built Soviet destroyer Tashkent was launched at Livorno in 1938 she was blessed by a Catholic priest and flew the Italian flag.' (P. 205.)

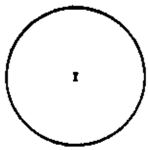
[16] U.S. State Dept. Decimal File, 711.00111 Armament Control/1470, January 3, 1939.

Electric and Westinghouse signified their intention to quote on the propulsive units for these destroyers.[17] After a few months of correspondence, the Navy Department indicated to interested manufacturers that such construction would tax U.S. capability which might be required for domestic purposes,[18] and the proposal was not implemented.

Figure 13–1 ORIGIN OF SOVIET NAVAL VESSELS, 1941 (IN TONNAGE)

Total Tonnage 119,500

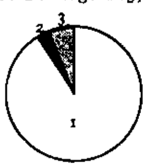
Submarines



(1) 119,500 gross tons, mostly with German and British technical-assistance

Total Tonnage 115,650

Destroyers



(1) 106,500 gross tons, Soviet-built to French and Italian designs

(2) 2,800 gross tons, built in Italy

(3) 6,350 gross tons, tsarist ships

Total Tonnage 104,000

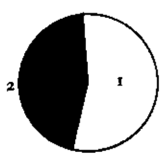
Battleships

(1) 69,000 gross tons, tsarist ships

(2) 35,000 gross tons, Soviet-built with German and American technical-assistance

Total Tonnage 47,964

Cruisers



(1) 26,400 gross tons, Soviet-built to Italian design

(2) 21,564 gross tons, tsarist ships

Sources: See text.

[17] *Ibid.*, 711.00111, Armament Control/2024, July 27, 1939.

[18] *Ibid.*, 711.00111, Armament Control/2158, October 3, 1939.

A large number of small torpedo boats ranging in size from 6 to 35 tons were built in the 1930s to Italian design. These were the Italian MAS type, with Italian-designed machinery and built under license in the Soviet Union. Twelve were built at the Marti yards in Leningrad and the remainder in Black Sea yards. These were supplemented by 23 other unknown types and seven converted tsarist gunboats.

SUBMARINE CONSTRUCTION BEFORE WORLD WAR II

Submarines have always occupied a primary place in Russian naval policy. Extensive tsarist work[19] was adapted by the Soviets at the end of the 1920s, although few tsarist-model submarines survived to become part of the Red Fleet—only the Metallist class (Electric Boat design) and three Russian submarines of the Bolshevik class made by Nobel and Lessner in 1915–6 were still operating in 1940.

Soviet construction began in 1928 with the L and M classes. The L class was based on a British L 55 sunk off Kronstadt and raised by the Soviets; 23 of the L class and one L Special were built to this model by 1938.

The largest class in numbers was the M, a small 200-ton coastal submarine of limited performance, built inland at the Krasnoye Sormovo works in Gorki and transported in sections to the sea. Saunders[20] suggests that such prefabrication was possible only because of the introduction of electric welding, which had been achieved under the General Electric technical assistance contract. The Malodki class appears to have been a Soviet design; there is no trace of direct Western antecedents.

There is evidence, however, that all other Soviet submarine development was heavily influenced by German U-boat design. In 1926 a German naval mission under Admiral Spindler visited the U.S.S.R. and, according to Woodward,[21] the Germans were asked to provide plans of the most successful German submarines, details of operational experience, and the services of German submarine experts. At the same time the Russians requested assistance in the design and building of motor torpedo boats and aircraft launching catapults. Thus the Russians 'obtained various sets of U-boat plans, the most important of which were those of the B-III type, one of the most successful designs for a conventional submarine ever produced.'[22] The B-III was developed by the German Navy into the Type VII, the backbone of the German U-boat fleet in World War II (some 600 were built). Woodward adds: 'In the

[19] E. M. Penova, *op. cit.*
[20] Saunders, *op. cit.*
[21] Woodward, *op. cit.*, p. 202.
[22] *Ibid.*

Table 13-2 ORIGIN OF SOVIET SUBMARINES IN WORLD WAR II

Class	*Weight (Tons)*	*Number Built*	*Year Built*	*Western Design Source*
Bolshevik	650	3	1915–16	Nobel and Lessner, Reval
Metallist	400	4	1916–24	Electric Boat
L 55	1100	1	1918	Ex-British made in Fairfield, Glasgow
L	896 and 1300	23	1929–35	Based on British L 55
L Special	1100	3	1933	Based on British L 55
Malodki	200	50	1928–30	Probably Soviet design
Garibaldietz	1200	8	1933–35	Italian Adriatico design
Pravda	1200 and 1800	17	1936	Italian Adriatico design
Chuka	650	46	1935–38	German B-III design
S (enlarged Chuka)	780	16	1937	German type VII U-boat
Kaler, Lembit	600 and 820	2	1936	Vickers-Armstrongs (Barrow)
V	—	—	1944	British Lend-Lease, Vickers-Armstrongs design

Sources: Jane's Fighting Ships, 1941 (New York: MacMillan, 1941).
D. Woodward, *The Russians at Sea* (London: Kimber, 1965), p. 202.

meantime a variant of the design was built in Russia—first known as the N class, and nicknamed "Nemka" ("German girl") and later as the "S" class.'[23] The Chuka class was based on the German B-III plans, and the S class (an enlarged Chuka) approximated the German Type VII U-boat.

Italian influence came in two submarine classes. The eight vessels in the Garibaldi class were of Adriatico design and the 17 Pravda-class submarines were a development from the Garibaldi.[24]

In addition, two submarines were bought from Vickers-Armstrongs in the United Kingdom in 1936.[25] The Soviet V class comprised Vickers-Armstrongs submarines built in the United Kingdom in 1944 and transferred to the U.S.S.R. under Lend-Lease.[26]

German naval instructors were provided to the U.S.S.R. in the 1920s and also under the 1939 Nazi-Soviet pact. Later British officers were supplied under Lend-Lease to provide training in methods of submarine attack.[27]

Attitudes of the U.S. Executive Branch toward the sale of submarine equipment to the Soviet Union changed in the first five or six years of the 1930s. A proposal received by the Electric Boat Company of Groton, Connecticut

[23] *Ibid.*
[24] *Jane's Fighting Ships, 1946–47.*
[25] *Ibid.*
[26] *Ibid.*
[27] Saunders, *op. cit.*, p. 78.

in January 1930 for the construction of submarines and submarine ordnance equipment for shipment to the U.S.S.R. was the subject of a company enquiry to the U.S. Navy. The latter, in a letter to the Secretary of State, argued that there was 'no objection' to the construction of submarines, etc., for such 'friendly foreign powers,' and further said that this was to the interest of the Navy as it kept domestic shipbuilders at work. The State Department, after noting the Navy position, pointed out that, although there was no legal restriction on shipments of munitions to the Soviet Union, the matter was 'viewed with disfavor by the Department. Consequently the Department views with disfavor the construction of periscopes, submarines and ordnance equipment for shipment to Russia.'[28]

Thus in 1930 the Navy Department was for shipment of munitions to the Soviet Union and the State Department against such shipment. By 1937 the Navy position was reversed. Another enquiry to the Electric Boat Company was referred to Washington. This time the Navy Department took detailed exception and the proposal remained dormant.[29]

There was a flow of American technology, however, under the Sperry Gyroscope technical-assistance contract for marine instruments, and a large number of Soviet engineers were trained by the company in the United States,[30] although attempts in 1937–8 to buy fire-control equipment were thwarted by Navy Department officers.[31]

ASSISTANCE UNDER THE NAZI-SOVIET PACT OF AUGUST 11, 1939

In exchange for raw materials, the Soviets received some German technical and military assistance. The Nazis handed over the partly finished cruiser Lützow, laid down at Bremen in 1937, and in May 1941 the latest available report was that the 'construction of the cruiser "L" in Leningrad is proceeding according to plan, with German supplies coming in as scheduled. Approximately seventy German engineers and fitters are working on the cruisers in Leningrad under the direction of Admiral Feige.'[32]

28 U.S. Dept. of State Decimal File, EE861.34/66, Letter, Navy Department to Secretary of State, January 29, 1930; and letter, Department of State to Electric Boat Company, February 5, 1930.

29 *Ibid.*, Letter, Secretary of Navy to Electric Boat Company, January 18, 1937. See also U.S. State Dept. Decimal File, 711.00111, Armament Control/547, March 26, 1937, in which Cordell Hull refers to an agreement by Electric Boat for construction of Soviet submarines.

30 U.S. Congress, *Investigation of Communist Propaganda.*

31 U.S. State Dept. Decimal File, 711.00111, Armament Control/1018, February 25, 1938.

32 A. Rossi, *Russo-German Alliance 1939–41* (Boston: Beacon Press, 1951), p. 96, quoting a German report.

Table 13–3 ORIGINS OF THE RED FLEET IN 1945

Type of Warship	*Renamed Tsarist Vessels*[1]	*Foreign Purchases*[1]	*Supplied under Nazi-Soviet Agreement (1939)*[2]	*Supplied under U.S. Lend-Lease**[3]	*Foreign Design, Foreign Machinery, Soviet Construction*[1]	*Soviet Design, Soviet Machinery, Soviet Construction*[1]
			(In units)			
Battleship	3	—	—	—	2	—
Aircraft carrier	1	—	—	—	2	—
Cruiser	3	—	1 (Lützow)	—	4	—
Destroyer	14	1 (Tashkent)	—	105	50	—
Torpedo boat	7	—	—	221	153	—
Other vessel	—	—	—	165	—	—
Total	28	1	1	491	211	0

Sources: [1] *Jane's Fighting Ships, 1941.*

[2] *Hauptarchiv*, Boxes 1137 and 1138, at Hoover Institution, Stanford University.

[3] U.S. State Dept., *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945), p. 21.

* Excludes 137 merchant ships and 2,398 pneumatic floats.

In the Leningrad yards German technicians took over construction and repair of several big Soviet ships. This cooperation lasted about 18 months, from late 1939 until May 1941, and, although the Soviets made great efforts to obtain German advanced technical data, there is no evidence that they succeeded to any great extent.

The benefit of this cooperation in the naval field is in some doubt. Admiral Miles of the British Naval Mission in Moscow sums the position in 1942 as follows:

> Although they [the Russians] had been in close touch with the Germans for nearly two years of war, their technical ignorance was surprising . . . they had only inefficient hydrophone submarine detecting gear, no magnetic mines, no concept of degaussing, no radar, and . . . no idea how to sweep magnetic or acoustic mines.[33]

LEND-LEASE ASSISTANCE TO THE SOVIET FLEET, 1941–5

The Soviet Fleet in 1941 comprised three battleships, eight cruisers, 85 destroyers and torpedo boats, 24 minelayers, 75 minesweepers, 300 motor torpedo boats and gunboats, and 250 submarines.[34] Lend-Lease added 491 ships to this total, comprising 46 submarine chasers (110-foot) and 59 submarine chasers (65-foot), 221 torpedo boats (24 of them from the United Kingdom), 77 minesweepers, 28 frigates, 52 small landing craft, two large landing craft from the United Kingdom, and six cargo barges. These were combat vessels, and quite distinct from the Lend-Lease merchant vessels, marine engines, and other maritime material.[35]

In tonnage terms, Lend-Lease probably doubled the Soviet Navy. Only a small number of ships have been returned, although the Lend-Lease master agreement required return of all vessels.

A certain amount of British Lend-Lease went to Russia, and Admiral Miles has left a pertinent comment on Soviet use of this assistance:

> Through either an inferiority complex or a completely misplaced confidence in their own technical ability they felt that as long as they were supplied with blueprints or instruments they had no more to worry about. All our advice was ignored on details as for example, the best position for fitting the asdic transmitter into a ship, or the necessity for training operators to work the gear. They refused to give us drawings of their destroyers and submarines wherewith to calculate the best position. The result was that they fitted the asdic dome in the wrong place and then accused us of sending them faulty equipment.[36]

[33] Saunders, *op. cit.*, p. 76.

[34] *Ibid.*, p. 75.

[35] U.S. State Dept. *Report on War Aid Furnished by the United States to the U.S.S.R.*

[36] Saunders, *op. cit.*, p. 76. This is similar to comments made by American engineers throughout the 1930s.

Despite this flow of assistance, the Soviet Fleet, according to German, French, British, and American observers, was most ineffective during World War II. After initial operating problems, such as when submarines broke surface after firing torpedoes, the naval forces appeared to keep to home waters. British naval opinion suggested that the Soviet Fleet spent its sea time patrolling at high speed in order to use up fuel and return to port for 'welcome home' parties.[37]

[37] *Ibid.*

CHAPTER FOURTEEN

Technical Assistance in Aircraft and Aircraft Engine Production

TECHNICAL-ASSISTANCE AGREEMENTS IN THE AIRCRAFT INDUSTRY

AIRCRAFT development and manufacture in the 1920s rested heavily on foreign aircraft and engine imports[1] and Junkers design and manufacturing techniques, even after Junkers personnel left the Fili plant in 1925. (See table 14–1.) Although there was considerable Soviet design activity,[2] this was not converted into a usable aircraft technology. From about 1932 onward, and particularly after 1936, there was extensive acquisition of Western aeronautical advances. This, fortuitously for the Soviet Union, coincided with an increase in competition among Western aircraft manufacturers, enabling the U.S.S.R. to acquire without much difficulty the latest Western developments. In several cases military aircraft were designed on Soviet account. Thus the heavy, slow, underpowered designs of the early 1930s were replaced by efficient Western designs.

Further, as N. M. Kharlamov, Director of TsAGI (Central Aero-Hydrodynamic Institute im. Zhukovski) informed the U.S. Moscow Embassy in 1937:

> . . . the Soviet Government had become convinced that the American manner of building aircraft was best suited to Soviet conditions since the American system of construction could more easily be adapted to mass production than any of the European systems.[3]

The United States thus became the main source of Soviet aircraft technology; between 1932 and 1940 more than 20 companies supplied either aircraft

[1] See Sutton, *Western Technology . . . , 1917 to 1930*, pp. 256–7, 259–62.
[2] R. A. Kilmarx, *A History of Soviet Air Power* (New York: Praeger, 1962), p. 107.
[3] U.S. State Dept. Decimal File, 711.00111 Armament Control/607, March 25, 1937.

or accessories. Technical-assistance agreements were made for Vultee attack bombers, the Consolidated Catalina, Martin Ocean flying boat and bombers, Republic and Sikorsky amphibians, Seversky amphibians and bombers, Douglas DC-2 and DC-3 transports, and the Douglas flying boat. Even smaller aircraft companies were not overlooked; for example, the entire Fairbanks Aviation Corporation and one of its managers—George Crandall—went to the U.S.S.R. to supervise their assembly and utilization.[4]

Italy was also an important supplier, with Savoia and Macchi technical assistance for flying boats and Isacco assistance for helicopters. French manufacturers supplied the Potez design. British manufacturers supplied the Fairey model and flying boats. Czech manufacturers supplied bombers. German assistance was forthcoming in the form of Heinkel and Dornier designs in the early 1930s and also under the Nazi-Soviet pact of 1939.

Finally, Lend-Lease provided an unprecedented technical bonanza, so that by 1945 the Soviets were on a par with the United States in aeronautical

Table 14–1 ORIGIN OF MILITARY AIRCRAFT IN THE SOVIET UNION, 1932

Plant	*Number Produced*	*Type of Aircraft Produced*
Aircraft Plants		
Plant No. 1 (formerly Dux, Moscow)	260	160 de Havilland Type 9a 100 Heinkel H.D. 43 fighters
Moscow plant	80+	80 Avro 504k training biplanes Moraine-Saulnier monoplanes
Plant No. 22 (Fili)	414	52 R3 biplanes (TsAGI design) 20 R6 reconnaissance (TsAGI design) 242 I4 Jupiter engine planes 80 Ju30 and ANT 6 (Junkers and TsAGI design) 20 ANT 6 bomber seaplanes
Plant No. 23 (Leningrad)	58	18 Avro 504L seaplanes 40 Savoia S.62 Scouting flying boats
Plant No. 31	251	150 Heinkel H.D. 55 scouting flying boats 46 MR-5 (Savoia S62 license) flying boats 12 T.B. 1 (TsAGI design) 45 Ju 30 and ANT 6 naval bombers
Engine Plants		
Plant No. 24 (Moscow)	400	280 M5 (Liberty) 120 Mono-Gnome rotary engines
Plant No. 26 (Rybinsk)	600	600 B.M.W. VI type for Heinkel H.D. 45 fighters
Plant No. 29 (Zaporozhe)	330	260 Bristol Jupiters 70 Hispano-Suiza

Source: C. G. Grey and Leonard Bridgman, eds., *Jane's All the World's Aircraft*, (London: Sampson Low, Marston and Co., Ltd., 1933), pp. 243c–244c.

[4] *Ibid.*, 861.5017—Living Conditions/538, Helsingfors, September 22, 1932.

design and probably in aircraft production techniques, with only a comparatively small deficiency in engine technology and electronic equipment.[5]

THE GLENN L. MARTIN COMPANY TECHNICAL-ASSISTANCE AGREEMENT

In late 1937 the Soviets acquired the world's largest plane—the first commercial plane able to cross the Atlantic nonstop with a payload of 7,500 pounds: more than any other aircraft of the time. This was a definite improvement in design over any plane then built.

Known as the Martin Ocean Transport, Model 156, the plane was built by the Glenn L. Martin Company of Baltimore with four 1,000-horsepower Wright Cyclone engines.[6] It was reported to have cost the Soviet Union $1 million.[7] Although capable of being flown to the Soviet Union, it was flown only to New York, dismantled, and shipped to the U.S.S.R. by boat.[8]

Also in 1937 the Glenn L. Martin Company made an agreement for the design of a Soviet bomber. There is some conflict over the details of this contract, summarized by Loy Henderson, the U.S. Chargé in the Soviet Union, in a letter to the State Department. In reference to a conversation with Kharlamov, director of TsAGI, Henderson says:

> . . . he [Kharlamov] made no mention to the effect that the Glenn L. Martin Company would also send engineers to this country. In this connection it may be of interest to note that since January 1, 1937, the Embassy granted visas to fourteen Soviet engineers and specialists who are proceeding to Baltimore to the Glenn L. Martin factory. This information would appear to be significant in view of the statements made by Mr. Dormoy . . . relative to the difference between the contract signed by the Soviet authorities with the Consolidated Aircraft Corpora-

[5] Kilmarx, *op. cit.*, p. 163, has the following excellent summary of this assistance, which is consistent with the data presented in this study:

> The objectives of the Soviet Union were more straightforward than its methods. By monitoring aeronautical progress and taking advantage of commercial practices and lax security standards in the West, the Russians sought to acquire advanced equipment, designs, and processes on a selective basis. Emphasis was placed on the legitimate procurement of aircraft, engines (including superchargers), propellers, navigational equipment, and armament; specifications and performance data; design, production and test information and methods; machine tools; jigs and dies; semi-fabricates and critical raw materials. Licenses were obtained to manufacture certain modern military aircraft and engines in the U.S.S.R. At the same time, a number of Soviet scientists and engineers were educated at the best technical institutes in the West. Soviet techniques also included assigning purchasing missions abroad, placing inspectors and trainees in foreign factories, and contracting for the services of foreign engineers, technicians and consultants in Soviet plants.

[6] *New York Times*, October 18, 1936.

[7] *Time*, December 6, 1937.

[8] *Ibid.*

> tion and the Glenn L. Martin Company, in which he points out that he understands that the Martin Company is to design and develop a new type of large plane for the Soviet air force instead of selling somewhat obsolete models which may have been released for export by the American military authorities. . . .[9]

Thus the Soviet DB-3, which many observers have noted as quite similar to the Martin 10 and 12 bombers, was probably designed in the Baltimore plant of the company by American engineers. The Soviet engineers were trained at the Martin Company in more advanced techniques, and took credit for its design.

SEVERSKY AIRCRAFT CORPORATION DESIGN CONTRACTS

The *New York Times* reported in May 1937[10] a $780,000 contract with Seversky Aircraft Corporation involving construction of, and manufacturing rights for, Seversky amphibians, which held the current amphibian world speed record of 230.4 m.p.h. The contract included an order for two complete aircraft with manufacturing rights for a total of $370,000. The balance of the order comprised a 60-day option for two additional aircraft and tooling for production of the aircraft. Under a technical-assistance clause, the company provided assistance for manufacture of these planes at the rate of 10 per day in the Soviet Union.

Late in the following year, Alexander P. de Seversky, President of the company, informed the State Department that the Soviets 'had contracted to purchase from the Company a large number of bombing planes of a new type to be designed by him. . . .'[11] A fee of $100,000 had been paid for design services, and de Seversky wanted to know whether any difficulty would be made in obtaining an export license. After being informed that a license would be granted if the planes involved no military secrets, de Seversky indicated that although the plane did not involve military secrets he 'feared that the War and Navy Departments might object to its exportation merely on the ground that it would be superior to any bombing plane now in existence.'[12] He quoted his recent difficulties in exporting internal bomb racks to the Soviet Union and cited a letter from the War Department stating that any license would have to come either from the Chief of the Air Corps or the Bureau of Aeronautics.[13] Finally, de Seversky indicated that he intended to address his request for an

[9] U.S. State Dept. Decimal File, 711.00111 Lic. Consolidated Aircraft Corp./1.

[10] *New York Times*, May 26, 1937, p. 27, col. 3.

[11] U.S. State Dept. Decimal File, 711.00111 Armament Control/1384, November 4, 1938.

[12] *Ibid.* From memorandum by Green, Chief Office of Arms and Munitions Control.

[13] *Ibid.*

export license to the State Department, 'in hope that this Department might expedite action in this matter.'[14]

THE UTILIZATION OF BOEING AND VULTEE AIRCRAFT DESIGNS AND U.S. EQUIPMENT

The Soviet Chatos used in the Spanish Civil War was 'almost an exact duplicate' of the Boeing P-26.[15]

The Boeing Aircraft Company four-engine bomber design, far more advanced than the heavy, slow six- and eight-engine Soviet designs, also attracted the Soviets. In 1939 the Boeing Company was approached 'with a view to the purchase of four engine bombing planes and manufacturing rights for the same. . . .'[16] It is probable, however, that the Boeing Aircraft Company was informally dissuaded from pursuing the agreement in light of the November Soviet attack on Finland. On the other hand, there is evidence that the Soviets were producing copies of the Boeing four-engine bombers during World War II. This could have been done only with American knowledge and assistance.[17]

Finally, in March 1937 production engineers from the Vultee Aircraft Division of the Aviation Manufacturing Corporation of Downey, California began arriving in Moscow 'in order to assist the Soviet Government in building in Moscow a factory which [could] turn out light combat planes.'[18]

Efficient specialized tools were also developed by American aircraft manufacturers and their equipment suppliers for aircraft production and purchased by the Soviets. For example, in 1938 the Lake Erie Engineering Corporation received a Soviet order for six hydraulic presses for forming metal aircraft sections.[19] In the same year Birdsboro Steel Foundry and Machine Company of Birdsboro, Pennsylvania filled a half-million-dollar order for hydraulic presses for aircraft manufacture.[20] Similarly, in 1938 the Wallace Supplies Manufacturing Company of Chicago, Illinois sold seven bending machines 'specially designed to bend tubing for aircraft and parts of motors' for $34,000.[21]

14 *Ibid.*

15 *New York Times*, April 21, 1937, 4:1.

16 U.S. State Dept. Decimal File, 711.00111 Armament Control/2424.

17 Luftwaffe Files, B-17 Project, National Archives Microcopy T 77–642–1837712.

18 U.S. State Dept. Decimal File, 711.00111 Armament Control/607, March 25, 1937. Six or seven production engineers remained about one year. The use of Vultee engineers was confirmed by N. M. Kharlamov, Director of TsAGI. (U.S. State Dept. Decimal File, 711.00111 Lic. Consolidated Aircraft Corporation/1.)

19 *Aero Digest*, February 1938, p. 100.

20 U.S. State Dept. Decimal File, 861.60/315, East European Division Memorandum, August 16, 1938.

21 U.S. State Dept. Decimal File, 861.60/310, Report No. 1542, Moscow Embassy, August 9, 1938. The Soviets deducted $1,600 for late delivery.

Most, if not all, aircraft accessories were straight copies of foreign products. When biplanes were used, 'the streamline wires [were] of English pattern, landing wheels of Palmer type, bomb-releases . . . of their own design, and the duralumin machine-gun rings . . . of French pattern.'[22] Aircraft fuel pumps were the French A.M. type and mobile starters were the Hucks type.[23]

A number of government-financed aviation developments—and U.S. Government records on these developments—were released to the Soviet Union. In 1931 at the request of the State Department and the Buckeye Pattern Works of Dayton, Ohio, the Secretary of War granted 'release of Records of Tests made of certain aluminum exhaust stacks at the Aviation Depot at Wright Field, Dayton, Ohio, for benefit of the Russian Soviet Government.'[24] No military objections were made to production of Wright aeronautical engines in Russia,[25] or to the application by Sperry Gyroscope to sell bomb sights.[26] Neither was objection made to export of Type D-1 and D-2 oil bypass relief valves in 1935[27] by the Fulton Sylphon Company of Knoxville.

Such purchases were, however, subject to interruption. According to Guy Vaughn, President of Curtiss-Wright, he broke off negotiations for sale of the manufacturing license for one of the company's propellers. Although the sale involved only two or three sample propellers 'he was so enraged by the behavior of the Soviet Government in its attack on Finland that he was going to call off the whole deal.' This termination involved some $1.5 million.[28]

THE DERIVATION OF SOVIET AIRCRAFT DESIGN

Until about 1934 Soviet aircraft design was characterized by heavy, slow, ungainly aircraft whose only possible advantage was payload. Beginning in the mid-1930s we find a succession of cleanly designed, fast, and probably efficient aircraft.

The clue to the sudden transformation lies in the technical-assistance agreements and specialized purchases described in the preceding sections. From these came a flow of modern aircraft heavily dependent on Western ideas and particularly production methods. Space prohibits complete description of origin; the Douglas Aircraft Company is therefore taken as a case

22 C. G. Grey and Leonard Bridgman, eds., *Jane's All the World's Aircraft* (London: Sampson Low, Marston and Co., Ltd., 1933), p. 243c.

23 *Flight*, October 23, 1941, p. 274.

24 U.S. War Dept. File, 452.8 Aluminum Exhaust Stacks and 400.112.

25 *Ibid.*, 452.8 Wright engines.

26 *Ibid.*, 471.6 Sperry Bomb Sights.

27 *Ibid.*, 400.3295 Sales Abroad.

28 U.S. State Dept. Decimal File, 711.00111 Armament Control/2389, December 4, 1939.

study and presented, with the DC-3 as a model, in more detail. In addition, table 14–2 lists major Soviet aircraft by type at 1943 and refers to some brief statements in Western sources concerning their origin.

Table 14–2 WESTERN DESIGN INFLUENCE ON SELECTED SOVIET FIGHTER AND BOMBER AIRCRAFT

Soviet Model	*Normal Range (Miles)*	*High Speed (M.P.H.)*	*Suggested Western Design Influence*	*Reference to Citation*
Fighters				
I-15			Boeing P-12	Kilmarx, p. 163
I-16	450	280	'Developed from old Boeing P-26'	*Aviation*, Feb. 1943, p. 16
I-17	600	300	'Patterned on the Submarine Spitfire'	*Engineer*, Nov. 7, 1941
I-18 (MIG-3)	—	375	Origin derived 'to a considerable extent from the British Hurricane'	*Engineer*, Nov. 7, 1941
I-26 (YAK-1)	—	400	'Resembles the Hurricane'	Stroud, p. 32
SU-2	—	275	Possibly developed from Brewster B2A Bermuda	*Aviation*, XLII, No. 2 (Feb. 1943), p. 221
Bombers				
SB-3	550	250	'Was developed to a considerable extent from Martin bombers (B-10 and B-12 series)'	Kilmarx, p. 227
CKB-26	2,500	240	'Many features of Douglas DC-2'	Kilmarx, p. 229
DB-3F	1,500	270		
ZKB-26	—	310	'A considerable resemblance to the American Martin 139'	*Engineer*, Nov. 1941, p. 134
PE-2	—	342	'Based on the French Potez 63'	Stroud, p. 36
YAK-4	—	315	'Appears . . . to have been based on the French Potez 63'	*Aviation*, Feb. 1943, p. 225: Stroud, p. 38
IL-2 Sormovik	—	250	'Similar . . . to . . . Fairey Battle'	Stroud, p. 36
Tu-4	—		Copy of Boeing B-29	Hooftman, p. 154

Sources: R. A. Kilmarx, *A History of Soviet Air Power* (New York: Praeger, 1962).
John Stroud, *The Red Air Force* (London: Pilot Press, 1943).
H. Hooftman, *Russian Aircraft* (Fallbrook: Aero Publishers, 1965).
Aviation, XLII, No. 2 (February 1943).
Engineer (November 7, 1941).

Although the Soviets produced more than 30 transport aircraft designs after 1934, their indigenous development work was severely limited. During the twenties the Russian designer Tupolov had produced, with Junkers technical assistance and in the Junkers concession plants,[29] the ANT-9 all-metal aircraft. This was followed in 1931 by the less successful ANT-14. With a top speed of 130 to 150 miles per hour, these were slow, gigantic aircraft and were abandoned after several crashes.[30] This left the Soviets without a modern transport aircraft, and in 1936, rather than pursue further development work, they made a technical-assistance agreement with the Douglas Aircraft Company of Santa Monica for production of the DC-3, renamed the PS-84 and then the LI-2.[31] This plane had more than double the range and more than twice the speed of the Soviet ANT series. However, it took until 1940 to get the first Soviet DC-3 off an assembly line, even with extensive assistance from Douglas Aircraft.[32]

The first flying boats built under the Soviets were constructed at Leningrad and Taganrog. In 1932 Plant No. 23 in Leningrad produced 18 Avro 504L seaplanes and 40 Savoia S-62 scouting flying boats, the latter under a license from the Società Idrovolanti Alta Italia of Milan—an outstanding designer of high-performance flying boats.[33] Also in 1932 the Taganrog Plant No. 31 on the Sea of Azov produced 251 planes, of which 196 were flying boats: 150 scouting H.D. 55s, built under the Heinkel license, and 46 MR-5s, built under the Savoia license.[34] The Soviets also acquired a license from the Macchi Company of Italy to produce the MBR series of flying boats, typical of Soviet flying boat design until 1945.[35] In 1937 an agreement was made with the Consolidated Aircraft Company of San Diego for technical assistance in the design and supervision (under Etienne Dormoy) of sea plane construction in the Soviet Union at Taganrog on the Sea of Azov.[36]

Meanwhile, tsarist work in the aviation field was being further developed. Several autogiro and helicopter designs were produced in the late 1920s and early 1930s: the KASKR-1, the TsAGI in various versions, and the Kamov A7 are examples of this early Russian design work. It is unlikely that these

[29] For material on Junkers, see Sutton, *Western Technology . . ., 1917 to 1930*, pp. 256–63; see also Auswartigen amts., *Akten zur Deutschen Auswärtigen politik, 1918–1945* (Göttingen: Vandenheock und Ruprecht, 1967).

[30] Kilmarx, *op. cit.*, p. 161.

[31] See p. 232.

[32] See p. 234.

[33] Grey, *op. cit.*, p. 244c.

[34] *Ibid.*, p. 246c.

[35] *Aviation*, September 1942, p. 286.

[36] U.S. State Dept. Decimal File, 711.00111 Armament Control/607, March 25, 1937. See also 711.00111 Lic. Consolidated Aircraft Corporation/1.

were successful,[37] although they had Western power plants; for example, the K-17 one-place coaxial rotor helicopter had a modified 17-horsepower Aubier-Dunne engine.

The Italian designer Vittorio Isacco worked in Russia in the early 1930s and developed a helicopter with blade tip power plants (the 120-horsepower de Havilland Gypsy 3) with a 300-horsepower Wright radial nose engine. *Aviation Week* commented that, 'In 1935 [Isacco] was given what in the U.S. would be known as the 'bum's rush' and he left the U.S.S.R. To this day the designer does not know the fate of his machine.'[38]

The first successful Soviet-designed helicopter, powered by two M-11 engines and produced at Tushino, was flown in 1941. In general, Soviet success with helicopters came after World War II; efforts between 1939 and 1945 were halting, dependent on Western engines, and could hardly be called successful.

In the field of airship design, the Italian general, Umberto Nobile, worked in the Soviet Union providing assistance in construction of Soviet airships.[39]

TECHNOLOGICAL ORIGINS OF SOVIET AIRCRAFT ENGINES, 1945

The bottleneck in tsarist aircraft production was engines; during World War I, owing to limited domestic capacity, three-quarters of Russian aircraft were equipped with imported engines; the only aircraft engine plants were the Tushino and the Russo-Baltic. The Soviets also imported aircraft engines during the 1920s. Then, by acquiring rights to manufacture foreign engines under license and with Western technical assistance, the Soviets were able to acquire rapidly a sizable engine-producing capacity.

Plants No. 24 and 25 were built in Moscow; No. 24 made Wright Cyclone engines under license and No. 25 made parts for Wright engines. Production was about 250 engines per month in 1938; some 12,000 workers were employed on three-shifts. Models produced were the M-25, M-34, M-63, and M-64, all based on Curtiss-Wright developments.

Although between 1939 and 1941 the Soviet Union had to depend on its own technical resources 'because so many foreign engineers at work in the U.S.S.R. were recalled to their own countries,'[40] after 1941 Lend-Lease played a role in providing a flow of designs and manufacturing equipment. The

[37] H. Hooftman, *Russian Aircraft* (Fallbrook: Aero Publishers, 1965), p. 79.

[38] March 5, 1956.

[39] See Zara Witkin papers, Hoover Institution Special Collection, p. 82. Nobile's book [Umberto Nobile, *My Polar Flights; An Account of the Voyages of the Airships Italia and Norge* (London: F. Muller, 1961)] contains no mention of this work.

[40] Kilmarx, *op. cit.*, p. 162.

Soviets standardized on a few successful types developed from Western designs and installed these into a large number of planes.

Prototypes of every Western aircraft engine were acquired. These were minutely examined, and composite 'Soviet' designs were built incorporating the best features of each. A report by Bruce Leighton describes one of these models at the Engine Research Institute in 1931:

> They've taken Packard, Conqueror, Rolls-Royce, Kestral, Hispano-Suiza, Fiat, Isetta-Franchini—tested them all, analyzed them down to the minutest details, including microphotographs of piston rings, flow lines in crank shafts, etc., taken good features of all, added some ideas of their own (particularly regards valve cooling) and built-up [*sic*] an engine which we're going to hear more of or I miss my guess.[41]

These early Soviet conglomerate designs were not successful; 'copying' is not always the outright gift it might at first sight appear to be. Neither is the process of taking the best features from several models always advantageous. There is a unity in good engineering design, and this unity can be sacrificed in the copying process without gaining compensating advantages.

In the entire world in 1944, about 130 basic types and 275 variations of aircraft engines, excluding German diesel engines, were either in production or had recently been in production. Of the 130 basic types, 48 were produced in the United States, 28 in Great Britain, 20 in Germany, 17 in Italy and 3 in the Soviet Union. Each of the three Soviet types was an adaptation of a foreign engine built under a licensing agreement. The M-38 liquid-cooled 12-cylinder V model was developed from the 1936 M-34, in turn developed from the Wright Cyclone. The M-88 was a 14-cylinder air-cooled radial engine based on the French Gnome-Rhône 14 N. The third engine type was the M-105, a 12-cylinder liquid-cooled V type based on the Hispano-Suiza 12Y engine.

PRODUCTION OF THE WRIGHT CYCLONE ENGINE UNDER LICENSE

Bruce G. Leighton, of the Curtiss-Wright Corporation, was given a seven-day reception and tour of Soviet aircraft plants in 1931.[42] At this time the Curtiss-Wright liquid-cooled engine was the only liquid-cooled American engine still in production. The U.S. Army initially supported development but, dissatisfied with the basic design, cut off funds in 1932. Development support for two other liquid-cooled engines, one of them the Curtiss-Wright H-2120, was continued by the U.S. Navy. Testing and development continued

[41] U.S. State Dept. Decimal File, 360.02, Bruce G. Leighton Report, December 10, 1931, p. 5.

[42] *Ibid.*

from 1933 to 1936, when the Navy withdrew support and reverted to air-cooled engines. The company, convinced that the design was mechanically poor, did not press further development. The second Navy-supported Curtiss-Wright project was a 12-cylinder V engine known as the V-1800. This was intended to replace the Curtiss-Wright Conqueror, and successfully completed its testing in 1934:

> Shortly after this test was completed, however, the Navy was forced by lack of funds to abandon most of its high-speed program and to cease support of the V-1800. The Army refused any appreciable support and the company did not wish to do further development at its own expense.[43]

As a result of the Leighton visit, the V-1800 engine was licensed to the Soviet Union, which funded further research work to raise the engine rating to 900 horsepower from the Navy test rating of 800 horsepower. This work was centered at Aircraft Engine Plant No. 24 (the Frunze) in Moscow, with parts manufactured at Works No. 25. By 1938 these plants employed about 12,000, producing about 250 Wright Cyclones (Soviet M-25) per month.[44]

A plant for manufacturing Cyclone engines was also built at Perm. This was about twice the size of the Wright plant in the United States, and by 1937 this facility was producing Wright Cyclone engines in quantity, although quality left something to be desired.[45]

LICENSING OF THE GNOME-RHÔNE (JUPITER) ENGINE

At the start of World War I, French builders were the leaders in air-cooled engines. The British and United States Air Forces both used French engines built in France or under license in the United Kingdom and the United States. The Gnome rotary, manufactured by the Société des Moteurs Gnome et Rhône, was one of the best of these early engines. After the war the Gnome Company purchased the license of the British Bristol Jupiter II; during the decade of the 1920s the Gnome-Rhône engineering department was dominated by English engineers from the Bristol Aeroplane Company. The only major innovation of Gnome-Rhône at this time was the Farman reduction gear, licensed back to the Bristol Company in 1926. After producing the Bristol Jupiter engine for some years, the Gnome Company came up with an improved engine of its own design, using American lined cylinders.[46] This cross-fertiliza-

[43] R. Schlaifer and S. D. Heron, *Development of Aircraft Engines and Fuels* (Boston: Harvard University, 1950), p. 267.

[44] Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, VIII 7b, National Archives Microcopy T 84–122.

[45] Arthur Nutt, 'European Aviation Engines,' *S.A.E. Journal*, XLI, No. 1 (July 1937), pp. 14–5.

[46] Schlaifer, *op. cit.*, pp. 138, 142, 146, 148.

tion of ideas led to the exceptional Gnome rotary engines of the 1930s; these were adopted by the Soviets.

The Jupiter, or Gnome-Rhône 114, was built at the Kharkov engine-building plant (Plant No. 29). Without question there were initial difficulties. Leighton reported:

> They are not happy about the Jupiter and have been having indifferent success with it. Too much skilled hand work I suspect. . . . In Paris a Gnome-Rhône man later told me they are now building 40 of their latest Jupiters for Russia. . . .[47]

Kharkov Plant No. 29 persisted and the Jupiter became Soviet Models M-85, M-87B, and M-88, of the last of which about 1,500 a year were produced by 1940.[48]

In the same manner the Hispano-Suiza engine was produced in Moscow at an enormous plant twice the size of either the Pratt & Whitney or the Wright factories in the United States. This engine became the Soviet M-105. A western observer noted that although the engine was 'somewhat heavy,' they were doing a good job and quality had noticeably improved between 1934 and 1937.[49]

THE PRATT & WHITNEY AIRCRAFT ENGINE LICENSING AGREEMENT

In July 1939, in a discussion between State Department and three representatives of the United Aircraft Corporation, the corporation attempted to ascertain the view of the U.S. Government toward a licensing agreement with the Soviet Union for the Pratt & Whitney Twin Wasp 1830 and the Twin Hornet 2180 aircraft engines. The State Department official did not reply directly but suggested that the sale of naval vessels should offer a guideline. United Aircraft then stated that in this case they would probably 'seriously consider' entering into a contract. To avoid the perennial problem of overly inquisitive Soviet inspectors in their plant, they proposed to insert a number of restrictive clauses.[50] No further data has been traced concerning this agreement.

[47] U.S. State Dept. Decimal File, 360.02, Bruce G. Leighton Report, December 10, 1931, p. 7.

[48] Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, National Archives T 84–122.

[49] Nutt, *op. cit.*, pp. 14–5.

[50] U.S. State Dept. Decimal File, 711.00111 Armament Control/1982, July 20, 1939. There was probably an earlier agreement, as the Soviet M-26 was based on the Pratt & Whitney Hornet. See Kilmarx, *op. cit.*, p. 112.

EARLY DOUGLAS DC-2 SALES TO THE SOVIET UNION[51]

The Douglas Company files on sales to the Soviet Union open in December 1933 with a letter from G. A. Gertmenian, a Los Angeles oriental-rug dealer, proposing a three-way deal under which Douglas would take payment for its aircraft 'in a credit with the Amtorg in rugs,' to be sold by Gertmenian. The latter suggested that Amtorg had a surplus of oriental Russian and Persian rugs accumulated in barter deals and was anxious to dispose of this stock. Indeed, added Gertmenian, they were more interested in 'arrangements for paying than . . . with the prices which they pay.'[52] Douglas Aircraft was understandably cool about tying aircraft sales to the rug market.

This initial approach was followed in early 1934 by a letter from Amtorg asking for details of the Douglas plant and its products, and whether a delegation of Soviet engineers could be received. Simultaneously, letters came from the International Seed Service (Internatsionalinii semenoi trest) suggesting 'publicity' for Douglas in the Soviet Union.

A Russian mission was sent to Santa Monica. This mission subsequently requested a quotation on the civilian DC-2 and data on the U.S. Army method of heating air-cooled engines on the ground in sub-zero weather. Then followed a request for detailed specifications of the new Northrop Gamma long-range bomber. The next day caviar and vodka were delivered to the home of G. W. Stratton, Vice-President of Douglas.

In June 1935 Amtorg ordered one DC-2 and one Northrop Gamma bomber and requested that Soviet engineers be allowed to enter both the Douglas and the Northrop plants for observation. Amtorg was promptly informed that the U.S. Government would not permit any representatives into the Northrop plant although permission might be granted for temporary entry to the Douglas plant. Then came an Amtorg request for four engineers of the Tupolov Commission, currently touring the United States, to visit the plant. This was followed by another wire two days later: 'TWO OUR ENGINEERS LEAVING FOR DOUGLAS FACTORY . . . AWAITING YOUR WIRE REGARDING THEIR WORK AT THE NORTHROP FACTORY.'

Douglas promptly reminded Amtorg that the U.S. Army had tagged the Northrop plant as 'absolutely closed,' but on July 5, 1935 Sokoloff, President of Amtorg, sent a telegram to Stratton: 'PLEASE AIR MAIL IMMEDIATELY COPIES YOUR COMMUNICATIONS TO AUTHORITIES REQUESTING PERMISSION OUR ENGINEER TO BE AT NORTHROP FACTORY FOR OUR GUIDANCE ENDEAVORING ASSIST IN THIS STOP.'[53]

[51] Based on Douglas Aircraft Co. files. The cooperation of the Douglas Aircraft Co. is gratefully acknowledged.

[52] Douglas Aircraft Co. files, *Russia—1934*.

[53] *Ibid.*

This was followed by a letter from Sokoloff expressing regret that negotiations 'had not been developing as smoothly and pleasantly as I hope,' and stating that the Douglas Company had agreed 'to obtain permission for our inspection on the parts and the complete airplanes. . . .'[54] A request for copies of the Douglas-War Department correspondence was repeated with the reasoning that unless Amtorg knew whom Douglas has contacted in the U.S. Army they would be unable to enlist the assistance of the Soviet Embassy.

On July 12, 1935 Donald Douglas ended the exchange by pointing out that application for permission had been made to the U.S. Army immediately upon receipt of the order, and that he personally had instructed his assistant not to furnish copies of the letters, as the U.S. Government would 'resent our turning over correspondence to you that they might regard as confidential.' Douglas concluded:

> Really Mr. Sokoloff, from Mr. Wetzel's talk of several hours with your two engineers, it is apparent that they are not so much interested in inspecting the parts of your airplane as they are in getting information on our building methods and equipment. . . . I must beg to point out to you that you have bought an airplane but not the right to our shop processes. . . .[55]

A CASE STUDY: THE DOUGLAS AIRCRAFT TECHNICAL-ASSISTANCE AGREEMENT FOR THE DC-3 TRANSPORT

Donald Douglas produced his first DC-3 in March 1935; within one year the Soviets decided this was to be the basic transport plane for the U.S.S.R. and concluded a technical-assistance agreement with the Douglas Aircraft Company, signed on July 15, 1936, for three years.

Within 30 days of contract signature, Douglas delivered the blueprint materials required to fulfill the assistance contract. The following were provided: three sets of manufacturing drawings and descriptions and specifications of materials; four sets of photographs (250 to a set); four copies of the *DC-3 Maintenance and Instructions Manual* and the *Pilots Operations Manual;* four sets of specifications 'in accordance with which Douglas purchases finished products, such as extrusions and forgings from third parties, including . . . source of supply and one set of sample pieces of extrusions'; three sets of static tests and laboratory reports; three sets of strength calculations; three reports of wind tunnel tests and the aerodynamic and stability calculations; three copies of the specifications for 'purchasing devices and other equipment'; three copies of descriptions of machines used in manufacturing (mainly bending machines, power brakes, and cutting tools), including names and

[54] *Ibid.*
[55] *Ibid.*

addresses of manufacturers; three copies of *Machinery and Equipment Used by the Douglas Company in Production of DC-3 Transports;* data pertaining to the technical conditions for producing important parts (such as process specifications; welding-flux, welding-rod, welding-torch tips; and tube-bending methods); three copies of methods of testing parts and special accessories; descriptions and/or drawings of necessary jigs, fixtures, and instruments for servicing; and a list of recommended spare parts.[56]

There are numerous detailed internal company memoranda still in the files which leave no question that instructions were to fulfill the agreement in a detailed and precise manner. The Soviet Union had no cause for complaint concerning the manner in which the company fulfilled its requirements under the agreement; the assistance was prompt, accurate, and such that any competent engineering organization could move into production of DC-3 transports in short order, as did other countries, such as Japan, with similar agreements.

In October 1937 the Soviet aircraft industry placed a $1.15 million order with Douglas for additional parts, tools, assemblies, and materials. The order included one complete DC-3 in subassembly and another in 'first-stage' production; both were minus engines, propellers, and automatic pilots. In addition, aluminum extrusions were ordered for another 50 aircraft, together with two complete sets of raw materials and 25 sets of finishing materials ranging from ash trays to zippers. Construction facilities, ordered at the same time, included one complete set of 6,485 templates, a set of 350 lead and zinc drop hammer dies, three sets of hydraulic mechanisms, all the necessary wood and plaster patterns, drill and assembly fixtures, a complete set of drop-hammer stamps, hydraulic-press parts, two crowning machines, and a set of 125 special tools. These were supplemented by information on the hydraulic-press process and the training of engineers in its operation.

Almost half of this second order consisted of 50 complete sets of raw materials, including aluminum castings, aluminum-alloy castings, forgings, extrusions, sheets and plates, bearings, stainless steel sheets, C.M. sheets, and Alclad sheet and strip.[57] It was rather like supplying 50 toy construction sets; the Russian plant engineers needed only to follow the drawings and put the pieces together.

In February 1938, however, another order was placed for nine more Douglas-made DC-3s, and in November 1938 (a year after the parts order)

[56] Copies of these items are in the Douglas Aircraft Co. files. The writer attests to their completeness; it took a day just to scan the material.

[57] The Douglas Co. threw in a set of special loft tools at no charge. The gift was criticized by the GUAP Commission because a straightedge and a spare part were missing.

yet another six complete transports were purchased.[58] It was not until 1940, four years after the agreement, that the Soviets got any domestic DC-3s, renamed the PS-84 or the LI-2, off a Soviet assembly line.

By early 1938, then, the Soviet DC-3 program was behind schedule. Even with 50 sets of 'first-stage' material, tools, specifications, materials lists, and other assistance, they were unable to get into production. One source of trouble may have been welding sections; the October 1937 materials and parts order contained a very large quantity of welding materials: too much, thought Douglas, for only fifty DC-3s. Yet on January 17, 1938 Amtorg came back to Douglas for still more welding rods and other welding materials (more than $7,000 worth, in all). These (Purox 1, Alcoa No. 1 and No. 2, etc.) were not made by Douglas, and as Alcoa was exchanging aluminum for Soviet oil, the use of Douglas as a purchasing agent is, in this instance, a mystery.[59] Another source of trouble was the hydraulic press for shearing and forming panels; events in early 1938 indicated pressure upon Amtorg in New York to obtain equipment and information. Douglas, however, did not make the hydraulic press, and only the provision of operating methods was included in the agreement.

The Amtorg order of October 1937 called for the supply of technical information on the Douglas method of hydraulic-press forming of sheet metal. The Soviets obviously recognized the central importance of this process and, it appears, were unable to get either a press or the requisite technical knowledge from the American manufacturer. The order to Douglas called not only for technical information and calculations relevant to the Douglas use of the press, but also for information obtainable only from Hydraulic Press Manufacturing Company, as the Douglas files reveal ('all erection and assembly drawings . . . drawings for spare parts . . . drawings of the dies'). Obviously Douglas did not agree to supply these, but on the Amtorg 'confirmation of order' these items are listed and then crossed out by someone at Douglas. This rather crude attempt to get the Hydraulic Press data was followed in March 1938 by an exclusive license granted by Douglas to Narkomvneshtorg (People's Commissariat for Foreign Trade) for the Guerin process (Douglas Patent No. 2,055,077 and others) 'whereby sheet metal may be mechanically cut to form a blank which may thereafter be formed into a part of objects and unique methods and apparatus of forming metal blanks. . . .'[60]

The Soviets then withheld payment for the manual and the list of parts for the Birdsboro press (required and supplied by Douglas under the agreement).

[58] Douglas Aircraft Co. files. Data taken from letter of V. K. Bogdan to Stratton, October 1, 1937.

[59] Douglas Aircraft Company files, 'Amtorg—Misc. Orders,' January 18, 1938.

[60] *Ibid*

In turn, Douglas withheld permission for Soviet engineers to visit the press until Amtorg paid. On March 28 Amtorg wired Douglas Aircraft that the check in settlement of the manual and parts had been mailed. The check did not arrive. On April 15 Amtorg wired that the check had been withheld because of Item 10, Paragraph K of 25-80/70143. The Douglas Company reply was very much to the point:

> The only part of this item upon which you have received no information is that, desired by you, from the Hydraulic Press Manufacturing Company. . . . It seems very strange to us, Mr. Bogdan, that you would withhold payment to us of some $30,000 in an effort to force us to get from the Hydraulic Press Manufacturing Company what they don't want to give us. If you have purchased Birdsboro Presses . . . and if you are so entitled to get the information you desire, it would seem much more reasonable to get it from Birdsboro who can get it from Hydraulic Press Manufacturing Company. We have made it very clear to you from the first that we are not selling you the design of the press, but that we would *endeavor* to get such information as the Hydraulic Manufacturing Company was willing to give you. . . .[61]

On April 19, the Soviet engineers came back once again about the Birdsboro press. A rubber change on the hydraulic mechanism had taken place without a Soviet engineer being present (the foreman who normally informed the Soviet engineers was absent and the shop men decided to go ahead with the change on their own), so that the change was made without Soviet knowledge. The Soviets immediately protested and Stratton took this opportunity to remind the GUAP (Main Administration of the Aircraft Industry) Commission of the terms of the agreement: 'I can assure you that we have no objection to your men observing our overhaul operations on the press. The only restrictions we have placed on your men is that they do not make sketches of anything in the plant.'[62]

Like other American companies and individual engineers, the Douglas management developed pragmatic rules for dealing with the peculiar Soviet outlook. Threats and bluff were met by firmness, and objection by counter objection.

[61] *Ibid.*
[62] *Ibid.*

CHAPTER FIFTEEN

Technical Assistance to Military Industries: Tanks, Guns, and Explosives[1]

ALTHOUGH this study is concerned with economic development, a section on military development is included for completeness. The Soviet Union has concentrated significant resources in this field and this, of course, has diverted resources both from capital expenditure and the standard of living. Further, although it appears unlikely that Western governments supporting free-enterprise systems could also rationally have supported the long-run military endeavours of the Soviet Union in the years before the Nazi invasion, such support, indeed, seems to have been the case.

In the 1920s it had been the U.S. State Department that had objected to shipments of armaments to the U.S.S.R.; the War and Navy Departments, however, found such shipments acceptable on the grounds that they maintained military suppliers in business. These positions were later reversed, and after the early 1930s we find the State Department encouraging shipment of military assistance[2] and the War Department expressing greater reluctance. This executive schizophrenia was carried to a point suggesting that Navy officers were unofficially sabotaging military sales already approved by Admiral Leahy, President Roosevelt, and the State Department.[3] A quotation from a State Department memorandum recommending approval to A. W. Hahn, a consulting engineer, to design and operate an aluminum-powder plant in the U.S.S.R. suggests, however, that the Department itself was somewhat self-conscious about its position. On January 3, 1931 Senator Smoot had inquired about the Hahn plant, and the Department handled the Senator's inquiry as follows:

[1] For information on searchlights see chap. 10, for aviation see chap. 14, and for shipbuilding see chap. 13.

[2] U.S. State Dept. Decimal File, 711.00111, Armament Control/583.

[3] *Ibid.*, 711.00111, Armament Control/1127 and /1841.

> No reply was made to Senator Smoot by the Department, as the Secretary did not desire to indicate that the Department had no objection to the rendering by Mr. Hahn of technical-assistance to the Soviet authorities in the production of aluminum powder, in view of the possibility of its use as war material, and preferred to take no position at the time in regard to the matter.[4]

The same memorandum reviews the State Department position on sale of armaments to the Soviet Union. Previously, according to the memorandum, the Department had refused permission for export to the Soviet Union of guns, rifles, ammunition, periscopes, submarines, naval planes, and machinery for the manufacture of smokeless powder. On the other hand, the Department had made no objection to the sale of blasting caps and fuses, commercial airplanes and engines, and helium gas. On the question of technical services for military end-use, the Department had viewed with disfavor the sale of a method 'for causing mustard gas to be indefinitely persistent' but had not objected to the sale, construction, or operation of a system of aerial survey, and assistance for production of nitrocellulose and purification of cotton linters.[5]

This distinction made between civilian and military products is hardly clear. The State Department had disapproved the sale of naval bombers by the Glenn L. Martin Company but had approved the sale of aircraft engines and technical assistance for the production of aircraft engines by Curtiss-Wright on the grounds these were for civilian use. The Curtiss-Wright engines had both civilian and military uses and certainly were used for military planes and tanks by the Soviets. Disapproval was voiced over the sale of submarine periscopes on the grounds that this was war material, but approval was given to the Hercules Powder Company to offer technical assistance for a large plant 'in the production of nitrocellulose,'[6] in the face of a letter from the War Department specifically stating that the assistance would be 'a very material military asset.'[7]

By 1938 the State Department had approved ammunition and battleships. In reply to a letter from the E. W. Bliss Company concerning a proposal to supply the U.S.S.R. with 'a complete plant for the manufacture of small arms ammunition, including the necessary machinery and full information concerning the operation thereof,' it was asserted on April 27, 1938 that this would not

4 U.S. State Dept. Decimal File, 861.659—DUPONT DE NEMOURS & CO./5. Aluminum powder is used, as an additive, to raise the explosive force of ammunition.

5 *Ibid.*

6 U.S. State Dept. Decimal File, 861.659—Nitrocellulose/5: '. . . this Department does not desire to interpose objection to your Company rendering technical-assistance to the Soviet authorities in the production of nitrocellulose and the purification of cotton linters, along the lines outlined in your communication.'

7 *Ibid.*, 861.659—Nitrocellulose/1 through/5.

contravene any existing treaty provided there were no military secrets involved.[8] President Roosevelt personally instructed the State Department to 'give all help' to the Soviet Union to have a 45,000-ton battleship built in the U.S.[9]

In brief, the grant of permission to export or not to the Soviet Union was obviously not always based on the question of the military end-use of the products.

European governments were even more active than the United States in approving the supply of armaments and providing technical assistance for their production. Germany supplied organizational assistance and later extensive military supplies under the Nazi-Soviet pact.[10] France supplied military assistance after the detente of 1933. Italy built the destroyer Tashkent, and the Fiat and Ansaldo companies were major suppliers of weapons.[11] Another major supplier was Vickers, which had a close relationship with the British Government and which supplied tank designs and models which became the basis for the standard Soviet tanks of World War II.

NEW TRACTOR PLANTS AND TANK PRODUCTION

A plant for the erection of tractors is well suited to the production of tanks and self-propelled guns. The tractor plants at Stalingrad, Kharkov, and Chelyabinsk, erected with Western assistance and equipment, were used from the start to produce tanks, armored cars, and self-propelled guns. The enthusiasm with which this tank program was pursued and the diversion of the best Russian engineers and material priorities to this end were responsible for at least part of the problem of lagging tractor production.

As early as 1931 the Chain Belt Company representative at Stalingrad reported that the newly opened tractor plant was making 'small tanks.'[12] In 1932 A. A. Wishnewsky, an American whose specialty—production methods—took him into many Soviet plants, reported that the principal emphasis in these plants was on production of munitions and military supplies. In all factories, he stated, at least one department was closed, and he would from time to time run across 'parts, materials, shells and acids' having no relation to normal production.

> He stated that it was particularly true of Tractorostroy [*sic*] where emphasis is being placed on the production of tanks rather than tractors.

8 U.S. State Dept. Decimal File, 711.00111 Armament Control/1076.

9 *Ibid.*, 711.0011 Armament Control/1154. See marginal notations by the President.

10 See *Hauptarchiv*, Hoover Institution.

11 A. Barmine, *op. cit.*, p. 189.

12 U.S. State Dept. Decimal File, 861.5017—Living Conditions/248, Report No. 608, Interview with E. T. Riesing, May 8, 1931.

> In his opinion, a least for the time being, the development of tractor production there has been designed to lead up to the production of tanks for military purposes.[13]

Such reports were confirmed a few years later by German intelligence, which concluded that in 1937–8 the Stalingrad Tractor Plant was producing a small three-ton armored car and a self-propelled gun at a rate of one per week, and the T-37 tank, patterned on the British A 4 E11, at the rate of one every four days. The 1937 Soviet War Mobilization Plan, of which the German Wehrmacht apparently had a copy, planned to double this output in case of war.[14]

A similar report was made in late 1932 from the Kharkov Tractor Plant by Ingram D. Calhoun, an engineer for the Oilgear Company of Milwaukee who was servicing hydraulic presses and boring machines for cylinder blocks. The Kharkov Tractor Plant, Calhoun stated, was turning out 8 to 10 tanks a day which had a maximum speed of 30 kilometers per hour. Tank production took precedence over tractor production and operators for these were being trained 'night and day.'[15] Calhoun added that 'they can fool the tourists but not the foreign engineers.'[16]

According to the Wehrmacht, the Kharkov tractor plant (the Ordzhonikidze) was producing in 1938 a self-propelled gun at a rate of slightly less than one a week and an armored car at a rate of one every four days. Kharkov also produced the T-26 tank, patterned after the British Vickers-Armstrongs six-tonner. The Soviet War Mobilization Plan envisaged a wartime output tripling the self-propelled gun rate and doubling that of armored cars, but maintaining the same tank production rate.[17]

In 1937 the Chelyabinsk Tractor Plant, known as the Stalin, was producing tanks of the BT series, patterned after the American Christie. Output in 1938 consisted of 32 of the 12-tonners and 100 of the BT-38, a 16-tonner. Mobilization Plan output was double these figures.[18]

Thus not only were all three of the new tractor plants producing tanks throughout the 1930s from the date of opening but they were by far the most important industrial units producing this type of weapon. As the projected War Mobilization output was only double the existant output, it can be

[13] U.S. State Dept. Decimal File, 861.5017—Living Conditions/420, February 8, 1932.

[14] Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), *Kampf-und Panzerkraftwagen-Werke*, List VII6, March 1941, p. 3, National Archives Microcopy T 84–122.

[15] U.S. State Dept. Decimal File, 861.5017—Living Conditions/576, December 28, 1932.

[16] *Ibid.*

[17] OKW *op. cit.*, p. 2.

[18] *Ibid.*, p. 5.

reasonably inferred that about one-half the productive capacity of these 'tractor' plants was being used for tank and armored car production from 1931 onwards. Thus the armaments program obviously reduced tractor production and adversely affected the agricultural program.

There are also, in the State Department files and elsewhere, numerous reports confirming the adaptability of Soviet general-equipment plants for war use. For example: 'The heavy industry plants are fitted with special attachments and equipment held in reserve which in a few hours will convert the plants into munitions factories. . . .'[19]

THE DEVELOPMENT OF SOVIET TANK DESIGN PRIOR TO WORLD WAR II

Soviet tanks before World War II owed much to American, British, and, to a lesser extent, French and Italian design work. Little German design influence can be traced in the period before 1939, except through the German tank center at Kazan, although there were other Soviet-German military links.

During the 1920s and 1930s the Soviets acquired prototype tanks from all producing countries and based their own development upon the most suitable of these foreign models. The 1932 Soviet tank stock is summarized in table 15–1.

Table 15–1 SOVIET TANK STOCK AND ITS ORIGINS, 1932

Tanks Available	*Origin*
20 Carden-Lloyd Mark VI	Made in United Kingdom by Vickers-Armstrongs, Ltd.
1 Fiat Type 3000	Made in Italy
20 Renault	Made in France, captured in Civil War
16 'Russian-Renaults'	Made in France, modified in U.S.S.R.
70 light tanks	Vickers 6-ton, Alternate A
40 Vickers Mark II	Made in United Kingdom by Vickers-Armstrongs, Ltd.
2 Christie M 1931	Made in United States by U.S. Wheel Track Layer Corp.
8 Medium Mark A	Probably Vickers-Armstrongs
25 Mark V	Captured from White armies in Civil War
8 eighty-ton	Not known; possibly Soviet manufacture based on Vickers designs, Mark V, (i.e., U.K. Flying Elephant of 1916)

Sources: R. E. Jones *et al. The Fighting Tanks Since 1916* (Washington: National Service Publishing Co., 1933), p. 173.
R. M. Ogorkiewicz, 'Soviet Tanks,' in B. H. Liddell Hart, ed., *The Red Army* (New York: Harcourt, Brace and Co., 1956).

[19] Horace N. Gilbert, *The Russian Industrialization Program* (unpublished manuscript in the Hoover Institution at Stanford University), p. 3.

From this early stock of Western models, together with technical-assistance agreements and the continuing purchase of foreign prototypes, we can trace the origins of Soviet tank models of the 1940s.

The Carden-Lloyd was a 1.69-ton machine-gun carrier (predecessor of the British Bren gun carrier of World War II) first produced by Vickers-Armstrongs, Ltd., in 1929. The Mark VI model sold to the Soviets had a Ford Model T 4-cylinder 22.5-horsepower water-cooled engine and a Ford planetary transmission.[20] This became the Soviet T-27 light reconnaissance tank produced at the Bolshevik plant in Leningrad.[21]

The Ordzhonikidze Tractor Plant at Kharkov started work on the T-26, based on the British Vickers-Armstrongs six-tonner (probably Alternative A), at about the same time. There were three versions—A, B, and C—of which B and C became the Soviet standard models produced until 1941.[22] Similarly the Soviet T-37 and T-38 amphibious vehicles were based on the Carden-Lloyd Amphibian, known as the Model A4 E 11 in the British Army.[23]

Walter Christie, well-known American inventor with numerous automotive and tank inventions to his credit, developed the Christie tank—the basis of World War II American tanks. Numerous versions of Christie tanks and armored vehicles were produced in the late 1920s and 1930s. Two chassis of the Christie M 1931 model medium tank (MB) were purchased by the Soviet Union in 1932 from the U.S. Wheel Track Layer Corporation.[24] After further development work this became not only the Soviet T-32 (the basic Soviet tank of World War II) but also several other development models in the U.S.S.R.: first the BT (12 tons), followed by the BT5 and the BT28, of which 100 were produced at the Chelyabinsk tractor 'school'[25] in 1938. They were standard equipment until 1941.

The Soviet T-34 and the American M3, both based on the Christie, had the same 12-cylinder aero engine: a V-type Liberty of 338 horsepower. Ogorkiewicz comments on the Christie model series as follows:

[20] R. E. Jones *et al.*, *The Fighting Tanks since 1916* (Washington, D.C., National Service Publishing Company, 1933), p. 122. See also Sutton, *Western Technology . . ., 1917 to 1930*, p. 245–8, for Ford Motor Company technical-assistance agreement for the production of Ford engines; and R. M. Ogorkiewicz, 'Soviet Tanks,' in *The Red Army*, ed. B. H. Liddell Hart (New York: Harcourt, Brace and Company, 1956), p. 297.

[21] *Genie Civil*, CXVI, No. 9 (March 2, 1940), pp. 154–5.

[22] *Ibid.*

[23] R. E. Jones, *op. cit.*, p. 304. Ogorkiewicz points out that Vickers-Armstrongs was the 'undisputed leader in tank design' in the 1920s. The Vickers six-tonner influenced the development of the American M3 and M5 Stuarts and was also adopted in the U.S.S.R. as the prototype of the T-26.

[24] *Ibid.*, pp. 168–9.

[25] Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, National Archives Microcopy T 84–122.

> The power-weight ratio was actually higher than could be efficiently used, but the Russians copied it all and confined their development largely to armament, which increased from a 37-mm gun on the original models of 1931–32, to 45-mm guns on BT5 of 1935 and eventually to short 76.2-mm guns on some of the final models of the series.[26]

Both the Soviet T-28 medium 29-ton tank and the T-35 heavy 45-ton tank resembled British models—the A6 medium tank and the A-1 Vickers Independent, respectively. However, Ogorkiewicz suggests that, although the layout 'closely resembles' the British models, these tanks were actually a sign of 'growing Soviet independence in the design field.'[27]

Imported French Renault designs were not developed, although they no doubt contributed to Russian tank knowledge. During the 1933 entente between France and the Soviet Union, the Renault Company delivered $11 million worth of 'small fast tanks and artillery tractors'[28] to the Soviet Union and supplied experts from the Schneider works and Panhard Levasseur, both skilled in the armored-car and tank field. Renault FTs or T-18s were not, however, produced in Russia.

SOVIET MACHINE GUNS AND AIRCRAFT WEAPONS[29]

Machine-gun development in tsarist Russia was limited to small-lot production of the Maxim machine gun at the Tula armory. The Soviet regime placed great emphasis on the development and production of this type of weapon, particularly for aircraft use. In 1944, for example, they produced:

Maxim machine gun	270,000
Degtyarev infantry machine gun	120,000
Degtyarev tank machine gun	40,000
Degtyarev Shpagin heavy machine gun	50,000 (for anti-aircraft use)
Goryunov machine gun	10,000
Shkas aircraft gun	40,000
Beresin aircraft gun	60,000
Total	590,000

26 Ogorkiewicz, *op. cit.*, p. 298.

27 *Ibid.*, p. 299. The reader is referred to Ogorkiewicz's excellent short paper (see fn. 20), which contains more detail on these Soviet tanks and a balanced assessment of their capabilities.

28 Philip Noel-Baker, *The Private Manufacture of Armaments* (London: Gollancz, 1937), p. 188.

29 Based on G. M. Chinn, *The Machine Gun* (Washington, D.C., U.S. Department of the Navy, Bureau of Ordnance, 1952), Vol. II, Part VII. This is an excellent declassified description of Soviet weapons in this class.

Table 15–2 SOVIET TANKS AND THEIR WESTERN ORIGINS, 1930–45

Soviet Tank Model Number	*Based on:*	*1938 Production*	*Produced at:*	*Employment (1937–8)*
T-18	Renault (F.T.)		Not produced	
T-26 (8-ton) A, B, C versions	Vickers-Armstrongs 6-ton A, B	Not known	Bolshevik works (Leningrad)	25,000 (1938)
			Ordzhonikidze (Kharkov)	About 20,000 (1937)
T-27 (1.7-ton)	Vickers-Armstrongs (Carden-Lloyd) Mark VI	Not known	Bolshevik works (Leningrad)	25,000 (1938)
T-37 (3-ton)	British Army Model A 4 E 11 (Carden-Lloyd Amphibian)	At least 90	Lenin machine works (Omsk)	About 5,000 (1937)
			Stalingrad tractor works	About 20,000 (1938)
			Chelyabinsk tractor technical school	About 25,000 (1938)
T-32 (34-ton)	U.S. Christie, which became the B.T.; then T-29 experimental	14	Kirov works (Leningrad)	40,000 (1938) in 3 shifts
		19	Stalin works (Kramatorsky)	32,000 (1937)
		15 (1937)		
			Uralmash	60,000 (1937)
BT (12-ton)		8 (motors only) (1937)	Polytechnic Institute (Kiev)	About 1,500 (1937)
		32	Chelyabinsk tractor technical school	
BT-28 (16-ton)	U.S. Christie	100	Chelyabinsk tractor technical school	About 25,000 (1938)
T-35 (45-ton)	Vickers A 1 of mid-1920s	About 5 (1939)	Probably Uralmash	60,000 (1937)

Source: Oberkommando der Wehrmacht, *Kampf and Panzerkraftwagen-Werke*, List VII6, March 1941, National Archives Microcopy T 84–122.

These weapons were characterized by extreme simplicity of design and rough exterior finish. They were, however, quite effective, and some Soviet weapons were probably the best in their class in World War II. Chinn commented in 1952 that because of the lack of skilled labor, 'weapons are designed to require a minimum of moving parts and fine finishes.'[30]

The Soviets borrowed heavily, but not completely, from the West in machine-gun technology. The Maxim, a famous Western gun, underwent various modifications by Soviet designers: i.e., the Maxim-Tokarev, the Maxim-Koleshnikov, and the Maxim-Esivnin. Thus the Maxim model 1910 became the basis of almost one-half of Soviet 1944 machine-gun production.

The Soviets, however, did introduce some innovations. The first of these innovations was the Goryunov (SG-43) machine gun, hailed as an entirely new weapon; as Chinn points out, some of its features were indeed new to Russian weapons, although 'they remind gun connoisseurs of principles and patents orginated earlier by designers in other countries.'[31] For example, the operating principle of the Goryunov gun was patented by John M. Browning 'but he never saw fit to put it into use.'[32] Certain other U.S. features were found in the weapon. It had, for example, a Mauser-type extractor and ejector. On the other hand, Chinn comments:

> Doing away with all unnecessary springs is one of the greatest accomplishments of Gurynev; in fact, the driving spring and its telescoping guide which is also spring loaded, are about all the springs employed for the gun's operation.[33]

During the 1920s the Soviets conducted an aircraft machine-gun development program 'with utmost secrecy.'[34] The result was the Shkas class of aircraft machine guns. The first production model appeared in 1933, followed by the standard version (KM-35), in steady production after 1935. The gun was capable of 1,800 rounds per minute and believed by the Soviets to be the best in existence. Chinn points out that:

> The Russians demonstrated great skill in adapting at low cost the best of time-proved principles to their particular needs. Construction was in two phases: a quick, coarse machining operation on all parts followed by final fitting and assembly on the work bench. Maximum use was made of semi-skilled labor with a minimum of fine gauged machine tool work. . . .[35]

Once again, however, we find some dependence on foreign ideas. Chinn describes the Shkas class: 'Thus the Shkas is an innovation based on the

[30] *Ibid.*, p. 20. It has been argued that extreme simplicity impaired their field use.
[31] *Ibid.*, p. 57.
[32] U.S. Patent No. 544657 of August 20, 1895.
[33] Chinn, *op. cit.*, p. 63.
[34] *Ibid.*, p. 72.
[35] *Ibid.*, p. 74–5.

Table 15–3 SOVIET MACHINE GUNS AND WESTERN DESIGN INFLUENCE, 1930–45

Soviet Model	*Year First Produced*	*Western Influence*
Maxim-Tokarev Maxim-Koleshnikov Maxim-Esivnin	1928	Maxim model 1910
SG-43 (Goryunov)	1928	Browning Patent No. 544657 Mauser-type extractor, ejector
Degtyarev	1926	Mauser locking; Vickers feed
Shkas aircraft gun	1932	Maxim ejection and buffer, Szakats (rotating feed), Berthier (piston actuated, propped breech, locking)
Shvak aircraft cannon	About 1944	Berthier action
Beresin aircraft gun	1940	Finnish Lahti 20 mm
V Ya aircraft cannon	1941	Scaled-up version of the Lahti

Source: G. M. Chinn, *The Machine Gun* (Washington D.C.: U.S. Dept. of the Navy, Bureau of Ordnance, 1951), Vol. II, Part VII.

features of the Maxim (ejection and buffer), the Szakats (rotating feed) and the Berthier (piston actuated, propped breech, locking).'[36]

By the same token the Shvak, a very light and extremely compact automatic aircraft gun with a range comparable to that of the U.S. M 3 cannon, was based on Berthier operating principles.[37] During the 1933 French-Soviet entente, the French sent experts on machine guns to the Soviet Union and their work can be recognized in the Shvak weapons and in the Shkas class.[38] The Shkas was replaced in 1940 with the 12.7-millimeter Beresin, deliberately constructed to be thrown away after a short period of use. Beresin design was 'greatly influenced' by a captured Finnish Lahti 20-millimeter machine cannon. The VYa 23-millimeter aircraft cannon was a scaled-up version of the Beresin.[39]

In general, machine-gun development was reasonably successful and might be described as a blend of skilled adaptation of foreign ideas with indigenous innovation. Soviet small arms were plagued with faults; 85 percent of the malfunctions were reported, however, to be due to bad cartridges rather than mechanical failures.[40]

[36] *Ibid.*, p. 79.

[37] *Ibid.*, p. 82.

[38] Noel-Baker, *op. cit.*, p. 188.

[39] Chinn, *op. cit.*, p. 94.

[40] *Ibid.*, p. 96. Ammunition also shows Western influence. The 12.7-mm cartridge was 'influenced' by the German T.u.F. 13-mm of World War I. The 20-mm had

THE HERCULES POWDER COMPANY AGREEMENT FOR MANUFACTURE OF COTTON LINTERS AND NITROCELLULOSE

In mid-1930 an agreement was concluded between Vsekhimprom and the Hercules Powder Company of Wilmington, Delaware for technical assistance in the production of nitrocellulose and cotton linters for explosives manufacture. Under the agreement the Hercules firm was to 'communicate the secrets of production and indicate all the production methods of bleaching common as well as oily linter, first and second cut of any viscosity. . . .'[41] for a number of grades—MVL 5, 10, 30, 50, 150, 250, and 500—with specified viscosity ranges and according to a stated specification. This had to be done in existing Soviet plants using existing equipment, and for this purpose Hercules sent an engineer to the U.S.S.R. and received three Soviet engineers annually into its U.S. plants for periods ranging from three to six months.

For nitrocellulose, more extensive assistance was agreed upon. The Hercules Powder Company was to

> . . . prepare a complete design of a nitrocellulose plant for the production of 5,000 tons yearly, arranged so as to enable the Vsekhimprom to double production in the future. The design shall be according to the method used in the plants of the Hercules Powder Co. and shall include all the mechanical appliances of production and all the technical improvements of the present time.[42]

The complete detailed design had to include cost estimates, description of the technological process involved, description of equipment, and dimensions of the building, in addition to 'working drawings of the apparatus and dimensions of the buildings, foundations for the apparatus, [and] calculations of the loads on the walls' which would enable Vsekhimprom to design the buildings. Also required were diagrammatical designs for the heating, ventilation, and refuse removal systems (with indications for steam pipes, water pipes and airconductors) and designs for raw material storage facilities, finished and semi-finished products, and mechanical appliances used in connection with loading and unloading.

The agreement also required disclosing processes for production of artificial leather, airplanes, medical colloids, cement for leather and Herculoid nitrocellulose for plastics (celluloid). Hercules guaranteed that quality would not be below its own production; supervised installation of equipment, construction

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a very strong physical resemblance to the nineteenth-century Gatling cartridge. The 23-mm, however, was distinctly different and according to Chinn had 'features of refinement' (p. 180). The reader is referred to Chinn's excellent study for further details.

[41] U.S. State Dept. Decimal File, 861.659 Nitrocellulose/1.

[42] *Ibid.*

and start-up; and sent its engineers to the U.S.S.R. for this purpose. Further, 10 Soviet engineers were admitted to Hercules plants in the United States for periods of three to six months to study nitrocellulose production methods.[43]

THE DRIVE TO PURCHASE ARMAMENTS IN THE UNITED STATES AND GERMANY AFTER 1936

Foreign purchases of armaments and technical-assistance agreements were expanded after 1936 and a determined effort was made to purchase new, advanced armaments systems and plants to manufacture these systems.

The United States was a prime focus of this drive. For this purpose the Carp Export and Import Corporation was established on Fifth Avenue in New York as a Soviet-front company. The President was Sam Carp, whose sister was married to V. M. Molotov, President of Council of People's Commissars of the U.S.S.R. The staff was American, including some retired officers of the U.S. Army and Navy.[44] This corporation had considerable influence in the United States.

In November 1936 the Soviet Embassy requested the State Department to intercede with the Navy Department for permission necessary to purchase heavy armor for battleships and cruisers from several steel companies.[45] This request was followed by a visit to the State Department by a group of Carp officials, who were assured by the Department that the proposed purchase of unassembled battleships would not be illegal or contrary to U.S. policy.[46] In a subsequent letter the State Department indicated it would not be possible, however, to supply 'designs, plans, working drawings and specifications of such vessels as the U.S.S. *Lexington*, *Colorado*, and *Mississippi*,' although there was nothing to prevent U.S. naval architects from preparing such designs on behalf of the Soviet Union.[47]

Purchases of war materials were, therefore, made directly from American manufacturers. Thus in 1938 the William Sellers Company of Philadelphia was reported negotiating a contract for the sale of heavy machinery for the manufacture of 12-inch steel plate known as 'stacked plate' for multiples for

[43] *Ibid.* This transfer had a favorable impact on the Soviet rocket program. Zaihringer points out that Soviet World War II rockets used 'Russian Cordite' with a composition of 56·5 percent nitrocellulose, similar to British and American propellants. 'Thus United States and U.S.S.R. propellant compositions were close by experimental coincidence and similar technology.' [A. J. Zaehringer, *Soviet Space Technology* (New York: Harper and Row, 1961), pp. 11–2.]

[44] U.S. State Dept. Decimal File, 711.00111 Armament Control/431.

[45] *Ibid.*, 861.6511/39, April 16, 1938.

[46] *Ibid.*, 711.00111 Armament Control/1153a.

[47] *Ibid.*, 711.00111 Armament Control/455, January 13, 1937.

armor-plate manufacture.[48] In March 1939 the State Department approved a proposal (already approved in the Navy Department) under which the Electric Boat Company of Groton, Connecticut would furnish plans, specifications, and construction services in the Soviet Union for a submarine.[49]

Both the Russians and the Germans initially expected benefits from the Soviet-Nazi military alliance of 1939, but the evidence is that the Soviet Union, at least, did not receive anything near its expectations. Rossi concludes from his study of the Fuehrer Conferences on Naval Affairs:

> From all the available evidence . . . the military collaboration between Germany and Russia does not seem to have gone very far in the technical field. Stalin asked for a great deal and was ready to give the necessary quid pro quo, but notwithstanding his eagerness to get hold of prototypes and the secret manufacturing processes of certain German weapons, he was to some extent restrained by the need not to endanger the profits he hoped to make out of his policy of neutrality. Over and above all this there was Hitler's deep distrust of Soviet Russia, once he had sobered down after his early successes. . . .[50]

This weapons-acquisition process culminated in the Lend-Lease program, under which large quantities of war materials were transferred to the Soviet Union.[51] However, about one-third of early shipments, and almost all shipments after 1944, were of industrial equipment, and not military end-use goods.

CONCLUSIONS

Although Soviet tanks and some guns were directly descended from Western models, a much greater degree of innovative effort was utilized on military products than in other sectors, so that the Soviets, in effect, had an indigenous military technology by 1941. Further, weapons were produced in large quantities over a full decade by using productive equipment and facilities built in 1930–2. This prudent, far-sighted policy accounts for Soviet ability to turn back the Nazi invasion before Lend-Lease goods flowed in in any great quantity.

In appears, although all the evidence is not yet available, that most Western governments (particularly the United States, Britain, France, and Italy) were willing to supply armaments and design assistance to produce armaments in the period before 1941, and that Germany also provided military assistance up until the eve of her 1941 'drang nach osten.'

48 *Ibid.*, 861.6511/39.

49 *Ibid.*, 711.00111 Armament Control/540, March 9, 1937.

50 A. Rossi, *The Russo-German Alliance 1939–1941* (Boston: Beacon, 1951), p. 97. For details of 1930–40 Krupp shipments, see *NIK 11625, Krupp—Report of the Department for War Material 1939–1940*, at Hoover Institution.

51 See U.S. State Dept., *Report on War Aid Furnished by the United States to the U.S.S.R.*

CHAPTER SIXTEEN

Technical Assistance to Planning and Construction Projects

THE DESIGN OF INDUSTRIAL PLANTS BY ALBERT KAHN, INC., OF DETROIT

ONE of the truly great surprises in researching this study was the discovery that the architectural design and supervision of construction of industrial units as well as the supply of equipment and similar assistance was very much an American responsibility. In the words of the Albert Kahn Co., Inc., the foremost industrial architects in the United States:

> It was in 1928 . . . that the most extraordinary commission ever given an architect came in the door unannounced. In that year a group of engineers from the U.S.S.R. came to the Kahn office with an order for a $40,000,000 tractor plant, and an outline of a program for an additional two billion dollars' worth of buildings. About a dozen of these factories were done in Detroit; the rest were handled in a special office with 1,500 draftsmen in Moscow.[1]

The 'outline of a program' presented to the Kahn organization in 1928 was nothing less than the First and Second Five-Year Plans of 'socialist construction.' Gosplan had decided upon those sectors it wanted developed and their approximate capacities.[2] No foreign influence has been found at the Gosplan level. These plans were then turned over to the Albert Kahn Company for conversion into production units.

Albert Kahn, Inc., probably unknown to even well-informed readers, is the most famous of U.S. industrial architects. In 1938 the company handled 19 percent of all architect-designed industrial building in the United States,

[1] G. Nelson, *Industrial Architecture of Albert Kahn Co., Inc.* (New York: Architectural Book Publishing Company, Inc., 1939), pp. 18–9.

[2] Planned capacities of some units, notably the automobile and tractor plants, were increased after consultation with U.S. firms.

in addition to projects in most major countries elsewhere in the world. Prior to 1939 the company designed and supervised construction of about $800,000,000 worth of industrial buildings in the United States alone.[3] This included the famous River Rouge plant of Henry Ford, plants for the Chevrolet, Packard, Hudson, General Motors, Oldsmobile, Cadillac, Chrysler, and De Soto automobile companies, Kelvinator, United Air Lines, Burroughs Adding Machine, Pratt & Whitney Aircraft, the Glenn L. Martin Company, and dozens of similar firms. For one customer alone, General Motors, the Kahn Company designed 127 major structures prior to 1939.

The $2-billion Soviet design project was two and a half times greater than all the U.S. business handled by the company between its foundation date, 1903, and 1939. As Kahn described the contract:

> Probably no organization has ever had a more severe test of its flexibility, speed, and competence. Not only did the plants have to be designed, but machinery had to be selected and ordered, process layouts had to be prepared and the very tools needed to build the plants had to be ordered here and shipped over.[4]

The formal agreement between Albert Kahn, Inc., and Vesenkha, under which the Kahn Company became consulting architects to the Soviet Union, was concluded in early 1930; upon signing the agreement Moritz Kahn (one of the three Kahn brothers) commented:

> In a short time I shall proceed to Moscow with a staff of twenty-five specialist assistants. We shall then help the Soviet Government to organize a designing bureau which will comprise about forty-five hundred architectural and engineering designers, selected principally from Soviet Russia, but also from America and other foreign countries. The bureau will be directed by the head of the Building Commission of the Supreme Economic Council.[5]

This bureau became Gosproektstroi (State Project Construction Trust) the major Soviet design and construction organization. Chief of Gosproektstroi and Chairman of the Vesenkha Building Commission was G. K. Scrymgeour, a Kahn engineer and the only American on the National Technical Soviet.[6] Scrymgeour outlined the Kahn unit functions as follows:

> The Albert Kahn unit was engaged to control, teach and design all light and heavy industry. . . . By the end of the second year we controlled in Moscow, and from Moscow branches in Leningrad, Kharkov, Kiev,

[3] Nelson, *op. cit.*, p. 18.

[4] *Ibid.*

[5] Amtorg, *op. cit.*, No. 3–4 (February 15, 1930), p. 55.

[6] *American Engineers in Russia*, Folder 3, Letter from Scrymgoeur; and Folder 4, letter from G. Growcott, Kahn engineer in Gosproektstroi.

> Dniepretrovsk, Odessa, Sverdlovsk and Novo-Sibirsk 3,000 designers, and completed the design of buildings costing (these are Soviet figures) 417 million rubles.[7]

The 3,000 designers in Gosproektstroi can be compared to the small size of the Kahn Company in the U.S. The company handled the immense volume of work outlined above, and then absorbed the Soviet design contract, with the following staff:

> In normal times the firm . . . employs about 400 men and women; among them some 40 secretaries, stenographers, typists and file clerks; about 15 accountants; 80–90 mechanical and electrical engineers; 40–50 field superintendents; some 30 specification writers, estimators, expeditors etc., 175 architectural designers and draftsmen.[8]

The problem, according to Kahn, was that 'a large percentage of Soviet draftsmen . . . had apparently never seen a pencil before and Kahn representatives not only had to run it by day, but hold classes at night.'[9]

Albert Kahn attributed further major advantages to the Soviet Union in its relationship with the Kahn Company. For example, said Kahn, there was only one client: 'this permits standardization of building construction; all factory buildings for any one type of construction can be built on standardized principles. The result will be a great saving in time and in cost in the preparation of plans and the cost of buildings.'[10] Moreover, added Kahn, this would enable revision of the Soviet building code with a 'saving of millions of dollars per annum because of the ultra-conservative character of that code.'[11]

There is in the State Department files an interesting report of an interview with nine engineers from the Albert Kahn unit who called at the U.S. Riga consulate in late 1930 for renewal of entry permits.[12] The report confirms that Kahn was undertaking supply of 'engineering and architectural talent' and that 27 American structural engineers, architects, sanitary engineers, and draftsmen were working in one large building in Moscow with 300 Russian engineers.[13] They reported that the Soviet planners indicated the nature of the plant required and the Kahn unit made the designs and drawings. Albert Kahn also maintained its own representatives at larger projects under construc-

7 *Ibid.*, letter from Scrymgoeur.

8 Nelson, *op. cit.*, p. 19.

9 *Ibid.*, p. 18.

10 Amtorg, *op. cit.*, February 15, 1930, p. 55.

11 *Ibid.* For a detailed description of Kahn-designed industrial buildings in the U.S.S.R. see 'Sowjetrussische Notkonstruktionen' Ing. Schauder, in *Beton und Eisen*, July 20, 1933, pp. 213–6.

12 U.S. State Dept. Decimal File, 861.641/9.

13 *Ibid.* However, the concensus was that only four or five of the Russians were engineers; the rest, with the exception of 20 girl tracers, were 'worse than useless.'

tion; for example a Mr. Drabkin was the Kahn representative at the Stalingrad Tractor Plant.[14]

MANAGEMENT ASSISTANCE AT THE PLANT LEVEL

Vesenkha had responsibility for implementation of the Five-Year Plans; this it passed onto designated construction trusts, although the responsibility for policy remained with Vesenkha. The decision was to utilize U.S. methods not only in construction but also in production planning.

A technical-assistance agreement was therefore concluded with W. N. Polakov, a management-consultant firm based in New York. Polakov became Chief Consulting Engineer to Vesenkha for the period December 1929 to May 1931. In a plant selected for the purpose, the firm demonstrated and tested the possibilities of scientific management applied to Sovietized plants. The plant selected manufactured machine tools, cutters, taps, dies, and a full line of standard metal-cutting tools; employed about 5,000; and was well equipped with modern American and German machine tools. Polakov estimated that the number of parts entering main production was about 200 and the number of consecutive operations varied from 10 to 70. Planning, scheduling, and dispatching of these operations and products were his most valuable contributions.

Polakov reorganized all departments, starting with the grinding and polishing shop. His basic innovation was the introduction of a layout chart representing jobs for each machine and progress made on each job.[15] The plant director issued an order requiring conformity to the Polakov proposals, and it was estimated that the annual cost saving by using Gantt Charts was in excess of one million rubles for this one plant, while production increased by 400 percent.

The Gantt Chart had been translated into Russian as early as 1924[16] and by 1934 was in its twenty-first Russian edition, with 100,000 copies in circulation. The problem tackled by the Polakov firm was translation of paper diagrams to shop-floor practice, a problem pointed out by many foreign delegations to the U.S.S.R. Soviet industry was swamped with paper calculations and diagrams unrelated to practice. Polakov's contribution was to translate Gantt methods into action in one model plant.

[14] *American Engineers in Russia*, Fisher material, Folder 1.

[15] W. N. Polakov, 'The Gantt Chart in Russia,' *American Machinist*, LXXV, No. 7, August 13, 1931, pp. 261–4.

[16] W. Clark, *Grafiki Ganta* (Moscow: 1931). Permission was granted by Wallace Clark & Co. to translate and publish in the U.S.S.R. without royalties. Another publication, *Shops and Office Forms*, had been translated and published in the Soviet Union without permission. Clark said he had never received a copy. *American Engineers in Russia*, Letter from Wallace Clark & Co., March 9, 1934.

Vesenkha also negotiated with Wallace Clark & Company, American distributor of Gantt methods in 1934; but the company 'came to the conclusion that they [the Russians] were not yet ready to accept our advice and follow it out in a way which would ensure successful results.'[17]

Other bureaus for design and construction received similar assistance, many under contracts with individual consultants. C. Butterworth, for example, was a consultant metallurgical engineer to Orgametal[18] (Institute for Organization of Production in Machinery and Metalworking Industries).

Butterworth specialized in organization of the heat-treating and working of steel and was made responsible for training graduate Soviet engineers in these processes. Butterworth's program included eight months organizing production in the Putilovets plant in Leningrad, two months in Moscow to select equipment and to design the plant layout for a forge shop, followed by five months in Rostov at Selmashstroi to establish process organization and control. Two months were then spent at Dnieprstroi designing plant layouts and finally eight months at the Nizhni-Novgorod plant planning and erecting forge equipment. Butterworth's last job was as consulting engineer on a project for building heavy railroad equipment.[19] It may readily be seen therefore that a single highly skilled and resourceful engineer could have an impact in a short space of time on a number of different projects.

F. A. Hannah was a similar specialist in reorganization for the NKRKI (People's Commissariat of Workers' and Peasants' Inspection).[20] B. E. Torpen was attached to Vsekomvodgosplan (All-Union Committee for Planning of Water Projects)[21] to provide technical assistance to Steklostroi (Glass and Ceramic Trust).[22] Many such individual consultants were attached to project-design and inspection organizations. For example, in a single Amtorg announcement in August 1930, the following 39 U.S. consulting engineers were listed as having been hired:

27 for the Commissariat of Transportation
3 for Grozneft (Georgian Oil Field Administration)
2 for Dnieprstroi
2 for Stalingrad Tractor Plant (33 had already left)
2 for the United Machine Building Trust
1 for Burtsvetmet (Non-Ferrous Drilling Trust)

[17] *Ibid.*
[18] Amtorg, *op. cit.*, February 15, 1930, p. 57.
[19] *American Engineers in Russia*, File 1, Letter of Charles Butterworth.
[20] Amtorg, *op. cit.*, February 15, 1930, p. 57.
[21] *Ibid.*
[22] *Ibid.*

1 for Dalles (Far East Lumber Trust)

1 for NKRKI (People's Commissariat for Workers' and Peasants' Inspection)[23]

The valuta crisis brought an end to this assistance and such contracts were not renewed after 1932. The First Five-Year Plan was hastily telescoped into a four-year plan to prepare the way for another propaganda assault: the Second Five-Year Plan. Vesenkha, the control for the Kahn unit, was dissolved and replaced by the ministries structure in January 1932.

SOYUZSTROI (ALL-UNION CONSTRUCTION TRUST) AND OTHER CONSTRUCTION UNITS

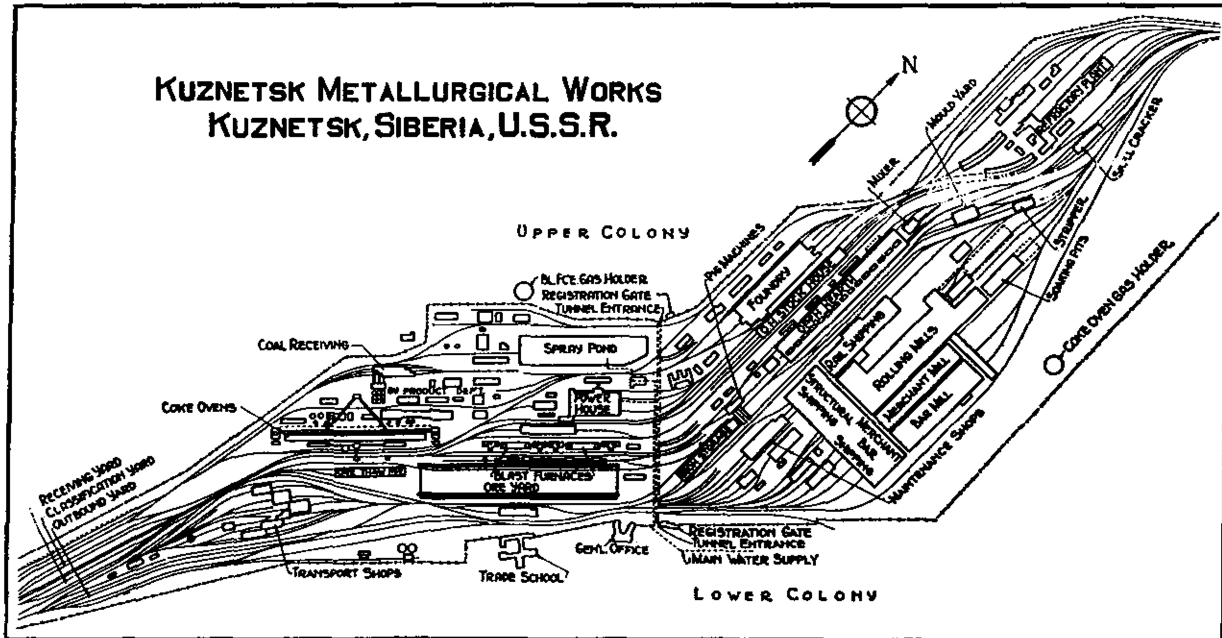
Soyuzstroi had responsibility for about one-quarter of new construction until 1933 when it was broken into smaller units attached to individual combinats. The Director of Soyuzstroi was Sergei Nemets, formerly an engineer with the Philadelphia construction company of Stone and Webster, Inc. The Chief Engineer of Soyuzstroi was Zara Witkin, whose early projects included the Hollywood Bowl and several large Los Angeles hotels. Initially

Table 16–1 SELECTED EXAMPLES OF TECHNICAL ASSISTANCE AT THE PLANNING AND DESIGN LEVEL

Function	*Soviet Organization*	*Foreign Assistance*
Long-term planning (to Jan. 5, 1932)	Gosplan	None identified
	Vesenkha	W. Polakov and Co.
Design and planning	Vesenkha	Albert Kahn, Inc.
	Gosproektstroi	Faudewag A-G
		Individual consultants
'Stroi' units	Magnitostroi	McKee Corp.
	Soyuzstroi	Zara Witkin
	Chemstroi	Alcan Hirsh
	Vsekhimstroi	Nitrogen Engineering Corp.
	Gosstroi	Longacre Construction Co.
Control and inspection	OGPU	Individual engineers, usually members of Western Communist parties.
Military construction	NKRKI	
Design units	Gipromez (State Institute for Design of Metallurgical Works)	Freyn Engineering Corp.
	Giproshakht (State Institute for Design of Coal Mines)	Allen and Garcia, Inc.

[23] *Ibid.*, August 1, 1930, p. 328.

Figure 16-1 LAYOUT OF KUZNETSK IRON AND STEEL PLANT PREPARED BY FREYN ENGINEERING COMPANY UNDER TECHNICAL-ASSISTANCE CONTRACT OF 1930



Source: Freyn Design, No. 10, October 1932, p. 2.

offered a position as Consulting Engineer in construction of the Palace of Soviets, Witkin supervised construction, in Moscow and elsewhere, of apartment houses, industrial units, and a number of the 'secret industry' units; these Witkin defined as 'having to do with the production or storage of war material or military equipment.'[24] There was no question in Witkin's mind when he was interviewed by the U.S. Consul in Poland at the end of 1933 that every tractor plant 'is of course a tank factory and an automobile plant a factory which may at any time produce mobile artillery.'[25] According to Witkin the best construction work was that done under the supervision of the OGPU, which handled all military work, confirming the evidence that the OGPU has built itself up into a major construction force in the Soviet economy.

Zara Witkin was also employed by Soyuzstroi to undertake a program of organization for the Second Five-Year Plan. According to Nemets, Director of Soyuzstroi, there had been no co-ordination in the First Five-Year Plan between new plants and older established plants. In order to avoid a repetition of this problem, Witkin was instructed to formulate a 'rationalization program' —in effect a program to integrate new construction projects for 1933–7 with existing plants. In order to do this, Witkin requested, and received, material to calculate the actual volume of construction achieved between 1928 and 1932.

Witkin's analytical summary includes his methodology and conclusions, including a series of charts relating actual accomplishments to plan variants between 1928 and 1932 and projections for 1932 to 1937. The most meaningful indicator of Soviet progress is Witkin's comparison of actual construction volumes in the United States and the Soviet Union, in which he concludes:

> In the decade 1923–1932 the average annual total volume of construction in the United States was slightly less than nine billion dollars. The entire five-year plan in construction . . . generally understood to compress 30 to 50 years of industrial development into 5 years, actually amounts to two-thirds of the average annual American construction in the last decade (1923–1932) including three years of unparalleled depression. That the far-famed Soviet Union five year plan was equivalent to less than one average year of American construction has a profound economic significance for both countries.[26]

[24] U.S. State Dept. Decimal File, 861.50–Five Year Plan/276, December 27, 1933.

[25] August 9, 16, and 30, 1934. See also unpublished manuscript in the Special Collections of the Hoover Institution at Stanford University. Unfortunately other papers and reports were destroyed after Witkin's death in 1948. Reports containing military information from Witkin and made to State Department officials were stamped 'No distribution' and filed. Eugene Lyons calls Witkin's task 'the most important assignment given to any single foreign specialist.' [*Assignment in Utopia* (New York: Harcourt, Brace and Co., 1937), p. 529.]

[26] *Engineering News Record*, August 16, 1934, p. 211. This conclusion is preceded by four pages of small print—a carefully structured analysis of construction volume.

In his final article Witkin related this fact to construction possibilities in the period 1932–7 and concluded: 'It furnishes the quantitative proof that the second five year plan is slightly smaller than the first.'[27]

The reader will recall the increasing censorship of information in the Soviet Union throughout the 1930s, culminating in the purge trials of 1937 and recurrent accusations of wrecking. Soviet trade journals abroad ceased publication after 1933 or so. The usual explanation has been Stalinist paranoia. A more likely factor may have been a dawning awareness of the inherent weakness of the socialist form of construction.

Although the exact construction volume achieved is not an integral part of the argument of this study, it is important to note that the actual volume of construction between 1928 and 1941 was probably less than has been generally accepted, and that this was achieved with extensive absorption of Western technology. By integrating these two key observations, we begin to get close to the reality of Soviet industrial development.

Thus the growth-rate figures originating in Soviet sources are maximal. Further, they include an unknown proportion of defective, low-quality output and probably double-counting. These qualifications do not, however, alter our conclusions concerning the relationship between rates of growth in specific sectors and assimilation of foreign technology.

The Fourth Gosstroi (State Construction) Trust in Leningrad provides another example of the extensive penetration of Americans and foreigners into actual construction work even at the lower levels. In 1930 the trust, handling construction in Leningrad, employed about 30 Americans and an unknown number of foreigners; in 1932 there were 141 aliens working for the trust, including 60 to 70 Americans.[28] Their purpose was to introduce the use of reinforced concrete in industrial buildings.[29]

The number of foreign workers in various construction trusts varied greatly. At the one extreme the Stalmost (Steel Bridge Construction) Trust in Moscow had, so far as we know, only one foreigner, Kaare Salberg,[30] a draftsman employed on checking specifications for bridges, plants, and buildings. At the other extreme there is a report that 200 new buildings were under construction at Petrozavodsk—all by American-Finns, of whom there were about 4,000 in an 'American village.'[31] This last example is unusual, although it was common for Finns and American-Finns to seek work in that part of Russia.

[27] *Ibid.*, August 30, 1934, p. 275.

[28] U.S. State Dept. Decimal File, 861.5017—Living Conditions/501 and /508.

[29] *Ibid.*, 861.5017—Living Conditions/508. There may be an element of exaggeration in this report; the interviewee says that an American bricklayer will lay 2,500 bricks per day versus 350 for a Russian.

[30] *Ibid.*, 861.5017—Living Conditions/696.

[31] *Ibid.*, 861.5017—Living Conditions/689.

It can be argued that in some cases American construction assistance, particularly in the housing sector, was not useful; i.e., the transfer was ineffective. The Longacre Construction Company had a contract to supply technical services and supervision on about $10 million worth of apartment buildings in Moscow and other large cities. The company also assisted in financing, so that there was a minimal valuta problem for the Soviets. In the first year all the $2-million construction was Soviet-financed, but in the second year $3-million worth of construction financing was shared 50–50, and in the third year the $5-million worth of construction work was 100 percent Longacre-financed. Longacre supplied an architect, an engineer, and 14 construction superintendents under the contract. A company member commented:

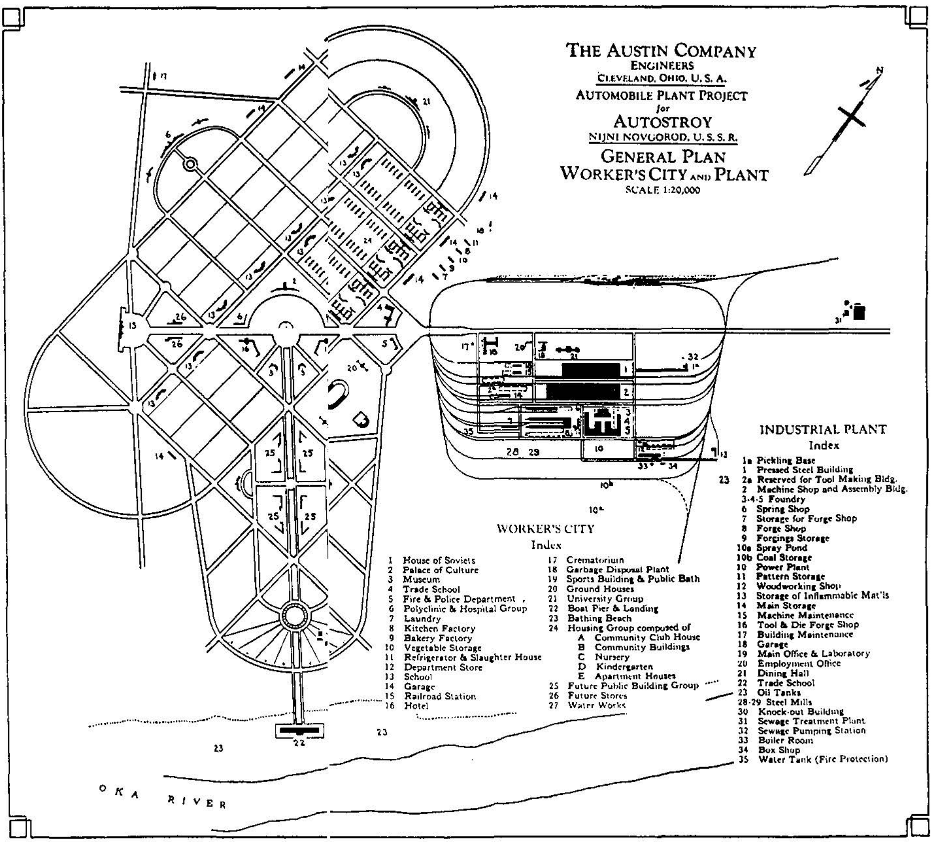
> We soon found that they did not want American apartments at all as the living conditions were such that three or four families had to occupy each apartment and they stated that this overcrowding was likely to obtain for some years to come in spite of the new apartments contemplated and under construction. They objected to providing a bathroom with each apartment; they did not want any hot water supply; they did not like the joist floor construction; they wanted brick walls 30 in. thick; they had no kiln-dried lumber; they wanted to use a cement mortar of 1–9 mixture instead of 1–3 in order to economize in cement; they had no check valves, no thermostatic traps, no automatic air valves so that hot water was the only method of heating that could be installed. When we got all through instead of having an apartment built in the American style we had plain Russian apartments the same as they were building themselves.[32]

Soviet architects during the 1930s had the responsibility of reflecting both Marxist ideology and modern technology (preferably American), and consequently had to strain after dual objectives.[33] Thus the principle of collectivization has influenced architectural development in housing, so that housing and cultural facilities reflect communal life rather than the individual. The large blocks of apartments constructed by Longacre achieved this objective. Factory kitchens, public bathing facilities, and communal clinics reflect the same objectives, and were also included in assistance agreements. Design had to reflect the dynamic features of a revolutionary society; therefore the advantages of standardization and simplification were consistent with this ideological objective. Some of the work of Le Corbusier, Wright, and modern European architects was consequently acceptable and referred to as the Soviet style, not because it was Russian but because it conformed to ideological prerequisites.

[32] *American Engineers in Russia*, Fisher material, anonymity of writer requested.

[33] See Arthur Voyce, *Russian Architecture* (New York: 1948), for an excellent summary of the philosophy of prerevolutionary and Soviet architecture.

Figure 16–2 LAYOUT OF NIZHNI-NOVGOD (GORKI) CITY AND AUTOMOBILE PLANT, PREPARED BY THE AUSTIN COMPANY IDER TECHNICAL-ASSISTANCE CONTRACT OF AUGUST 1929



Source: The Austin Co.

This argument does not conflict with the Longacre experience; the commentator felt he had been hired to build 'American style.' In fact, Longacre was hired to build the standard Soviet multistory communal apartment buildings but with American methods. These did not 'take' because the specialized materials and equipment required were not available, so that the Longacre Company and other foreign construction firms were forced to 'make do.'

DUPLICATION OF AMERICAN EXCAVATION EQUIPMENT

In return for equipment orders, American manufacturers often supplied the Russians with construction superintendents. When the Western equipment was later duplicated by the Russians, the superintendents were often asked to stay on and break in the Soviet-made duplicates.

One of these American superintendents was John E. Cook of the Ohio Locomotive Crane Company, sent to the U.S.S.R. by his company to erect, operate, and service cranes at the Dniepr Dam, Nizhni-Novgorod, and Kuznetsk.[34] Another was Gustav S. Bell, an engineer employed by Sauerman Brothers, Inc., of Chicago, who was in the Soviet Union for 20 months supervising the operation of equipment bought from Sauerman for construction of the canal and locks at Svirstroi.[35] Another superintendent at Svirstroi was Gustav A. Johnson, an engineer for Bucyrus Erie Company, employed to erect and start operation of Bucyrus steam shovels and grading machinery. Johnson also worked at the Magnitogorsk Iron and Steel Plant supervising excavation of the foundations and on a drainage project in Krasnodar.[36] The Thew Shovel Company of Lorain, Ohio supplied W. R. Parker to supervise excavation with its shovels at the Bobriki chemical combine.[37] Parker made the interesting comment that the work he supervised was continued day and night and that it was 'common knowledge' that the work was rushed so that the plant could produce poison gas.

The extensive use of foreign companies and their equipment in excavation work is exemplified in the Magnitogorsk iron and steel project—probably the largest single project undertaken in the U.S.S.R. in the period 1930–45. Table 16–2 gives a full list of excavating equipment used at Magnitogorsk; all

[34] U.S. State Dept. Decimal File, 861.5017—Living Conditions/240, Report No. 7623, Riga, April 10, 1931.

[35] *Ibid.*, 861.5017—Living Conditions/314, Report No. 7939, Riga, August 11, 1931. See chap. 19 for copying of Sauerman equipment.

[36] *Ibid.*, 861.5017—Living Conditions/200, Report No. 214, Riga, November 28, 1930. For other engineers and conditions at Svirstroi see /283, Report No. 7830, Riga, June 30, 1931.

[37] *Ibid.*, 861.5017—Living Conditions/349, Riga, October 16, 1931.

units are of either American or German manufacture. It was not until 1933 that early Soviet copies of this equipment began to appear in excavation work, and Lend-Lease import figures suggest that there was still a strong demand for excavation equipment in the 1940s.[38]

The extensive field tests of foreign equipment under Russian working conditions generated accurate data for evaluation and choice of models for duplication. American engineers themselves played a role in the selection process. Gorton, Chief Engineer for the Vaksh project in Central Asia, was assigned the task of preparing a mechanization plan for Glavklopkom. His main recommendation was that single units of American agricultural and construction equipment be 'purchased for study,'[39] as these had been thoroughly tested under 'practical conditions' in the United States and found to be successful.[40]

Table 16–2 ORIGIN OF ALL EXCAVATION EQUIPMENT USED IN MAGNITOGORSK CONSTRUCTION

Name of Firm and Type of Excavator	*Bucket capacity (Cubic Meters)*	*Number of Units*
Electric		
Bucyrus 50-B	1.5	2
Oren-Koppel multi-bucket	—	1
Steam		
Bucyrus 3-B	0.5	1
Bucyrus 41-B	0.95	2
Marion 450	0.75	5
Marion 32	1.00	1
Oren-Koppel	1.00	1
Oren-Koppel (with grab bucket)	—	2
Meck and Gambrok-C	1.5	1
Meck and Gambrok M-U	1.5	1
Meck and Gambrok	0.75	1
With Internal Combustion Engine		
Oren-Koppel Type 6	0.75	1
Parson	—	1
Lubeck	—	1

Source: Magnitostroi, *Informatsionnyi Biulleten'* (Magnitogorsk: 1930) p. 64.

38 U.S. State Dept. *Report on War Aid Furnished by the United States to the U.S.S.R.*, p. 23.

39 W. L. Gorton, *The Mechanization of Excavation Work on Irrigation Canals and Drainage* (Tashkent, July 2, 1931), p. 36.

40 *Ibid.*

Gorton also investigated possible manufacturing facilities and for this purpose visited Rostov on the Don. He estimated that the new Selmashstroi plant could, after installation of the new equipment expected, manufacture Fresnos, wheel scrapers, Miami-type scrapers, Chattin-V-type diggers, and plows. Investigation of two smaller plants in Rostov, on Ilych and Pushkin streets, led to the conclusion these plants were not in a position to make even the simplest equipment. The Trust construction department shop was also not in a position to manufacture new equipment, although it could undertake repairs.[41]

So we find that American engineers were not only responsible for implementation of the First Five-Year Plan in such positions as Chairman of the Building Committee of Vesenkha, but that they also superintended such jobs as the operation of excavation equipment on site and the selection of construction equipment models for duplication in the new Soviet plants.

[41] *Ibid.*, p. 36.

CHAPTER SEVENTEEN

The Process of Technical Transfer: Firms, Engineers, and Institutions

FOREIGN FIRMS IN THE SOVIET UNION[1]

MOST leading American corporations and many smaller firms have had trade or technical-assistance agreements with the Soviet Union, although these have generally not been made public. Documentation has survived in the State Department files, and it appears that many corporations either informed the Department of their intentions or worked very closely with the Department. No case has been found in the files, after about 1919, in which a U.S. company acted contrary to the expressed wishes of the Department. There is some evidence, not conclusive, that some companies, rather hesitant about negotiating a contract with the Soviet Union, were tacitly encouraged to do so by the Department.[2]

Insofar as Germany is concerned there was until 1941 a unified approach to Soviet trade, with the German Foreign Office playing a dominant role over individual German firms. It is surmised, but without archival evidence, that links between British firms and the British Government were also close; there is no question, for example, that compensation for the Lena Goldfields expropriation was achieved only by the refusal of the British Government to conclude a new trade agreement until the Lena question had been settled with some semblance of equity.

One generalization can be made: throughout the 1917–45 period, transfers of technology to the Soviet Union were made not only with the acquiescence of Western governments but with their approval and often encouragement. There is no question about the fact that the slightest sign of disapproval by

[1] This section is based primarily on the recorded experience of American firms. Experience of foreign firms (for example, Metropolitan-Vickers of the United Kingdom) was not significantly different.

[2] See Sutton, *Western Technology . . . , 1917 to 1930*, p. 347.

any Western government would have choked off such an agreement. Any credit or blame for these transfers must in the final analysis be placed with Western political circles and government administrators and not with private corporations.

BREACHES OF CONTRACT WITH FOREIGN FIRMS BY THE SOVIET UNION

The widely held assumption that the Soviet Government has not defaulted on commercial agreements with individual firms is inconsistent with evidence in the Decimal File and elsewhere. Almost all known concessions provide examples of gross breach of contract on the part of the Soviet Government;[3] there is a strong probability that other concessions did not publish their experiences for fear of ridicule. Expropriation utilized economic pressure; physical violence has been identified in very few cases. The Soviets were careful to cover expropriation with a façade of legality, and to this end numerous newspaper articles, a few books, comments by sympathetic businessmen, and court 'trials' were developed to weave a fabric of legality. Concession expropriations were, however, not the only examples of Soviet commercial default. Nonpayment of salaries, consultant's fees, and debts to private Western firms —and expropriation of patents, designs, drawings, prototypes, and equipment without payment—are also recorded in the Decimal File.[4]

One of the largest contracts concluded with an American firm was the McKee Corporation contract for construction of seven blast furnaces, some steel mills, and a town at Magnitogorsk. McKee maintained 80 American engineers on the project for one year and then cut the contract back to 'one unit':

> This happened because the Soviet Government was too inaccurate in the payments provided for in the contract. The McKee Company was compelled to draw up supplementary provisions according to which the Soviet Government was to make payments three months in advance. However, when the Government failed to comply with this provision, the firm of McKee stated that it would take advantage of its right to annul the contract and would recall all its personnel from Magnitogorsk within one month.[5]

The J. G. White Engineering Corporation of New York suffered monetary losses in two separate contracts with the U.S.S.R. The first breach involved

[3] See chap. 2.

[4] The writer has had access to *complete* corporate papers or documents based on corporate resources in only two instances. In both cases there was clear evidence of Soviet default.

[5] U.S. State Dept. Decimal File, 861.5017—Living Conditions/452, March 19, 1932, quoting *Zarya* (Harbin, China).

the comparatively small amount of $7,000 in nonpayment of expenses for railroad men whom the White Company had sent to the Soviet Union. This was similar to numerous other cases of nonpayment of expenses.[6] The second case was a more significant breach of contract. The Soviets requested the White Corporation to make a proposal for supervision of construction at Svirstroi Dam. The proposal submitted required a total payment of $975,000 with an advance retainer of $100,000 to protect White against contracts made with U.S. engineers hired for the project. The proposal was accepted by cable from Moscow and orally by Amtorg in New York, and, said White, 'Amtorg pressed us very hard to start designing work and get our men off before the retainer was received, which [delay] they explained on the basis of red tape. . . .'[7]

The White Corporation therefore, at Amtorg insistence, hired the engineers and started design work. As the White Corporation reported it, sometime later the Soviets 'advised us they had changed their plans and had decided not to engage us. . . .'[8] The Company claimed $400,000, comprising White's costs for 'the designing and organization work we had been prevailed upon by Amtorg to start here, notwithstanding we had not received our $100,000 retainer.'[9]

Amtorg offered $10,000; this was refused. Amtorg then raised its offer to $20,000; this was accepted by White Engineering 'because of our belief that Russian credit was insecure. . . .' The amount was promptly paid.

Thus on a claim of $400,000, of which $50,000 was out-of-pocket costs, White Engineering suffered a loss of $30,000 out-of-pocket expenses due to breach of contract by the Soviet Union, in addition to loss of the contracted work.

Treatment of foreign firms was clearly unethical in yet another way. Firms were played off one against another in an attempt to get free technical data and drawings in a manner usually amounting to fraud. The case of E. B. Badger & Sons and Alco Products is a good example. Both firms were negotiating with Mashinoimport for construction of a large oil refinery and had submitted bids in 1934 on construction and equipment.[10] Amtorg in New York invited both firms to send representatives to the Soviet Union for further negotiations with the declared intent of letting a construction contract. E. B. Badger said that Amtorg indicated that another firm would also be sending representatives, but Alexander M. Hamilton, Export Sales Manager of Alco Products, said he was told by Amtorg that Alco Products alone would be

[6] U.S. State Dept. Decimal File, 861.602/252, December 31, 1930. See also chap. 3.
[7] *Ibid.*
[8] *Ibid.*
[9] *Ibid.*
[10] U.S. State Dept. Decimal File, 861.602/263.

sending representatives. Both principals brought two engineers to the U.S.S.R. and started separate negotiations with Mashinoimport in Moscow. The State Department report claims that:

> Mashinoimport took advantage of the competitive spirit between the two firms in order to obtain unusually detailed information regarding their manner of arriving at estimates and regarding the various processes and types of machinery which they proposed to employ.[11]

As neither firm wanted to prejudice its negotiating position, the information was freely provided by both companies. The Badger bid was $1.8 million, 25 percent to be paid in cash and the balance over four years; the Alco bid is not known. After some three weeks of negotiations in Moscow, each party was informed *independently, without knowledge of the other*, that if its bid was reduced by approximately 40 percent Mashinoimport would consider giving it the contract, paying for both the equipment and the work in cash. Both firms refused the offer and went to the U.S. Embassy on account of the attempted 40-percent reduction—not because they were then aware of unethical practices.

The U.S. Embassy reported both firms as indicating the lower prices would have meant a loss. Badger, for example, said 'his firm had prepared the estimates in the same manner as it would have prepared them for an American firm.'[12] Both Badger and Hamilton, reads the Embassy report, expressed indignation that when Amtorg had invited their respective firms to send representatives to Moscow it had not intimated that there was such a wide difference between the bid and the price the Soviet Government was prepared to pay. Hamilton said that the cost of the trip alone to Alco Products was $50,000 and that if Alco had known the Soviets could only pay such a small amount they would have dropped the matter.

As in other cases, the Soviets then demanded all drawings, documents, blueprints, technical descriptions, and similar material brought into the Soviet Union and viewed as confidential by both firms. Mr. Badger was informed that 'before departing from the Soviet Union he should leave these documents with Mashinoimport which would see that they were inspected by the customs authorities and sealed.'[13] Badger did not hand over his blueprints, no doubt having been forewarned of past Soviet appropriations. Some he burned and some handed over to the Embassy with a request that they be sent out in the diplomatic pouch or burned. Hamilton, on the other hand, handed over his documents to Charles H. Smith in Moscow.[14] The Soviet authorities

11 *Ibid.*

12 *Ibid.*

13 *Ibid.*

14 For the background of Charles H. Smith, of the American-Russian Chamber of Commerce, see Sutton, *Western Technology. . . , 1917 to 1930*, pp. 119, 284–5, and 289–90.

refused to allow Badger's assistant to be present during the 'customs' examination of the other documents, which lasted one and one half hours, 'during which period,' according to Badger, ' . . . it would have been possible for most of the important documents to have been photographed.'[15]

The Embassy report concludes:

> The Embassy is of the opinion that when Mashinoimport issued through Amtorg invitations to the two firms to send representatives to Moscow it believed that by offering to pay cash and by playing one bidder against the other it could obtain the plant at costs greatly below those set forth in the original estimates.[16]

The Embassy further comments that:

> . . . the type of questions put to Mr. Badger and [one of the engineers] by various Soviet engineers with regard to the machinery and processes which his firm proposed to employ led him to believe that the Soviet Government was considering, in case it could not obtain the desired reduction in price, the possibility of using Soviet engineers to build the plant and of purchasing abroad only those machines which could not possibly be manufactured in the Soviet Union.[17]

This question of Soviet expropriation of drawings and technical data occurred many times; indeed, one has the impression there was an almost compulsive intent to collect such material, although drawings by themselves, without material specifications and extensive backup data, would have had only limited usefulness.

The Radio Corporation of America had similar problems with drawings, even after the State Department obtained a promise from the Soviets to desist. In 1937 RCA engineers in Moscow were being searched and their documents and drawings retained for examination.[18] This was coupled with a refusal to let the engineers be present while the drawings were being examined.[19] A 1938 memorandum by George F. Kennan summarized Soviet intent; after pointing out that some Soviet practices aroused resentment, Kennan added:

> An example of these practices is provided by the efforts which are frequently made by Soviet officials to utilize business connections in order to get possession of foreign plans, charts and diagrams, by the use of which Soviet factories can themselves undertake production of commodities previously purchased abroad.[20]

15 U.S. State Dept. Decimal File, 861.602/263.

16 *Ibid.*

17 *Ibid.*

18 U.S. State Dept. Decimal File, 861.602/267 and 361.11—Employees/349.

19 U.S. State Dept. Decimal File, 36.11—Employees/349.

20 U.S. State Dept. Decimal File, 124.61/119.

Kennan pointed out that written assurances were given in 1937 that American nationals would be permitted to remain during examination of their possessions. He continued:

> Nevertheless in the current year [1938] we have witnessed the violation of these assurances in the case of engineers of the Radio Corporation of America working in the Soviet Union and the retention by Soviet authorities of drawings, plans, et cetera for periods long enough to permit copies to be made. There is good reason to believe that papers taken by Soviet authorities from American citizens have led to infringement of important American patents.[21]

The State Department did not protest in the RCA case, as the company did not want to alienate further orders from the Soviet Union.[22]

Another case of expropriation of drawings and patents was that of Joe Lavelle, a case which occupied the U.S. Embassy in Moscow from 1936 to 1939. Joe Lavelle, an inventor living in Montana, patented a railroad frog[23] in April 1931. Drawings and technical data were given to a Soviet representative, Ulanov, to consider use of the patent in the Soviet Union. That was the last Lavelle heard of his drawings and patent. Successive inquiries by the State Department over three years, through the Moscow Embassy, yielded only the response that the drawings could not be found.[24]

The common thread in these cases—White Engineering, E. B. Badger, Alco Products, RCA, and Joe Lavelle—and many others not here described is that the Soviets obtained technical information (particularly drawings) unethically and at the expense of the originator.[25]

DEFAULTS ON SALARY PAYMENTS TO FOREIGN ENGINEERS

There is considerable evidence that the Soviets defaulted extensively on payments to foreign engineers. This assertion, however, is modified by a clause in many individual contracts granting the Soviets a right to cancel the

21 *Ibid.*

22 U.S. State Dept. Decimal File, 124.61/134.

23 U.S. Patent No. 1,802,057.

24 U.S. State Dept. Decimal File, 861.542 Lavelle, Joe. ***Subject: Protection in U.S.S.R. of Patent Right of Joe Lavelle, American Citizen, in a Railroad Frog.***

25 For a few of numerous similar cases see U.S. State Dept. Decimal File, 861.541/1 (seizure of papers on manufacture of aluminum foil); 861.542/62 (copying Central Railway Signal Co. devices); 861.602/264 (Otis Elevator); 861.42761/65 (IBM); 861.42761/71 (National Cash Register); 861.544/5 (Universal Picture Corp. accuses Soviets of stealing story of *Once in a Lifetime*); and 124.61/134 (U.S. Embassy protest re engineer Wood in which Soviets retained his drawings and plans. Also see 361.11—Employees/349 and 124.61/118 and 119.

Such behavior is, of course, ethical under Communist philosophy as it advances world revolution; indeed, it would be grossly unethical for a Communist *not* to undertake such acquisitions if there were any chance they would advance the cause of Communism.

contract freely.[26] Those contracts examined by the writer are worthless from the viewpoint of protection of the foreign engineer; it is presumed that potential employees were so anxious to obtain business that insufficient care was taken to have contracts examined by competent lawyers in the United States or Germany before signature.[27]

During July and August 1931 a large number of such contracts were cancelled outright due to the valuta shortage. The exact number is not known 'but it is thought that it affected a very large number of persons employed in Russia, particularly Germans.'[28] Many contracts were broken unjustly but, so far as German workers were concerned, little was made public, as the German Government had a policy of not making trouble for the Soviets 'on behalf of these little people, [and] little was done in their behalf.'[29]

Many similar American cases were reported to the State Department; they include August Tross (a drilling superintendent in the Baku oil fields),[30] Mitchell N. Jordan,[31] George F. Hardy,[32] Balog,[33] Willard Gorton,[34] E. G. Puttmann,[35] Olson,[36] and others.

Also in the Departmental file are letters from legal firms in the United States on behalf of clients. For example, the New York lawyers Murphy and Fultz made inquiry in 1937 on behalf of a client engineer who was paid no

[26] See U.S. State Dept. Decimal File, 861.602/248.

[27] See Appendix A. See also U.S. State Department Decimal File, 861.5017—Living Conditions/537 and /771 for an example of an individual work contract. The Gorton contract (Appendix A) is one of the better contracts, yet Clause 13 give the Soviets the right to cancel 'at any time.'

[28] U.S. State Dept. Decimal File, 861.5017—Living Conditions/248.

[29] *Ibid.*

[30] U.S. State Dept. Decimal File, 861.5017—Living Conditions/771. Soviets 'did not keep conditions on payment.'

[31] *Ibid.*, 861.5017—Living Conditions/518. Jordan deposited $3,800 in Soviet bank but was not allowed to withdraw it.

[32] *Ibid.*, 861.5017—Living Conditions/458. 'After he had been working for five months the Soviet official in charge of employing foreign specialists sent for him and told him that his contract was broken and that they would no longer pay him in American dollars. He was offered a new contract in rubles. . . ." He had no funds to return to the U.S. and therefore had to accept.

[33] *Ibid.*, 361.11—Employees/291. The Soviets broke his contract. 'It is apparent from the statements made and the evidence submitted by Mr. Balog that the contracts offered by the Russian representatives in New York to American engineers etc. are tricky instruments which are not worth the paper upon which they are written, and that Americans who venture to Russia having faith in such contracts are bound to be very much disillusioned and to be put to great inconveniences and expense. . . .'

[34] See p. 34.

[35] *Ibid.*, 861.602/254. Ten engineers were dismissed on 'trumped-up charges.' One month later the remaining engineers had their dollar allowances cut.

[36] *Ibid.*, 861.5017—Living Conditions/423. 'Like so many others Mr. Olson complained that the Russians failed to live up to their contract with him and sought to evade it from the outset through technicalities.'

salary at all for the second year of his service with the Soviets.[37] The widespread nature of Soviet default on individual work contracts is indicated by the inquiry of a single Detroit attorney handling no fewer than 10 claims from former employees of the Stalingrad Tractor Plant. John L. Sullivan wrote the State Department, saying: 'I have about ten claims of former employees . . . and it appears to the writer that their contracts have been violated by the above named concern [Stalingrad Tractor Plant].'[38] The State Department referred attorney Sullivan to Congressman Fish for information on Amtorg and made no further comment.

Details of a single case will illustrate the personal hardship often caused by such Soviet defaults. In 1930 Homer Trecartin was hired by Sharikopodshipnikstroi (Ball-Bearing Construction Trust) as a consultant on the construction of a gigantic ball-bearing plant.[39] The one-year contract, dated March 17, 1930, was made with Amtorg, with the right of renewal at $20,000 per year to supervise construction of the Kaganovitch plant. Although it was agreed that his salary would begin in the U.S., with 60 percent of it to be deposited in dollars at the Chase Bank in New York and the balance payable in local currencies, Trecartin received no funds before sailing from New York to England on August 16, 1930. The Soviet Embassy in London then sent him to Italy to discuss equipment for the plant. At this point, September 1, he had received neither travel nor salary funds and so cabled Amtorg. Having received no reply by September 10, Trecartin then cabled Amtorg: 'FOUR TELEGRAMS TO WISHNEVESTSKY SINCE AUGUST 30 UNANSWERED ABSOLUTELY WITHOUT FUNDS SITUATION DISGRACEFUL CABLE TWO HUNDRED DOLLARS IMMEDIATELY.'

On September 22 he sent a further cable: 'NO MONEY RECEIVED SALARY LONG OVERDUE THREATENED ARREST EVICTION YOUR TREATMENT SCANDALOUS CABLE ME DIRECT IMMEDIATELY PALACE HOTEL MONEY AND FUTURE INTENTIONS.' Amtorg's answer to this cable was 'REMITTING FUNDS TOMORROW.'

Trecartin finally received $200; he was then owed $666, plus $1,000 which should have been deposited in New York, plus travel expenses. The point to be emphasized is that Trecartin was one of a small group of top consultants, a man of wide experience and first-rank qualifications. The treatment accorded lesser-ranking engineers, without even considering the fate of specialists and skilled workers, can be readily envisaged.[40]

[37] *Ibid.*, 861.5034/59. See f.n. 40 (below) for State Department action.

[38] *Ibid.*, 861.60/231.

[39] *Ibid.*, 861.6511 Officine Villar-Perosa.

[40] Trecartin asked the State Dept. to bring this matter to the attention of other engineers and several companies. There is no indication in the files that this was done. It could have been done informally but, if so, it had no impact, as this was one of the early agreements. One copy of the material was sent to the Dept. of Commerce marked 'Strictly Confidential,' but the State file was not declassified until the writer's application on May 19, 1967.

One rather small group of engineers tried to ingratiate themselves with the Soviet regime. It is suggested (there is no evidence either way) that this group may have been trying to substitute political ardor for their own technical deficiencies. One group of 16 engineers wrote articles favorable to the Soviet regime.[41] Sixty Germans, Americans, and others—mainly technicians—supplied letters favorable to Soviet propaganda image for publication.[42] A bond issue was promoted inside the Soviet Union by a group of U.S. specialists including Guy C. Riddell, Miles W. Sherover, William C. Aitkenhead, Atherton Hastings, and others.[43]

On the whole, however, American engineers were strictly nonpolitical and hardworking, tried to do their jobs and, as their writings show, were shocked at the privations of the Russian people. It is the misery and privation, rather than criticism of the Soviet system, which is reflected in the interviews and writing.[44] Some engineers, it is true, received Soviet rewards; the Order of the Toilers of the Red Banner was received by six U.S. engineers at the Dniepr Dam, but there was nothing political about this award so far as the recipients were concerned.[45] Several received the Order of Lenin and one—F. B. Haney—did become a Soviet citizen.

In general, there was little ideological sympathy attached by individual Americans to their contribution to Soviet development. There were ideological connections in the early 1920s (the 'arm's length hypothesis' is discussed in the first volume) and certain ideological links between American firms and the Soviet Union will be traced in *Western Technology and Soviet Economic Development, 1945 to 1965*, but these are relatively minor. The years 1929–32 witnessed the Great Depression in the United States; engineers went to the Soviet Union because they could not find work in the United States. Only a fraction could even be termed sympathizers. Most were disgusted by the brutality and coercion.

George Burrell, working for Grozneft (Georgian Oil Field Administration) is typical: 'I myself am no Communist, for if the Soviet dictatorship should be

41 U.S. State Dept. Decimal File, 861.5017—Living Conditions/584 contains a translation of these articles sent to Washington, D.C.

42 *60 Letters: Foreign Workers write of their Life and Work in the U.S.S.R.* (Moscow: 1936).

43 Gorton Special Collection at Hoover Institution, Stanford University, Envelope 12.

44 The interviews filed by the State Dept. under 861.5017—Living Conditions support this point at considerable length and in great detail. This is a superlative primary source for a study of living conditions in Soviet Russia during the time of the First Five-Year Plan.

45 U.S. State Dept. Decimal File, 861.6463/62. The Order was awarded to Col. Cooper, Frank Pfeiffer, Murphy, Miles, Winter, and James Thompson. Banner recipients received a pension, free transport, rent reduction, and exemption from Soviet income tax if their income was not over 6,000 rubles per year; not a great advantage.

established here I would probably be chased down a back alley along with more affluent and wealthy people.'[46]

In the final analysis these American engineers could see what had happened to their professional confrères in Russia; they worked with 'prisoner engineers' and appreciated and even tried to lighten their burden.

Several engineers sent by firms were offered individual contracts to stay and work directly for Soviet organizations in order to copy foreign equipment. J. Urbanik, at the Stalin Auto Plant, reported that after copying several of the older Gleason machines the Soviets tried to enlist his assistance in copying a new Gleason gearmaking machine.[47] Emil Lutzweiler, employed by the Gogan Machine Company of Cleveland to install machinery for making automobile bumpers, was offered 650 rubles per month to sever his connections with Gogan and stay in the U.S.S.R.[48] In the field of automatic railroad signals, the Soviets were having trouble installing equipment copied from signal units covered by U.S. patents and offered John M. Pelikan '$100 per month more than he receives from his company if he will resign from it and enter into a personal contract with them for five years.'[49] There is nothing unethical about such offers, but they do illustrate the point that the Soviets probably had difficulties copying foreign equipment in a satisfactory manner.

There is a problem concerning reports by returning workers on Soviet conditions. One can find detailed reports from workers in the same industry—even in the same plant—at the same time, reporting quite opposite events and conditions. There is no question that this has led to confusion concerning the nature of Soviet technological development. For example, a toolmaker, Walter Wells, wrote an article for *American Machinist* in 1931 concerning his professional experiences in Moscow. All in all he produces three pages of favorable impressions, with hardly a single criticism of the Soviet way of life. His impressions are sufficiently detailed to indicate that, unless he were a complete liar, he was not at all unhappy and left for reason beyond his control.[50] On the other hand, most foreign engineers' reports in the State Department

[46] G. A. Burrell, 'Life in a Soviet Town' (unpublished manuscript in the Hoover Institution, Stanford University). It is worthy of note that it was the smaller companies and individual engineers that contributed to the Fisher data *(American Engineers in Russia)*. No large company made a contribution.

[47] U.S. State Dept. Decimal File, 861.797/37.

[48] *Ibid.*, 861.5017—Living Conditions/441.

[49] U.S. State Dept. Decimal File, 861.5017—Living Conditions/233.

[50] Walter Wells, 'An American Toolmaker in Russia,' *American Machinist*, LXXV, November 26, 1931, pp. 816–18. A careful reading of this article leads to the conclusion that it may not have been written by a tool and die maker. Although some tool and die makers are well read I find it difficult to accept such phrases as 'delicate viands' and 'stipulation is precie in the contract.' No one except Mr. Wells has ever praised Russian sanitary facilities.

files describe bad conditions and give wholly unfavorable impressions of the Soviet system and standard of living at the same time as Wells.

These conflicting reports can, however, be reconciled. For example, in the Wells article, as in numerous books written in the 1930s favorable to the 'Soviet experiment,' attention is focused *only* on the favorable or that which can be interpreted favorably. This is the essence of Soviet censorship: only the favorable is reported. Objectivity reflects both good and bad aspects, and these must be blended for an accurate picture.

There is evidence that the Soviets tried to ensure that only favorable aspects would be reported by returning workers. However, in talking with State Department officials most—but not all—such workers felt they were safe enough to tell the truth as they saw it, so that the State Department files are understandably much closer to the truth than published material. There *was* an incentive, however, to present the Soviet line after return to the U.S.—the possibility of further employment: not a small consideration in the 1930's. A number of engineers, however, said they had been threatened by the OGPU, and there is evidence of OGPU activities inside the United States against American engineers who spoke too freely.[51]

In sum, there were several incentives to continue the Soviet line and very few incentives to tell the whole story concerning Soviet conditions. This interpretation is supported by the requests in both the State Department files and the Fisher material at the Hoover Institution for confidence and anonymity.[52]

SUITS BY GERMAN ENGINEERS AGAINST THE SOVIET UNION FOR BREACH OF CONTRACT

German as well as American engineers endured breach of employment contracts by the Soviet Union. The State Department contains an excellent report on applicable suits filed in the Prussian Labor Courts (Preussische Arbeits-Gerichte). This report was the result of an interview by the Berlin Consul General with Judge Tuchler, head of the press department of the court system, at the end of 1932.[53] Judge Tuchler estimated that there had been about 150 such suits filed between 1930 and 1932 in the Prussian Labor Courts,

51 See V. A. Kravchenko, *I Chose Freedom* (New York: Scribner's Sons, 1946), p. 185. Information is given on how the NKVD controlled American engineers after their return to the U.S.

52 The writer has honored these requests where made in the Fisher investigation at the Hoover Institution. These were private requests in a private investigation. The State Department material is public property and has been officially declassified; therefore similar requests made to State Department officials in the 1930s have not been recognized (with one exception in which the Department made adverse comments on an individual), and names are incorporated into this text.

53 U.S. State Dept. Decimal File, 861.602/249, Report No. 1075, Berlin, December 19, 1932.

and that if all German engineers with grievances had filed, the number of suits would have amounted to several thousands.

According to Judge Tuchler the contracts varied greatly in content (this was also the case with American contracts), but 'the general impression which the judges in the German courts got from the suits was that there was a general tendency upon the part of the Russians not to observe their contracts.'[54]

German suits for breach of contract were directed at the Soviet Trade Delegation in Berlin; this organization, however, claimed that it was not responsible, as the contracts were in the names of various internal Soviet organizations. The German courts held that the Delegation had power of attorney, as the contracts had been signed in Berlin. Unfortunately, most Germans overlooked a clause which said that the Trade Delegation signature alone did not put the contract into effect. Thus the Soviets were able to insert further clauses in Moscow—and did so; the German engineers had no choice but to submit to the arbitrary new terms.

The chief basis for claims in the Prussian courts was nonsupport of German families remaining behind in Germany while the breadwinners worked in the Soviet Union. The contracts agreed that part of the salary, averaging about 150 marks per month, should be paid in Germany. Because of the valuta shortage, this arrangement was not welcome in Moscow, and ways were found to circumvent part-payment in foreign currencies. A common circumvention was to submit the contract to Vesenkha, where it was cancelled and an all-ruble contract arbitrarily substituted. These unilateral contracts placed German workers in an impossible position; they could not support their families, had no way of converting ruble salaries into marks in order to transfer funds back to Germany, and when they tried to return home the Soviets refused to pay return fares on the ground that the *Germans* were breaking the contract.

There was another less-common type of suit, in which German workers sued for the return of funds deducted from wage payments as 'voluntary' subscriptions to Soviet loans. When the German courts found evidence of pressure or breach of contract, they decided in favor of the German workers. The report concludes that 'most of these cases were settled amicably, the Russians agreeing to pay.' However, it is estimated that only about 10 percent of such breaches came to court; the greater number did not, therefore, receive compensation.[55]

INSTITUTIONAL INFLUENCES ON THE TRANSFERS

The influence of political forces and Western foreign offices on the transfer, and particularly its major vehicle—trade—is an important topic which can only be touched upon here.

[54] *Ibid.*
[55] *Ibid.*

No evidence exists in State Department or the German Foreign Office files to show an awareness of the links between trade, the transfer of technology, and ultimate Soviet objectives. Politicians and foreign office officials were apparently unaware of such links. Certainly German Foreign Office and U.S. State Department policy statements support the argument that the links were not recognized. The only evidence of such recognition is in the subsequent reluctance of Goering and Hitler to send weapons under development to the U.S.S.R. U.S. Navy officers also actively opposed Roosevelt's approval of battleships and destroyers for the Soviet Union; and the State Department did act in 1940 to stop transmission of technical data and aviation gasoline equipment after the Soviet invasion of Finland. These objections, however, were in reference to outright military goods. Nowhere, with two minor exceptions, does the evidence show recognition of the connection between ultimate Soviet objectives and the necessity for an industrial structure to fulfill these objectives.[56]

This has possibly been the result of a superficial definition of a strategic good: i.e., in terms of immediate military use rather than in terms of economic principle. A State Department memorandum argued that the Hercules Powder contract to supply nitrocellulose technology should be approved on the grounds that 'no munitions are involved but merely services.'[57] In 1934 Henry Morgenthau removed restrictions on trade with Russia (which had been imposed as a result of the dumping of goods in the United States) although the U.S. Government had evidence concerning forced-labor camps in the Soviet Union. If forced labor was used, then production costs would be artificially lowered. The general objective of all Western governments up to 1945, including Nazi Germany, was to encourage or at least not to hinder trade and its embodied technical transfers. The writer does not accept the argument that 'times were different' and that criticism of this view is hindsight. Soviet objectives were as plain in 1917 as they are today. The Communist Party has never been coy or reluctant to expand on its intentions regarding the capitalist world. Immediate operational or tactical aspects may be obscure, but never the long-term objectives. Neither have foreign Communist parties nor the Soviet Union denied the link between trade and military-strategic objectives; they are intimately linked in the dogma. On the other hand, we have seen since 1918 in major Western countries a pervasive mythology that the Soviets do not really mean what they say, or if they do, their objectives have no relationship to economic or industrial factors—particularly trade.

[56] Military Intelligence in the U.S. War Department hinted at such a link, as did a German Foreign Office memorandum in 1928. See Sutton, *Western Technology . . . 1917 to 1930, p. 11.*

[57] U.S. State Dept. Decimal File, 861.659 Nitrocellulose/4, reply from W. R. Castle.

In brief, the policies of all Western governments in regard to technological transfers between 1917 and 1945 were inconsistent with declared Soviet intentions regarding the Western world.

THE ROLE OF SOVIET NATIONALS IN THE UNITED STATES

While American engineers designed and supervised projects in the Soviet Union and American and European firms manufactured equipment for Russian plants, there was a counterpart flow of Soviet nationals to the United States and, to a lesser extent, to European countries. There were legal and illegal elements in this flow; only the legal elements are considered here.[58] Soviet nationals were sent abroad in large numbers to be trained; to acquire information, drawings and designs as part of study commissions; and to conduct negotiations for purchase of complete plants, equipment, and technical assistance.

The flow of Soviet nationals to the United States between 1929 and 1945 falls into three time periods. Between 1929 and 1931 there was heavy traffic to fulfill numerous technical-assistance agreements in force and to negotiate the purchase of equipment. This flow tapered off as Soviet supplies of hard currency declined. The second stage extends from 1934 to the Nazi-Soviet pact of 1939; Soviet engineers visited the U.S. for lengthy training but in more specialized activities: oil-refining, aviation, and military industries. The third stage came under the Lend-Lease program and included the training of Soviet personnel and the grant of engineering and technical information. An illegal acquisition known as Super-Lend-Lease may have been as important but is not here considered.[59]

In the 18 months between January 1, 1929 and June 15, 1930, just over 1,000 Soviet nationals arrived in the United States (see table 17–1); only four (Soviet wives joining their husbands) came for personal reasons. Eighty-one percent (or 842) came for training courses under technical-assistance contracts with American firms or for purposes related to such contracts. Just over 13

[58] The illegal flow of information has been extraordinarily large. See David J. Dallin, *Soviet Espionage* (New Haven: Yale University Press, 1956), pp. 103–2. The history of this aspect remains largely unwritten. It may be inferred from an official F.B.I. statement, 'The facts are that Soviet agents for three decades have engaged in extensive espionage against this country, and through the years have procured a volume of information which would stagger the imagination' and '[a] large group of Soviet-bloc officials stationed in the United States has systematically over the years developed a most important part of the modern intelligence machine which was referred to by one Soviet official as the best industrial spying system in the world. Volumes could be written as to the techniques used. . . .' [U.S. Senate Judiciary Committee, *Exposé of Soviet Espionage*, 86th Congress, 2nd session, May 1960 (Washington, D.C.: 1960), pp. 1 and 5.]

[59] See Jordan, *op. cit.*, p. 265.

percent had business in relation to the purchase of U.S. equipment, and only an insignificant 1.2 percent (or 12 individuals) came in connection with sale of Soviet products in the United States. It is clear that about 99 percent of the Soviet nationals came in relation to some phase of the transfer of U.S. technology to the Soviet Union.

This group has been further examined in regard to declared interests: i.e., the industrial sector they visited while in the United States. It was found that more than 46 percent were interested in automobiles, tractors, and aviation equipment, about 13 percent were in the machinery sector, 7 percent were in mining, and the remainder were scattered over the whole range of U.S. industry. It is interesting to note that some Soviet entrants gave rather unimaginative false reasons for their visits; this suggests that the percentages may not be wholly accurate. For example, Petr Kushnarev declared to immigration officials that he came to study agricultural equipment, although his destination was Pratt & Whitney, manufacturers of aircraft engines.[60] Anatoli Bariantinsky similarly gave study of agricultural machinery as his reason for a visit to the Ex-Cell-O Aircraft Corporation.[61]

On the whole, Soviet visits to American plants in 1929–30 did not occasion too much concern. Large groups of Soviet workers and foremen came for training—particularly to Ford Motor Company in Detroit and General Electric in Schenectedy. Smaller groups of Soviet engineers went to other companies for specialized training. Of these, 24 Soviets went to Sperry Gyroscope Company for training in searchlight manufacture; 10 went to the A. J. Brandt Company in connection with reconstruction of the Yaroslavl truck plant; another 10 went to Roberts and Schaefer, the coal-mine consultants; and smaller groups went to the Seabrook Company for training in road construction, the Du Pont Company in connection with nitric acid manufacture, American Locomotive and Car Works for locomotive construction, Newport News for turbine construction, and the Powers Company concerning office equipment. The largest group in the 1929–30 period was probably at Ford Motor Company; 81 Soviet engineers and technicians have so far been identified as resident at the Ford Detroit plant.

Concern grew after 1936–7, when Soviet emphasis in technical acquisitions shifted more overtly to military-related industries: oil refineries, aviation engines, aircraft, and radio communications equipment. At the same time, pressure grew to acquire far more data in these fields than had been agreed upon; indeed, sometimes such data could not be supplied at all. From about

[60] U.S. Congress, *Investigation of Communist Propaganda*, 71st Congress, 2nd session, Special Committee to Investigate Communist Activities in the United States. Part 3, Vol. 3 (Washington, D.C.: 1930), p. 194.

[61] *Ibid.*, p. 184.

1936 to 1941 there was a continuing battle between individual American firms, the Navy and War Departments, and Soviet engineers attempting to gain access to off-limits areas of plants, to send more engineers and observers than agreed, or to obtain information beyond that contractually stipulated.

Table 17–1 DECLARED PURPOSE OF SOVIET NATIONALS ARRIVING IN U.S., JANUARY 1, 1929 TO JUNE 15, 1930

Purpose	*Jan. 1 to Dec. 31, 1929 (12 Months)*	*Jan. 1 to June 15, 1930 (6 Months)*	*Total Number*	*Percent of Total Number Arriving*
Visiting U.S. firms under technical-assistance contracts	157	268	425	40.9
Taking training courses in U.S. plants or studying U.S. industries	302	115	417	40.1
Purchasing equipment in U.S.	65	74	139	13.4
Other (including Amtorg personnel)*	19	27	46	4.4
Selling Soviet products in U.S.	8	4	12	1.2
Totals	551	488	1,039	100.0

Source: Based on data submitted by P. Bogdanoff (President of Amtorg Trading Company) to the Special Committee to Investigate Communist Activities in the United States. U.S. Congress, *Investigation of Communist Propaganda*, Part 3, Vol. 3 (Washington, D.C.: 1930).

* No personal travel, except four Soviet wives joining their husbands in the U.S.; balance are Amtorg and Vesenkha personnel.

The Douglas Aircraft Company provides a good example of these disputes. Its experience was typical and repeated wherever the writer has been able to discover information concerning activities of Soviet engineers. The Douglas 1936 technical-assistance and sales agreement allowed five (later eight) Soviet engineers to observe in the Douglas plant. These engineers were defined as production men, but it was understood that a group of Soviet inspectors would also be sent to check out DC-3s under construction on Soviet account. Five production men were indeed sent—but also 13 unannounced Soviet design engineers. This latter group contained some interesting names. One was M. Gurevich: probably the mathematician and designer of the MIG fighter (the 'G' in MIG). Another was Miasishchev: a seaplane designer. Lisunov, another design engineer, later gave his name to the Douglas DC-3 in the U.S.S.R.—first called the PS-84 and later the LI-2 and LI-24. Later in 1937, a group of three visitors at Douglas included a P. I. Baranov, introduced to Douglas as a chief engineer; a P. I. Baranov was also director of the aviation industry in the U.S.S.R.

In sum, although the five inspectors remained one year, numerous other permit applications by Amtorg were granted, so that there were no fewer than 77 Soviet engineers (excluding interpreters) in the Douglas plant: at least 20 at one time.

Douglas also had major problems with the Soviet inspectors. In March 1938 Stratton complained to Rosoff, President of Amtorg, that no parts were getting through inspection and that unusually rigid requirements were holding up shipment; in fact the inspectors demanded something for which they had not contracted. Stratton pointed out that Douglas had been led to believe that the parts were to be used in the Soviet Union in the manufacture of airplanes; but the inspectors argued that they were for instruction purposes in those Soviet plants where the DC-3 was to be built, and therefore had to be of a higher standard, and were in fact special parts.[62]

In February, Conant, Douglas's Production Chief, wrote an ironic letter to the GUAP Commission protesting such arbitrary inspection and pointing out that scratches occurred on aluminum panels because 'airplane parts are made by man on machinery and not laid like eggs by an Easter Rabbit.'[63] Added Conant, 'I still believe that somebody must have been in earnest when you bought these planes. . . . That wasn't stage money you gave us . . . we don't make these parts for our amusement, we actually use these contemptible pieces of metal to build damned good airplanes that actually fly. . . .'[64]

Conant's letter had little effect. In August, Douglas routinely informed Amtorg that two DC's had scratches in the aluminum center section corrugation but that these, according to standard practice, had been 'doubled' and passed inspection. Promptly, and predictably, Amtorg came back demanding a 'substantial discount.' The affair was settled only when Douglas gave a lifetime guarantee for the planes.[65]

There was a major problem with the attempt to gain unauthorized access to other U.S. plants.[66] The Soviets tried to gain access to the Consolidated Aircraft plant at San Diego under their technical-assistance agreement, although this was not, and could not be, included in the contract. Ambassador Troyanovsky wrote to Kelley, Chief of the East European Division of the State Department, asking him to expedite such permission and suggesting that it would do no harm, 'particularly since we can build similar airplanes only in the distant future.'[67] Troyanovsky also asked for the blueprints to be

[62] Douglas Company Files, *Amtorg Outgoing Prior to 1939*, March 7, 1938.

[63] *Ibid.*, February 1938.

[64] *Ibid.*

[65] *Ibid.*, Telegram, August 9, 1938.

[66] As Kilmarx summarized this problem, 'Wherever controls existed the Soviet Government attempted to circumvent them. . . .' [R. A. Kilmarx, *op. cit.*, p. 86.]

[67] U.S. State Dept. Decimal File, 711.00111, Armament Control/584, March 23, 1937.

delivered *with* the PBY-1 under construction and not later. Access was denied to the plant on grounds that 'particular equipment cannot be effectively isolated' and that a group of seven Soviet engineers had recently been conducted through the plant.[68]

In 1940 RCA queried the State Department concerning termination of that part of its agreement allowing training of Soviet engineers at the RCA Camden (New Jersey) plant, 'in view of the rise of anti-Soviet feeling.'[69] This suggestion was supported by Mr. Fly, Chairman of the Federal Communications Commission, who expressed doubts concerning the wisdom of allowing Soviet engineers to continue at the Camden plant.[70] A memorandum in the State Department European Affairs Division concluded, however, that it would be 'unfortunate' to request RCA to cancel.[71]

Another aspect of the Fish Committee data on Soviet nationals visiting the United States in 1930 is worth special mention. In a number of cases visits were made to U.S. firms where there was no other record of a technical-assistance agreement or large sale of equipment. For example, in the first six months of 1930, Soviet nationals are reported to have visited Richard Brothers in Detroit; the Accounting and Tabulating Machine Company; Oliver Farm Equipment; Kalitt Products, Inc.; Arthur Nickel Company of Cleveland; Yukon Fur Farms, Inc., of Petersburg, Alaska; Burd Piston Ring Company of Rockford, Illinois; Pontiac Engineering Company; John Deere Company; Bethlehem Shipbuilding; American Can Company, and the Pennsylvania Railroad. No source states that these companies had any form of technical-assistance agreement with the Soviet Union. It is obvious that the visits in question were important as they were cited by the Soviet nationals as the reason for entering the United States. In some cases, a group of Soviets were received; five went to the Pennsylvania Railroad, four to John Deere, three to Burd Piston Ring, five to the Arthur Nickel Company, and so on.[72] As this data covers only a six-month period, the proposition is suggested that many technical-assistance agreements are still to be revealed and that this three-volume study may well only scratch the surface.[73]

68 *Ibid.*

69 U.S. State Dept. Decimal File, 861.74 RCA/33, December 4, 1940.

70 *Ibid.* Also see 861.74 RCA/30–39 concerning entry of Soviet nationals into the Camden plant and the problems created. (Item /30½ is missing; item /31 is still classified). This was similar to attempts to gain entry to the Douglas plant at Santa Monica.

71 U.S. State Dept. Decimal File, 861.74 RCA/30.

72 U.S. Congress, *Investigation of Communist Propaganda*, p. 183.

73 *Ibid.* Another aspect worth noting is the existence of a Chelyabinsk Tractor Plant office in the Union Trust Building in Detroit. In the first six months of 1930 alone, no less than 33 Soviet nationals stated this office was the objective of their visit.

The length of stay in the United States generally varied between three and twelve months. Few cases were found in which the stay extended beyond one year. A 10-percent sample was taken (by the writer) of all arrivals in 1929, and six to twelve months was found to be the average duration in the United States. Short stays of one to three months' duration involved sales of Soviet products and purchase of equipment.

HIGH-LEVEL TECHNICAL ACQUISITION VIA DIPLOMATIC CHANNELS

One avenue of technical acquisition, obviously reserved for processes difficult to obtain by other means, was to appeal directly to the U.S. Department of State. For example, in February 1939, Umansky, Chargé d'Affaires in the U.S., indicated a desire to have

> . . . blueprints, specifications and photographs of certain machinery employed by the United States Army Corps of Engineers in the construction of Fort Peck and Sardis dams, and . . . the manufacture by the General Electric Company of exhaust driven turbo superchargers. . . .[74]

In response Secretary of State Hull forwarded drawings, photographs, and specifications used in construction of the dams but indicated that both the Navy and War Departments objected

> on the grounds of military secrecy . . . to the acceptance by the General Electric Company of any order from a foreign source involving the development and manufacture of an exhaust driven turbo supercharger for use on an internal combustion engine.[75]

Another example of a high-level approach to technical-data collection resulted from the successful use of new rescue equipment by the U.S. Navy to save 33 members of the U.S. Submarine *Squalus*, sunk on May 23, 1939 off Portsmouth, N. H. Within two months Chargé d'Affaires Chuvakhin informed the Secretary of State that the U.S.S.R. was 'impressed by the effectiveness of the rescue equipment developed by the United States Navy . . . which may be looked upon as a humanitarian rather than a military development,' was desirous of obtaining 'as much information as is available' conerning the use and construction of the Rescue Bell and Momsen Lung and training of personnel in use of the equipment,[76] and was prepared to purchase these items. On October 26, 1939, the Secretary of State forwarded a pamphlet

[74] U.S. State Dept. Decimal File, 711.00111, Armament Control/1525. The writer conjectures that the Soviets really wanted only the G. E. supercharger design, were unable to get it, and included it in a 'package request' to the State Department, hoping that this would receive more favorable attention.

[75] *Ibid.*

[76] U.S. State Dept. Decimal File, 711.00111, Armament Control/2053, August 24, 1939.

entitled *Submarine Safety-Respiration and Rescue Devices*, which the U.S. Navy said contained the required information.[77]

RUSSIAN SCIENCE AND WESTERN TECHNOLOGY

After the Revolution, numerous Russian engineers found their way to the United States and started life anew, finally becoming American citizens. Although one would expect these Russians to have little sympathy for the Soviet regime it appears that considerable assistance was given to the Soviets by some of the more successful of these exiles.

It was argued in the previous volume[78] that Russia had a group of highly talented aircraft designers before the Revolution; most of them later came to the U.S. Igor Sikorsky became a leading designer of flying boats in the United States: his chief engineer was Michael Gluhareff, and Serge Gluhareff was his structural designer. The Sikorsky amphibian was sold to the Soviet Union.[79] Alexander de Seversky headed another group of prominent Russian aircraft designers, including M. Gregor, A. Kartvelli, A. Toochokoff, A. Pishvanov, S. Tchemesoff, and P. A. Samoilo. In 1937 Seversky received from the Russians a $370,000 contract for manufacturing rights and two model Seversky amphibians.[80]

Vladimir N. Ipatieff was equally prominent as a chemist. His personal history suggests that although the Soviet system is certainly well-designed to absorb Western technology it has weaknesses in the application of Russian scientific research to practical production.

Ipatieff was a great chemist by any standard. His work in catalysis and promoters and particularly in their application to petroleum technology ranks among the very finest of scientific achievements. Ipatieff was also a general in tsarist Russia. During World War I, while in charge of the Russian chemical industry, he built it up to the point of independence from Germany. Under the Soviet Government he continued his work toward the development of a chemical industry and, as laboratory facilities were lacking, he was allowed the extraordinary privilege of working several months of each year in Germany. Ipatieff had more than 300 publications to his credit, in addition to dozens of prizes, and was the only individual ever to hold membership in both the Russian National Academy of Sciences and the National Academy of Sciences in the United States.[81]

77 *Ibid.*

78 Sutton, *Western Technology . . . 1917 to 1930*, p. 259.

79 *Time*, June 14, 1937.

80 *Ibid.*

81 American Institute of Chemists, *Vladimir N. Ipatieff, Testimonial in Honor of Three Milestones in His Career*, November, 1942. See also V. N. Ipatieff, *op. cit.*

In 1930 Ipatieff left the Soviet Union and came to the United States, where he worked first for Universal Oil Products, which built parts of the Ufa refinery, and then at Northwestern University. When he refused to return to the U.S.S.R. the Soviet Government withdrew his Russian citizenship, expelled him from the Academy of Sciences, and had him publicly denounced as 'an enemy of the people.'[82]

The history of Ipatieff and others such as Sikorsky, Ostrimilenski, and de Seversky must be kept in mind in any study of Western technology in relation to Russia. It is *not* that Russian talent is lacking;[83] indeed there appears to be an affinity between Russian scientists and certain theoretical and research areas in mathematics and physics. The heart of the problem is the great weakness of totalitarian systems in the application of scientific advance to the industrial structure in any rational manner. No chemist, nor indeed any scientist, of Ipatieff's stature has emerged during the 50 years after the Bolshevik Revolution, despite the enormous funds poured into science and the comparatively comfortable conditions in which scientists live and work.

The experience of Ipatieff and his fellow emigrés in the United States then suggests that the weakness is not in Russian scientific talent, but in a coercive system which stifles scientific achievement and provides no means for the rational application of technical progress.

[82] It is a tribute to the courage of Russian scientists that only 62 of the 100 members of the Russian Academy came to vote and six dared even to vote against Ipatieff's dismissal.

[83] As suggested by Werner Keller, *Ost minus west=null* (Munich: Droemersche Verlagsanstalt, 1960).

CHAPTER EIGHTEEN

The Process of Technical Transfer: Propaganda, Standardization and Duplication

THE 'INABILITY HYPOTHESIS' AND THE REQUIREMENT FOR PROPAGANDA

ABSENCE of detailed Soviet or foreign writing concerning *implementation* of construction work, except generalities on 'socialist construction,' leads to an examination of motives for this gap and a survey of the available evidence on the implementation process.

There are numerous Soviet publications with construction photographs published before 1934. Some 17 books in Western languages originated within the Soviet Union, together with various illustrated descriptions of construction during the First Five-Year Plan. A large multi-volume series[1] published between 1930 and 1934 has numerous pictures of construction, although few details are given. It is interesting to note, and explainable in terms of our study, that such publications were not issued after 1934.

When these publicized projects are identified and compared with data contained in this study, two ideas become evident: first, that each major project described in the Soviet publications utilized foreign assistance, equipment, and technology; and second, that actual construction generally took place between 1929 and 1934. Although the plan started in 1928 and was announced in mid-1929, contracts for construction were not let until 1929–30. Foreign engineers arrived on site a few months later. They noted only a small amount of ineffective preliminary work. For example, even Amtorg comments on the Stalingrad Tractor Plant:

> While preliminary work on the site of the Stalingrad Tractor Plant had been conducted for some time, the actual work on the construction of the principal departments started only in June when the plans arrived from the United States. . . .[2]

[1] *U.S.S.R. in Construction.*

[2] Amtorg, *op. cit.*, V, No. 7 (April 1, 1930), pp. 134–5.

This was three years after work at Stalingrad had started.

The backward nature of early Soviet efforts may be illustrated by several examples. These support an 'inability hypothesis': the Soviets were unable to implement construction of the First Five-Year Plan until foreign engineers arrived.

The Svir Dam was started in 1922—the first large Soviet power project. Although it was designed and intended to be built by Russian engineers, work was continually delayed from 1922 until the early 1930s due to the inexperience of Soviet designers. It was ultimately patterned on the Keokok Dam on the Upper Mississippi River in Iowa and was built with extensive Western technical assistance. As such, it is an excellent example of the 'inability hypothesis.'[3] There is no question that the Soviets reduced Western assistance on the Svir project as much as possible, that it took 10 years to get Svir into operation, and that the project ultimately required Western help.

Again at the Baku hydroelectric project we find a similar situation. The problem was well summarized by a Badger Company engineer working at Baku:

> After working four years, spending in the neighborhood of four million dollars building the concrete flume to by-pass the river, all the auxiliary pump houses, the main pump house and installing all the machinery it was found they had no rock bottom on which to build the dam. . . .[4]

The 1926 Ford Delegation visited a proposed factory near Rostov and suggested it was nearer realization than Stalingrad, as 'a field office had been built and the buildings had been staked out.'[5] Several groups of engineers were working out details of various departments. These men all worked with American technical magazines and books as guides. The pressed-steel work specialist whose drawings were examined had not much practical experience, judging from the design of a blanking and perforating die which was faulty in several respects.[6]

A Stalingrad tractor plant to produce 10,000 tractors a year was also begun in 1926. The Ford Delegation said it was offered to them as a concession, but the Soviets were very vague about details. The Delegation was shown a picture of the plant, but when questions were raised about a number of tall chimneys the Soviets backed off and dropped the question.[7]

[3] U.S. State Dept. Decimal File, 861.5017—Living Conditions/283. See also Sutton, *Western Technology . . . , 1917 to 1930*, p. 201–2.

[4] *American Engineers in Russia*, Folder 3, Item 27.

[5] *Report of the Ford Delegation to Russia and the U.S.S.R.*, p. 53.

[6] *Ibid.*

[7] *Ibid.*, p. 52. A tractor plant in popular imagination might be thought of as having tall chimneys. In practice such chimneys are associated with smelting operations, which are not usually associated with tractor assembly. The reception of the Ford Delegation is reminiscent of the legendary Potemkin villages in the time of Catherine the Great.

Similar evidence of technical inability may be found in reports in the Soviet press. It was reported in 1929,[8] some 12 years after the Revolution, that 10 sugar plants in the Ukraine were still in a state of 'technical preservation,' i.e., capable of being operated but without the necessary managerial and engineering talent. Other examples will be found throughout this volume; an excellent instance is the Chelyabinsk Tractor Plant, which was started as a copy of the packaged Stalingrad plant but ran into such extraordinary problems that American engineers were called in to provide solutions.[9]

Moreover, the official review of the first year of construction, before Western companies entered the U.S.S.R., indicates a miserable picture. Gosplan, in reviewing the first year, 1928–9, entered the vague conclusion that '1928–9 was a year of increased creative revolutionary activity of the masses in town and country, the most important manifestation of which was socialist emulation.'[10]

Table 18–1 summarizes selected evidence concerning construction start dates and the introduction of Western skills.

Table 18–1 PREMATURE CONSTRUCTION STARTS ON SELECTED PROJECTS

Project	*Construction Start*	*Source of Information*
Turkmenistan irrigation	Davis arrived September 1929; work had earlier been started at four locations and stopped at three.	Gorton Special Collection, Hoover Institution, letter from Davis.
Selmashstroi (Agricultural Equipment Plant)	Ford Delegation of 1926 noted attempts to start	*Ford Delegation Report (1926)*, pp. 49, 52–53.
Stalingrad Tractor Plant	each of these projects.	
AMO Truck Plant	Ground was marked out for the first two, and new equipment was idle for AMO truck plant.	
Krivoi Rog Iron and Steel Plants	Project established about 1927 by Gipromez; described as 'inadequate' by U.S. consultants (Perin and Marshall).	Farquhar Papers, Box 4, Folder 3.
Dniepr Dam	Work started on site in 1926.	
Uralmash	Announced start February 1, 1927; actual start 1930.	*U.S.S.R. in Construction*, No. 9, p. 18.
Kuznetstroi	Plans ready 1928. Site still covered with grass in mid-June 1930.	Frankfurt, *op. cit.*, p. 26.

8 *Pravda*, No. 98, April 28, 1929.

9 See p. 188.

10 *Izvestia*, No. 195, August 25, 1929.

It is therefore concluded that the Soviet Union actually started to work on projects of the First Five-Year Plan as early as 1926, but cautiously, doubting its own ability, and very wisely without publicity. The utter lack of internal technical resources for such a gigantic move forward became apparent about early 1929 and is well-described by Rykov:

> Money alone is insufficient for new construction work . . . we now have to make great efforts to assimilate West European and American technique . . . the utilization of foreign scientific technical experience in the course of the five year period is bound to attain immeasurable larger dimensions. It is not very often realized to what extent the utilization of foreign technique is needed . . . when our own new cadres have matured . . . the need for foreign specialists will decrease. But now . . . such measures as engaging only a few hundred foreign specialists will not solve the problem.'[11]

Rykov presents the example of artificial silk:

> . . . for instance . . . the production of artificial silk. . . . Here we are struggling no end with the thing, but are still unable to design and draw up a proper plan or form a sensible idea of a plan. Whereas abroad this branch of industry, notwithstanding all the obstacles resulting from the private ownership, is developing very rapidly. With us this branch might develop with immeasurably greater rapidity, but nevertheless we have shown ourselves as weak as children.[12]

This problem, a fundamental one, as suggested by Rykov, is therefore dubbed the 'inability hypothesis'; i.e., without assistance from capitalist countries the Soviet Union would not have had the technical resources to make any economic progress during the 1930s and 1940s.[13]

Realization of inability coincided with economic censorship. Increasingly tight censorship and increasing propaganda from 1927 onwards are directly related to this fundamental problem. In other words, the raison d'être for Soviet propaganda and censorship in the economic field was to conceal the prime role of capitalist technology in Soviet economic progress.[14]

[11] *Pravda*, No. 94, April 24, 1929.

[12] *Ibid.*

[13] Similar arguments were made by contemporary engineers; for example, John R. Westgarth, a British engineer employed by the Soviets as an inspector on the work of other foreign engineers, said: 'The ultimate objective of the Five Year Plan was to compass by economic warfare the destruction of the capitalist world. This became clear to anyone taking part in the working of the plan, but one of the things man had to learn was that the Communists simply had not the brains to carry out the gigantic task to which they had set their hands.' [John R. Westgarth, *Russian Engineer* (London: Denis Archer, 1934).] A careful reading of Westgarth's book suggests that the Soviets skillfully utilized his luke-warm attitude towards things non-British as a means to check on the work of other foreign engineers.

[14] For a fascinating explanation of other factors involved see Leon Herman, *Varieties of Economic Secrecy in the Soviet Union* (Santa Monica: The RAND Corporation, December 1963) (Report No. P-2840).

The problem of inability was compounded by the lack of technically trained men who were at the same time members of the Communist Party. To retain Party control it was essential that at least the directors of combinats should be Party members. To overcome the problem of technical inadequacy, the Party was forced to appoint to responsible technical positions Party members with no technical training whatsoever, irrespective of the consequences for efficiency and production. As noted in the previous volume, when there was a conflict between economic efficiency and Communist Party control, the Party always, without exception, took precedence.

Thus, most directors of combinats and large construction projects in the early 1930s were nontechnical party men, replaced only gradually with hastily-trained Party members. The director of the Karsak Pai copper mines had been a schoolteacher immediately prior to his appointment.[15] The director of the Stalingrad Construction Trust had been a barber immediately prior to his appointment to Stalingrad.[16] The backgrounds of the construction chiefs at Magnitostroi and Kuznetstroi, both top-priority projects, suggest the technical limitations facing the Soviets. Frankfurt, appointed Chief of Construction for Kuznetstroi on May 30, 1930, was a textile man, and by his own admission he 'had only a most perfunctory notion of metallurgy and particularly of Kuznetstroi. . . .'[17] At the same time J. P. Schmidt, also from the textile industry, was appointed Chief of Construction at Magnitogorsk. Both were Party members. These men could not make any contribution whatsoever to construction[18] but had impeccable Party credentials.

The cost of these nontechnical Communist Party functionaries to Soviet economic development was great. Time after time technical decisions were made on the basis of dogma; economic and engineering rationality were abandoned. Ideological solutions to technical problems sometimes had disastrous consequences. Geologist Ussov, in charge of exploration of Siberian iron ores in the late 1920s and early 1930s, was insistent that the projected Kuznetsk iron and steel complex could not be maintained on existing ore deposits. This conclusion was ridiculed by the Party. Frankfurt, the ex-textile-mill operator and Director of Kuznetstroi, stated:

> He [Ussov] was requested to come to Kuznetsk. Swamping us with geological terminology, references to world practice and science, Professor

[15] U.S. State Dept. Decimal File, 861.5017—Living Conditions/323.

[16] Lyons, *op. cit.*, p. 353.

[17] Frankfurt, *op. cit.*

[18] The author has had the opportunity to spend some six months in and around iron and steel plants combined with some metallurgical training, but would consider himself totally unable to contribute anything to the planning of such a plant; it would be problem enough to read the blueprints. Obviously an ex-textile operator would have less capability.

> Ussov persistently tried to persuade Bardin and me that the deposits at Telbiss and Temir-Tau were not and could not be greater than the twelve to fifteen million tons that were already known. In his opinion prospecting for more ore in that region was a stupid waste of time and money.[19]

Poor Ussov was probably accused of being a 'wrecker' and a 'counter-revolutionary,' but in 1939 nature and Professor Ussov had the final word: Telbiss ran out of ore. The Temir-Tau deposits were more trouble than they were worth; they had .03 percent zinc content—treacherous to furnace linings.

It is therefore understandable that Party propagandists responsible for publicizing socialist progress were not always technically very sophisticated. One photograph, with the caption 'Testing an Airplane Motor,' shows a worker about to swing the propeller of an aircraft engine, obviously with the intention of starting the engine.[20] Unfortunately, the engine is mounted on a steel trolley, with four wheels; if the engine *had* started—worker, propeller, engine, and four-wheeled trolley would have gone on an eventful trip. Again, it was claimed that the turbo-generators of the Shatura generating plant were 'made in the U.S.S.R';[21] a picture of the generator casing showed prominently displayed the well-known symbol § of the Siemens-Schukert firm in Germany. Similarly the Berezniki chemical combine claimed that its 'girders were manufactured on the spot in a special factory . . . the tempo of the shock brigades allowed the building operations to proceed at a dizzy rate of speed.'[22] Examination of the photograph, however, reveals in large letters along the length of the girders the inscription, 'POWER-GAS CORP. LTD. STOCKTON-ON-TEES ENGLAND.'

The impatient propagandists could hardly wait for the motors to start and the paint to dry on the walls of newly built plants before claiming a victory for socialism. The previous volume of this study indicated how the development of the Soviet oil industry up to 1930 (and indeed after this date as well) was completely a product of Western technology skills and equipment. This remarkable construction program was, on completion, immediately claimed by T. Gonta in a little booklet, *The Heroes of Grozny, How the Soviet Oil Industry Fulfilled the Five Year Plan in Two and a Half Years*, published in Moscow in 1932.

In the pulp and paper industry, experiments were carried on to manufacture paper from peat to help solve the problems caused by the acute shortage of wood pulp. These were reportedly carried on at the Barkhat peat factory by Remmer, an engineer who produced a paper comprising 10 percent rag stock,

19 Frankfurt, *op. cit.*, p. 28.
20 Amtorg, *op. cit.*, VI, No. 12 (June 15, 1931), p. 275.
21 *La Vie Economique*, No. 115 (May 5, 1930), p. 4.
22 *U.S.S.R. in Construction*, No. 5, 1932.

20 percent waste paper, and 70 percent peat moss. This was publicized in the Moscow *Pravda* of April 20, 1932 together with the claim that the newspaper itself had been printed on the new peat paper. Samples of *Pravda* were forwarded to the U.S. Department of Commerce in Washington, D.C., for analysis, with this result: 'It is actually similar to the ordinary newsprint paper, being composed entirely of wood fiber in the proportion of sixty percent ground wood and forty percent sulphite wood fiber.'[23]

In brief, although the Communist Party accurately recognized technology and specifically Western technology as the engine of Marxist progress, its initial views of this technology were almost childlike. This should not obscure the fact that the Party was willing to learn from mistakes and that by 1940 and certainly after the Nazi invasion of 1941 the most extreme forms of ideological control of engineering functions had been dropped. As the reality of economic development dawned, propaganda became the means to hide the weaknesses of 'socialist construction' from the West, and probably from rank-and-file members of the Russian Communist Party itself.

Thus censorship and propaganda have played an essential role in the transfer process by obscuring technical backwardness and ineptitude from the outside world.

AMERICAN BUSINESSMEN AND SOVIET PROPAGANDA OBJECTIVES

There is no question that American businessmen, and to a lesser extent engineers, were utilized to further Soviet propaganda objectives and disguise Soviet technical inabilities. One must be careful to distinguish between the motivations of different groups of businessmen and engineers. There was one group, quite small, that knowingly promoted Soviet objectives and were sympathetic to the Communist cause. A second group denied the existence of such Soviet practices as forced labor but did so out of honest conviction and belief. A third group at first denied or excused Soviet brutality and then, as the facts came to light, revised its opinions. A fourth group, including most, but not all, of the engineers on site, was clear-sighted from the first.

The issue of forced labor is a good example to demonstrate the point. There was ample evidence in the early 1930s of forced labor in the Soviet Union. The State Department had a great deal of accurate information. Further, nine out of ten engineers interviewed by the Department mentioned this practice and provided evidence of it.

[23] U.S. State Dept. Decimal File, 861.656/4, Department of Commerce, letter dated July 7, 1932.

On the other hand, the American-Russian Chamber of Commerce was used as a forum for Soviet denials of the use of forced labor. A speech by Colonel Cooper, Chief Consultant to the Dniepr Dam, to the American-Russian Chamber of Commerce at the Bankers Club in New York on January 28, 1932[24] illustrates the point. After referring to the serious interference since 1922 with the flow of trade with the Soviet Union, Colonel Cooper said:

> . . . a hue and cry was raised against these limited Russian exports by politicians and propagandists and, I regret to say, some businessmen who because of their selfish interests are ready to injure the interests of our country as a whole. Last year they tried to convince the country that all Russian products that came into this country were manufactured by convict labor. . . . The Chamber has made a real study of these charges. It has obtained signed statements from many leading American businessmen, who have actually been to Russia and have personally observed labor conditions there, and I am glad to say that not one of these men think that labor in Russia is forced.

Colonel Cooper then points to the great turnover of labor on Russian construction sites as 'undeniable proof' of absence of forced labor. The interesting point is the reason why Colonel Cooper was so strongly convinced that forced labor did not exist, when hundreds of reports in the State Department files from returning engineers or those renewing passports indicated that it did exist. The explanation is roughly as follows: the Soviets valued Colonel Cooper highly as a businessman and as an engineer, and made great efforts to conceal conditions from him. We know this because of a detailed report by one of his assistants, Emegass, on this precise point: the devices utilized by the Soviets to keep Colonel Cooper in relative ignorance of conditions.[25]

Secondly, there are logical fallacies in Cooper's statement. One cannot argue that because forced labor is absent in one location it does not exist elsewhere. Nor can one infer from high turnover that forced labor does not exist. Nor can one prove a negative, as Colonel Cooper was attempting to do. There is ample evidence of forced labor on all major construction sites, and this is indeed admitted in the 1941 plan, which includes NKVD plan objectives and mentions the existence for example, of NKVD-Koppers coke-oven designs.

A few engineers knowingly made erroneous pro-Soviet statements to ingratiate themselves with the Soviets. For example:

> One of the American engineers who had been to the States brought back with him clippings of a speech he had made before an Engineering Society in the U.S. about Russia and conditions there. We congratulated him on

[24] Amtorg, *op. cit.*, VII/VIII (1932–3) bound in rear (Hoover Institution, Stanford University).

[25] U.S. State Dept. Decimal File, 861.50/FIVE YEAR PLAN.

> being such a liar and he replied that was what the Russians wanted and what he was being payed [*sic*] for. . . .[26]

Others were apparently paid or threatened not to complain.[27]

Thus propaganda and the use of foreign firms and individuals to develop Soviet propaganda objectives are intimately related to the inability hypothesis and subsequent Western assistance. In the face of technical inability, propaganda became necessary. One of the most useful outlets was the vehicle of assistance itself—the Western firm and individual businessmen and engineers.[28]

THE STANDARDIZATION AND DUPLICATION OF WESTERN TECHNOLOGY

The operational key to the development and utilization of technology within the U.S.S.R. is contained in the two words 'standardization' and 'duplication.' Strategic objectives, such as world revolution, are disguised by evasion while technical inability is disguised by propaganda, technical extravaganzas, and censorship. The actual process of technical acquisition, apart from the semantic disguise, involves several phases: consideration of all Western processes, selection of a single standard process, and then multiplication of the single selected process.

The first stage required widespread acquisition of knowledge concerning technical processes, economic structures, and organizational techniques throughout the Western world. This technical dragnet was unbelievably thorough and complete. It is doubtful if any technical or economic development of consequence has escaped examination by the Soviets. When information could not be acquired overtly, it was acquired covertly, by espionage, from governments, companies, and individuals. Such information was translated, summarized, and distributed to planning, design, research, engineering, and economic bodies.

Prototypes of promising processes were acquired. These prototypes were examined, dissected, cataloged, and analyzed in the most minute detail. The process most suitable for Soviet conditions was then selected and became the standard. If the process was a leading or key activity, foreign engineers were

26 *American Engineers in Russia*, Dickinson papers, Folder 4.

27 Kravchenko, *op. cit.*, p. 185.

28 After 1958 the Soviets developed a much more effective means of disguising their objectives. The Sputnik dramatically demonstrated Soviet rocket and space achievements, and made their missile capability credible. From this it was deduced, erroneously, that the Soviets had made technical progress along a broad front. From this erroneous assumption came decline of export control laws at precisely that time when Western technology was needed by the Soviets and when technology along a broad front was slipping well behind the West. This is the fallacy of composition in assessing Soviet technology—a predilection to assume broad Soviet technical progress where in fact it does not exist.

hired to carry out or assist in the selection process. When the standard had been identified, it was prepared for duplication and standard drawings were prepared.[29] *This process of identification of standards and subsequent duplication is found in all major Soviet industries for the period under examination.* In aircraft engines, the standard designs were the Gnome rotary air-cooled and the Hispano-Suiza liquid-cooled models. In aircraft the standard designs were by de Havilland, Junkers, Heinkel, Savoia, Douglas, Potez, Martin, Vultee, Sikorsky, Seversky, Consolidated, and Isacco. Tractors were standardized on the Caterpillar 15/30 and the International Harvester and the Farmall row-crop tractor. Combines used the Holt model, light trucks and automobiles were standardized on the Ford Model A, trucks were based on Fiat models and the Hercules, sintering plants were based on Dwight Lloyd designs, and ore crushers on Simons. Standard lathes were the German DIN and the Warner & Swasey turret lathe, and diesel engines were Sulzer, Deutz and MAN.

One question presents itself: why were the Soviet engineers and planners so successful in choosing the best foreign technologies? Given 25 or so competing Western transport planes, by what process did Soviet engineers choose the Douglas DC-3, the most prolific transport model in the history of aviation, within two years of its initial production? Why the Ford Model A, and not General Motors, Dodge, Studebaker, Fiat, Renault, or any one of a hundred other possible automobile model choices? Why Curtiss-Wright aircraft engines, RCA radio stations, General Electric electrical equipment, and Koppers coke ovens? In almost every case the Soviets made an excellent choice. They invariably chose a more successful, lowcost process. In the light of the history of technical transfers, the Soviet choice of Western techniques has been superb.

One explanation might be the highly detailed comparative technical studies conducted in the Soviet Union on Western technological processes. A recent example is N. N. Kalmykov, *Burovaya Tekhnika i Tekhnologiya za Rubezhom* (Moscow: Nedra, 1968). This study compares precise technical details of different makes of rock drills and other equipment; it includes diagrams and charts obviously not supplied by the Western manufacturer. It is clear then that the Soviet system has institutional procedures enabling the rapid, usually successful transfer of Western technology at low cost and in a relatively efficient manner.[30]

[29] *Vestnik Standardizatsii* (Komiteta po standartizatsii: Moscow) for 1928–32 has details for part of this standardization process.

[30] Transfer is not always successful. See pp. 312–4 on the single-tower sulfuric-acid process; an argument will be made in the next volume that the Soviets moved too quickly on cotton-pickers; they made the right choice (the Rust spindle principle, subsequently used by four American manufacturers), but underestimated the technical problems. Hence they had 800 cotton pickers in 1940 (the U.S. had none), and only 100 left in 1945. John Rust subsequently ironed out the design problems and production got under way in both the U.S. and Soviet Union on the Rust machine in the late 1940s.

First, since about 1920 the Soviets have conducted a thorough and continuing world-wide dragnet of technical advances. They have probably acquired or tried to acquire one of every article made in the West.

Second, specialized institutes, such as VINITI (All-Union Institute of Scientific Information), have been established with overseas branches to institutionalize this acquisition process.

Third, this dragnet has been aided by local Communist parties and sympathizers, particularly where industries have maintained secrecy over methods or where Western governments have maintained industrial security precautions. The relaxed nature of Western security precautions has been a major asset enabling Western Communists to acquire this technology.[31]

Fourth, co-operative Western manufacturers have provided data and samples in anticipation of large orders. The monopolistic nature of Soviet trade organizations has been utilized to extract more data than would usually be made available to a potential Western customer.

Fifth, the market system has already pointed the way to the most successful among competing Western methods, although the information may be obscured to Western buyers by advertising and sales pressures. Choice can be more objective and more knowledgeable under the Soviet system, which can derive the advantages of the market system without succumbing to its emotional pressures.

Finally, Western engineers have been hired as independent consultants to prepare reports and advice on the most suitable process or equipment.

These constitute a formidable package of advantages which the Soviet Union has used with great skill. In addition Soviet buyers have insisted without fail on the most advanced processes that can be supplied by Western companies. On numerous occasions special development work has been undertaken to advance the frontier of the technology to be transferred. For example, in the electrical equipment industry, Metropolitan-Vickers Company has commented:

> The Russians . . . have always been eager to have the very latest plant and a turbine now building for Moscow will have the highest combined pressure and temperature of any turbine in the world, this having been made possible by the metallurgical researches of the Metropolitan-Vickers Company. . . .[32]

[31] Whittaker Chambers comments on the role of the American Communist Party: '. . . one of the periodic rituals at Gay Street was known as "filling the box." Every so often, Charlie, Maria and I would fill it with hundreds of thin leaflets in white paper covers. These were patents which anybody could then buy for a small fee from the United States Patent Office. . . .' [*Witness* (New York, Random House, 1952), p. 305.]

[32] *The Times* (London), May 22, 1933.

The British Thomson Houston Company made a similar observation in regard to a large Soviet order for special transformers in 1945:

> . . . [These are] the first transformers to be built in Great Britain for use on a 3-phase, 50 cycle system transmitting power at 242,000 volts between lines. The input voltage rating is 15,750. The transformers comprise three single phase units forming a 120,000 kvA bank. This was the largest bank rating for power supply yet made in Great Britain. . . .[33]

In Switzerland, the Brown-Boveri Company, also manufacturers of electrical equipment for industrial purposes, made a similar observation:

> In this field a whole series of exceedingly interesting new designs is to be reported,which we had an opportunity of developing in connection with the order we received for equipping the large aluminum works at Zwetmetsoloto in Russia with a large number of electric annealing and hardening furnaces. The large output required from this plant, the exceedingly large dimensions of the pieces to be treated and the resulting high power requirements made necessary designs which considerably exceeded in dimensions and type of construction the scope of our furnace design as used up to date. . . .[34]

With reference to aluminum plants, the International General Electric Company commented on the Stupino Aluminum Plant:

> For this plant, General Electric designed and furnished special electric furnaces, unusual in size, for aluminum ingot heating, aluminum coil annealing etc. as well as special heating elements and accessories for hardening large-size finished aluminum sheets in salt baths.[35]

In brief, the Soviets have demanded and been supplied with the frontier work of capitalist systems, *often before it is utilized in the country of origin* and sometimes to special order with the recipient firm working out the technical problems. This policy requires extensive information, assimilation of foreign techniques, and a great deal of skill to avoid mistaken choices. Such choices were the work of numerous specialized research institutes established by the Soviet Union in the 1920s and 1930s.

The years 1932–4 were critical for Soviet engineering and development. This was the period of change from all-imported equipment to absorption of the output of the new imported giant plants and the expanded and re-equipped tsarist plants.

Fortunately, we have a copy of the Glavkhlopkom plan, *Mechanization in 1932*, prepared by Willard Gorton, an American engineer, which illustrates the change in one sector.

[33] H. A. Price-Hughes, *B.T.H. Reminiscences: Sixty Years of Progress* (B.T.H., Ltd., 1946), p. 112.

[34] *Brown-Boveri Review*, January 1932, p. 24.

[35] *The Monogram*, November 1943, p. 17.

The report describes new equipment for 1932 by origin and suggests how this change to standardized equipment based on Western models took place. This material is summarized in table 18–2.

In brief, the relatively simple equipment—horsedrawn dumpers, scrapers, ditchers, and plows—making up about one-quarter of the total capital expenditure for Glavkhlopkom—was to be produced by old tsarist plants. All the tractors were scheduled to be supplied by the new plants at Stalingrad and Kharkov, built with U.S. and German equipment and with technical assistance as outlined in the text.[36] This comprised about 40 percent of total expenditure. One-third of the expenditure was to be used for imported equipment, including 24 draglines, 10 elevator graders, and 20 Ruth machines. Thus it was the more complex, specialized equipment that had to be imported. From this and similar data from other sources, we can deduce the principle that

Table 18–2 1932 GORTON MECHANIZATION PLAN SUMMARY

	Imported from U.S.		*Produced by New Plants*		*Produced by expanded Tsarist Plants*	
	Units	*Million Rubles*	*Units*	*Million Rubles*	*Units*	*Million Rubles*
Group I: Heavy Equipment						
Draglines	24	2.40				
Dumpers					48	.14
Tractors (60 hp.)			48	.43		
Group II: Light Equipment						
Horse scrapers					—	—
Tractor scrapers					180	.36
Ditchers					140	.42
Elevator graders	10	.10				
Plows					239	.05
Tractors (30 hp.)			559	2.80		
Tractors (60 hp.)			10	.09		
Group III: Operating Equipment						
Ruth machines	20	.60				
Plows					60	.60
Dredges					20	.80
Tractors (60 hp.)			60	.54		
Total	54	3.10	677	3.86	687	2.37
Percentage imported from U.S.				33.2		
Percentage from U.S.-built tractor plants				41.4		
Percentage from rebuilt tsarist plants				25.4		
				100.0		

[36] P. 185–8.

substitution of domestic for foreign equipment started with that which was simple and easy to produce, and extended to that which was more complex and difficult to manufacture only as experience was gained.

This was a step-by-step procedure, but with its own problems. Louis Ernst suggests one, and his description is worth quoting in detail:

> The Russian usually has machines and equipment from the most widely separated sources, and no spare parts at all. In Voroshilovsk, for example, in the by-products department, we had pumps from Skoda, run by motors from Germany's A.E.G., some on Italian ball bearings and some on Swedish S.K.F. bearings. The steam pumps came from Worthington, in the U.S., while some small turbine pumps came from Britain's Metro-Vickers. Some relays came from G.E., and the motor controllers from Cutler-Hammer. No catalogues were available and, even if we had been able to select the necessary replacement or spare parts, currency was obtainable only under the most extreme circumstances. Therefore, the engineer in Voroshilovsk had to begin from the very beginning, by having drawings made of all parts. Then he had to plan changes to accommodate his machines to Russian parts if this should become necessary. In other cases he had to cast around for Soviet organizations capable of fabricating those parts that he knew might wear out or break. He had to be farsighted indeed, under these conditions, to avoid shutdowns because of machine failures.[37]

DUPLICATION OF THE SELECTED STANDARD DESIGN

Standardization was the prelude to production. The distinguishing feature of Soviet production has been gigantic runs of a standard model. Whereas the usual practice in Western systems is to have models appealing to different demand segments and relatively short production runs followed by a model change, the Soviet practice has been to utilize its giant plants to produce simplified models with no changes for long periods. This gives not only large quantities, but provides an excellent training ground for unskilled workers. Numerous model changes in the early stages of developing a modern technique may inhibit efficiency or at least the development of a 'learning curve.'

The tractor industry provides an excellent example of standardization practices. Three large plants were built by 1933; these comprised the Soviet tractor industry until 1943. Each of these plants turned out, apart from its military quota, a standardized tractor model based on a Western example. Large capacity, with only one model change in 1937, enabled gigantic production runs. Table 18–3 illustrates the capacity and production of these key Soviet tractor plants, as calculated by Dodge, compared to Western plants making the same model tractor.

[37] Louis Ernst, 'Inside a Soviet Industry,' *Fortune*, October 1949, p. 172.

Table 18–3 PRODUCTION CAPACITY IN SOVIET UNION AND UNITED STATES FOR SELECTED TRACTOR MODELS

	United States	*Soviet Union*
	(In Drawbar Horsepower)	
Caterpillar 60 crawler	550,000 (Peoria)	1,500,000 (Chelyabinsk)
Fordson 10/20 wheel	1,000,000 (Dearborn)	200,000 (Krasnyi Putilovets)
International 15/30 wheel	600,000 (Milwaukee)	1,200,000 (Stalingrad and Kharkov)

Source: Adapted from Norton T. Dodge, 'Trends in Labor Productivity in the Soviet Tractor Industry' (Harvard University, Economics Department, Ph.D. Dissertation, February 1960).

In 1935 Soviet turbo-generators were standardized on 12,000 kilowatt and 24,000 to 25,000 kilowatt model sizes, produced with G.E. technical assistance at KHEMZ.[38] This standardization is reflected in the 1935 annual plan for the People's Commissariat of Heavy Industry.[39] All power-station turbo-generators scheduled for production in 1935 were multiples of these standard sizes and none were scheduled for import.

In sum, 12,000 kilowatt units were scheduled for Kuibyshev GRES No. 3 and Krimskaya GRES No. 1; 24,000–25,000 kilowatt units were scheduled for All Union Heat Institute No. 3, Stalinsky No. 1 and No. 2, Kisel GRES No. 3, Sverdlovsk No. 1, Chelyabinsk GRES II No. 5, Novosibirsk GRES, and Kiev II No. 1, and 50,000 kilowatt units were scheduled for Stalinogorsk No. 2 and No. 3, Sredne-Uralsk GRES No. 1, and Zuevka II No. 4.

This comprises the complete annual plan for 1935. The plan used no imported turbo-generators and only three models of domestic standard KHEMZ turbo-generators.

The same principle may be seen in coke ovens. At first they were imported in Koppers, Disticoque, and Otto variants. Soviet oven production was based on the Koppers design. These were produced in quantity at Kramatorsk[40] and became the standard coke oven; by 1940 even the NKVD was able to build Soviet-Koppers coke-oven batteries in distant areas using forced unskilled labor. (See table 18–4.) As Soviet organizations succeeded in adopting the Koppers design, imports were cut off entirely.

[38] For G. E. technical assistance, see chap. X. For data on standards see John P. Hardt, *Dispersal of the Soviet Electric Power Industry* (Alabama: Maxwell Air Force Base, 1957), p. 39. The standard size for steam-condensing stations was changed in 1939 to either 6,000, 8,000, or 12,000 kilowatts.

[39] Smolensk Archives, WKP 444 1935, National Archives Microcopy T 87–49.

[40] See p. 131.

Table 18–4 THE DUPLICATION PROCESS IN COKE OVEN CONSTRUCTION, 1930 TO 1945

Plant Location	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945
ALCHEVSK			KOPPERS A. G. (Germany)															
GORLOVKA I			DISTICOQUE S.A. (France)															
KERCH				KOPPERS COMPANY Inc (United States)														
MAGNITOGORSK I				KOPPERS COMPANY Inc (United States)														
RUCHENKOVO					'SOVIET' KOPPERS													
GORLOVKA II					'SOVIET' KOPPERS													
MAKEEVKA					'SOVIET' KOPPERS													
STALINO					'SOVIET' KOPPERS													
ZAPOROZHE					'SOVIET' KOPPERS													
KAMENSKOE						'SOVIET' KOPPERS												
KUZNETSK						'SOVIET' KOPPERS												
MAGNITOGORSK II						'SOVIET' KOPPERS												
MARIUPOL						'SOVIET' KOPPERS												
KRIVOI ROG						'SOVIET' KOPPERS												
GUBAKHA						DISTICOQUE S.A. (France)												
TAGIL											'SOVIET' KOPPERS							
CHELYABINSK											'SOVIET' KOPPERS							
KOMSOMOLSK											'SOVIET' KOPPERS							
MAGNITOGORSK III												'SOVIET' KOPPERS						
ORSK												'NKVD' KOPPERS						
IGARKA														'NKVD' KOPPERS				
PECHORA														'NKVD' KOPPERS				
MAGNITOGORSK IV															'SOVIET' KOPPERS			

CONCLUSIONS

The Soviets attempted to industrialize about the mid-1920s; this was not successful, and the evidence suggests an 'inability hypothesis.' This problem was overcome by contracting with foreign firms in the period from late 1929 to 1931 to fulfill the First Five-Year Plan.

It was most important, for political reasons, to disguise both local inability and the sources of industrial progress. This disguise was only partially successful; some information had to be publicized to allay apprehensions of Western companies. Some data were therefore made available by Soviet trade delegations. This information, coupled with reports from returning engineers, provides a means of penetrating the propaganda shield.

Western assistance was focused by the Soviets upon simple, clearcut objectives; to build new, gigantic, mass-production units to manufacture large quantities of simplified standard models based on proven Western designs without design changes over a long period. Thus after the transfer of Western technology, simplification, standardization, and duplication became the operational aspects of Soviet industrial strategy.

CHAPTER NINETEEN

Copying as a Development Mechanism

THERE has been a great deal of discussion, but without detailed empirical support, of 'copying' by Soviet engineers: i.e., the reproduction of processes and equipment already in use abroad without the permission or even knowledge of the foreign owner. This is, of course, both ethical and legal under a Communist system. It is ethical because no absolute industrial property rights can exist for individuals under Communism; it is legal because Soviet patent law, in reflecting this philosophical base, offers no meaningful protection. Protection is given to individual Soviet citizens only to protect the interests of the Soviet state, and not because the Soviet citizen has any economic rights.

In research for this study, an extraordinary amount of what is generally known as copying, was unearthed.[1] There is no question that the large number of single-sample items ordered or requested by Soviet trade organizations from the 1920s until the present day have been used as prototypes. From the Soviet viewpoint the foreign capitalist, inventor, or artist has no inherent property rights, and so this practice has extended from hand-tools and scientific books (for unauthorized translation) to industrial equipment.

Western economists suggest that socialist or planned systems have major innovative problems. Hirschman, for example, argues astutely that 'a planned economy is likely to behave much like the guild system; the process of 'creative destruction' is constitutionally alien to it because destruction here means self-destruction rather than destruction of somebody else.'[2]

[1] To a Communist copying is a moral act as it promotes Communism. Under Western law and ethics the same practice may be, if protected by patents, industrial theft. Copying and theft may therefore be synonymous in Western but not in Soviet ideology.

[2] A. O. Hirschman, *The Strategy of Economic Development* (Yale University Press: 1958), p. 59.

It follows, therefore, that, as innovation is the means to technical progress, a socialist system, if it cannot generate rational innovation internally, must assimilate innovation from outside: from capitalist systems. This transfer is precisely what the Soviet Union has achieved.

A preliminary stage and a common practice is to request literature, drawings, and samples from individual foreign companies. When attempts to copy on the basis of such freely-supplied data are inadequate or faulty, the next move is to acquire technical assistance or minor products without payment as part of another major contract. A case involving both technical assistance for a non-contracted product and acquisition of minor prototype items was the Amtorg technical-assistance contract with the Douglas Aircraft Company of Santa Monica for production of the DC-3 transport plane. As the author worked through files of orders placed by Amtorg with the Douglas Company, it became obvious that Amtorg had used Douglas facilities to purchase items (always one of each) made by other companies. For example, the Special Tool List in the October 1937 order[3] contains the following items chosen by the author at random:

Item	*Quantity*
Boyer air hammer UUB-63033	1
Utica pump nut pliers No. 517	1
Kennedy steel tool kit	1
Chromalox electrical welding pot, Model P-50, 230-volt, 1138 W, Serial No. P-39	1
Weston electric welding pot, 664 capacity model	1
Purox cutting torch	1
Buck bar, TB 1171	1

Examination of lists of special tools bought by Douglas Aircraft on behalf of Amtorg reveals that these were small tools manufactured by many different concerns and that the quantity ordered was *always one* only. This, unknown to Douglas, was part of the massive technical acquisition program carried out by the Soviets. A sample of every Western product and copies of patents, journals and other publications of possible technical value were shipped to the Soviet Union for analysis and reproduction, if possible.[4] Use of innocent 'front companies' was necessary to obscure the nature of this vast acquisition program. The manufacturer of the Boyer air hammer, for example, would be reluctant to fill an Amtorg order for one hammer, but would fill a Douglas

[3] Douglas Aircraft Company Files.

[4] Foreign Communist parties were enlisted in this dragnet. See p. 293.

Aircraft order without question. Only when outright copying on the basis of this type of indirect acquisition was impracticable was an agreement made to purchase technical assistance. Thus the many agreements which make up the bulk of this study tell only a part of the story; it may be presumed that far more technology was acquired without benefit of formal agreement.

By 1936 Soviet commentators began to claim indigenous Soviet designs, while admitting earlier copying. For example, E. Satel wrote:

> If during the first years of work our plants did copy foreign models, they are now successfully solving even more complicated problems of technique and design. Examples of these may be seen in aviation construction, as demonstrated by the flight of the ANT-25, the heavy diesel tractor, and the all-purpose caterpillar tractor. . . . Such complicated machines as slabbing and intermediate sheet-rolling mills for the sheet-rolling department of Zaprozhstal are our own Soviet design, the former created by the designers of the Krammatorsk Machine-Building Plant and the latter by those of the Urals Machine-Building Plant.[5]

None of these claims of Soviet design stand up to rigorous examination. Each of Satel's examples of Soviet design has been traced in this study to foreign origin, except the ANT-25, which was replaced by foreign designs.[6] Further, in the period under examination (1930–45), we have found no major Soviet industrial design to have been retained in preference to a foreign design.

THE EMPIRICAL EVIDENCE FOR SOVIET INDUSTRIAL COPYING

The evidence for extremely widespread copying of foreign equipment is overwhelming. Nearly every engineer interviewed by the State Department made some comment on the question, and many gave precise details concerning the uninhibited copying of Western equipment. Examples from some widely varying fields will suggest the extent of this practice.

In October 1931 the U.S. Warsaw Embassy reported an interview with an American engineer, C. E. Wildman, returning from a sales trip in the U.S.S.R., where he represented the Buckeye Incubator Company of Springfield, Ohio.[7] Wildman commented, 'The incubators used on the poultry farms are copies of American makes with steam and hot water systems of heating. . . .' Wildman

[5] *Za Industrializatsiiu*, No. 199, August 27, 1936.

[6] The ANT-25 was replaced by foreign aircraft designs between 1937 and 1941; the heavy diesel tractor was the Stalinetz 65, based on the Caterpillar 60; the 'all-purpose caterpillar tractor' was the Farmall; the slabbing mills were based on a Demag mill; and the sheet mills were developed under the United Engineering and Foundry contract.

[7] U.S. State Dept. Decimal File, 861.5017—Living Conditions/359.

offered his products to the Soviet organization, and when the Soviets had obtained from him the lowest wholesale prices, they offered to purchase a few units for exhibition and trial. The informant stated that this was a well-known Soviet method of obtaining American models for later duplication.[8]

The Embassy report continues:

> [Wildman] saw much evidence . . . that the Soviets have no respect whatsoever for patent rights. They consider patent rights as a part of organized capitalism and an institution from which laboring classes obtain no benefits. If the Soviets cannot buy models directly from modern countries they purchase them in the open market for shipment to Soviet Russia where they are later copied. . . .[9]

The Geary feeder[10] and Geary-Jennings sampler,[11] used in ore-treatment plants, are well-documented examples of Soviet copying. The Geary feeder was placed on the market in the United States in June 1927 and the Geary-Jennings sampler in December 1928. They came quickly into use throughout the world. J. F. Geary requested the State Department to obtain some protection in the Soviet Union.[12]

Numerous inquiries had been received by Geary from organizations and individuals in the U.S.S.R.; these Russian inquirers had been furnished catalogs, drawings, photographs, and other information on the same basis as inquirers from all other countries. As J. F. Geary himself said, ' . . . in spite of all the sales material sent into Russia, and in spite of the fact that similar material sent into other countries brought results in the form of orders, no orders whatever have ever been received from anyone in the Soviet Union.'[13]

At first Geary and his associates ascribed this to adverse business conditions. Then 'a succession of friends' brought back the same information: that Geary feeders were in use in the Soviet Union. This was emphatically confirmed when a group of Soviet engineers from Mekhanobr (State Institute for Planning Ore-Treatment Plants), touring local mines and mining plants in the Utah area, visited Geary:

> These men together with a Mr. Rundquist, came to this country to study American methods. They showed interest in the construction of the Geary feeders, but when solicited for an order remarked: 'Oh no, we built them over there ourselves!'[14]

[8] *Ibid.*
[9] *Ibid.*
[10] U.S. Patent No. 1,766,625, June 24, 1930.
[11] U.S. Patent No. 1,937,473, November 28, 1933.
[12] U.S. State Dept. Decimal File, 861.542—GEARY, J. F./2.
[13] *Ibid.*, 861.542—GEARY, J. F./3–6.
[14] *Ibid.*

The extent of copying within a single industrial sector—oil-well drilling—may be illustrated from the statements of August Tross, an American drilling superintendent in the Baku oil fields in the early and middle 1930s. According to Tross, who assisted in making up lists of equipment to be purchased in the United States, only a small part of the equipment was actually imported; the Soviets tried to make the rest domestically. 'In copying foreign equipment,' he said, 'there is a total disregard of patent rights.'[15] Tross added that German firms were at first utilized to produce American patented equipment, and cited the example of the Schaffer blowout preventer. In the same report, Tross provided a list of 'some types' in process of reproduction at the end of 1934 in the oil-drilling industry:

Equipment Copied	*U.S. Firms Holding Patents*
Rock bits	Hughes Rock Bit Co. (Texas)
Roller bits	Reed Roller Bit Co. (Texas)
Drilling bits	Zublin Drilling Bits Co. (Los Angeles)
Dunn tongs and elevators	Bryan Jacobson Co.
Blowout preventers	Schaffer Co. (Los Angeles)
Rotary rigs	Emsco Rotary Draw Works (Los Angeles)
Rotary rigs	National Oil Well Supply Co.(Los Angeles)
Butler elevators	Oil Well Supply Co. (Pittsburgh)

Insofar as copying of oil-field equipment is concerned, it was Tross's opinion that the Soviet copies, although almost identical to their prototypes in appearance, were poorer in quality.[16]

This flow of technical information was, of course, all in one direction. The Tross agreement[17] included the following clause: '11. The Employee [i.e., Tross] shall not disclose any business secrets which shall have become

[15] U.S. State Dept. Decimal File, 861.5017—Living Conditions/771, Moscow Legation Report No. 240, November 3, 1934. Tross was a drilling superintendent and had daily contact with the equipment listed over a period of some years, so that his evidence is more compelling than that of a sales engineer's, for instance, who visits the U.S.S.R. on a business trip and gets only a quick look at 'Soviet-made' equipment.

[16] For a later example of Soviet practice, N. N. Kalmykov, *op. cit.*, provides a detailed comparison of current (1968) American oil tool products (i.e., roller bits, spiders, rotary rigs, etc.) on a company-by-company basis. This type of comparative study has only one use: to enable Soviet engineers to reproduce foreign technology. Such detailed company-by-company comparisons of competitive products would hardly find a market in the United States. Examination of drawings in the book suggests that the focus is on reproduction of U.S. equipment. See, for example, the drawings on pp. 58 and 70, the temperature gradients diagram on p. 216, and the illustrations on pp. 230 and 234.

[17] U.S. State Dept. Decimal File, 861.5017—Living Conditions/771.

known to him during his employment. . . .'[18] On the other hand the Soviets made every effort to acquire business secrets from the United States and other countries. For example, Tross comments, 'Officials of Azneft . . . have to my knowledge requested American firms to send them free of cost samples of certain lighter types of machinery and have used the samples as models.'[19] The one-way nature of the flow is further illustrated by the quite different definitions of 'industrial secrets' used in the U.S. and the U.S.S.R. In the Soviet Union *any* information of an economic or technical nature is classified as secret.

There are several well-documented cases of the copying of excavation equipment. Kostiszak, resident construction superintendent in the Soviet Union for the Thew Shovel Company, was asked the circumstances under which duplication of Thew shovels took place. The interviewer's report is as follows:

> . . . without previous notice . . . two drag-line buckets of 2½ cubic yards capacity, exact duplicates of the American equipment but manufactured in the mechanical shops of SVIRSTROY, were delivered to him on the job. Requesting an explanation he was informed by the Soviet engineer in charge of the excavating machinery that buckets and other repair and replacement parts would in the future be manufactured in Soviet shops. . . .[20]

Kostiszak later visited the Svirstroi shops and found other buckets similar to Thew equipment in process of manufacture: 'They were exact duplicates of the American buckets; American replacement teeth were fitted to the Soviet buckets but the rest of the material was Russian.'[21] The 'Soviet Thews' proved equal on the job to the American equipment.[22]

Kostiszak recounted a similar episode with drag-line cables. Each imported American machine came supplied with two replacement cables. Two feet was cut from several replacement cables and shipped to the Svirstroi laboratories in Leningrad. A few months later four cables of Soviet manufacture were supplied—of inferior wire—but Kostiszak believed that with the right grade of wire the Russians could supply a high-quality cable. In general he noted that 'Soviet mechanics are continually dismantling, measuring and reassembling machinery on the job'—possibly to acquaint themselves with it, but Kostiszak

18 *Ibid.*

19 *Ibid.*

20 U.S. State Dept Decimal File, 861.5017—Living Conditions/283, pp. 13–4 of attached report.

21 *Ibid.* Bucket teeth on drag lines wear out more quickly than any other part.

22 U.S. State Dept. Decimal File, 861.5017—Living Conditions/283, pp. 13–4 of attached report.

believed that these activities had some connection with copying.[23]

The Rust cotton-picking machine offers an example of an assistance agreement which, although superficially beneficial to the Western company, was impossible to enforce and provided the same end result to the Soviets as copying. J. D. Rust, co-inventor, with his brother, of the Rust cotton-picking machine, came to the Soviet Union in 1936 at the invitation of the Soviet Government to demonstrate his machine. Two machines were bought by Amtorg, and Rust stayed with a mechanic for one month to demonstrate their operation.[24]

While in the Soviet Union, Rust negotiated a contract granting manufacturing rights for the machine under which the Rust brothers supplied detailed drawings. The circumstances making this move desirable were described as follows:

> Mr. Rust and his associates felt that it was advisable to reach an agreement with the Soviet Government by which they would obtain some compensation for the manufacturing rights of the machine, since they felt that if they refused to cooperate the Soviet Government could easily purchase one of the machines from an individual in the United States or elsewhere once they are in general use, and with this model they could manufacture their own units, without the necessity of compensating the Rust brothers for the rights. . . .[25]

The report continues:

> The Rust brothers made careful studies of the Soviet patent laws and realized that it would be extremely difficult for them to protect their interests in this country unless they reached an amicable agreement with the Soviet authorities. . . .[26]

The contract provided for a single lump-sum payment of $20,000 to Rust and his associates in the event that the machine was adopted and at least 10 units per year were manufactured, but there was to be no payment if fewer than 10 units were manufactured in any one year. Rust suggested to the U.S. Moscow Embassy that if Soviet engineers were unable to copy they would have to buy machines in the United States and in that case Rust would receive more than $20,000. In any event the Rust brothers felt that nothing had been lost.

23 *Ibid.* Gustav S. Bell, a superintendent for Sauerman Brothers, Inc., in the Soviet Union, similarly reported that Sauerman excavators were copied and that he was offered a position to supervise erection and installation of 'Soviet Sauermans.' (See U.S. State Dept. Decimal File, 861.5017—Living Conditions/314.)

24 U.S. State Dept. Decimal File, 861.61321/68, Report No. 1879, Moscow Embassy, September 14, 1936.

25 *Ibid.*

26 *Ibid.*

There is, of course, an obvious and major loophole. Rust was not to receive payment until 10 machines per year had been manufactured to his drawings. How was he to know whether 10, 20, 50, or *no* machines had been manufactured? Soviet plants are, with the exception of a few show plants, closed to outsiders. In brief, his protection was completely illusory.[27]

Another indication of the wide range of copying activities may be noted quite simply by examining domestic Soviet price lists of industrial equipment. The whole range of such equipment was based on Western models. For example, blast-furnace equipment produced by Uralmash and described in its 1934 price list included:

Otis winch (with drum, no spares)
Brosius tap gun (with attachments)
McKee throat system
Freyn burners (with dampers)
Orr locks (stoppers)
Theisen stack gas cleaner
Demag stripping crane
Simplex butterfly valve

All these, and numerous other items of foreign derivation, were priced in rubles in Decree No. 277, of May 10, 1934, issued by the People's Commissarist of Heavy Industry.

The U.S. Embassy in 1934 produced a short list of Soviet imitations of American products and reported that it was a 'well-known fact' that samples were purchased in the United States and copied. Among these copies were,

Morgenthaler linotype machines[28]
Pressed Steel Company dumping cars
Black & Decker electric power tools, including drills, bench grinders, drill stands, rock drills of the jack-hammer type and bronze stokers

[27] The subsequent history of this case is not known; the State Dept. files close at this point. Soviet cotton-picking machines are very similar to American models, as will be shown in the next volume. Given the history of Soviet-American economic relations, it is unlikely that any payment was ever made to the Rust brothers. They probably lost their investment in travel expenses to Moscow and the drawings supplied under the contract.

[28] This was copied at the Max Holz works in Leningrad, an ex-tsarist plant considerably expanded with imported equipment in 1932–3. The manufacture of Morgenthaler linotypes was started in 1932 'on the model of a typesetter imported from Germany.' Only two had been built by fall of 1932 and they could not be used 'owing to great errors of construction and to poor quality of the metal employed.' Approximately 6 to 7 percent of the 1,000 workers were German. (U.S. State Dept. Decimal File, 861.60/267.)

Hamilton Press Company presses
Cincinnati Milling Machine milling machines
American Tool Company lathes
Sullivan Machinery underground coal cutters
Buick automobile (copied at the Amo plant)[29]

Many similar examples could be quoted and, indeed, are found throughout the whole range of Soviet industry.

A number of cases in the State Department files demonstrate outright fraud on the part of the Soviets. The Cardox case shows the inability of Western companies to do anything in the face of such fraudulent practices. In 1925 the Safety Mining Company of Chicago developed a method and apparatus known as Cardox for use in lieu of explosives for blasting or breaking down coal underground. The great advantage of Cardox lay in its safety feature: it could be used in gassy mines. The company took out fundamental patents in the United States and major foreign countries. By 1930 the method was used with success in the United States and the United Kingdom and was being developed in France.

In 1935 the Safety Mining Company wrote the State Department: 'Several years ago our entire knowledge of the method was placed before responsible representatives of the Soviet Government with a view to laying the groundwork for future negotiations.'[30] The company learned that the information provided in confidence had been utilized, tested, and in 1934 published in a Soviet trade journal.[31] 'The trade journal admits that they have duplicated the best features of CARDOX as developed in the United States and Great Britain and that for 1934 the Government allocated about 350,000 rubles for this work.'[32]

The letter concluded by asking for State Department assistance and commented, 'We understand that the Soviet Government has been involved in a great many instances of this kind, to the immeasurable detriment of the creative and industrial interests of this country.'[33]

Although one could infer from the Safety Mining Company letter that knowledge of such appropriation was widespread, there is mixed evidence on this score. There is no evidence that the State Department warned businessmen of this practice (this could, however, have been done verbally). By the 1930s all larger corporations were probably aware of the problem; for example,

[29] U.S. State Dept. Decimal File, 861.797/35, Report No. 165, Moscow Embassy, September 7, 1934.

[30] *Ibid.*, 861.542—CARDOX/1.

[31] *Ugol'*, No. 105, June 1934.

[32] *Ibid.*

[33] U.S. State Dept. Decimal File, 861.542—CARDOX/1.

Du Pont de Nemours was approached by a Mr. Boston, who desired to make purchases on behalf of Carp Export and Import Corporation, the Soviet munitions-purchasing front in the United States. After company officers had been requested to accept orders for 'small sample quantities of very recent development,'[34] it was reported to the State Department that 'since it was clear that the object of the Corporation was merely to attempt to copy the trade secrets of du Pont [*sic*], Major Casey said that Mr. Boston's proposals had not been accepted.'[35]

On the other hand, in a case similar to that of the Safety Mining Company, we find a comparatively small company at the beginning of the 1930s under the impression that diplomatic recognition of the U.S.S.R. would overcome lack of patent protection and copying. The Sharples Specialty Company, centrifugal engineers of Philadelphia, were owners of a process used in the petroleum-refining industry. They made a single installation in the U.S.S.R and were well aware that this was only 25 percent of the needed capacity. The Soviets had no other way of getting the first installation, which they could then copy. Sharples had no protection,[36] and suggested recognition of the U.S.S.R. would overcome the problem.

PATENT PROTECTION IN THE SOVIET UNION[37]

There was agreement in the United States that Soviet patents were worthless.[38] The Safety Mining Company, in writing about Cardox, stated:

> Every effort was made to obtain effective patents in Russia but this eventually proved to be impossible. The single patent which we did obtain was, in the opinion of competent counsel, utterly worthless and on advice of counsel, further efforts in this direction were abandoned.[39]

It is difficult, but not completely impossible, to present evidence concerning Soviet expropriation of foreign patents filed in the Soviet Union. It is difficult because mere collection of evidence of infringement in Soviet Russia would constitute espionage and lead to prompt arrest. For this reason there are no court cases involving infringement of foreign patents in the Soviet Union. However, the concessions provide evidence of patent expropriation because

[34] *Ibid.*, 711.00111/Lic. Carp Export and Import Corp/6, June 10, 1937.

[35] *Ibid.*

[36] U.S. State Dept. Decimal File, 861.6363/278, January 31, 1930.

[37] See Sutton, *Western Technology . . . , 1917 to 1930*, pp. 299–303.

[38] There were a few exceptions. (See U.S. State Dept. Decimal File, 861.542/31 and /32.) In the light of Whittaker Chambers's comments, one presumes the advice given by Lee Pressman to the Rust brothers (above, p. 306) was favorable to the U.S.S.R.

[39] U.S. State Dept. Decimal File, 861.542—CARDOX/1, May 22, 1935.

some concessionaires filed patents inside the U.S.S.R. on processes introduced under the concession agreement. The Richard Kablitz concession, one of the largest and most important, supplies a prime example.

Kablitz was the only U.S.S.R. manufacturer of economizers, stoking devices, and furnaces. Operating six plants in the U.S.S.R., Kablitz equipped more than 400 Soviet plants in the 1920s.[40] An advertisement in *Izvestia Teplotekhnicheskogo Instituta*[41] was used by the Kablitz concession to stress patenting of its devices in the U.S.S.R.,[42] and indeed the company habitually referred to its economizer as 'Pat. Kablitz' rather than just 'Kablitz.' The company obviously strove to publicize the claim of patent protection to inhibit Soviet organizations anxious to produce similar devices.[43]

When the Kablitz concession was expropriated,[44] the patented devices were also expropriated and taken over by the Soviets, notwithstanding Soviet patent protection. Kablitz finally limited its suit in the German courts to compensation for these expropriated patents and dropped the concession property claim.[45] The only reason, therefore, that evidence is available in this case is that Kablitz operated a concession inside the U.S.S.R. and had evidence in company files. Such evidence of infringement could not be collected by other foreign patentees suspecting patent infringement; indeed the thought of attempting to gain entry to the files of a Soviet organization is somewhat amusing.[46]

The practical difficulty of collecting such information, even officially, is illustrated in the Geary case discussed above. The Moscow Embassy was instructed by the State Department to investigate the case, and after so doing, reported 'that after careful investigation by the Embassy, no information can be secured in regard to the reported reproduction and use in the Soviet Union of machines developed and patented by Mr. J. F. Geary in the United States. . . .'[47] The report then added that such copying was a 'well-known fact.'

[40] Sutton, *Western Technology . . . , 1917 to 1930*, pp. 180, 302, 329, 333, 346.

[41] No. 7 (9) 1925.

[42] See *Vestnik Komiteta po Delam Izobretenii*, No. 4–5, April 8, 1925.

[43] See p. 21. The advertisement mentions the fact of a 'patent' in no less than 16 places.

[44] See pp. 21–2.

[45] *Ibid.* There is no evidence of compensation for either the patents or the concession.

[46] Consequently, the prevalent impression (even in 1968, by the U.S. Patent Office) that Soviet patents may offer some protection is wholly erroneous. There can be no meaningful protection of private industrial property under a socialist system of the Russian type.

[47] U.S. State Dept. Decimal File, 861.797/35, Report No. 165, Moscow Embassy, September 7, 1934, p. 2 of attachment.

However, as noted above, the Geary machines *had* been reproduced (although the Embassy had not been able to so determine). Soviet visitors to the United States in search of further information admitted as much to Geary, quite apart from the reports brought back by associates and friends of Geary and by Soviet visitors.[48]

Some firms, without any clear notion of the disadvantages, have been anxious to patent their devices in the Soviet Union. For example, the Globe Steel Tubes Company of Milwaukee filed applications in the United States and 15 foreign countries on an entirely new method of manufacturing steel tubing and wrote to the State Department, 'Although we have spent more money in the prosecution of our patent application in Russia than in any other country, very little headway had been made. . . .'[49] The Soviets rejected the initial Globe application on the grounds of 'prior art' and quoted an old textbook article. This, according to Globe, 'really has no bearing whatsoever on the new invention.'[50] Globe appealed through Senator Follette to the State Department, which in turn instructed the Moscow Embassy to investigate. The Soviets quickly obliged by granting a patent. The Commissariat of Foreign Affairs is quoted by Ambassador Bullitt:

> On September 21, 1931 an application for the granting of a patent for a method and appliance for the production of seamless tubes was received from the foreign firm Globe Steel Tubes Company. On May 7, 1932 the Section refused to grant a patent. On October 9, 1932 the firm appealed to the Council for the Consideration of Complaints. By the decision of the Council of May 20, 1934 the decision of the Section was set aside and patent was granted.[51]

The basic problem facing these foreign equipment manufacturers and accounting for their anxiety was that no meaningful protection could be acquired against Soviet expropriation of industrial property. Russian law offered no protection, and the expensive exercise of filing a foreign patent in the Soviet Union was a waste of time.[52] On the other hand, Western manufacturers needed protection, as equipment was being openly copied with no regard at all for property rights.

Larger companies, such as General Electric and Westinghouse, have made agreements concerning patented devices and probably the Soviets have lived by such agreements, not because they thought such agreements were legal, ethical, or ultimately desirable, but because they temporarily needed G.E.

[48] See p. 303.
[49] U.S. State Dept. Decimal File, 861.542—GLOBE STEEL TUBES CO. /1–9.
[50] *Ibid.*
[51] *Ibid.*
[52] The Dorr Company had taken out a number of Soviet patents and found payment of the annual patent fee 'a considerable burden,' but continued to pay it as long as there were prospects of doing business there. (See U.S. State Dept. Decimal File, 861.542/31.)

more than G.E. and comparable firms needed the Soviet Union. It was the medium-sized manufacturers (like Richard Kablitz), the individual consulting engineers, and the individual foreign inventors who suffered—they had no bargaining power, and this weakness was ruthlessly exploited by the Soviets. Neither did these firms carry much weight in the State Department or in Western political circles: officials did take up such matters on request, and extensive reports were developed, but in all cases the end result was inaction.

Thus foreign manufacturers, except those companies with technological bargaining power, were faced with the problem that on the one hand a Soviet patent was worthless and on the other hand that their innovations were being expropriated without consideration for property rights. The only possible recourse, and a weak one, was to attempt to negotiate a formal agreement for use of patents, even in the face of monopolistic trade organizations and known expropriation. Colonel Pope of Nitrogen Engineering tried to do this in his second agreement[53] by formalizing the copying process. Similarly a smaller company, Dewey and Almy Chemical Company of Cambridge, Massachussetts found that Soviet canned crab meat sold in the United States was packaged in containers which made unauthorized utilization of the company's patents. To formalize this infringement, Dewey and Almy attempted to negotiate a technical-assistance agreement and obtain some compensation.[54]

The writer has found no evidence to suggest that these attempts were successful, and indeed has found no evidence that payment has been made for such use except when patents were transferred by agreement with large corporations whose technology was unique or desirable. Briefly, the Soviet Union has taken care not to disturb certain corporations—General Electric, RCA, Food Machinery Corporation, and IBM—for a pragmatic reason: these firms provide laboratories for Soviet technical advance, and have done so for some 50 years. On the other hand, size is by itself no protection. Ford Motor Company, Du Pont, and Sullivan Machinery, have all been faced with breaches of contract.

The next task is to examine technical transfers in more detail, and for this purpose three examples are considered: one unsuccessful transfer and two highly successful transfers.

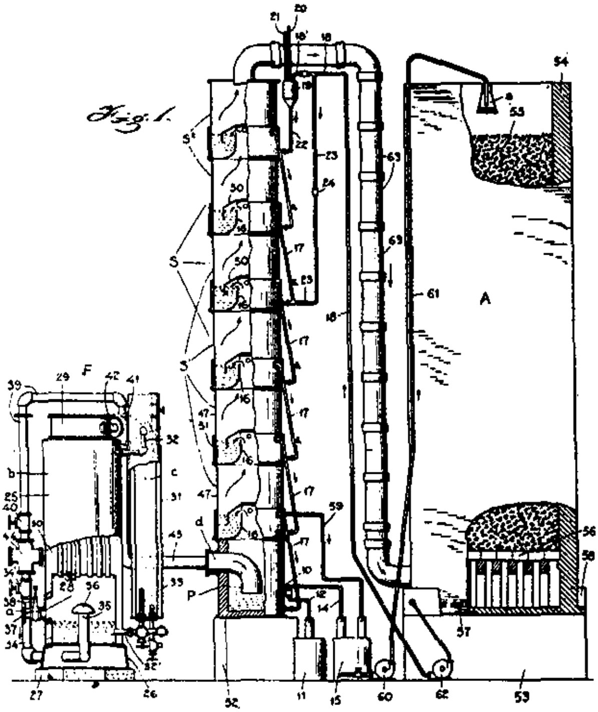
AN UNSUCCESSFUL TRANSFER: THE SOVIET DESIGN FOR A ONE-TOWER CHAMBER SYSTEM FOR SULFURIC ACID

Interest was aroused in the United States in 1934 when two Soviet scientists announced in *Zhurnal Industrialnoi Khimii* (November 1933) a new process for

[53] See p. 98.

[54] U.S. State Dept. Decimal File, 861.602/293, East European Division memorandum, January 27, 1938.

Figure 19–1 SINGLE-TOWER METHOD OF PRODUCING SULFURIC ACID: ORIGINAL U.S. DESIGN



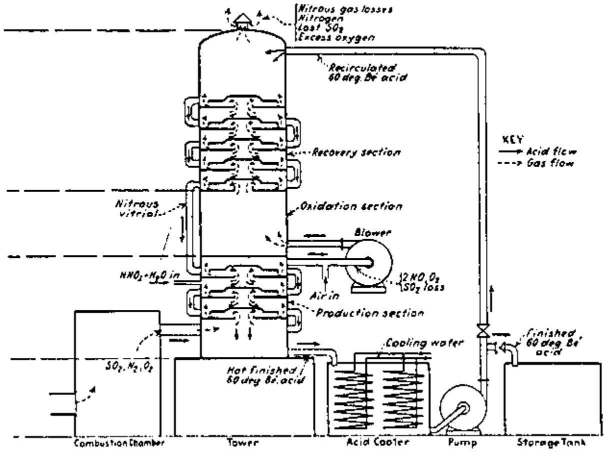
Source: U.S. Patent No. 1,513,903 of November 4, 1924.

manufacturing sulfuric acid, claimed to be of considerable significance. Sulfuric acid is normally made in a series of six towers; P. V. Samarski and E. K. Ziberlich proposed to substitute a one-tower design with a capacity about 18 times that of the standard Peterson six-tower process.

The article was translated and a summary appeared in the December 1934 issue of *Chemical and Metallurgical Engineering*. The editor of the American journal appeared somewhat skeptical over the proposal and commented that the theoretical aspects were not clear and that there were gaps 'in the details of applying the process.'[55] An editorial note in the January 1935 issue made yet another point: 'Furthermore, the one-tower type bears considerable

[55] *Chemical and Metallurgical Engineering*, December 1934.

Figure 19–2 SINGLE-TOWER METHOD OF PRODUCING SULFURIC ACID: SOVIET VERSION



Source: P. V. Samarski and E. K. Ziberlich, *Zhurnal Industrialnoi Khimii,* November 1933, reproduced in *Chemical and Metallurgical Engineering,* XLI, No. 12 (December 1934), p. 643.

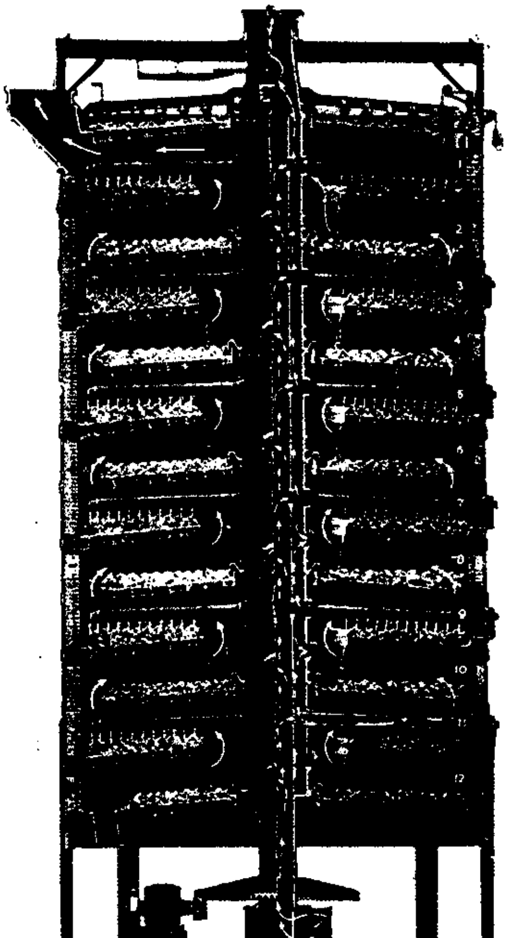
resemblance to a one-tower chamber system disclosed in U.S. Patent 1,513,903 of 1924, which, as has been pointed out by its owners, has never been successful.'[56]

The Soviet article avoided discussion of how to dissipate the enormous heat reaction inherent in the single-tower design. It is notable (see figure 19–2) that the Soviet design repeats the basic fault in the American patent and ignores the heat problem entirely.

Examination of the flows and mechanical arrangements in the tower in both the original 1924 U.S. patent and the Soviet version shows that these fall in the same positions and perform the same functions, particularly in the cases of the combustion chamber, the pumps, the acid cooler, and the storage tank. The only difference between the two versions is in the greater detail of the original design. There is no improvement nor distinguishing feature at all in the Soviet version; it is a much-simplified and rather crude copy of the U.S. patent. Nothing more has been heard of the single-tower design and Soviet manufacture of sulfuric acid continues to be based on multi-tower Western processes.

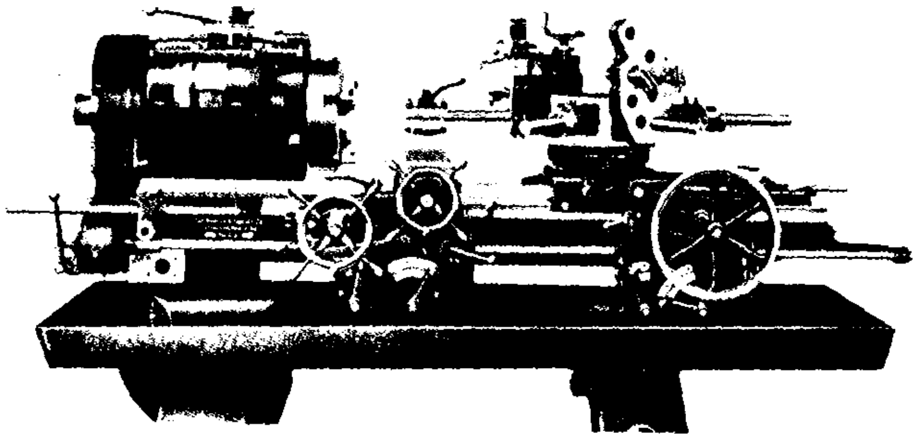
[56] *Ibid.*, January 1935.

Figure 19–5 NICHOLS-HERRESHOFF 12-HEARTH ROASTER FOR PYRITE FINES



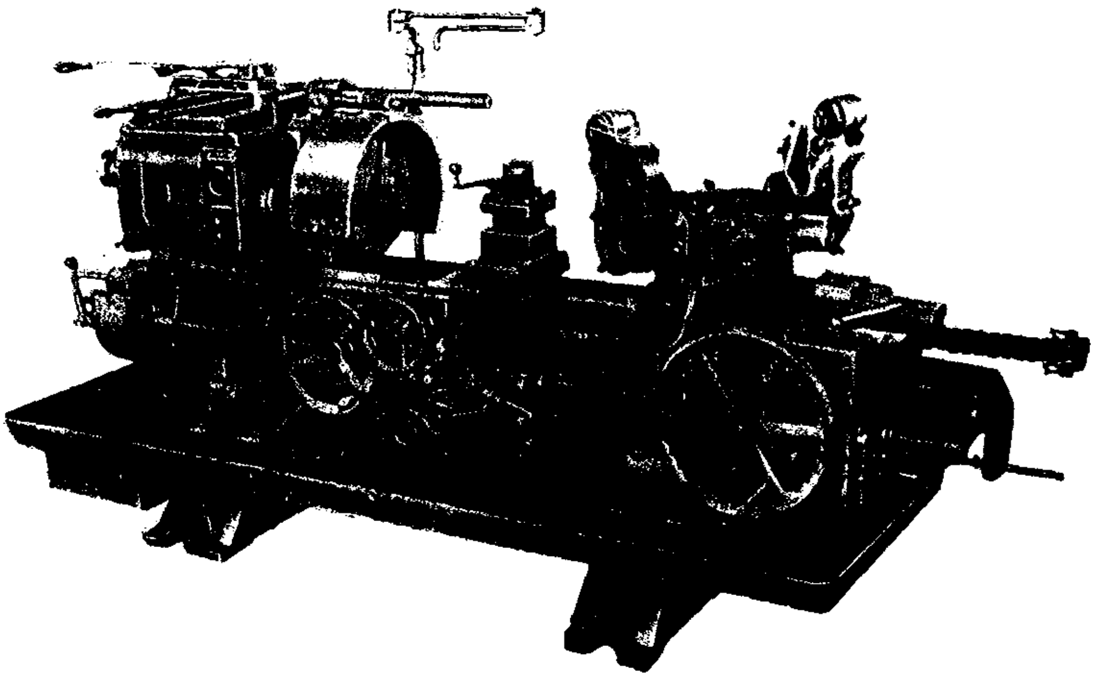
Source: A. M. Fairlie, *Sulfuric Acid Manufacture* (New York: Reinhold, 1936), p. 103.

Figure 19–3 THE WARNER & SWASEY COMPANY NO. 2-A UNIVERSAL HOLLOW HEXAGON TURRET LATHE (1929)



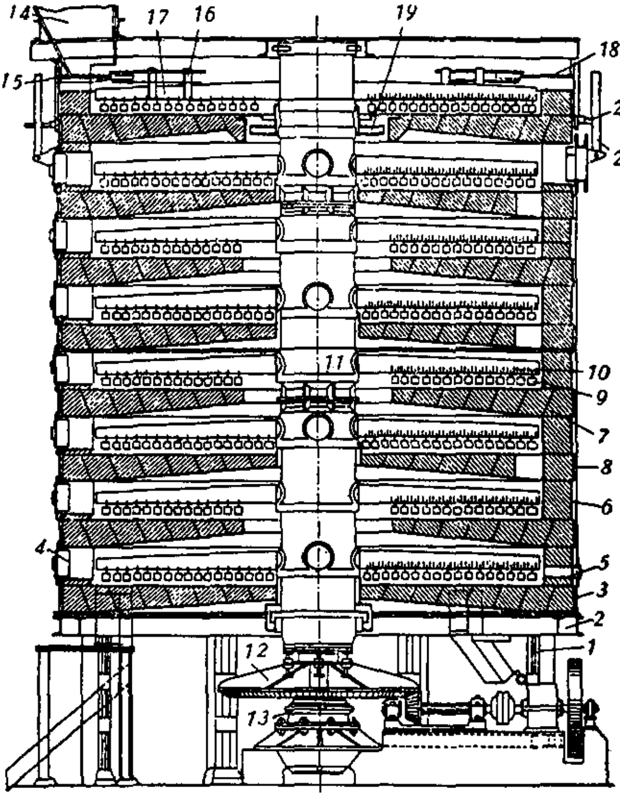
Source: Warner & Swasey Co. Cleveland, Ohio.

Figure 19–4 MODEL 1 K 36 TURRET LATHE PRODUCED BY THE IM. ORDZHONIKIDZE TURRET LATHE PLANT, MOSCOW (1932–50)



Source: Warner & Swasey Co., Cleveland, Ohio.

Figure 19-6 TYPE VKhZ 8-HEARTH ROASTER FOR PYRITE FINES



Legend:

1. Column
2. Ring
3. Jacket
4. Inspection door
5. Discharge
6. Insulation
7. Brick base of roof
8. Concrete (red brick normally used)
9. Rabble blade
10. Rabble arm
11. Shaft
12. Gear drive mechanism
13. Bearing
14. Hopper
15. Feed plate and apron
16. Feed arm
17. Feed scraper
18. Feed raceway
19. Iron plate
20. Lever
21. Outlet

Source: Bolshaya Sovetskaya Entsiklopediya, 1945 ed., LI, col. 14.

A SUCCESSFUL TRANSFER: THE WARNER & SWASEY TURRET LATHE[57]

In 1932 the Ordzhonikidze, or Works No. 28, was opened in Moscow for production of machine tools. By 1940 the plant employed 5,000 people working in three shifts.[58] Some 35 million rubles were invested in the plant, which was planned to produce 3,400 machines annually, specializing in turret lathes.

Production started in 1932 with a 65-millimeter bar capacity turret lathe: a direct copy of the Warner & Swasey 65-millimeter turret lathe model No. 2-A of 1929. The degree of similarity between the two machines is remarkable; it appears the Soviet engineers did not try to 'improve' the American model (as they did in other cases) but faithfully reproduced the complete machine.

A SUCCESSFUL TRANSFER: MECHANICAL FURNACES FOR ROASTING PYRITES

The Nichols-Herreshoff pyrites-roasting furnace was developed by the Nichols Copper Company of New York (later called the Nichols Engineering and Research Corporation) and over the years modified and improved, until by the mid-1930s it had the form indicated in figure 19–5. The furnace was a cylindrical structure with from four to twelve hearths containing detachable rabble arms allowing replacement while the furnace was in operation.[59]

This design was adopted in the Soviet Union. It is widely used under the name 'VKhZ mechanical furnace,' after the Voskressensk Chemical Plant, where it was first utilized. The model shown in figure 19–6 is an eight-hearth VKhZ model.[60] Further, the summary article on sulfuric acid manufacture in *Bolshaya Sovietskaya Entsiklopediya* is little more than a discussion of foreign equipment types: Lurgi and Wedge furnaces, Cottrell-type electro-filters (called the XK-30) and the standard Gay Lussacs and Glover towers, among others.

CONCLUSIONS: THE ADVANTAGES AND DISADVANTAGES OF COPYING

To a developing latecomer such as the Soviet Union, the obvious advantage of copying is that investment in research and development for a desired process can be avoided. There is, in addition, a less obvious and more important

57 The assistance of the Warner & Swasey Co., Cleveland, Ohio is gratefully acknowledged.

58 Oberkommando der Wehrmacht (OKW/Wi Rü Amt/Wi), March 1941, Miscellaneous German Records, National Archives Microcopy T 84–122.

59 A. M. Fairlie, *Sulfuric Acid Manufacture* (New York: Reinhold, 1936), p. 103.

60 *Bolshaya Sovietskaya Entsiklopediya* (Moscow, 1945) LI, Col. 14.

advantage; there is no necessity to invest in processes and experimentation that may prove fruitless. To achieve a single successful process, dozens (sometimes hundreds) of somewhat similar processes may have to be researched and partially developed. Most of these never pass beyond the research stage. Avoidance of the cost of unsuccessful but necessary product development, often called 'waste' by socialist ideologues, or the 'wastes of competition' in some textbooks, is the greatest gain for the latecomer. The latecomer also gains time as well as avoiding monetary investment. The gain in time by the Soviets has been extraordinary. The wide-strip mill—a fundamental development in iron and steel rolling—was installed in the Soviet Union within a few years of its development in the United States and before installation in Europe. The Warner & Swasey turret lathe copied in 1932 was the company's 1929 model. In chemical engineering, the processes acquired were ahead of those installed elsewhere in the world: a 1,000-ton-per-day nitric acid plant is large even today. The Douglas DC-3 contract was concluded within one year of the first flight. Although the tractor models (International Harvester and Caterpillar) were soon discontinued by their makers, any tractor is an advance over a yoke of oxen. It is not an exaggeration to say that the Soviets acquired 30 years of foreign technical development in three years, although it took 10 to 15 years to absorb the acquisition. Scarce resources may therefore be spread further by copying, either for the benefit of the consumer or—as in the Soviet example—to build a massive military complex and provide assistance for world revolution.

There are, however, disadvantages. The original expensive winnowing-out process of invention and the selection of desirable innovations were undertaken under circumstances differing from those in Russia. A process suitable for Pittsburg, Pennsylvania or Dortmund, Germany may not be suitable for Omsk, Siberia. Climate, natural resources, labor skills, and even topography may have an adverse influence. The Soviets are well aware of this problem, and plants have been specially designed or adapted by foreign firms for Soviet conditions. The onus of performance has often been placed upon the Western contractor by the insertion of penalty clauses in the contract.[61]

[61] For example, the 1937 E. B. Badger contract for supply and installation of three continuous alcohol and distillation and refining units. Pages 17–9 of the contract set forth the penalties payable by Badger in the event that the equipment does not meet guarantees. One formula among half a dozen provides for liquidating damages in the event the concentration of alcohol produced falls below guarantee and reads: 'Formula: Guaranteed strength (99.8 by Volume) minus the actual strength (percentage by Volume) × 1/3 contract price ($123,333.33) × .3 = Liquidated damage for one unit. The maximum liability of the COMPANY under this guarantee for liquidating damages shall be $7,333.32 per unit.'

This type of precise guarantee was typical.

A more subtle, very important, and long-range disadvantage is the loss of technical experience and initiative. It is unlikely that an imported technology can be efficiently operated, particularly when foreign advice and influence are shut off immediately after installation, as in the Soviet Union. Soviet claims demand cautious examination. For example, the Soviets claim that they have operated U.S.-installed steel mills at a rate far in excess of 100 percent capacity. This, however, is no great feat. Steel mills can be operated temporarily in excess of 100 percent capacity; the point missed by the Soviets is that continual operation in this high capacity range will lead to breakdowns and rapid obsolescence. This kind of operating experience, and the exchange of advice necessary between equipment manufacturer and user, is lost to a closed society.

Another definite disadvantage is that the Soviets have no way of being certain whether any specific foreign process is indeed the most advanced. How does one judge technical advance or the state of an art without oneself developing the frontiers of technology? This comes out clearly in the single-tower sulfuric acid example above. Superficially an attractive proposition, it is technically impracticable. Thus the Soviet engineer and planner, by virtue of lack of development experience, is led into technological traps—gigantomania, over-design, and the inability to distinguish between theoretical and practical solutions.

Above all, the basic flaws of centrally planned systems are obscured. Such systems are static. They do not have innate ability for rational self-generated technical advance. As Hirschman points out, in socialist societies the process of 'creative destruction' means 'self-destruction' rather than 'destruction of somebody else.' Centrally planned systems are permanently doomed—without capitalist help—to the era of gaslight and buggies, or Model Ts and crystal radios, or IBM 7090s and Fiat 124s, depending on the date of the final overthrow of capitalism. This is the Achilles' heel of socialism. Without capitalism, or some variant of a market system, centrally planned systems are doomed to technical stagnation. This is why copying is pervasive and has persisted for 50 years. It explains the perennial trumpeting of 'Soviet technical advance,' the ever-continuing flow of propaganda, and the abject fear of foreign political ideas.

CHAPTER TWENTY

Problems of Technical Assimilation

THE Soviet economy in the last half of the 1930s suffered from massive technical indigestion; it had absorbed at one gulp the most advanced of Western techniques. On the other hand—and this cannot be lightly dismissed—the Soviets did achieve their political goals; and this, from the Communist viewpoint, justified any sacrifices and problems. Some of the major problems, as they relate to the technical transfer, are briefly summarized below.

THE PROBLEM OF BACKWARDNESS

It is true that Russia in 1930 was backward, but not quite in the sense generally accepted. Tsarist Russia had a relatively advanced industrial structure with definite signs of indigenous Russian development.[1] Growth rates in the late nineteenth century were at least equal to, if not better than, anything achieved under the Soviets, and without the terrible cost incurred by the Soviet 'experiment.' However, Soviet Russia was backward in the sense that the Revolution had stripped Russia of technical, managerial, and certainly innovative skills; at the end of the 1920s the regime was in no condition even to maintain current operations without foreign help, and certainly in no position to consider the gigantic technical steps contemplated. The loss of skills had resulted from Revolution-induced emigration and from the backward nature of the Russian peasant, now more or less forcibly moved into new factories. There is no question that this ignorance in the working force led to massive spoilage of new equipment and gross inefficiency; *Za Industrializatsiiu*, for example, asked the rhetorical question, 'How is it possible that a factory built according to the last word in American technique and equipped with

[1] Sutton, *Western Technology . . . , 1917 to 1930*, pp. 183–4.

first-class foreign lathes and automatic machines cannot for 10 months emerge from its disorganized state?'[2]

There are numerous reports from foreign engineers supporting this charge of the improper use of equipment. For example, a State Department report of an interview with Paul Lauer, an electrical engineer formerly with Brown-Boveri and at the time of interview with I. G. Farbenindustrie, noted that 'although a great deal of the industrial equipment with which he came into contact was first class, machines would be operated day and night in an attempt to force production and . . . when they finally broke down no one was able to repair them.'[3]

Such reports of gross inefficiency, related to the low level of worker skills, are commonplace; what is noteworthy is the wide variety of sources generating such comments. An open letter to *Za Industrializatsiiu*[4] from 35 Russian engineers at Chelyabinsk said that the plant was on the verge of total collapse. An American engineer at Stalingrad, Ellwood T. Riesing, pointed out massive spoilage of new equipment and laid it to ignorance and perhaps 'a little sabotage.'[5] A German tool designer at Stalingrad said he had never worked under such inefficient conditions.[6] *Ekonomicheskaya Zhizn*[7] had numerous articles on 'technical illiteracy.'

By 1945 the factory worker had become somewhat more efficient, but a different form of backwardness remained. This might be called innovative backwardness. When compared to Japan, another country exemplifying development via foreign borrowing, the extent of this backwardness is surprising. The Russians have emphatically shown ability to absorb and adapt foreign methods and equipment; what is obviously missing—propaganda to the contrary—is clear-cut indigenous self-generated innovation. There is none that can compare in any way to outside development. If we compare Soviet Russia to Japan in 1945, ignoring tsarist development for a moment, we find that the Japanese were beginning to make successful self-generated efforts (in machine tools and optical equipment, for example), whereas similar efforts in the U.S.S.R. (synthetic rubber is an excellent example) were not successful. The Soviets *did* make advances in military production, which is amenable to central, bureaucratic direction.

[2] *Za Industrializatsiiu*, No. 123, May 6, 1931.
[3] U.S. State Dept. Decimal File, 861.50—FIVE YEAR PLAN/246.
[4] March 19, 1931.
[5] U.S. State Dept. Decimal File, 861.659—TRACTORS/2.
[6] *Ibid.*, 869.659—TRACTORS/3.
[7] For example, in the issue of April 3, 1931.

THE THEORETICAL VIEWPOINT OF SOVIET ENGINEERS

An argument can be made that the Soviet technological transfer was ineffective, or at least grossly wasteful, on the basis of charges by American engineers that the Soviet engineers were 'too theoretical' and that practice and theory differed.[8] While willing to teach the practical aspect as developed by years of experience, Americans found Soviet engineers distrustful and too willing to revert to theoretical discussion of why a specific American practice would not work. There is no question that this led to wasted time and effort and was partly responsible for ineffective transfers.

The Soviet attitude stemmed to some extent from a European and prerevolutionary view of the place of an engineer; in this view an engineer wore white gloves and only gave instructions. The American engineer (and this accounts in some measure for the success of American practice) rolls up his sleeves and gets his hands dirty. The prerevolutionary attitude was encouraged in the Soviet era because there was safety in being able to point to theory if something went wrong and the OGPU made unwelcome inquiries. Possibly (and the importance of this should not be underestimated) the Russian engineer was thinking ahead to the time when he might have to 'prove' the correctness of personal actions before a commission of inquiry. The basic point is that the American engineer was well aware that theory applies to certain idealized conditions and that in practice events are not always covered by theory. For example, in the 1930s there was nothing in Western literature, and certainly not in Soviet literature, about the cause of local deformation of steels without wear or abrasion, although new gages had been reported as worn out within the first day of use. Theory, as known at that time, did not explain such a phenomenon; but experience provided a rudimentary safeguard against unwelcome results.

On the other hand, Russian engineers displayed great resourcefulness in keeping plants operating without spare parts, usually denied by the planners, and with widely varying types of equipment. In other words, the Russian engineer had technical adaptability when he needed it. Placing this observation alongside the 'too much theory' argument leads to the conclusion that the problem may stem mainly from ideological factors. Although capitalist

[8] In almost every case in which the State Dept. interviewing officer touched on this problem, the American engineer made a comment to this effect. The criticism also appeared in official reports by American companies to the Soviet Union; for an example, see the report on the coal industry made by Stuart, James & Cooke, Inc., reported in the *Moscow Daily News*, June 3, 1931, p. 1.

It is interesting to note a current Soviet preoccupation with theory. At a time when the great need of Soviet industry is practical efficiency, we find, for example, an article on technical progress in the economy cast to a very great extent in terms of theoretical, not practical achievements. (See 'V avangarde tekhnicheskogo progressa,' by Academician M. Keldysh, in *Pravda*, No. 314, November 9, 1968.)

technology is held up as a model to be copied, the individual Western engineer has been, it is explained by the Party ideologue, held back by his capitalist masters and therefore does not appreciate new concepts and new methods; these can be achieved by Russian engineers under the guidance of the Party. In general, therefore, the writer is not willing to condemn individual Russian engineers. Part of the explanation for their theoretical attitude lies in the need for self-protection, part in ideologically tinted engineering decisions made by the Party, and part in training. In other words, if a Russian engineer is placed in a non-Soviet operating environment, he will probably act like a Western practitioner of the art.

The reason underlying the Soviet need for extensive Western assistance relates to the 'inability hypothesis'; Soviet engineers were unable to master the art of designing modern equipment within the Soviet environment. This statement is exemplified by the half-dozen Soviet attempts in the 1920s to produce a tractor.[9] The Karlick and similar designs were quickly abandoned as heavy, underpowered, and unworkable, and were replaced with the Fordson, Caterpillar, and International Harvester. In aircraft the slow, heavy ANT designs were replaced with cleanly designed, fast, and more powerful Western designs.[10]

It was recognized that these problems could be overcome. For example T. W. Jenkins, Chief Engineer for United Engineering at Zaporozhe, commented:

> Despite the many difficulties I have experienced in Zaporozhe and in other plants I feel that the enthusiasm displayed by the engineers and workers will eventually permit them to achieve a considerable amount of success in the operations of their plants. This undoubtedly will take a number of years, but in the end I feel that they will master the technique and eliminate most of the bureaucratic hindrances that prevent them from carrying out their work at the present time in a logical, orderly and efficient manner.[11]

In practice the problem was not overcome by 1945. Many of the copies in the early and mid-1930s suffered as a result of Soviet attempts to incorporate 'improvements' into the original Western designs. This was followed by a Party instruction not to incorporate changes; the result is that by 1940 or so we find *exact* copies of Western models in metric measurements. This is in itself quite an achievement; the Stalinets 80 tractor, for example, is a metric-system copy—very precise—of the Caterpillar D-7.[12]

[9] See Sutton, *Western Technology . . . , 1917 to 1930*, pp. 133–5: 'Attempts to Develop a Soviet Tractor, 1922 to 1926.' Also see V. A. Korobov, *Traktory avtomobili i sel'skokhozyaistvennye dvigateli* (Moscow: 1950). Compare pp. 6–7, the Mamin designs, with pp. 8–15, Western designs.

[10] See chap. 11.

[11] U.S. State Dept. Decimal File, 861.6511/34.

[12] The methods of copying the Caterpillar D-7 will be covered in Volume III.

THE PROBLEM OF IDEOLOGY VS. TECHNOLOGY

A major problem was created by the conflict between engineering logic and ideological objectives. At the outset it must be clearly stated that the Communist Party correctly recognized technology as the heart of economic development and since the beginning has placed continued emphasis on technology and technical progress; the power and discipline of the Party has remained solidly behind absorption and infusion of foreign technology. The analysis made by the Party is correct.

However, Party ideology is also responsible for the idea that the machine is in some way more productive under socialism than under capitalism. A machine is completely impervious to ideology; it must be operated within limits, it must be maintained, and it must have skilled operators; neglecting any one of these is perilous: the teachings of Lenin are no substitute for oil, maintenance, and skill. In the 1930s the Party injected itself into day-to-day operating procedures, and the efficiency of the machine suffered.

Ideology conflicted with efficient technical development in another way. Soviet purchasing and technical missions had a quota of Party members, whose contribution was repressive. In 1928, for example, a Soviet purchasing commission visited the Arthur G. McKee Company in Cleveland, Ohio; the chairman of the commission was a party member with no knowledge of metallurgy, but 'his father had been a worker in the South Urals steel plants and a great revolutionist and that made his son eligible.'[13] Three Russian engineers on the commission provided the technical experience necessary.

SABOTAGE OR INEFFICIENCY?

We are here concerned only with the possibility of sabotage insofar as it may have affected the transfer of technology. Possibly 20 percent of the interview reports in the State Department files refer to alleged incidents of sabotage in industrial plants. There is a distinction between overt sabotage and neglect, and certainly a difference between sabotage and inefficiency, although the end results may appear to be the same.

There was clearly sabotage before 1930 but probably less between 1930 and 1945. The question of how much cannot be answered. Whether the *real* sabotage was instigated by those on trial for *alleged* sabotage cannot be determined either. However, it is reasonably certain that there was some expression of opposition to the Soviet regime.

One report from the State Department files has been selected and summarized as an example. In 1932 the Riga Legation interviewed Edward Boyle, who had been in Russia from 1922 until 1932. Before 1921 he had been

[13] *American Engineers in Russia*, Stuck MS, p. 21.

superintendent of the foundry in the Panama Canal Zone and was then utilized by the Soviets as a trouble-shooter on foundry problems.[14] The 14-page report suggests that Mr. Boyle was a stable individual (this was also the impression of the interviewing officer) who had had a lengthy uninterrupted stay in the U.S.S.R. Further, although he was a valuable employee he did not receive valuta payments and did not request payment in dollars. The report also suggests that he had adapted well to Russian life, had very few complaints, and in general was a well-balanced individual who asked only for work and enough to support himself. In brief, there is no evidence that Boyle was biasing his answers. Where his information can be checked, it checks out well with other reports.

Boyle stated he had encountered 'innumerable' acts of sabotage in the foundry industry, particularly in the years 1922–9:

> It was a simple matter for him to distinguish between lack of technical knowledge and a deliberate policy of sabotage. . . . Ignorant and inexperienced men whom force of circumstances had placed in charge of foundries were willing, and even anxious, to obtain the benefit of his knowledge and cooperation, while master mechanics and engineers of the former regime usually made it impossible for him to accomplish anything constructive in their plants.[15]

Boyle cited his first assignment at Mariupol, where two cupolas had not worked well since installation two years previously; he was told the assignment might be dangerous. The cupolas were perfectly designed. These were the first cupolas designed under the Soviets but 'minor obstructions and failures, obviously deliberately installed or caused, had prevented the cupolas from producing for two years.'

On the other hand, Boyle cited the case of blowholes in cylinder castings for locomotives being produced in Leningrad; these he quickly deduced as the result of poor pouring methods due to lack of experience.[16] This last example points up an abysmal lack of technical experience. Many problems blamed on sabotage may have been the result of sheer ignorance.

Although the evidence is fragmentary, there unquestionably was sabotage; how much will never be known. This, as Boyle stated, tapered off about 1930 for the simple reason that the penalties were too harsh. Sabotage or 'wrecking' became the excuse adopted by the Party after 1930 for the inefficiencies of a socialist system. It is suggested, again with fragmentary evidence, that after 1930 the sabotage claimed was not sabotage at all, but merely the result of inefficiency.

[14] U.S. State Dept. Decimal File, 861.5017—Living Conditions/486.

[15] *Ibid.*, p. 7.

[16] *Ibid.*, p. 9.

THE PURGE TRIALS OF 1936–7

Reports of the American Embassy in Moscow also supported the view that the purge trials were not the primary cause of existing industrial problems.[17] The problems were due to more basic factors: 'the inability of Soviet engineers and workers to master fully the intricacies of modern industrial technique'; the refusal of workers to increase productivity without further compensation; and the periodic breakdown of production machinery and lack of proper repair and maintenance. The Stakhanovite (shock worker) movement was singled out for special mention as a factor in causing machinery breakdown.

A 1937 report[18] established four basic reasons for the current industrial setback. First was the inexperience and carelessness of Soviet engineers and workers 'and their present inability to fully appreciate and master the more complicated technique of modern industry.' This deficiency was explained on the ground that Russian workers were technologically backward, and that many if not most Russian workers with skills had been either driven out of Russia or liquidated at the time of the Revolution. Thus the 1937 labor force did not have the 'feel of the machine' and retained 'too much of the proverbial Russian spirit of "Nitchevo" . . . to have a real understanding of the care and accuracy needed to master fully modern industrial technique.'

The report pointed out (and this is supported by the findings of this study) that:

> . . . one of the principal complaints of foreign engineers who have worked for any time in the Soviet Union is the failure of Soviet workers and engineers to appreciate the necessity for doing painstaking and precise work. The foreign technician soon learns that generally speaking the Soviet worker is apparently incapable of, or at least does not understand the necessity for, observing the limited tolerances called for under modern engineering technique.

Another common complaint by foreign engineers with regard to Soviet engineers was that they very often endeavored to improve upon the design of foreign equipment without realizing that such efforts might throw the entire machine out of balance or cause other complications. These shortcomings caused the percentage of rejects to be very high. The model changeover in the Gorki Automobile Plant in 1935 is an example; the new model was essentially a copy of the 1934 Ford but Soviet engineers attempted to introduce changes

> which apparently led them eventually into difficulties. In any event, over a year and a half after production was started on the new car they have failed to attain the daily production figures for the old model, which

[17] These conclusions are based on interviews with U.S. businessmen and engineers and on Soviet sources.

[18] U.S. State Dept. Decimal File, 861.60/288.

was an exact copy of the 1930 American FORD and which they learned to build with the full assistance of a large number of American engineers and specialists.[19]

Second, was the failure of the Stakhanovite movement to increase productivity, under this plan, workers were sometimes encouraged to increase the capacity of their machines beyond that which they were built to stand. Boastful articles appeared in the Soviet press stating that machines were producing more under socialism than under capitalism; repair work was neglected and the wear and tear led to breakdowns. Third, the Soviet copies of foreign machines were the first to break down 'and it was not so very long before many foreign machines followed suit.'[20] The arrest or dismissal of members of commissariats and plant directors removed many of the more capable members of Russian industry. The report concluded that Russian youth were beginning to appreciate the intricacies of modern machinery and that although there was a 'definite crisis' in Soviet industry this did not presage a complete breakdown in industrial development.

There is also other evidence to suggest that inadequate technical knowledge was much more to blame than wrecking or carelessness. One example is the erection of three continuous alcohol distillation and refining units by E. B. Badger. These were linked up to fermentation tanks constructed by Soviet organizations to drawings supplied by the Badger Company. The first of three such units was brought into production in 1936, but by 1937 the Soviets were requesting Badger to return two American engineers to solve problems which had arisen in operation and 'alleging that the Company's equipment did not produce satisfactory results.'[21]

Two Badger engineers made the trip from the United States, briefly investigated, and found that the difficulty caused only by the lack, in the Soviet-constructed tanks, of an agitator from which the raw product was supposed to be taken before treatment by the American-installed equipment. Lack of an agitator gave the raw liquid a nonuniform consistency which affected the quality of the final product. An agitator had been included in the original design, but 'the Soviet engineers had for some reason failed to install this device.'[22] An agitator was then installed by the Badger engineers and the unit worked satisfactorily. Two rather obvious points may be made: first, to understand the necessity for uniform raw materials requires only elementary knowledge of chemical engineering—indeed little more than common sense, and second (this is common to other cases), the original American drawings and designs were not followed by the Soviet engineers.

19 *Ibid.*
20 *Ibid.*
21 U.S. State Dept. Decimal File, 861.602/284. See also Chap. 8, p. 116.
22 *Ibid.*

THE PROBLEM OF CENTRAL PLANNING

From the Western viewpoint, certain major elements in the Soviet economy are not quite what they seem. Above all the concept of central planning devolves into little more than a means of political control. In the period examined there was no case in which central planning achieved an end which could not have been achieved in some more efficient manner; given this observation, it is suggested that the objective of central planning is political, not economic.

The traditional objective of central control is reputed to be a balanced move forward on an integrated industrial front. The theory is that such a giant step forward achieves more than piecemeal efforts brought about by operation of the market system. The first observation is that over the last 50 years the Soviets have more or less utilized a system of central control and the United States has not. In terms of addition to the Gross National Product, general living standards, and overall technical progress, the United States is far ahead today, suggesting that over the long haul the enterprise system, or an approximation of it, is far more effective. Such a system also has certain human advantages.

Second, if we examine a lesser time period of Soviet development, such as the years 1930 to 1945, in more detail, the advantage of central planning is at best not clear. It took several years of statistical work to get ready for the First Five-Year Plan, and then the figures were revised (upwards) at the last minute as American companies indicated they could build units much larger than those requested. Construction starts did not coincide as they should have, the First Five-Year Plan was not integrated with the existing industrial structure, and construction finishes were even less well integrated.

The term 'Five-Year Plan' had no empirical significance whatsoever. A little thought will indicate why this is so. Even under conditions of perfect supply, abundant labor and technical skills, and a flexible transportation system, it would be difficult to start a large number of major projects at one time; it would be patently absurd to hope, or want, to finish them at the same point, because of the widely differing gestation periods of sophisticated industrial systems.

An attempt to match the actual start and finish dates with those indicated by the Plan reveals no correlation whatsoever. What actually happened is summarized in the following paragraphs.

Specific units were begun as soon as foreign contractors could supply the skills and the equipment. There were varying delays in installation because of unskilled labor, theoretically trained or entirely untrained Soviet engineers, and a basic apathy, whipped into action only periodically by udarnik campaigns. When the engineering time horizon more nearly matched the 'political planning' time objective, the engineering factors were disgracefully sacrificed to meet a propaganda deadline. In an efficient system, the start-up of blooming mills and blowing-in of blast furnaces should follow a precise timetable determined ONLY by engineering factors. When construction schedules were rearranged to build the most conspicuous plant features (i.e., smoke stacks) first, or mills were started up before all installations were complete and not in accordance with manufacturers instructions, then in truth the lunatics were running the asylum. This was well stated by the Chief Engineer of United Engineering:

> One of the principal weaknesses I have noted during my stay is that the directors of the plants and the engineers invariably send in optimistic reports to Moscow regarding performance and invariably make promises which they realize cannot be fulfilled. For example, the directors of the plants promised Moscow that the Soviet-made rolling mill would be in operation in October 1936. The mill was not completed as scheduled and the Soviet engineers sent a full explanation to the authorities, blaming the delay on the lack of materials and giving other excuses. Finally during the month of November and the first part of December strenuous efforts were made to complete the rolling mill before the end of the year. The Soviet engineers explained to me that it was absolutely necessary for them to operate the rolling mill before the end of the year in order to be in a position to request additional funds for the construction of the mill in 1937. They explained that larger credits were granted to Soviet mills which were in a position to show that they had more or less lived up to schedule. During the above-mentioned period I estimate that approximately 2,000 working hours were wasted in the effort to operate the mill before the end of the year. The equipment was installed in a temporary manner and finally on December 24 the rolling mill was operated for five hours and then shut down. The directors of the factory, however, were able to send telegram to Moscow on that date announcing that the rolling mill was in operation.[23]

Although much equipment was especially made to fit Soviet factor proportions and labor skills, problems arose with used equipment—for example, with the Ford automobile tire plant transferred to the U.S.S.R. in 1944. This was a two-story operation in the United States and the opinion of U.S. engineers was that 'it could not function properly unless it was housed in precisely the same type of building in which it had been housed in Michigan. . . .'[24] The

[23] U.S. State Dept. Decimal File, 861.6511/34. T. W. Jenkins, United Engineering Chief Engineer at Zaporozhe. For an excellent summary of start-up problems in the tractor plants see Dodge, *op. cit.*, pp. 281–7. A certain proportion of problems was created, of course, by general engineering factors normally connected with the establishment and start-up of new plants.

[24] U.S. State Dept. 861.645/17, Memorandum of Conversation, April 1, 1943.

Soviets could not provide such a building and the Ford plant was eventually housed in a one-story operation with consequent loss of efficiency.

Thus it may be concluded that the Soviets had numerous problems in technical assimilation. Many of these were problems associated with unskilled labor and normal technical assimilation procedures. Two factors, however, complicated the transition: the intervention of ideology into the technical sphere, and rigid central planning. Thus the transfer was far more difficult than that of Japan, for example, which absorbed Western technology and by 1945 was starting to forge ahead on her own.

CHAPTER TWENTY-ONE

Western Technology and Sectoral Rates of Growth, 1930-45

DURING the period from 1930 to 1945, Soviet technology was almost completely a transfer from Western countries; only two major Soviet innovations have been identified: SKB synthetic rubber and the Ramzin once-through boiler; both were supplemented with Western methods by 1945.[1] One significant Soviet achievement was the conversion of U.S. and British equipment to the metric system, with subsequent duplication of a metric copy rather than the imported original. Such conversion should not by any means be underestimated; it requires a great deal of technical ingenuity and engineering skill.

Thus the conclusion is that for the period from 1930 to 1945 Soviet technology was in effect Western technology converted to the metric system.

It was suggested earlier that the modus operandi during this period required Gosplan to estimate the desired capacity for each industrial sector while leaving the initial implementation process to Albert Kahn Company and the supply of initial engineering talent and equipment to other Western companies. At the same time, arrangements were made to duplicate this equipment in newly built plants. Gosplan objectives should logically have been related to the amount of Western assistance procured. This proposition may now be

[1] The almost complete absence of Soviet innovation was, so far as the writer is concerned, a surprise. Time after time a particular process or piece of equipment was assumed to be of Soviet origin (in accord with the bias noted on page 8), but in all cases except those few mentioned in the text a Western precursor was found. The explanation is simply that it was cheaper to borrow rather than develop internally; however, this explanation is limited to the period 1917 to 1945.

If any reader has specific examples of Soviet innovation for 1917 to 1945, information on them would indeed be welcome and certainly included in later work. It should be stressed that generalities are of little use—and indeed vague generalities account for much of the present confusion about Soviet achievements. The suggestion must be *specific:* for example, 'the Model Kh AZ-241 meat grinder is a Soviet innovation.' We are, of course, interested in innovation rather than invention or discovery.

profitably explored. There follows an examination of actual rates of growth by sector in relation to technical assistance. In sum, we first look at planning objectives and then at the fulfillment of these objectives in relation to Western assistance.

The initial problem is to measure effectively and accurately the degree of technical assistance in a quantitative manner. One method would be to compare that capacity built with the percentage of Western technical assistance received. For example, 100 percent of the Soviet automobile-manufacturing capacity was of Western origin and utilized Western equipment. However, such a measure cannot be calculated for those industries (such as flour milling and vodka manufacture) in which very little *qualitative* data exists. Neither can it be calculated in industries such as mining, in which individual Western mining engineers carried the initial burden of establishing the method by which a mine was to be developed, bringing the mine into operation, supervising initial operations while gradually introducing imported equipment (followed by Soviet equipment made to Western designs) and finally handing over operations to Soviet mining engineers. Neither does such a measure include situations in which a single piece of imported equipment (which might comprise less than one percent of the total capital expenditure) allows a new plant to operate, whereas without it production is zero. Thus while 'percent of capacity built to Western technique' is an initially attractive quantitative measure, it is not useful.

The measure used is a scale of 1 through 10, each value on the scale being determined by an assessment of the importance of technical transfers from the West. The scale takes into account not only the supply of Western designs, equipment manuals, and engineers, but operator training, quality and production guarantees, patents, and training of Soviet engineers in Western plants: in brief, the whole complex of transfers which make up technical assistance. In this system a large number of factors related to technical assistance enters into individual scale values. Where no foreign assistance at all can be identified and an indigenous process is used, then the scale value is zero: i.e., no technical assistance. At the other end of the scale, a value of 10 is assigned where, as in tire manufacture, a technical-assistance agreement provided the process, plant design, follow-up assistance, equipment, and operator training, and also provided more than 90 percent of the output in the period 1930–45.

One could argue that a value of 10 should require complete Western operation of the plant as a pure concession for the whole period 1930 to 1945 as well as other assistance factors. Under this definition there would indeed be no sectors with a value of 10, and only one or two with 9. The important point to be made is that the scale utilized does not define a value of 10 as indicating 100-percent operation by Western companies throughout the period 1930–45.

The scale ignores operation by Soviet personnel after installation. By the same token an operator of an automobile or a washing machine in the United States cannot claim or be held responsible for the design and manufacture of the product he uses.

In other words a maximum scale value of 10 includes operation by Soviet workers for the period after start-up to 1945, maintenance performed by Soviet engineers, and duplication of the equipment for use at other locations. Such duplication, of course, as in two categories of machine tools (lathes and vertical drilling machines), could account for most of Soviet productive capacity by 1945. The scale focuses then on *transfers and origin of technology* rather than composition of aggregate capacity in a sector at the end of the period.

PLANNING OBJECTIVES AND WESTERN TECHNICAL ASSISTANCE

It has been suggested in the light of preliminary evidence[2] that Gosplan decided upon those sectors it wanted developed under the plan and then contracted with foreign organizations to build large-scale units in those sectors. Capacity was then expanded by duplication of the transferred Western technology. The Gosplan estimates were, however, qualified by Western engineering advice. Cases are found in which Gosplan suggestions regarding capacity were considerably expanded when foreign companies indicated they could build much larger units than those requested. No cases were found where a company offered to build a smaller unit or refused to build that capacity established by Gosplan; modifications appear always to have been in the direction of increase.

If this assessment of Western participation is correct, there should be a relationship between planning objectives formulated in various plans and the degree of technical assistance introduced: the greater the increment in output planned then the greater (other things being equal) the foreign technical assistance. Unfortunately other things are not equal. There is a considerable difference between technological complexity and capital-output ratios, and consequently between the amount of foreign assistance required by different sectors. In blast-furnace construction, a straightforward and easily assimilated process, technical assistance was limited to the Western provision of designs. By 1937–8 Gipromez had its own design; in automobile assembly, far more complex, the Soviets had not mastered Western technology even by 1970.

With this qualification in mind, data were derived for a number of sectors in which it is possible to estimate both technical assistance and planning objectives. World War II cut short the Third Five-Year Plan; consequently

[2] See pp. 249–52.

data was derived for 1937 objectives in relation to 1932 output. This is presented for a dozen sectors in table 21–1.

Table 21–1 SOVIET PLANNING OBJECTIVES AND WESTERN TECHNICAL ASSISTANCE

Sector	*Planning Objective of 1937 in Relation to 1932 Output (Percent)*	*Technical Assistance Scale*
Zinc	608.0	9
Motor vehicle tires	543.0	10
Bicycles	447.8	10
Sulfuric acid	420.2	9
Steam locomotives	338.0	3
Sugar	302.0	4
Electric power	283.8	8
Canned food	279.3	7
Machine tools	266.7	9
Woolen fabrics	240.9	4
Boots and shoes	219.5	2
Cotton fabrics	187.5	4
Flour	142.8	2

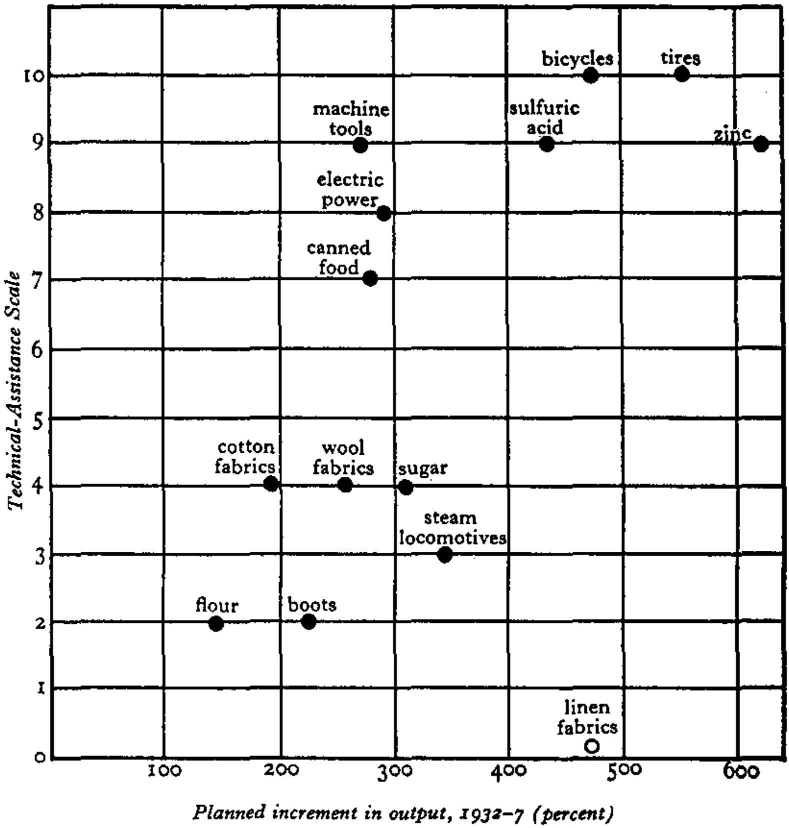
Sources: Planning objectives: Gosplan, *The Second Five-Year Plan* (London: Lawrence and Wishart, n.d.), pp. 545–55.
Technical-assistance scale: see text.

Examination of the data presented in table 21–1 and figure 21–1 suggests, although the scatter is pronounced, that planning objectives were broadly associated with technical assistance. Certainly this becomes clear if we examine both ends of the range presented. Zinc, with the most ambitious planning objective (a sixfold increase of output between 1932 and 1937), had a high technical assistance scaling of 9. Similarly bicycles and motor vehicles, the only sectors listed with scalings of 10, had very high planning objectives: increase by a factor of five. On the other hand, if we examine the other end of the range we find the flour sector had the lowest planning objective and the lowest scale of technical assistance: 2.[3]

Thus in broad terms the extent of planning objectives may be, as we would expect, related to the extent of foreign technical assistance.

[3] The listing in table 21–1, plotted in figure 21–1, comprises all sectors (except one) in which data for both planning objectives and technical assistance could be found and related. One sector not listed—linen fabrics—had a high planning objective and a rating of zero on the technical-assistance scale. This was rejected, as the lack of evidence of technical assistance for this particular sector was not convincing; the negative case is always difficult to prove.

Fig. 21–1 RELATIONSHIP OF PLANNING OBJECTIVES TO TECHNICAL ASSISTANCE, 1932–7



Sources: Planning objectives: Gosplan, *The Second Five-Year Plan* (London: Lawrence and Wishart, n.d.), pp. 545–55.
Technical assistance: see text.

SECTORAL GROWTH RATES AND WESTERN TECHNICAL ASSISTANCE

If the hypothesis of this study is to be supported, those sectors of the Soviet economy with the highest growth rates should prove to be the recipients of consistent and significant foreign technical assistance. Conversely those sectors with low growth rates should *not* be recipients of foreign technical assistance.

These propositions can be examined in a reasonably precise manner by comparing rates of growth by industrial sector[4] with the amount of foreign technical aid in that sector. Tables 21–2 and 21–3 and figure 21–2 illustrate this relationship.

All sectors with rates of growth in excess of an annual average 11 percent and below 4 percent are listed in the tables and plotted in figure 21–2 and compared to technical assistance for that sector when it can be estimated.

SECTORS WITH HIGH GROWTH RATES

The sector with the highest annual average rate of growth between 1928 and 1955 was bicycle manufacture: 23 percent. This sector received the benefits of a technical-assistance agreement with the Birmingham Small Arms Company of England, manufacturers of the popular BSA bicycle. Steel tubes, a major input in bicycle manufacture, were manufactured on Western equipment using Mannesman, Pilger, Stiefel, and other German processes, possibly at the Nikopol plant installed by the Tube Reducing Company. Rubber tires for bicycles were manufactured at Yaroslavl, which received technical assistance from the Seiberling Rubber Company. Ball bearings for bicycles were manufactured at the plant erected under the Italian Villar-Perosa agreement. Thus the bicycle-manufacturing process was obtained from the West, operators were trained by Western companies, and input materials were wholly developed with Western technical-assistance agreements and equipment. This sector is therefore given a ranking of 10; it is difficult to envisage means of further assistance unless Western engineers had remained throughout the period 1930–45 to operate the Velo bicycle plant.

In lead and zinc mining and smelting (20 and 19 percent growth, respectively) development and operation of mines and construction of smelters and refineries was almost wholly American in the early 1930s. It was estimated that at the mining engineer level of skills, 90 percent of the underground engineers were American and only 10 percent Russian.[5] Americans handed over responsibility to hastily trained Soviet engineers in 1932–3; almost all Americans left by 1936. The underground equipment was initially American and German, replaced partly after 1934 with Soviet copies. Smelters and refineries were completely American-designed, equipped with British, German, American

[4] G. Warren Nutter, *The Growth of Industrial Production in the Soviet Union* (Princeton: Princeton University Press, 1962), pp. 96–7. Nutter's data cover annual average rates of growth from 1928 to 1955; this volume is limited to 1928–45. This is not, however, a major qualifying factor, as the benefits of technical assistance persist after installation, and installations from the early 1930s were still operating in the 1950s and the 1960s. Further, the transfer continued in the 1950s and 1960s, as will be demonstrated in the next volume.

[5] P. 44.

equipment, and initially operated by American superintendents. A scaling of 9 is therefore applied to both lead and zinc production.

Motor vehicle tires were made only in Western-supplied plants—the Yaroslavl plant built under the Seiberling contract of 1929 and re-equipped with British machinery in the 1950s; the Ford Motor Company truck-tire plant, with a one-million-tire-per-year capacity, supplied under Lend-Lease in 1942–5; the Toyo Tire Company, Ltd., plant at Mukden and Manchu Rubber Company, Ltd., tire plant at Liaoyank, both removed from Manchuria to the U.S.S.R. in late 1945.[6] This sector is scaled at 10.

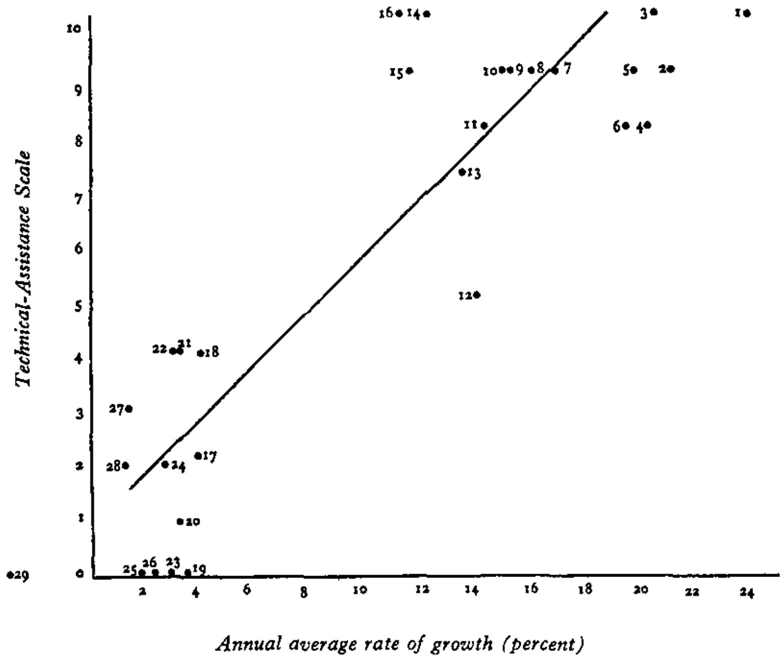
Table 21–2 INDUSTRIAL SECTORS IN U.S.S.R. WITH ANNUAL AVERAGE GROWTH RATES GREATER THAN 11 PERCENT, 1928–55

Number on Figure 21–2	*Industrial Sector*	*Annual Average Growth Rate, 1928–55*[1] *(Percent)*	*Position on Technical-Assistance Scale*[2]
1	Bicycles	23.0	10
2	Lead	20.1	9
3	Motor vehicle tires	19.4	10
4	Steam turbines	19.2	8
5	Zinc	19.0	9
6	Diesel engines	18.7	8
—	Mineral fertilizer	17.1	Not estimated
7	Machine tools	16.3	9
8	Power transformers	15.5	9
9	Rayon and mixed fabrics	14.7	9
10	Asbestos shingles	14.5	9
11	Electric power	13.9	8
12	Natural gas	13.4	5
—	Roll roofing	12.9	Not estimated
13	Canned food	12.8	7
14	Clocks and watches	11.9	10
—	Macaroni	11.8	Not estimated
15	Sulfuric acid	11.2	9
16	Silk fabrics	11.3	10

Sources: 1 G. Warren Nutter, *Growth of Production in the Soviet Union* (Princeton: Princeton University Press, 1962), p. 96.
2 Text.

[6] Edwin W. Pauley, *Report on Japanese Assets in Manchuria to the President of the United States, July 1946* (Washington: 1946), p. 204. Reparations will be covered in Volume III.

Fig. 21-2 RELATIONSHIP OF TECHNICAL ASSISTANCE TO ANNUAL AVERAGE RATE OF GROWTH, 1928–55



The only plant making steam turbines was the Stalin at Leningrad, producing Metropolitan-Vickers models to company drawings and initially with British technical assistance.[7] The British engineers left in 1933, and from that time on the Soviet engineers were on their own; this sector is scaled at 8 as there is evidence that by World War II turbine technology had been mastered and some independent work started.

Diesel engines are scaled at 8. Three systems (Sulzer, MAN and Deutz) were used—all from Germany. The technical-assistance agreements expired in the early 1930s, and from that time on eight plants manufactured diesels to these systems. Attempts to produce locomotive diesel engines with General Electric assistance failed, and production was abandoned in 1937 and not resumed until the 1950s.

[7] P. 160.

SECTORS WITH LOW GROWTH RATES

Examination of those sectors with the lowest growth rates also provides support for our hypothesis. Table 21–3 lists those sectors for which Nutter estimates less than 4 percent average annual growth between 1928 and 1955.

Five sectors have a zero rate of growth. Of these, three are hardly candidates for technological improvement and indeed are traditional Russian peasant industries: low-grade tobacco (makhorka), vodka, and felt footwear all had growth rates of only 1 or 2 percent and utilized no foreign technology. Salt (3.4 percent) and linen fabrics (2.1 percent) similarly had low rates of growth and used no identifiable foreign technology.

The case of flour is interesting in the light of the hypothesis. The sector had a growth rate of only 1.1 percent and a low incidence of identifiable foreign technology. On the other hand, a resolution passed by the Collegium of the People's Commissariat of Foreign and Domestic Trade on November 27, 1929 decreed that contracts should be concluded with American firms for the planing of new flour mills, for the employment of six U.S. engineers to provide technical assistance for machinery construction, and for the employment of 10 U.S. engineers to establish a standard flour mill and assist in its construction.[8] In brief there was clear formal intent to supply technical assistance to this sector. There is, however, a report from one of the Americans later employed in design of flour mills which confirms, in the final analysis, the lack of technical transfers from abroad:

> Mr. Hess was employed in Kazakstan where he was designing and building flour mills, under the supervision of American engineers. These flour mills were built entirely with Russian material, except part of the machinery. Work on the flour mills has ceased on account of the lack of local material. It was agreed that the Russians would buy milling machinery and construction machinery in the United States. For this undertaking thus far no machinery has been purchased. Part of it is Russian made machinery which is very low in grade and of which there is only a meager supply.[9]

Thus the flour sector in the final analysis had *incomplete* technical assistance.

Steam locomotives had an annual average growth rate of 1.2 percent. Out of approximately 25,000 locomotives built or acquired between 1928 and 1945, about 6,500 were imported (almost all U.S. Army types or German and British prototypes). The remaining 18,500 were based on successful tsarist models and built in the expanded tsarist-era plants. The basic Russian steam locomotive (indeed, the most numerous class of locomotive in the world) was the Vladikavkaz, first built in 1910 and then adopted by the Soviet. The Su and SO classes built by the Soviets were also tsarist models. Thus only about one-

[8] U.S. State Dept. Decimal File, 861.6584/3.

[9] *Ibid.*, 861.5017—Living Conditions/239.

quarter of the 1945 locomotive stock was imported, the balance being Soviet-made to tsarist design. The scale of technical impact is given as 3 (by virtue of the import of General Electric, Brown-Boveri, U.K., and German prototypes and the use of individual consultants for wheel-making, etc.). The annual average growth rate of 1.2 percent is also low.

A group of sectors with low growth rates includes boots and shoes, raw sugar, starch and syrup, matches, cotton fabrics, woolen and worsted fabrics, and vegetable oil. The common link between these sectors is that they all relate to the consumer—consistently the lowest priority in the Soviet Union. Although these sectors used some foreign equipment and the textile industries used early technical assistance, the growth rates reflect both the low priorities given to consumer sector imports and the low percentage of foreign assistance.

Table 21–3 INDUSTRIAL SECTORS IN THE U.S.S.R. WITH ANNUAL AVERAGE GROWTH RATES LESS THAN 4 PERCENT, 1928–55

Number on Figure 21–2	*Industrial Sector*	*Annual Average Growth Rate 1928–55*[1] *(Percent)*	*Position on Technical-Assistance Scale*[2]
17	Boots and shoes	3.7	2
18	Raw sugar	3.7	4
19	Salt	3.4	0
—	Starch and syrup	3.3	Not estimated
20	Matches	3.3	1*
21	Cotton fabrics	3.0	4**
22	Woolen and worsted fabrics	2.9	4**
23	Vodka	2.8	0
24	Vegetable oil	2.4	2
25	Linen fabrics	2.1	0
26	Felt footwear	1.7	0
27	Steam locomotives	1.2	3
28	Flour	1.1	2
29	Low-grade tobacco	1.7	0

Sources: 1. G. Warren Nutter, *Growth of Production in the Soviet Union* (Princeton: Princeton University Press, 1962), p. 96.
2. Text.

* Matchmaking equipment was imported and negotiations were reported for a concession with the Swedish match-maker, Kreuger. This small sector not covered in the text.

** There was considerable assistance to the textiles industries (all sectors) in the early to middle 1920s. In the period 1930–45 assistance took the form of equipment imports only; thus the sector is scaled at 4.

In conclusion, if we examine the findings of this study concerning technical assistance in relation to annual average rates of growth we can make two points. First, those sectors with high rates of growth had high levels of technical assistance. Second, those sectors with low rates of growth had low levels of technical assistance. It is interesting to note that this relationship is only broadly in accord with planned objectives, as was pointed out at the beginning of the chapter. For example, the high growth rate of bicycles and the low growth rate of steam locomotives were certainly not in accord with planned objectives.

Consideration of the factors making for economic growth given in the text suggests that Western technical assistance was the major causal factor in Soviet economic growth for the period 1928–45.[10]

The imposition of 'domestic savings' on the Russian people is not an alternate explanation for Soviet development, but, in the Soviet scheme of things, it is a necessary prerequisite to the basic method used: transfer of Western technology.

What is 'domestic savings' in the Soviet scheme? It is the planned direction of resources into industrialization at the expense of personal consumption. This the Soviets have done ruthlessly. Agricultural products—eggs, butter, grain, flax, etc., were exported to pay for imports of Western technology. Capital construction in the consumer sector—housing, roads, hospitals, etc.,—was curtailed and resources diverted into industrial and military construction.

Forced saving of this type, however, will not by itself bring about rapid development, although it may be a necessary prerequisite for the release of resources. This road to development also requires either an outside source of technology or the diversion of resources into research and development to achieve technology internally. In the West, technology developed over a period of several hundred years during the gradual industrialization of Europe and the United States; it was this enormous pool of technology which was successfully tapped by the Soviets. They tapped it by imposing forcible saving on the Russian consumer and exchanging released resources for Western processes, plants, and equipment. Consequently, although such saving is a necessary prerequisite, it is not an alternate explanation for Soviet growth.

Therefore, the Soviet road to development will not work without cooperative capitalist neighbors with advanced technology which can be introduced into the socialist system.

10 It is, of course, possible to make more precise statistical determinations; however, calculation of the technical-assistance scale is to some extent arbitrary and does not justify more than preliminary statistical treatment. It is the direction of the argument that is important, not precise calculation of correlations.

CHAPTER TWENTY-TWO

Conclusions

THIS study provides empirical support for the traditional argument in economic development theory that borrowed technology from advanced countries is a primary explanation for economic growth among latecomers. Although the study is based on the economic history of one country—the Soviet Union—that country is among the largest in population and resources and the most important in strategic terms.

Conclusions are acceptable only to the extent that data sources are acceptable. The official Decimal File (the central file of the U.S. State Department) and the Oberkommando der Wehrmacht Archives provided extensive and accurate detail, some of which has been previously unavailable to nonofficial researchers. The technical detail extracted from these sources constitutes the main empirical base for this volume; the abundance is fortuitous, as it coincides with significant industrial growth in the Soviet economy. It should be pointed out, however, that the conclusions presented here are quite different from—in fact, almost completely opposite to—those arrived at by State Department report writers and researchers presumably using the same source material.[1] Obviously, these differences require explanation.

The Decimal File records include texts of technical-assistance agreements between Western firms and the U.S.S.R. and reports made by departmental field officers after interviewing returning American engineers. These interview reports, although often filed under 'Living Conditions,' are an excellent source of technical detail. The Wehrmacht Archives establish the structure of Soviet

1 See pp. 4–6. There are statements, from 1918 (Minutes of the War Trade Board) to 1968 by State Department officials from the Secretary of State downwards, to the effect that trade and the transfer mechanisms described in this and the previous volume have had no major effect on Soviet economic development. On the other hand there is a report in the State Department files that names Kuhn, Loeb & Co. (the long-established and important financial house in New York) as the financier of the First Five Year Plan. See U.S. State Dept. Decimal File, 811.51/3711 and 861.50 FIVE YEAR PLAN/236.

industry: i.e., the numbers, types, and locations of individual plants. In general, the Decimal File contains information on the nature of the technology or processes used and the Wehrmacht data provide the output, capacity, and location of each plant. Integration of both the State Department and Wehrmacht data provides a reasonably complete picture of technical transfers and their focus and effect within the Soviet Union. Soviet source material provides supplementary information.

The initial and obvious conclusion is one of significant growth in the Soviet economy between 1930 and 1945, although this growth was irregular over the course of time and between sectors. The widespread impression of smooth, regular, balanced growth, with major production increases and fulfillment or near-fulfillment of plans from year to year is not valid. If central planning is intended to provide balanced industrial development it has been, in the Soviet experience, a miserable failure. Some recent Soviet books, in fact, now characterize the period 1936 to 1940 as one of fluctuation and even decline in output—a pattern confirmed by this study.[2] During the period as a whole, there was major but fluctuating growth in the output of a wide range of products; the fluctuations provide additional support for the argument.

The increase in output came from two types of productive units: new gigantic plants, such as KHEMZ and Uralmash, with modern, sophisticated technology; and ex-tsarist plants, such as Putilovets and Dynamo, greatly expanded and re-equipped. Some new giants, such as Kramatorsk and Berezniki, were located at or near small ex-tsarist plants, no doubt to make use of existing transportation and raw materials facilities. A general observation is that in both groups of plants the technology was always the most advanced known and very commonly on a scale far beyond that previously built anywhere.

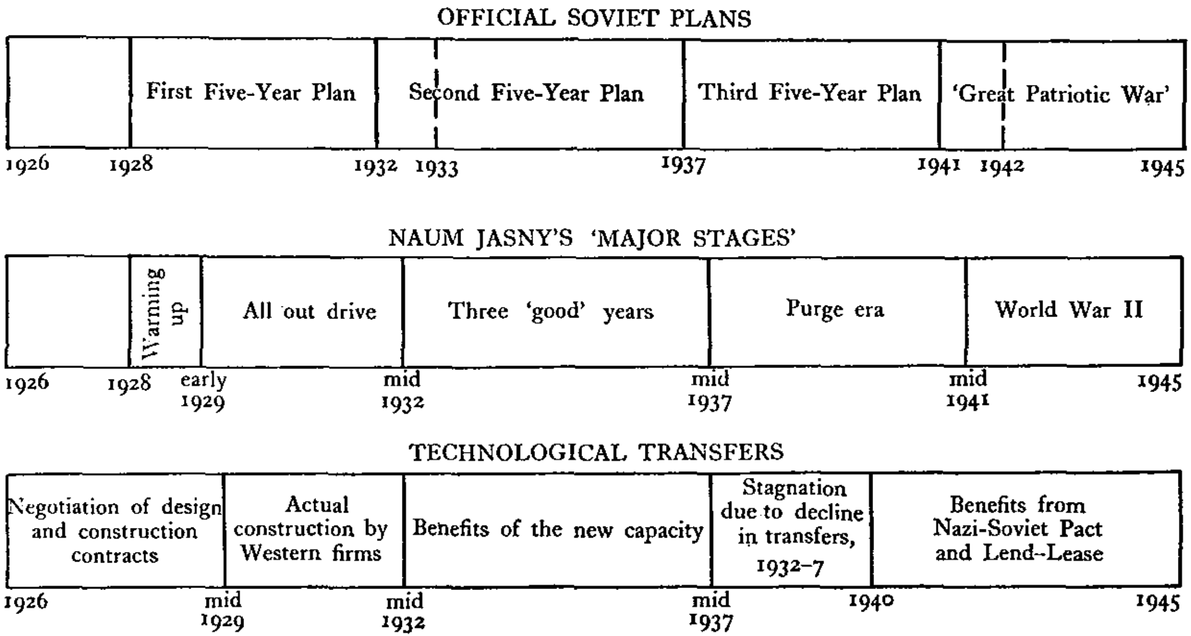
Almost all new major units, except Second Baku oil refineries and chemical, aviation, and other military plants, were begun in the years 1930 to 1932, and rarely between 1933 and 1940. From 1941 to 1945 there was an increasing amount of construction behind the Urals. Construction starts bore little relationship to the dates specified in the various Five-Year Plans, and, as is already known, construction often dragged on for years after planned completion. The plans were therefore a propaganda facade, completely misleading in the quest for an understanding of the real dynamics of Soviet growth.[3]

The actual chronology of Soviet growth between 1930 and 1945 is outlined and related to the official plans and Naum Jasny's parallel conclusions in figure 22–1.

[2] See, for example, *Tekhnicheskii progress v chernoi metallurgii SSSR* (Moscow: 1962), p. 6.

[3] Naum Jasny made a similar suggestion. See p. 342.

Fig. 22–1 CHRONOLOGICAL RELATIONSHIP BETWEEN OFFICIAL SOVIET PLANS, JASNY'S 'MAJOR STAGES,' AND TECHNOLOGICAL TRANSFERS



Sources: Official Soviet Plans. Naum Jasny, *Soviet Industrialization 1928–1952* (Chicago: University of Chicago Press, 1961), p. 13.
Note: Dotted lines in the 'Official Soviet Plans' indicate the terminal date of an original plan, later modified.

In brief, the year 1930 advanced the Soviets along a road begun 50 years earlier under the tsars.[4] There were numerous ineffective construction starts between about 1926 and mid-1929; this observation leads to the 'inability hypothesis.'[5] In the summer and fall of 1929, many wide-ranging technical assistance agreements were concluded with foreign firms. American engineers began arriving on site toward the end of the year. The fundamental construction agreement was that made in February of 1930 with Albert Kahn, Inc., of Detroit, builders of the Ford River Rouge, General Motors, Packard, and other large plants in the United States. The Kahn group undertook design, architectural, and engineering work for all heavy and light industrial units projected by Gosplan. Kahn's chief engineer in the U.S.S.R., Scrymgoeur, was chairman of the Vesenkha building committee.[6]

The units designed and started in 1929–32 were of truly gigantic size—usually far larger than units designed and built by the same construction firms in the rest of the world and, in addition, combining separate shops or plants for the manufacture of inputs and spare parts. The Urals Elmash combinat multiplied Soviet electrical equipment manufacturing capacity by a factor of seven; the KHEMZ at Kharkov, designed by the General Electric Company, had a turbine-manufacturing capacity two and one-half times greater than the main G. E. Schenectady plant; and Magnitogorsk, a replica of the U.S. Steel plant at Gary, Indiana, was the largest iron and steel plant in the world. When the Soviets claim these units are the 'largest in the world' they do not exaggerate; it would of course be impolitic of them to emphasize their Western origins.

Although design and layout during this period was American, probably one-half of the equipment installed was German. Of this, a large amount was manufactured in Germany to American design on Soviet account. In quantity, American-built equipment was probably second and British third.[7] Some sectors owed a great deal to other European countries; cement mills were largely from one firm in Denmark, ball bearings from one firm in Italy and another in Sweden, small ships from Italy, and aluminum technology from a French company.

In two years, then, there was a massive infusion of foreign technology, foreign engineers, and foreign equipment. Most of these engineers had gone by mid-1932, but they left behind standard designs based on Western models

[4] The Foss Collection at the Hoover Institution illustrates the comparatively advanced nature of tsarist industry.

[5] See pp. 284–6.

[6] See p. 250. A dozen Soviet plants were designed in Detroit in 1929 before the Kahn group went to the U.S.S.R.

[7] Before 1932–3 Soviet-made equipment was rare.

and enormous manufacturing capacity. This gigantic capacity to produce simplified standard designs was by no means fully in operation by 1933; the rest of the decade was required to master the new processes, install all the equipment, train workers, bring the subsidiary plants into phase with the main plants (a major headache), and expand operations.

First priority was given to the military departments in each of the new plants. Much of the original drive behind industrialization had been military. This goal was clearly stated in 1929 by Unashlicht, Vice President of the Revolutionary Military Soviet:

> We must try to ensure that industry can as quickly as possible be adapted to serving military needs . . . [therefore,] it is necessary to carefully structure the Five-Year Plan for maximum co-operation and interrelationship between military and civilian industry. It is necessary to plan for duplication of technological processes and absorb foreign assistance . . . such are the fundamental objectives.[8]

The requirement for interrelationship was achieved quite simply by establishing a department devoted to military products in every new works; thus every plant built in this period was producing at the same time civilian and military equipment, although the military requirements took first priority.[9] The writer has little evidence at hand, but it is possible that many of the production problems of the 1930s were caused by diversion of the best in Russian talent and materials to the military departments in each plant. It is ironic, from the Western viewpoint, that contracts viewed as serving the cause of world peace (Henry Ford, for example, elected to build the Gorki plant to advance peace) should have been utilized immediately for military end-uses.[10]

Production increases between 1933 and 1940 were not, except for petroleum refining, wood distillation, and a couple of other sectors, obtained by building new plants but by increasing the output of plants built by Western companies in 1930–3. In 1941 there were still only four large tractor plants: Putilovets Stalingrad, Kharkov, and Chelyabinsk (the Altai Tractor Plant opened in 1944, utilized equipment mostly evacuated from Kharkov); still only three major automobile-truck plants (Moscow, Yaroslavl and Gorki); and still only two giant machine-building plants (Kramatorsk and Uralmash). When units were built after 1932–3 they were subsidiary to the giants of the early 1930s. These important facts are obscured by the chronology of the Five-Year Plans.

[8] *Pravda*, No. 98, April 28, 1929.

[9] Search of the OKW files fails to reveal a single plant in 1937–8 that was not devoting part of its capacity to war purposes. The German intelligence lists of plants producing war equipment were at the same time, in fact, comprehensive lists of all Soviet plants.

[10] For a contemporary example, one might consider the intention announced by President Johnson to supply American equipment to the Togliatti automobile plant in the U.S.S.R. in 1966–8.

Those major new units built from 1936 to 1940 (except military plants) were again planned and constructed by Western companies. This second era has been much less publicized, but the State Department files do contain information on these contracts. Petroleum-cracking, particularly for avgas, was one such sector; all refineries in the Second Baku and elsewhere were built by Universal Oil Products, Badger Corporation, Lummus Company, Petroleum Engineering Corporation, Alco Products, McKee Corporation, and Kellogg Company. Advanced steel-rolling mills were supplied under the United Engineering agreement, and in 1938–9 the Tube Reducing Company installed a modern tube mill at Nikopol and supplied equipment for another. In 1937 the Vultee Corporation built an aircraft plant outside Moscow. These and similar agreements in half a dozen sectors ran from about 1936 to 1940 with few public news releases.

In 1940 as a reaction to the Nazi-Soviet agreement and the subsequent attack on Finland, assistance from the United States tapered off. The Nazi-Soviet pact replaced this assistance and gave another boost to the Soviet economy. The agreement makes specific reference to imports of German machinery; Soviet want lists emphasized modern machine tools, and the Germans, it would appear from the Hauptarchiv, had problems in designing, producing, and shipping the desired large quantities of advanced equipment. The Soviets kept well ahead on their raw-material deliveries, but German firms were consistently late in their machine-tool deliveries. German occupation of Czechoslovakia was indirectly beneficial to the Soviet Union, as large shipments of Czech machine tools were then channeled to the U.S.S.R.

The real bonanza was Lend-Lease; about one-half the equipment supplied under the master agreements had reconstruction potential; Nutter estimates it equalled one-third of Soviet pre-war industrial output.[11] These deliveries continued under the little-known 'pipeline agreement' of October 1945, so that Lend-Lease supplies actually continued through 1947. There is no question that the Soviets ended World War II with greater industrial capacity than in 1940—in spite of the war damage—and on a technical parity with the United States.[12]

Finally, another source of both increased capacity and technology was the World War II reparations agreements, in which the emphasis was on capital transfers, of which the Soviets received the lion's share. Germany (both zones), Austria, Manchuria, Finland, Rumania, Hungary, Italy, and other countries made a heavy contribution to the Soviet economy. This flow extended from

11 G. Warren Nutter, *op. cit.*, p. 214.

12 There are, however, State Department memoranda which minimize the technical flow under Lend-Lease.

1944 to 1955 and will be covered in the next volume.[13]

Growth between 1930 and 1945 was therefore uneven in part because it depended upon flows from the West and, indirectly, upon temporary detentes and changing political conditions. Looking at the picture as a whole, there were two massive injections of Western technology and capacity, in the periods 1930–3 and 1943–5. Even given the extensive destruction of World War II, and assuming that 25 percent of the Soviet economy was destroyed, the Soviets were far better off in terms of both capacity and technology by 1946 than before the war. Destroyed facilities were more than replaced by reparations and Lend-Lease, and, more importantly, replaced with equipment 10 to 15 years more advanced.

No major technology or major plant under construction between 1930 and 1945 has been identified as a purely Soviet effort. No usable technology originated in Soviet laboratories except in the case of synthetic rubber, and this was not up to U.S. standards in 1941. Equipment and processes transferred from the West were sufficient to fulfill *general* Soviet production claims, although their *annual* claims *are* doubtful. Acquisition of capacity and knowledge was slow and painful. There were major production and quality problems; there were problems with unskilled labor; machinery was abused; and the concept of rigid central planning in this period may itself have been contra-developmental.[14] The almost universal image of rapid development via Soviet central planning crumbles when we are confronted with the evidence. There is an obvious necessity to re-examine our assumptions concerning Soviet development in the light of the argument made in this study. On the other hand, it is to Soviet credit that they recognized the potent force of technology, identified its origins, and ruthlessly harnessed it to their own programs.

Although this requirement for assistance and technology from capitalist countries was recognized at an early date, the quantity required and the continuing nature of the demand for transfer over a long period were underestimated even by the Soviets. This is reflected in the 'inability hypothesis.' Rykov and others warned in 1929 that 'such measures as engaging only a hundred or two foreign specialists cannot solve the problem. . . .'[15] Once the

[13] See p. 138 for Manchurian machine tool reparations.

[14] If the reader doubts the assertion that central planning can be contra-developmental, the case of Japan, in relation to the U.S.S.R. and Communist China, should be examined. Using a more or less free-enterprise system, the Japanese at first copied freely and then forged ahead on their own. Today (1968) the Soviet Union is going to Japan for technical assistance, although tsarist Russia was technologically ahead of Japan in 1880–90. The comparison of Communist China and Japan is even more illuminating.

[15] *Pravda*, No. 94, April 24, 1929.

Party became convinced of the necessity for complete infusion of foreign technology and placed its weight behind the transfer, the acquisition process became extraordinarily efficient and highly effective. Indeed, Soviet engineers have from time to time admitted as much. A one-time manager of Gipromez, Zaviniagin, has stated:

> How have the Soviet engineers benefited from cooperation with Americans? It is not immodest to say that they successfully went through an American school and with the knowledge acquired they are carrying out in our metallurgy the last word in American technique which has been derived from many years of experience. . . .[16]

If our argument for technological transfer as a prime explanation for Soviet growth is accepted, then other observations on the Soviet enigma begin to fall into place. Why, for example, increasing censorship? Why the travel bans? Why a moon trip while the domestic Soviet automobile stock is less than that of the Argentine?

Prior to 1932, descriptions of Western assistance activities can be found in Soviet sources; most of this study could at least have been outlined from Soviet sources alone. Then came the enigma of increasing censorship and the claims of spectacular economic advances. After 1932 Soviet sources are of little use and other sources must be used; thus construction of the Second Baku refineries by American companies in 1937–41 is censored in Soviet literature and hardly noted in open Western sources.

Continuous Soviet industrial espionage on a world-wide scale—in itself a subject overdue for extensive treatment—is another enigma. Soviet engineers, scientists, planners, and Party members at home and abroad have an insatiable curiosity and well-developed techniques for gaining information on all aspects of Western technology. The observation may be superficial, but it sometimes appears that the Soviets are more interested in the latest American industrial processes than in the number or sizes of our missiles or tanks. From the Soviet viewpoint, the industrial vigor of the United States is as much an enigma as any Western question over Soviet tactics. Thus economic censorship, industrial espionage, the placing of Soviet industrial plants 'off limits,' the continuing objections to specific plant visits ('under repair,' 'the bridge is out,' and so on), the establishment of 'show place' farms (where the crèches are the most-inspected units): these phenomena are explainable within the context of our argument. Free access to all industrial units throughout the Soviet Union by foreign observers would reduce the Western view of a more or less vigorous socialist technical progress to that of widespread industrial backwardness

[16] A. Zaviniagin, 'U.S.S.R. Favors American Engineers and Equipment,' *Freyn Design*, No. 11, March 1934, p. 19. This statement is consistent with those of American engineers working for Gipromez; see pp. 62–4.

(despite extensive use of Western methods and equipment) with pockets of simulated efficiency provided for foreigners. This widespread backwardness is not inconsistent with high rates of growth in many sectors of Soviet industry. Foreign technological efforts have been concentrated in sectors capable of rapid expansion (iron and steel, electricity generation) by use of simplified standardized technology. Furthermore, output in quantitative terms suggests very little about industrial or economic efficiency.

The threads of our empirical examination are pulled together in chapter twenty-one and provide the general conclusion that the greater the foreign technical assistance to a specific Soviet sector, the greater its annual average rate of growth during the period between 1928 and 1945 and beyond. Turbines, bicycles, tires, and machine-tools were the manufacturing sectors with the highest growth rates. Consumer industries such as flour manufacture and mechanical sectors such as steam locomotives received less technical assistance from abroad, and these sectors had the lowest growth rates. Considerable detail in this and the previous volume suggests these relationships are causal.

The years 1944–5 form a natural break in our discussion. Technical transfers continued after this time, as the Soviets continued to struggle for indigenous innovation, but in more varied and complex forms. Whereas concessions were the prime transfer vehicles for the period 1917–30 and technical-assistance agreements from 1930 to 1945, the method of transfer changed considerably after World War II.

APPENDIX A

Technical-Assistance Agreement Between W. L. Gorton and Sredazvodhoz, February 6, 1930

AGREEMENT MADE this sixth day of February 1930, by and between SOVIET UNION MIDDLE ASIAN WATER ECONOMY SERVICE, an organization of U.S.S.R. hereinafter called 'SREDAZVODHOZ' and W. L. Gorton of Boise, Idaho, hereinafter called 'GORTON'.

WITNESSETH

WHEREAS, Sredazvodhoz is desirous of employing the services of said Gorton in capacity of a Construction Engineer for work in Turkestan, U.S.S.R. and

WHEREAS, said Gorton is desirous of rendering his services to Sredazvodhoz in the hereinbefore described capacity,

Now, THEREFORE, the parties hereto agree as follows:

1. Sredazvodhoz agrees to employ the services of said Gorton in the capacity of Construction Engineer for the period of time as hereinafter provided, at the compensation of ONE THOUSAND DOLLARS ($1000.00) per month, payable monthly, on the first day of each calendar month, it being understood that SIX HUNDRED DOLLARS ($600.00) per month, lawful money of the United States of America, that is to say, Sixty percent (60%) of said monthly compensation, shall be deposited, to the credit of said Gorton, in a bank located in the United States of America, the name and location of said bank to be designated, in writing, by said Gorton. The remaining FOUR HUNDRED DOLLARS ($400.00) per month, that is to say, Forty percent (40%) of said monthly compensation, is to be paid in U.S.S.R. currency at the official rate of exchange then prevailing.

2. Said Gorton agrees to perform necessary construction work for Sredazvodhoz in Turkestan to the best of his ability and knowledge and in accordance with instructions of Sredazvodhoz and whenever not needed for services in

Turkestan, Gorton shall be available for assignment to construction work at any point within the jurisdiction of Sredazvodhoz.

3. It is further understood and agreed that all reports, designs, drawings as well as any other information prepared by Gorton in accordance with the performance of his duties, shall be deemed the property of Sredazvodhoz, and shall not be disclosed by said Gorton directly or indirectly to any third party or parties, or published without a written consent of Sredazvodhoz expressly given therefor.

4. Said Gorton agrees to depart from Boise, Idaho for U.S.S.R. not later than March 6, 1930, and to proceed directly to Tashkent, Turkestan and to report for duty to Sredazvodhoz immediately upon arrival.

5. Sredazvodhoz agrees to pay for actual reasonable traveling expenses of said Gorton for the entire trip each way, as well as second class steamer and railroad transportation from Boise, Idaho, U.S.A. to Tashkent U.S.S.R. and return upon expiration of the term of this agreement or its termination prior thereto, it being understood that the transportation and traveling expenses each way shall not exceed the amount of Five Hundred Dollars ($500).

6. Sredazvodhoz agrees to pay actual cost of railroad tickets, hotels and a lump sum of 10 roubles (10R.) a day for living expenses in case said Gorton is traveling in U.S.S.R. in accordance with the instructions of the administration of Sredazvodhoz.

7. Sredazvodhoz agrees to furnish said Gorton, during the time of his employment as herein provided, living quarters in the city of Tashkent, without cost to Gorton, of a character similar to living quarters used by others occupying a position similar to that occupied by said Gorton.

8. It is understood that said Gorton shall pay income tax levied in U.S.S.R., it being understood that Sredazvodhoz shall pay for and on behalf of said Gorton the difference between the amount of income tax required under the laws of U.S.S.R. and the amount of income tax which would be required at the rate existing under the laws of U.S.A.

9. Said Gorton shall abide by the laws existing in U.S.S.R. as well as by all the rules and regulations issued by Sredazvodhoz.

10. The term of employment of said Gorton shall be two years beginning with the date of departure of said Gorton from Boise, Idaho, to Tashkent, U.S.S.R.

11. Said Gorton shall have vacation consisting of two weeks during each year of his employment by Sredazvodhoz, full salary to be paid to him during such vacation.

12. Said Gorton agrees that he will not, while in the employ of Sredazvodhoz accept work from or perform services for any other enterprise or organization without consent of Sredazvodhoz expressly given in writing.

13. Sredazvodhoz shall have the right to terminate this agreement at any time in case of any contingencies beyond control of Sredazvodhoz or in case of prolonged illness of said Gorton, it being understood that Sredazvodhoz shall pay the return trip of said Gorton from U.S.S.R. to U.S.A.

14. In case said Gorton proves himself to be grossly incompetent or negligent in the performance of his duties hereunder, Sredazvodhoz shall have the right to terminate this agreement, it being understood that in such case Sredazvodhoz shall not pay for the return trip of said Gorton from U.S.S.R. to U.S.A.

15. Any differences arising between the parties to this agreement shall be settled by the court of U.S.S.R.

IN WITNESS WHEREOF, Soviet Union Middle Asian Water Economy Service has caused this instrument to be executed by Amtorg Trading Corporation, 261 Fifth Avenue, New York, its duly authorized representative, and the said Gorton has hereunto set his hand the day and year first above written.

SOVIET UNION MIDDLE ASIAN WATER ECONOMY SERVICE

BY: Amtorg Trading Corporation

BY: A. C. Mamaeff

W. L. Gorton

Source: Willard L. Gorton Special Collection at Hoover Institution, Stanford University.

APPENDIX B

Technical-Assistance Agreement Between Vsekhimprom and Nitrogen Engineering Corporation

CONTRACT

BETWEEN STATE TRUST OF ALL THE UNION CHEMICAL INDUSTRIES 'VSEKHIMPROM' AND NITROGEN ENGINEERING CORPORATION, JUNE 29, 1931

ON this............day of............, 1931 we, the undersigned STATE TRUST OF ALL THE UNION CHEMICAL INDUSTRIES 'VSEKHIMPROM', the legal successor to the STATE COMPANY FOR THE CONSTRUCTION OF CHEMICAL APPARATUS 'KHIMSTROI', hereinafter referred to as VSEKHIMPROM and represented by *J. L. Piatakoff (President)* of the one part, and NITROGEN ENGINEERING CORPORATION, incorporated under the laws of the State of New York in the United States of America, hereinafter called 'NITROGEN' and represented by *Frederick Pope (President)* of the other part, hereby agree to the following:

I. THE SUBJECT MATTER OF THE AGREEMENT

PAR. 1. KHIMSTROI and NITROGEN have heretofore, on or about the 11th of November 1928, entered into a written agreement, providing, among other things, for the erection and putting into operation, under NITROGEN's technical advice and direction, of a plant or plants for producing synthetic ammonia within the territory of USSR, and the grant to KHIMSTROI by NITROGEN of the right to use within such territory the methods, principles and processes of NITROGEN for the construction and operation of such plants, on the terms and conditions set forth in said written agreement; and under said written agreement NITROGEN is now engineering for VSEKHIMPROM an initial plant for the production of synthetic ammonia, located at Berezniki in the Province of Perm.

PAR. 2. VSEKHIMPROM is contemplating the construction of additional plants for the production of synthetic ammonia, and may hereafter desire to construct further plants, in connection with which NITROGEN, under the terms of said written agreement, is now obligated to render engineering service to VSEKHIMPROM, and Vsekhimprom is now obligated to employ and pay NITROGEN therefor.

PAR. 3. It is the desire of the parties hereto that the terms and conditions of the aforesaid written agreement of November 11, 1928, shall, so far as they relate to such additional plants and further plants, be modified in certain respects as hereinafter set forth.

II. WAIVER OF RIGHTS AND RELEASE OF OBLIGATION

PAR. 4. Except as hereinafter provided, NITROGEN waives any and all rights which it now has, or may hereafter have with respect to such additional and further plants, under said written agreement with KHIMSTROI, and KHIMSTROI and VSEKHIMPROM and NITROGEN hereby mutually release and discharge each other of any and all oblgations with respect to such additional and further plants, arising under said written agreement of November 11, 1928. Nothing herein contained, however, shall constitute a waiver or release of any rights or obligations with respect to said initial plant.

III. GRANT OF RIGHTS

PAR. 5. Subject to the payment of the fees and the performance of the conditions hereinafter provided, NITROGEN hereby grants to VSEKHIMPROM the exclusive rights in perpetuity for VSEKHIMPROM within the territory of USSR to build, extend, operate and transfer for operations in other state enterprises, chemical plants for the manufacture of synthetic ammonia, according to the methods, principles and processes of NITROGEN.

PAR. 6. For five years from effective date hereof NITROGEN shall assign to VSEKHIMPROM any and all patents or reserved rights in USSR covering methods or apparatus for the manufacture of synthetic ammonia said patents and reserved rights to be transferred to VSEKHIMPROM for the full period for which they are valid.

PAR. 7. NITROGEN and VSEKHIMPROM mutually agree to inform each other forthwith, without request, of all technical improvements and inventions achieved by them, or which they have learned and are free to disclose, relating to the manufacture of synthetic ammonia, to the end that VSEKHIMPROM in the territory of USSR and NITROGEN in other parts of the world, may be enabled to make use of such improvements in plants which they design, install and/or operate. NITROGEN and VSEKHIMPROM further mutually agree to deliver to each other detailed drawings, schemes, specifications and calculations such as may be in their possession. This obligation to exchange information regarding technical improvements shall continue for a period of five years from the effective date of this agreement.

IV. CONSULTATION, TECHNICAL AND ENGINEERING SERVICES

PAR. 8. NITROGEN shall render to VSEKHIMPROM, as herein provided, consultation, technical and engineering services to assist VSEKHIMPROM in projecting, constructing, installing and placing in operation synthetic ammonia plants within the territory of USSR. Such consultation, technical and engineering services shall be based upon the best methods and principles which are or may be at the disposal of NITROGEN.

PAR. 9. It is understood that VSEKHIMPROM shall have in its employ or at its disposal a competent and ample staff of engineers and competent forces of skilled and ordinary workmen for carrying out the projects and that the obligation of NITROGEN shall be to supply the special technical knowledge and information relating to the design, installation and production of synthetic ammonia plants according to its methods and processes. Nitrogen shall freely render to VSEKHIMPROM advice and assistance, when requested by VSEKHIMPROM, in the selection and employment by VSEKHIMPROM of competent engineers of general technical training and of skilled workmen, so far as VSEKHIMPROM shall desire to employ persons of other than Russian nationality, but such engineers and skilled workmen shall be solely employed by and responsible to VSEKHIMPROM, and NITROGEN assumes no responsibility regarding their work or the continuance of their employment. It is intended that the consultation, technical and engineering services rendered by NITROGEN for the assistance of VSEKHIMPROM shall be sufficient to enable a competent technical organization under the direction of VSEKHIMPROM to project, construct, install and operate synthetic ammonia plants.

PAR. 10. As soon as practicable, and in any event within forty days after the effective date of this Agreement, NITROGEN shall forward by mail or by personal messenger to VSEKHIMPROM five copies each of all drawings now possessed by it indicating its latest developments in the synthesis of ammonia from water gas, coke oven gas, natural gas, electrolytic hydrogen or other sources of raw material, together with explanation as to the purpose and capacity of the apparatus or equipment shown on each drawing and the operating results which have been achieved. Similarly, NITROGEN shall deliver to VSEKHIMPROM five copies of each of all future drawings of equipment or apparatus pertaining to ammonia synthesis which shall be made by NITROGEN within a period of five years from the date of this Agreement. NITROGEN shall deliver to VSEKHIMPROM all such technical and construction calculations as NITROGEN deems necessary and will upon the request of VSEKHIMPROM deliver to them other calculations useful for their purposes, if such calculations are then in the possession of NITROGEN, NITROGEN further will assist, as far as is reasonable, the engineers of VSEKHIMPROM in becoming familiar with such calculations. It is understood that the drawings referred to in this paragraph include only those which indicate the latest developments, and do not include obsolete or preliminary drawings and sketches or any drawings or sketches of special equipment made for other clients which are confidential and which NITROGEN has no right to disclose. It is further understood that the drawings referred to in this paragraph do not include drawings covering details which have been covered by drawings already delivered to KHIMSTROI under the terms of the aforesaid agreement entered into on or about the eleventh day of November, 1928. A list of such drawings as are now available for delivery to VSEKHIMPROM under this paragraph is attached hereto marked 'Exhibit A'.

PAR. 11. As soon as practicable, and in any event within forty days after the effective date of this Agreement, NITROGEN shall forward by mail or by personal messenger to VSEKHIMPROM a copy of its specifications for the purchase and manufacture of equipment and apparatus for use in the manufacture of synthetic ammonia, and NITROGEN shall similarly forward to VSEKHIMPROM copies of future specifications relating to such equipment and apparatus. It is understood that the specifications referred to in this paragraph do not include duplicates or specifications already furnished by NITROGEN to VSEKHIMPROM under the terms of the aforesaid agreement entered into on or about the eleventh day of November 1928, nor do they include specifications of special equipment for other clients which are confidential and which NITROGEN has no right to disclose. A list of the specifications now available to be furnished to VSEKHIMPROM is attached hereto marked 'Exhibit B'.

PAR. 12. NITROGEN shall forward by mail or by personal messenger to VSEKHIMPROM detailed drawings and/or specifications, instructions and formulae for the preparation of all solutions, catalysts, etc., necessary for the synthesis of ammonia according to the methods and processes of NITROGEN, including all improvements and changes in such instructions and formulae made by NITROGEN within the period of five years from the effective date of this Agreement that are applicable to the plants constructed by KHIMSTROI under this agreement, and VSEKHIMPROM may during this same period send engineers to visit any factory owned by NITROGEN making catalysts, when such plant is operating.

PAR. 13. NITROGEN shall forward by mail or by personal messenger to VSEKHIMPROM detailed written instructions for the use of its technical staff in starting and operating the synthetic ammonia plants and all departments thereof constructed by VSEKHIMPROM under this Agreement, and shall inform VSEKHIMPROM of all improvements made by NITROGEN within the period of five years from the effective date of this Agreement in methods of operation of synthetic ammonia plants so far as such improvements are applicable to the plants constructed by VSEKHIMPROM under this Agreement.

PAR. 14. During the period of five years commencing with the effective date of this Agreement, NITROGEN shall, whenever requested by VSEKHIMPROM, and with reasonable promptness, prepare and deliver to VSEKHIMPROM in Moscow (or, at the option of VSEKHIMPROM, to its representative in New York or at the office of NITROGEN in Europe):

(a) Plans, specifications, and drawings of such scale and completeness as VSEKHIMPROM requests for the installation by VSEKHIMPROM of additional plants within the territory of USSR for the manufacture of synthetic ammonia according to the methods and processes of NITROGEN.

(b) Estimates and calculations of costs of such plants and costs of production of synthetic ammonia in such plants.

(c) Projects, the substance and scope of which is shown in Exhibit C. A preliminary project is to be mailed from NITROGEN's office not later than eight weeks after the acknowledgment by NITROGEN of receipt of all necessary information. A final project is to be mailed from NITROGEN's office—complete only in its major parts—not later than six months after receipt by NITROGEN of information of acceptance of corresponding preliminary project. The rest of the final project is to be mailed from NITROGEN's office thirty days after acknowledgment by NITROGEN of receipt of all necessary information therefor.

Such plans, specifications, drawings and estimates shall be in such detail and shall be accompanied by such explanatory notes as shall be requested by VSEKHIMPROM and NITROGEN is able to prepare required for the proper planning and execution of the projects. At the request of VSEKHIMPROM, NITROTEN shall send to USSR such number of engineers as in the judgment of NITROGEN shall be necessary to explain such plans, specifications, drawings and estimates, and to take part in the defence of the projects when such projects come up for consideration before the USSR Government authorities. VSEKHIMPROM may at its option and at its own expense send its own engineers to take part in the preparation of such plans, specifications, drawings and estimates, and to inform NITROGEN regarding local conditions which will affect the building and installation of the plants.

PAR. 15. During the period of five years from the effective date of this Agreement NITROGEN shall, when requested by VSEKHIMPROM, and in the manner and to the extent in this paragraph provided, place at the disposal of VSEKHIMPROM skilled and experienced engineers for advice, competent instruction and consultation, either in the offices of NITROGEN New York or Europe, or in USSR, or elsewhere as VSEKHIMPROM may elect.

(a) VSEKHIMPROM may notify NITROGEN in writing at any time, and from time to time, of its desire to have the services of any number of Engineers of the Engineering Staff of NITROGEN up to a total of three such Engineers for any specified days in a period of twelve months commencing, so far as one Engineer is concerned, thirty days after receipt by NITROGEN at its New York office of such written notice, and so far as two other Engineers are concerned commencing three months after receipt of such written notice by NITROGEN at its New York office. Thereupon, NITROGEN shall be required to make available to VSEKHIMPROM the services of such number of engineers for such days, within the aforesaid period of twelve months, and VSEKHIMPROM shall be obliged to pay Nitrogen for the services of such engineers the remuneration provided in paragraph 17 hereof in twelve equal installments payable on the first day of each month of such period of twelve months. In giving such written notice to NITROGEN, VSEKHIMPROM shall state as definitely as possible the nature of the consultation and advice required of such engineers in order that NITROGEN may select for this purpose the engineers properly qualified to render such advice and consultation.

(b) Additional engineers may be furnished to VSEKHIMPROM by NITROGEN in accordance with agreement that may be made from time to time by the parties hereto and for remuneration as provided in paragraph 17 hereof; and regardless of any such agreement, NITROGEN shall use its best endeavours to make available its engineers to render advice and consultation to VSEKHIMPROM to the full extent desired by VSEKHIMPROM.

(c) For advice and consultation services rendered by NITROGEN to VSEKHIMPROM in the office of NITROGEN in New York or Europe or in USSR up to a total of 300 engineer days in any one year, and in addition thereto 200 engineer days in any one year, only in the offices of NITROGEN in New York or Europe, no charge shall be made by NITROGEN. It is understood, however, that for such consultation and advice in its own offices, without remuneration therefor, NITROGEN shall not be obligated to have its skilled engineers available at any particular time but shall be free to make agreements with other clients which might at various periods require the services of such engineers.

PAR. 16. During the five years from the effective date of this Agreement, NITROGEN shall, at the request of VSEKHIMPROM, send to USSR skilled engineers capable of interpreting plans, inspecting work, and advising the representatives of VSEKHIMPROM in charge of the construction, installation and operation of such additional plants, in order to assist such representatives of VSEKHIMPROM, provided, however, that NITROGEN's obligation to have such engineers available for such purpose shall for any period be limited to and included within the number of engineers that VSEKHIMPROM shall have notified NITROGEN it requires, as provided in paragraph 15 thereof. Additional engineering service of the character provided for in this paragraph may be furnished by NITROGEN to VSEKHIMPROM in accordance with agreement that may be made from time to time by the parties hereto, and NITROGEN shall at all times use its best endeavours to supply such engineering service to VSEKHIMPROM so far as it can make its skilled engineers available for such purpose.

V. REMUNERATION

PAR. 17. VSEKHIMPROM shall pay to NITROGEN for the rights and technical services to be rendered by NITROGEN to VSEKHIMPROM as herein provided, the following sums in United States Gold Dollars in New York City:

(a) Eighty Thousand dollars ($80,000) within thirty days after the effective date of this agreement.

(b) Eighty Thousand dollars ($80,000) on January 1st, 1932, or in the event that the plant now building at Berezniki is completed before that date then this payment must be made within five (5) days of such completion.

(c) Sixty thousand dollars ($60,000) one year after the effective date of this agreement.

(d) Sixty thousand dollars ($60,000) two years after the effective date of this agreement.

(e) Sixty thousand dollars ($60,000) three years after the effective date of this agreement.

(f) Sixty thousand dollars ($60,000) four years after the effective date of this agreement.

(g) Fifty dollars ($50.00) per engineer day, this is per engineer per day, for all engineers furnished by NITROGEN to VSEKHIMPROM at the request of VSEKHIMPROM, as provided in paragraphs 14, 15 and 16 hereof, except for such engineers as are furnished at no per diem cost as specified in paragraph 15, sub paragraph (c), together with the travelling and living expenses of such engineers when their services are required away from the offices of NITROGEN. The engineer days referred to herein shall include the time occupied in travelling from the offices of NITROGEN or from such other points as may be designated by NITROGEN in case such engineers are sent to the service of VSEKHIMPROM to such other points, and shall include all the days until such engineers can return to the points from which they left to go to the service of VSEKHIMPROM. The travel of engineers to and from the service of VSEKHIMPROM shall be by the quickest and most direct transportation, other than air transport, affording first-class accommodations.

(h) For the service, expenses and material consumed by draughtsmen of NITROGEN in preparation of plans, specifications, and drawings and for the other services provided in paragraph 14, hereof, the actual cost of draughtsmen to NITROGEN plus 100% (one hundred percent) for overhead.

(i) The remuneration provided in sub-paragraphs (g) and (h) hereof shall be payable upon rendering of bills therefor by NITROGEN, except to the extent that payment monthly in advance is provided by paragraph 15 hereof. Such bills shall be rendered by NITROGEN to VSEKHIMPROM monthly.

IV.* LIVING AND WORKING CONDITIONS OF NITROGEN EMPLOYEES

PAR. 18. VSEKHIMPROM shall be responsible to NITROGEN for furnishing to the engineers and representatives of NITROGEN when engaged in work in behalf of VSEKHIMPROM in USSR:

(a) First-class lodging and subsistence, or in Moscow only equivalent cash allowance therefor, equal to that furnished or available to the highest grade non-Russian technical men employed or residing in USSR, in addition suitable office accommodation and equipment shall be provided,—all of which shall be for the sole and exclusive use of such employees and be conveniently adjacent to the point at which the services of such engineers are required by VSEKHIMPROM; and private automotive transportation between place or lodging and place of work, as requested from time to time by such engineers.

(b) First-class medical and surgical and/or hospital services and medical supplied for any sickness, accident and/or disability suffered by such engineers and representatives from any cause whatsoever while in USSR. In case of disease acquired before entering the USSR, but developing only thereafter this paragraph shall be in full force and effect, but the entire expense thereof shall be a charge against NITROGEN.

(c) VSEKHIMPROM agrees to provide such engineers and representatives with a properly authenticated letter stating that he is visiting USSR at the request of VSEKHIMPROM and asking representatives of the Government to aid him wherever possible and to facilitate his compliance with all formalities especially those of entrance and exit to and from the USSR.

(d) VSEKHIMPROM agrees to do all possible to facilitate the importation of, and to pay all customs duties, fees, and/or other charges collected by the USSR on:

* Beginning this section, document misnumbered in original.

1) All equipment necessary to such engineers in the performance of their duties such as drawings, books, instruments, and
2) clothing, medicines and personal articles reasonable required by such engineers, and
3) amounts of food, all not exceeding the maximum specified in list B attached hereto.
4) Also additional amounts of any of the above for the personal use of such engineers, should such be necessary to retain the services of such engineers.

VSEKHIMPROM agrees also to do all possible to facilitate the export of any records and any of the above-mentioned things except food and to indemnify NITROGEN against loss or damage of such property and equipment, whether the property of NITROGEN or its Employees whilst in transit in USSR, and will at the time of export provide a letter duly authenticated to facilitate such export.

(e) The rights granted to NITROGEN in paragraph 18 and applicable to its engineers under these warranties shall constitute warranties to NITROGEN and shall extend to all representatives of NITROGEN.

PAR. 19. VSEKHIMPROM agrees to reimburse NITROGEN and/or NITROGEN's engineers, within ten days after receipt of claim for any expenses incurred by NITROGEN and/or NITROGEN's engineers due to failure of VSEKHIMPROM to supply any of the services and/or facilities specified in the preceding paragraph and specifically authorizes NITROGEN and/or NITROGEN's engineers to incur such expenses immediately and without any notification in the event of such failure on the part of VSEKHIMPROM.

PAR. 20. All engineers and/or employees sent into USSR under this agreement by NITROGEN are employees of NITROGEN and not of VSEKHIMPROM, and VSEKHIMPROM shall not pay any remuneration to said engineers.

PAR. 21. NITROGEN shall have the right at any time to withdraw any particular engineer from USSR and replace such engineer with another engineer, but only in unusual cases shall such withdrawal take place until the arrival of a substitute. But the traveling and living expenses incurred as the result of any such withdrawal and/or replacement at the instance of NITROGEN shall be borne by NITROGEN. VSEKHIMPROM may require the withdrawal and/or replacement within a reasonable time of any engineer, and NITROGEN will agree thereto, but such withdrawal and replacement shall be at VSEKHIMPROM's expense unless NITROGEN agrees, on submission by VSEKHIMPROM of a statement of reasons for such requirement, that such withdrawal and replacement is necessary for the fulfilment of NITROGEN's obligations under this Agreement.

PAR. 22. VSEKHIMPROM assumes and will pay or will reimburse NITROGEN or its engineers and/or representatives, if any of its engineers and/or representatives have paid any taxes and/or other obligatory expenditures specified by the laws of USSR of the engineers and/or other representatives of NITROGEN while in USSR.

V. PERIOD OF OPERATION OF AGREEMENT

PAR. 23. The period of operation of this Agreement is fixed at five years counting from the date of its making, provided, however, that where rights are specificially granted for a longer period, such rights shall not terminate with the expiration of the agreement.

PAR. 24. In case NITROGEN shall be dissolved or amalgamated with some other enterprise, all its rights and obligations under this agreement fully pass on to its successor. In case VSEKHIMPROM shall be dissolved or amalgamated with some other USSR Government enterprise, all such rights and obligations of VSEKHIMPROM under this Agreement pass in their entirety to the State enterprise which shall be designated by the Supreme Council of National Economy of USSR.

VI. FORCE MAJEURE

PAR. 25. If either party is prevented from carrying out the herein contained provisions by reason of any war, civil commotion, epidemic, fire, cyclone, flood, embargo, governmental or physical cause, existing or future, beyond the reasonable control of such party, and interfering with the performance of such party hereunder, the party so interfered with shall be excused from such performance to the extent of such interference during the period thereof; providing, however, that the party so interfered with shall use due diligence and take all reasonable steps to remove the cause or causes preventing it from carrying out its obligations hereunder, and to resume such obligations with all reasonable promptness.

VII. ARBITRATION

PAR. 26. All disputes arising out of the performance and interpretation of the present agreement are settled by the method indicated in the special annex with which the present agreement forms an integral part.

VIII. GENERAL STATEMENTS

PAR. 27. The legal addresses of the parties are: VSEKHIMPROM, Moscow, Diakoff pereulok 4, USSR.

NITROGEN, 535 Fifth Avenue, NEW YORK, U.S.A. Provided, however, that either party may change such legal address by notice in writing to the other party.

PAR. 28. This agreement becomes effective from the date of its sanction by the Supreme Economic Council attached to the Council of People's Commissaries of the Union of S.S.R., such date being referred to herein as 'the effective date,' but unless NITROGEN receives written notice of such sanction within sixty days of the signing of this agreement by NITROGEN, this agreement shall not be binding upon NITROGEN without its separate written assent.

PAR. 29. Taxes of all kinds in connection with the making and operation of the present agreement are to be borne by VSEKHIMPROM.

STATE TRUST OF ALL THE UNION
CHEMICAL INDUSTRIES "VSEKHIMPROM"

WITNESS: *by J. L. Piatakoff*

....

NITROGEN ENGINEERING CORPORATION

by Frederick Pope

WITNESS:

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DATED: Berlin, June 29, 1931.

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APPENDIX C

Technical-Assistance Agreements between the Soviet Union and Western Companies, 1929-45

Western Company	*Country of Origin*	*Technical Transfer to Soviet Union*
Accounting and Tabulating Machine Co.	United States	Power machines
Akron Rubber Reclaiming Co.	United States	Rubber-plant reclamation; training Soviet nationals
Aktiebolaget Vallenbygg-nadsbyran	Sweden	Construction of Svir Dam
Alco Products, Inc. (Div. of American Locomotive)	United States	Petroleum refineries
Allen & Garcia Inc.	United States	Coal mine development
Allgemeine Elektrizitäts Gesellschaft	Germany	Electrical machinery
American Can Co.	United States	Canning processes
Ansaldo	Italy	Shipbuilding
Ansonia Clock Co.	United States	Clocks and watches
Audio-Cinema, Inc.	United States	Sound film technology
Austin Co.	United States	Automobile plant construction; design of Gorki city
Babcock & Wilcox, Inc.	United States	Boiler design
Badger, E. B., & Sons	United States	Wood distillation, oil refineries
Bagley & Sewell Co.	United States	Newsprint manufacture
Baldwin Locomotive Works	United States	Locomotive repair shops
Baltimore & Ohio Railroad	United States	Railroad operations
Birdsboro Steel Foundry & Machine Co.	United States	Hydraulic presses

Western Company	*Country of Origin*	*Technical Transfer to Soviet Union*
Birmingham Small Arms Co.	England	Bicycles
Bliss, E. W., Co.	United States	Power-plant design; small arms ammunition
Blom and Kamroth	United States	Meat-packing plants
Boeing Aircraft Co.	United States	Aircraft
Borsig, A.	Germany	Refrigeration technology
Brandt, Arthur J.	United States	Reconstruction of AMO works
British Thomson-Houston Co., Ltd.	United Kingdom	Power stations
Brown-Boveri Co.	Switzerland	Gas blowers; aluminum mill equipment
Brown Instrument Co.	United States	Electrical recording instruments
Brown-Lipe Gear Co.	United States	Gear manufacture for automobile industry
Bucyrus-Erie Co.	United States	Excavating equipment
Budd Manufacturing Co.	United States	1934 auto model change (21S)
Burd Piston Ring Co.	United States	Tractors
Burrell-Mase Engineering Co.	United States	Expansion and management of Grozneft
Casale Ammonia S.A.	Italy	Nitrogen fixation; manufacture of synthetic ammonia
Caterpillar Tractor Co.	United States	Training Soviet nationals
Cellulose de Bourges	France	Chemicals
Chain Belt Co.	United States	Conveyors
Chase, Frank D., Inc.	United States	Design of foundry projects
Cheretti & Tonfani	Italy	Design and construction of conveyors
Chicago Kitchen Co.	United States	Design of community kitchens
Cie de Produits Chimiques et Electrométallurgiques Alais, Troques et Camargue	France	Aluminum
Clark, Wallace, & Co.	United States	Gantt methods
Cleveland Tractor Co.	United States	Training Soviet nationals
Cooper, H. L., & Co., Inc.	United States	Dniepr Dam
Craven Bros. (Manchester), Ltd.	United Kingdom	Special machine tools

Western Company	*Country of Origin*	*Technical Transfer to Soviet Union*
Curtiss-Wright Corp.	United States	Aircraft engine manufacturing license
Davy Bros., Ltd.	United Kingdom	Forging manipulators
Deere & Co.	United States	Agricultural equipment
Deilmann Bergbau	Germany	Design of mines at Solikamsk
Demag Aktiengesellschaft	Germany	Manufacture of cranes, hoisting equipment and blooming mills
Deutsche Tiefbohr A-G	Germany	Drilling deep water wells
Deutz Motorenfabrik A-G	Germany	Construction of Deutz diesel engines
Dewey & Almy Chemical Co.	United States	Crab meat containers
Diebold Safe & Lock Co. (Diebold, Inc.)	United States	Watch factory
Disticoque S.A.	France	Coke ovens
Douglas Aircraft Co., Inc.	United States	Aircraft: DC-3
Dow Chemical Co.	United States	Styrene
Dueber-Hampden Watch Co.	United States	Construction and equipment of watch plant
Du Pont, (E.I.) de Nemours & Co.	United States	Synthetic ammonia, nitric acid and fertilizer technology
Eastman Construction Engineering	United States	Construction
Electric Auto-Lite Co.	United States	Electrical equipment in autos and tractors
Elektrokemisk	Norway	Manufacture of Soderberg electrodes
Ericsson, L. M., A/B	Sweden	Telephone equipment
Ex-Cell-O Aircraft and Tool Corp.	United States	Stated by Soviets as agricultural implements
Fairbanks Aviation Corp.	United States	Aircraft manufacture
Farben, I. G.	Germany	Chemicals
Farrel-Birmingham Co., Inc.	United States	Sykes machines
Ferguson, Hardy S., & Co.	United States	Paper-mill technology
Fiat s.p.a.	Italy	Automobiles, aircraft, ships

Western Company	*Country of Origin*	*Technical Transfer to Soviet Union*
Ford Motor Co.	United States	Automobile plant construction and auto tire plant
Foster-Wheeler Corp.	United States	Petroleum refineries
Freyn Engineering Co.	United States	Iron and steel plants
Frolick & Knupfel	Germany	Design and construction of mines
Gaillard-Parrish	United Kingdom	Sulfuric acid
Gibbs, Harry D.	United States	Chemical processes; phthalic anhydride
Gogan Machine Co.	United States	Automobile bumpers
Goodman Manufacturing Co.	United States	Coal cutters
Graver Corp.	United States	Refineries
Great Northern Telegraph	Denmark	Telegraph operations
Grusonwerk, Friedrich Krupp	Germany	Manufacture of equipment for crushing plants
Hahn, A. W.	United States	Aluminum powder
Harburger, Eisen, and Bronzewerke, A-G	Germany	Manufacture and design of equipment for oil-crushing mills
Heinkel	Germany	Aircraft
Henshien, H. G.	United States	Meat packing plants
Hercules Motor Corp.	United States	Reconstruction of Yaroslavl truck engine plant
Hercules Powder Co.	United States	Nitrocellulose; cotton linters
Hilaturas Casablancas, S.A.	Spain	Coal cutters
Houdry Process Corp.	United States	Catalysts
Humboldt-Deutz Motoren, A-G	Germany	Diesel engines (all sizes)
Imperial Chemical Industries, Ltd.	United Kingdom	Chemical manufacture
International General Electric Co., Inc.	United States	Electrical equipment (all types)
International Harvester Co.	Canada	Agricultural implements
International Harvester Co.	United States	Training Soviet nationals
Irving Air Chute Co., Inc.	United States	Parachutes
Isacco, Vittorio	Italy	Helicopters
Jenkins Co.	United States	Petroleum refineries

Western Company	*Country of Origin*	*Technical Transfer to Soviet Union*
Kahn, Albert, Inc.	United States	Supervision of Five-Year Plan design and construction
Kallitt Products, Inc.	United States	Electrical equipment
Karlstad Mechaniska Verkstaden A/B	Sweden	Construction of turbines, Svirstroi
Kohorn, Oskar, and Co.	Germany	Production of artificial silk by viscose process
Koppers Construction Co.	United States	Coke ovens and by-products
Krupp, Friedrich, A.G.	Germany	Manufacture of special grades of steel, cement
Kugellager, Vereinigte	Germany	Ball bearings
La Compagnie Générale de Télégraphie	France	Radios
Lockwood, Greene & Co., Inc.	United States	Textile-plant construction
Loeffler	Czechoslovakia	High-pressure boilers
Longacre Engineering and Construction Co.	United States	Apartment buildings
Lucas & Luick	United States	Gas plants and pipelines
Lummus Co.	United States	Refinery construction
Lurgi Gesellschaft für Chemie und Hüttenwesen m.b.H.	Germany	Sulfuric acid process
Maatschappi	Holland	Saccharification of wood pulp for production of fodder and glucose
Macchi	Italy	Flying boats
Manchu Machine Works	Manchuria	Machine-tool plant
Manchurian Machine Tool	Manchuria	Machine-tool plant
Marietta Manufacturing Co.	United States	Carbon-black plant unit
Marshall & Sons, Ltd.	United Kingdom	Locomotives for lumber industry
Martin, Glenn L., Co.	United States	Bomber design
Maschinen und Bronze-Waren Fabrik A-G	Germany	Machine tools
Maschinenbau A-G	Germany	Manufacture of compressors

Western Company	*Country of Origin*	*Technical Transfer to Soviet Union*
Maschinenbau-Anstalt 'Humboldt'	Germany	Installation of concentrator equipment
Maschinenfabrik Augsburg-Nürnberg A-G	Germany	Construction of MAN—Diesel engines, simple 4-cycle motors, simple and double 2-cycle motors with and without compressors, and machines and equipment for cold storage plants
McClintock & Marshall Const. Co.	United States	Building erection for Stalingrad Tractor Plant
McCormick Co.	United States	Baking-plant design
McDonald Engineering Co.	United States	Industrial plants, cement, elevators
McKee, Arthur G., & Co.	United States	Magnitogorsk iron and steel plant; petroleum refineries
Mechanical Engineering (Chicago)	United States	Meat-packing plants
Merritt Engineering & Sales Co., Inc.	United States	Manufacture of rolled-steel railroad-car wheels
Messer Co. A-G	Germany	Construction of autogenous welding equipment
Metropolitan-Vickers Electrical Co., Ltd.	United Kingdom	Construction of steam turbines; power plants
Midwest Rubber Reclaiming Co.	United States	Assistance in rubber-plant construction; training Soviet nationals
Miller, Max B., and Co.	United States	Petroleum refineries
Moisseiff, Leon S.	United States	Bridge consultation
Multibestos Co.	United States	Design and technical assistance in construction of factory for asbestos products
National Rubber Machinery Co.	United States	Tire-building machines
Newport News Shipbuilding & Dry Dock Co.	United States	Turbine construction
Nickel, Arthur, Co.	United States	Iron-ore mining

Western Company	*Country of Origin*	*Technical Transfer to Soviet Union*
Nitrogen Engineering Corp.	United States	Ammonia-fertilizer plant construction and operation
Nobile, General Umberto	Italy	Airships
Nordberg Manufacturing Co.	United States and United Kingdom	Railroad equipment
Oglebay, Norton Co.	United States	Iron-ore mine development
Ohio Locomotive Crane Co.	United States	Operation and servicing of cranes
Oliver Farm Equipment Co.	United States	Tractor plows
Otis Elevator Co.	United States	Moscow subway elevators
Owens Bottle Co.	United States	Bottle-closing patent and machinery for silicate industries
Parke, Davis & Co.	United States	Pharmaceutical products
Passburg, Emil, and Berthold Block	Germany	Design of vacuum plants
Penick & Ford, Ltd., Inc.	United States	Construction of corn production and refining plants
Pennsylvania Railroad	United States	Railroad operating methods
Peterson, Hugo	Germany	Peterson sulfuric acid process
Petroleum Engineering Corp.	United States	Petroleum refineries
Pflanzennamme	Germany	Manufacture of peat products
Polakov, W. N.	United States	Management consultants
Pontiac Engineering Co.	United States	Smelter construction
Power-Gas Corp., Ltd.	United Kingdom	Gas generator plant
Pratt & Whitney Aircraft Co.	United States	Stated by Soviets as agricultural implements
Radio Corporation of America	United States	Exchange of patents and information, radio and TV
Radiore Co.	United States	Prospecting assistance
Remington Rand, Inc.	United States	Office equipment
Republic Aviation Corp.	United States	Aircraft
Richard Bros.	United States	Tractor manufacture

Western Company	*Country of Origin*	*Technical Transfer to Soviet Union*
Riedinger Maschinen- und Bronzewarenfabrik A-G	Germany	Metals manufacture
Roberts & Shaefer Co.	United States	Detailed designs and plant drawings Donetz coal trust
Rockwell, W. S., Co.	United States	Furnace technology at Stalingrad
Rosoff Subway Construction Co.	United States	Subway construction (probably not implemented)
Rust Brothers	United States	Rust cotton-picking machine
Safety Mining Co.	United States	Manufacture of CARDOX
Sauerman Bros., Inc.	United States	Equipment operation
Savoia	Italy	Flying boats
Sayer, E. Y., Engineering Corp.	United States	Steam electric plant
Scintilla A-G	Switzerland	Manufacture of magnetoes and ignition equipment
Seabrook, C. F., Co.	United States	Road construction
Seiberling Rubber Co.	United States	Sale of rubber tire plant
Seversky Aircraft Corp.	United States	Aircraft
Sharples Specialty Co.	United States	Petroleum centrifuge equipment
Siemens-Schukert	Germany	Electrical equipment
Smidth, F. L., A/S	Denmark	Cement plants
Smith, C. V., Co., Thetford	Canada	Asbestos milling
Société de Prospection Electrique Procédés, Schlumberger	France	Electrical prospecting for oil
Société Française Anonyme 'Lumière'	France	Manufacture of films
Sociétés du Duralumin	France	Duralumin
Soieries de Strasbourg S.A.	France	Production of artificial silk by viscose process
Southwestern Engineering Co.	United States	Design, construction and operation of metal plants
Sperry Gyroscope Co., Inc.	United States	Marine instruments, bomb sights
Standard Alcohol Co.	United States	Rubber technology
Standard Oil Co. of New York	United States	Operation of Batum refinery: synthetic ethyl alcohol

Western Company	*Country of Origin*	*Technical Transfer to Soviet Union*
Stockholms Superfosfat Fabriks Aktiebolaget	Sweden	Construction, equipment, and operation of plant with annual production of 20,000 tons calcium cyanamid and 3,000 tons carbide (Chernorechensk Plant); manufacture of yellow prussiate of potash; construction of equipment and operation of Karabliss Cyanamid and Carbide Plant
Stuart, James & Cooke, Inc.	United States	Coal industry; grain elevators
Sullivan Machinery Co.	United States	Mining equipment
Sulzer Gebruder A-G	Germany	Construction of 2-cycle Sulzer diesel engines
Swasey, Warner P.	United States	Tractor manufacture
Szepesi, Eugene	United States	Accounting systems in textile mills
Taft, Pierce Mfg. Co.	United States	Manufacturing of tools, jigs, etc.
Telefunken Gesellschaft A-G	Germany	Manufacture of long-distance receiving sets
Thew Shovel Co.	United States	Dragline operation
Timken-Detroit Axle Co.	United States	Automobile industry
Torfplattenwerke A-G	Germany	Construction of plant for manufacture of peat insulation plates
Tube Reducing Co.	United States	Tube mill installations
Union Construction Co.	United States	Drawings and specifications for dredges
Union Switch and Signal Co.	United States	Railroad automatic block signals
United Engineering & Foundry Co.	United States	Hot and cold wide-strip mills in steel and aluminum industries
Universal Oil Products Inc.	United States	Refinery construction
U.S. Wheel Track Layer Corp.	United States	Christie tanks

Western Company	*Country of Origin*	*Technical Transfer to Soviet Union*
Verband Deutscher Werkzeugmaschinfabrik Ausfuhr	Germany	Organization of joint technical office bureau in Berlin for execution of designs for equipment of metal manufacturing plants; organization of machine display room in Moscow
Vereinigte Carborundum & Elektritwerke A-G	Germany	Manufacture and design of plant for artificial abrasives
Vereinigte Kugellager Fabriken A-G	Germany	Manufacture of ball bearings
Veritas S.A.	France	Technical assistance on tanker construction
Vickers-Armstrongs, Ltd.	United Kingdom	Tanks
Villar-Perosa Officine (RIV) s.p.a.	Italy	Manufacture of ball bearings
Vom Bauer	United States	Electric furnaces
Vultee Aircraft (Div. of Aviation Mfg. Corp.)	United States	Bombers
Webber & Wells, Inc.	United States	Food processing
Westinghouse Electric and Manufacturing Co.	United States	Power plant design, aviation test equipment
Westvaco Chlorine Products Corp.	United States	Chemical industry
Wheeler, Archer E., Engineering Co.	United States	Non-ferrous metals
White, J. G., Engineering Corp.	United States	Technical assistance on Svir Dam
Wilson, M. L.	United States	
Winkler-Koch Engineering Co.	United States	Cracking technology
Yukon Fur Farms, Inc.	United States	Organization of animal farms
Zahn A-G	Germany	Carbon disulfide

Note: These are equivalent to the Type III concessions described in Volume I.

APPENDIX D

Guide to Sources of Material

THE official numbering system of the U.S. State Department Decimal File (the central file) is used in this volume. The records for 1910 to 1930 used in *Western Technology . . ., 1917 to 1930* have been published on microfilm and references in that volume are to the National Archives microfilm. Records dated after 1930 utilized in this volume have not, as yet, been published on microfilm and references therefore refer to the Decimal File number. Thus, for example, 861.5017—Living Conditions/100 may be found in the National Archives under this file number and, although unpublished, is available for special purchase under this number. Later references, after about 1945, are held in the State Department; some for 1945 have been published in the annual series *Foreign Relations of the United States*. The greater part of the microfilmed State Department records as well as privately collected material used in this volume has been deposited at the Hoover Institution, Stanford University.

German archival material, available at the National Archives, is referred to by microcopy number; for example T 84–122–1421674 refers to Microcopy T 84, Roll 122, Frame 1421674.

Most of the scarce periodical literature is available at the Hoover Institution or the Library of Congress. Soviet technical books cited are in most cases available only at the Library of Congress, although those used in this study have been, for the most part, deposited with the Hoover Institution.

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Index

Western Technology and Soviet Economic Development 1945 to 1965

Third volume of a three-volume series

By

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FOR

Jane and Elizabeth

Preface

The considerable financial burden for this three-volume study has been borne by the Hoover Institution on War, Revolution and Peace established by former President Herbert Hoover at Stanford University. The Institution's extensive archival holdings, a library in excess of one million volumes, first-rate research facilities, and the unique freedom given to individual researchers make it an unparalleled center for original research. The Institution is, of course, in no way responsible for my errors and omissions, nor does it necessarily accept my argument.

Of the many at the Hoover Institution who have contributed to this study special mention should be made of Dr. W. Glenn Campbell, Director of the Hoover Institution since 1960; Mr. Alan H. Belmont, Associate Director for Administration; and Dr. Roger A. Freeman, Senior Fellow. The assistance given by the expert curators and an efficient Library staff is also gratefully acknowledged.

The Hoover Institution Press, headed by Mr. Brien Benson, handled the publication chores for the series and particular acknowledgment is due the editorial staff: Miss Michelle Hogan, former production editor; Miss Liselotte Hofmann, assistant editor; Mr. London G. Green, the editor directly responsible for the first two volumes; and Mrs. Carole Norton, who supervised the editorial work on volumes One and Two and undertook the detailed editing of this final volume. Miss Marcia Taylor compiled the bibliography and Mrs. Joan Johanson compiled the index for this volume.

To these and others who have given their assistance—thank you.

Stanford, California
June, 1970.

A. C. S.

Contents

Tables

Figures

Introduction

This is the third volume of an analysis of the impact of Western technology and skills on the industrial development of the Soviet Union. With this volume, which covers the years 1945-1965, the original hypothesis that by far the most significant factor in the development of the Soviet economy has been its absorption of Western technology and skills[1] is substantially supported over a period of 50 years.

The reader should bear in mind the distinctions made in this analysis between science and technology and between invention and innovation. Science is here defined as theory and laboratory development of theory, while technology is the selective application of scientific findings to industrial production. Similarly, invention is the process of discovery and the prototype development of discovery, while innovation is the selective application of invention to industrial production. Usually there are many inventions available for selection in any industrial system; but in practice only a few are applied to become innovations.

No fundamental industrial innovation of Soviet origin has been identified in the Soviet Union between 1917 and 1965, and preliminary investigation suggests that this situation continued throughout the decade of the sixties.[2] Soviet innovations have consisted, in substance, in adopting those made first outside the U.S.S.R. or using those made by Western firms specifically for the Soviet Union and for Soviet industrial conditions and factor resource patterns. A comparative statement of Soviet innovation—to the limited extent that it exists—is made in chapter 25.

The question now is: Why does the Soviet Union lack major indigenous innovation? Up to about 1957 the explanation could well have been posed in terms of "catching up," i.e., it was cheaper and less time-consuming for the U.S.S.R. to adopt Western technology than to institute the innovative process herself. After about 1957 the catching-up hypothesis cannot be supported; the

[1] See A. C. Sutton, *Western Technology and Soviet Economic Development, 1917 to 1930* (Stanford: Hoover Institution, 1968). Hereafter cited as Sutton I.

[2] The cut-off date varies according to the amount of information available for each industrial sector; for chapter 21 (shipbuilding), information was available to July 1967, while for chapter 9 (non-ferrous metals) information is scarce after the early 1960s.

Soviet Union had caught up technically in the thirties and once again in the forties by "borrowing" in one form or another from the West.

In 1957 came the era of "peaceful competition between systems," when Khrushchev challenged and threatened to "bury" the United States economically. This challenge may well have been a bombastic cover for Soviet intent to increase—not reduce—the acquisition of Western technology. On the other hand, Soviet economists may have concluded that the years 1957-58 represented the zenith of technical assimilation from abroad and that Sputnik would usher in an era of Soviet innovation. Some Soviet innovation did indeed evolve in the late 1950s—in fact examples appear to be concentrated in these years—but it did not survive in the face of dynamic Western technical advances.[3]

Today it is no longer a question of "catching up." It is a question of the innate ability of the Soviet system to innovate at all. On the basis of the research findings elaborated in this three-volume series, we conclude that a society with the kind of central planning that guides the Soviet Union has virtually no capability for self-generated indigenous innovation.

Yet Soviet propaganda concerning Soviet technology has by and large been successful. In the face of the empirical evidence in these volumes, the Soviets have convinced a large proportion of the Free World, and perhaps the Communist Party of the Soviet Union itself, of their technological prowess.

Although the record of foreign technological dependence is largely expunged from Soviet writing, it is possible from time to time to find frank and open statements bearing on the issue. For example, at the Twenty-third Congress of the CPSU in 1966, the report on the directives delivered by Kosygin included the straightforward statement:

> The Soviet Union is going to buy ... over a thousand sets of equipment for enterprises and shops in the chemical, light, food and other industries. Deliveries from the fraternal countries will cover 48 percent of our needs in sea-going freighters, 40 percent of our needs in main line and industrial electric locomotives, about 36 percent of our needs in railway cars.[4]

As the Soviet definition of "sets" of equipment equals complete plant installations and the period covered by the statement was five years, the magnitude of the planned assistance may be readily seen.[5]

This Soviet dependence on foreign countries has largely escaped the attention of the Western world. For example, a survey conducted by the U.S. Information

[3] Among many examples, see chapter 15 and synthetic fibers.

[4] Novosti, *23rd Congress of the Communist Party of the Soviet Union* (Moscow, 1966), p. 256. See also A.C. Sutton, *Western Technology and Soviet Economic Development, 1930 to 1945* (Stanford: Hoover Institution, 1971; hereafter cited as Sutton II), p 3; and A.C. Sutton, "Soviet Merchant Marine", U.S. Naval Institute *Proceedings*, January 1970.

[5] These figures coincide with the material presented in chapter 21 (for ships) and chapter 20 (for locomotives).

Agency on European opinion concerning the relative success of U.S. and Soviet scientific and technical achievements[6] had extraordinary results. Accepting that the layman does not make a distinction between science and technology, then in 1961 more people in Western Europe believed the Soviet Union was technically ahead of the United States than vice versa. This opinion varied by country: in Great Britain 59 percent thought the Soviet Union was ahead and only 21 percent thought the United States was, while in West Germany one-half of the interviewees thought the United States was ahead compared with 19 percent for the Soviet Union. Where further questions were asked of those who thought the Soviet Union ahead, the answers were not in terms of Soviet use of Western technology but rather in terms of factors not supported by this study. Only about 15 percent of the German responses mentioned "captured German scientists" as a key factor in Soviet weapons and atomic energy programs. But most "Soviets-ahead" answers tended to be negative about the United States rather than positive about Soviet "success"; i.e., there were such observations as "Americans like a good time," "no coordination in America," "insufficiency of good scientists in the U.S."[7]

The paradox, or perhaps dilemma, that remains with us is that this study presents detailed and profuse evidence not only at variance with the Soviets' own interpretations of their achievements—despite their exceptional statements that hint otherwise—but also at complete variance with the beliefs of a majority of the Free World, including its academic communities. The confusion may even extend into U.S. Government departments. To illustrate this point, it may be profitable to explore the views of the U.S. State Department concerning Soviet technology and Soviet economic achievements because the State Department, as the senior U.S. executive department, has excellent sources of information and plays the paramount role in the establishment of U.S. economic policy toward the U.S.S.R.

Published State Department papers and statements made by State Department officials to Congress suggest conclusions directly opposed to those of this study. In brief, the State Department has consistently argued from 1918 to the present time—but more importantly in the years since about 1960—that Soviet industrial development has little connection with Western technology, and specifically that it has no vital connection with trade or with the other mechanisms discussed in this study as technology transfer vehicles.

In *The Battle Act Report: 1963*, submitted by the State Department to Congress, it is stated that trade with the West had made "[an] obviously limited contribution to Soviet economic and industrial growth" and that denial of trade could not affect basic Soviet military capability. The report continued to the

[6] Leo P. Crespi, "The Image of U.S. Versus Soviet Science in Western European Public Opinion," in R. L. Merritt and D. J. Puchala, eds., *Western European Perspectives on International Affairs: Public Opinion Studies and Evaluations* (New York: Praeger, 1967).

[7] *Ibid.*

effect that the Battle Act embargo program was not as extensive as in the early 1950s on the grounds that "the inevitable process of industrial and economic growth during those 12 years has meant that the Soviets have developed their own productive capability in many of the areas where a restraining impact was necessary and possible 10 years ago."[8] This State Department report was made precisely at a time when the Soviets were midway in a program to purchase complete industrial sectors in the West—concentrated fertilizers, synthetic rubbers and fibers, engines, computers, electric locomotives, and automobiles—all for industrial sectors either nonexistent or very backward in the U.S.S.R. in 1963.

A great deal of information for this study was derived from reports made by various U.S. industry delegations to the Soviet Union under the auspices of the State Department, although not all such delegation reports have been declassified. Some delegations commented adversely on the value of their visits insofar as the United States is concerned, and indeed from the technical viewpoint there has been little U.S. advantage. For example, the American Gas Industry Delegation was greeted in Leningrad by a number of prominent officials, and

> . . . a major part of their presentation included a discussion of a butane regeneration plant in the city and of its use in the local gas distribution supply operations. It was with extreme difficulty that a visit to the butane regeneration plant was finally arranged. The plant had not been in operation for two years.[9]

An American petroleum industry delegation was shown four refineries in August 1960[10]— three of them (Nuovo Ufa, Novo Kuibyshev, and Syzran) Lend Lease refineries,[11] and the fourth (Novo Baku) either a Lend Lease refinery or a Soviet copy of a U.S. installation.[12] The reports made by this delegation have been of particular value to the study. A skilled observer—and members of the delegation were skilled observers—cannot be easily fooled. Although

8 U.S. Dept. of State, *The Battle Act Report: 1963*. Mutual Defense Assistance Control Act of 1951 (Washington; 1963), p. 8. See Sutton II, pp. 3-6, for other State Department and academic statements on this topic; also see p. 211 for Assistant Secretary of Commerce Jack N. Behrman's denial of Soviet "copying" of agricultural machinery.
This writer is of course by no means the first to have raised serious doubts about the analytical performance of the State Department. A well-qualified critique which touches on some aspects of this study has been made by a former assistant chief of the Division of Research of the State Department: Bryton Barron, *Inside the State Department*, (New York: Comet Press, 1956). See p. 417 below.

9 "U.S.S.R. Natural Gas Industry," Report of the U.S. Natural Gas Delegation, July 1961, p. 38.

10 Robert E. Ebel, *The Petroleum Industry of the Soviet Union* (New York: American Petroleum Institute, June 1961), p. 107.

11 U.S. Dept. of the Interior, *A History of the Petroleum Administration for War, 1941-1945* (Washington, 1946), p. 270.

12 See p. 135.

13 All delegations, without exception, commented favorably on the hospitality.

the delegation was given a cordial reception,[13] written information was not forthcoming in abundance[14] and plant visits were difficult to arrange. Despite such problems, however, the reports display the observers' great perspicacity and technical skill.

The restrictions imposed by U.S. Government classification of data were only partly countered by the excellence of private reports, however; sometimes an alternative and more circuitous approach had to be applied to determine process origin. The most direct alternative was to isolate exports of technology to the Soviet Union by U.S. and foreign manufacturers and trace such exports to specific locations in the Soviet Union—this was the *modus operandi* in volumes One and Two. (State Department files provided detailed information for the period 1917-1945.) It was not possible to rely entirely on the same procedures for the period 1945-1965, since for this period the U.S. Government has restricted information pertaining to such transfers.

Hence another alternative was used in preparing volume Three. In addition to starting with Western firms and tracing technology to the Soviet Union, the author examined and traced back to a possible Western origin (within reasonable limits of time and space) major processes or equipment items known to be in use in the Soviet Union. When a technical link was thus established, a search was begun for a specific Western export or contract; by this means it was found that the Soviet synthetic rubber "Narit," for example, is a chloroprene rubber that traces back to the export of Dupont technology under Lend Lease. Much work originated in U.S. military departments and required only search and collection. For example, the "Moskvich" and "Leningrad" television sets had already been traced by the U.S. Air Force to East German origins, and turbojet engines had been traced to German BMW 003 and Junkers 004 and British Rolls-Royce engines. The Stalinets S-80 was found to be the Caterpillar D-7 in an extensive study by the Caterpillar Tractor Company.

Not all technical links could be fully confirmed. For this reason, two degrees of identification accuracy have been established and are referred to throughout the text. Where positive identification has been made, i.e., where a specific process or piece of equipment is identified in acceptable sources as of Western origin, it is classified as a "positive identification." On the other hand, if identification had to be "inferred" it is so noted; inferred identification includes the category for which information has been provided on a confidential or background basis. The YaAZ truck engine of 1947, for example, is inferred to be a General Motors engine on the basis of comparisons of technical data and the knowledge that such engines were exported to the U.S.S.R. under

[14] U.S. Congress, *Hearings*, Special Committee on Atomic Energy, 79th Congress, 1st session, November 27, 28, 29, and 30, 1945, December 3, 1945; Part I (Washington: U.S. Government Printing Office, 1945).

Lend Lease. Soviet adoption of some nonferrous metals processes has been indicated to the writer on a confidential basis.[15]

Khrushchev's challenge to the West in the late 1950s for peaceful competition coincided with the beginning of a massive Soviet program to purchase complete plants from the West. The year 1957 is central to our study. Up to that time the Soviets had been duplicating technology imported in the 1930s and under Lend Lease; no indigenous progress of any magnitude had been achieved, while certain industries, such as chemicals and synthetic fibers, were perhaps 40 years out of date. Consequently, rates of growth were slipping.

In 1957 several books were published in the Soviet Union proclaiming the benefits of socialist production and the role of Lenin and the Communist Party in bringing about the wonders of socialist Russia. An examination of some of these books[16] suggests several factors germinal to our study. First, little specific information is given; Moskatov, for example, uses multiple or percentage statements rather than absolute figures. Secondly, and of more interest for our purposes, data concerning qualitative factors—somewhat more difficult to disguise—suggest there was an extremely limited product range in Soviet industry in the late 1950s; a situation confirmed by the present study. Sominskii[17] lists a number of machines by model number, and the origins of these machines are presented in the text below. Moskatov covers similar ground and in one or two cases gives a quantitative framework for the number of models actually in use; e.g., in 1957 there were six basic models of tractors. There is, of course, no mention of the origins of this tractor technology.

In brief, Soviet publications on the question of technical progress make statements that, while greatly abbreviated, are not inconsistent with the findings of this study in the sense that no statement is made concerning types of equipment not covered in this text. The technology for types not mentioned did not even exist; such is consistent with subsequent purchase abroad as outlined in this study.

Finally, in a study full of paradoxes let a supreme paradox be suggested. The Soviet Union is the dedicated enemy of the Free World—this by the admission of its own leadership. There is no question that since 1917 there has been a continuing advocacy of the overthrow of capitalist systems. Yet the technical transfers described in these volumes have been the lifeblood of the Soviet industrial process and of the Soviets' ability to back up their avowed campaign of world revolution.

[15] Many aspects of the transfer have been more adequately discussed elsewhere. For example, the transfer of a duplicate set of plates for printing currency (from the U.S. Treasury to the Soviet Union, thus giving the Soviets the ability to print unlimited quantities of currency redeemable in U.S. dollars) has been well described and documented in Vladimir Petrov, *Money and Conquest* (Baltimore: Johns Hopkins Press, 1967).

[16] V. S. Sominskii, *O tekhnicheskom progresse promyshlennosti SSSR* (Moscow, 1957), and P. G. Moskatov, *Po puti tekhnicheskogo progressa* (Moscow, 1957).

What is more, the technical transfers have not only been allowed by Western governments but have in fact been encouraged and sometimes even singled out for acclaim. For example, the builder of the first modern Soviet trawlers—Brooke-Marine, Ltd., of Lowestoft, England—was honored by Queen Elizabeth with an M.B.E. (Member of the Order of the British Empire) for Charles Ernest White, the assistant general manager in charge of production.[18] In 1946 Swedish firms were reportedly threatened by their government's ministry of industry and commerce if they refused to take Soviet orders.[19] In Germany in the 1950s and 1960s the Howaldtwerke shipyards in Kiel, owned by the German Government, was a prominent builder of ships on Soviet account. Then in the mid-sixties came President Johnson's "bridges for peace," which opened wider the floodgates of American technology for the Soviets, although, to be sure, a similar argument had been used by Edwin Gay of the War Trade Board in 1919 to initiate trade with the Bolsheviks ("trade would bring the Bolsheviks into the civilized world").

Such, then, is the confused political arena for the transactions discussed in this study.

[17] Sominskii, *op. cit.* n. 16, p. 95.
[18] *The Shipbuilder and Marine Engine Builder* (London), February 1956, p. 119.
[19] *Electrical Review* (London), vol. 139, p. 890.

PART I

The Transfer Mechanisms: 1945 to 1965

CHAPTER ONE

Lend Lease and the "Pipeline Agreement," 1941 to 1946

There are two aspects to Lend Lease transfers: (1) shipments made under the five Supply Protocols of 1941-45 and related programs and (2) shipments made under the October 1945 "pipeline agreement"—after the end of the war with Japan and covering goods in inventory or procurement on September 2, 1945.[1]

U.S.S.R. LEND LEASE PROGRAM: THE SUPPLY PROTOCOLS

Negotiations on the First Supply Protocol began on December 7, 1941, but they were postponed until December 28 due to the entry of the United States into war with Japan. A few Soviet military requests in the First Protocol could not be fulfilled or had to be scaled down, and while the War Department was able to meet most commitments it could not at first supply all requests for trucks, guns, and light bombers, antiaircraft guns, antitank guns, and mortars. The War Department did supply tanks, trucks and planes, 100,000 field telephones, 500,000 miles of field telephone wire, 20,000 tons of toluol, 12,600 tons of leather, and 1,500,000 pairs of army boots. Approximately 1,752,000 tons of supplies were made available under this protocol.

[1] Data used in this chapter are from the unpublished U.S. Dept. of State, "Report on War Aid Furnished by the United States to the U.S.S.R." (Washington: Office of Foreign Liquidation, 1945). The published Supply Protocols are not a guide to actual shipments, only to anticipated ones. The reader should also consult George R. Jordan, *From Major Jordan's Diaries* (New York: Harcourt, Brace and Company, 1952), based on Soviet copies of the delivery notes; in most categories Major Jordan's report is consistent with the State Department publication, but sometimes he includes details to be found only in the Lend Lease invoices stored at the Federal Records Center, Suitland, Maryland.
The "pipeline agreement" of October 1945 is published in *Documents on American Foreign Relations*, VIII, July 1945-December 1946 (Princeton: Princeton University Press), pp. 127-32. It should be noted that Schedules A and B to the "pipeline agreement" have not been published but are available from the Department of State; a copy of these schedules has been deposited in the Hoover Institution Library.
The reader should also consult a manuscript of unknown but clearly authoritative authorship in the Hoover Special Collections: "*U.S.S.R. Lend-Lease Program*" (1945). This has data on the virtually unknown "special programs."

The Second Supply Protocol, known as the "Washington Protocol," was signed December 6, 1942, and approximately 770,000 short tons of material were made available by the War Department and 3,274,000 tons by all U.S. agencies. The War Department delivered planes, jeeps, antiaircraft guns, explosives, toluol, tractors, radio sets, clothing, field telephones and wire signal equipment, battery charging sets, tubes, and radio components. Items requested by the Soviets but not offered by the U.S. in this protocol included tarpaulin material, field glasses, radio locators, radio beacons, stereoscopic observation instruments for artillery, radio repair trucks, and light field repair shops for tanks and trucks.

The Third Supply Protocol, known as the "London Protocol," was signed in London on October 19, 1943. The War Department made substantial offerings against all Soviet requests except in teletype apparatus and in locomotives where it offered 500 to 700 locomotives against requests of 2000 to 3000. The total supplied by the War Department was 1,466,000 tons, including substantial quantities of locomotives, railroad cars, industrial lift trucks, tractors, cranes (mobile construction and port use types), power shovels, and teletype apparatus. The United States also began production on Soviet account of 600 steam locomotives and procurement for 10,000 flatcars and 1,000 dump trucks.

The Fourth Supply Protocol, signed in February 1944, covered the last half of 1944 and 1945. It included substantial deliveries of radio locators, tractors, large radio stations, cranes, shovels, shoes, and medical supplies; the main new item under this protocol was mobile construction equipment. U.S. offerings totaled 1,700,000 tons as well as port equipment (valued at $10 million) that included floating, portal, and mobile cranes for the Black Sea ports and heavy cranes for Murmansk and Archangel. The following U.S. offers were turned down by the Soviets: nonstandard combination power supply units, mainline electric locomotives, and nitroglycerin powder.

The Fifth Supply Protocol, signed in March 1945, included motor vehicles, cranes and shovels, tractors, road construction equipment, locomotives, some signal equipment but mainly industrial equipment.

There were in addition programs subordinate to the main Lend Lease Supply Protocols. These included an Arctic program for the supply of Soviet arctic ports, the "Outpost" program for construction of ports in the Soviet Far East, and the highly important Northern Siberian Air Route Program, as well as "Project Milepost" in support of Soviet Far Eastern operations.

The Northern Siberian Air Route program to establish a trans-Siberian airways system was initially suggested to Ray Ellis, director of the Radio and Radar Division of the War Production Board, while he was on a visit to the U.S.S.R., and was handled separately from the main Supply Protocol arrangements. Equipment comprising transmitters, receivers, and range equipment for eight major and 50 minor stations, and valued at $12 million, was requested and substantially assigned by March 30, 1945, for 7000 miles of airways with five 200-mile feeder lines.[2] The relationship of this program to Allied wartime operations is obscure.

COMPOSITION OF LEND LEASE SUPPLIES TO THE SOVIET UNION

About 98 percent of U.S. exports to the Soviet Union between June 1941 and September 1945 consisted of Lend Lease supplies. Table 1-1 shows the major categories of supplies and the approximate amounts shipped; this section describes the content of each of these supply categories in more detail.[3]

Table 1-1 MAJOR CATEGORIES OF LEND LEASE SUPPLY TO THE SOVIET UNION

Category	*Description of Category*	*Amounts (Arrived in Soviet Union)*
I	Aircraft and equipment	14,018 units
II	Vehicles (including tanks and trucks)	466,968 units
	Explosives	325,784 short tons
III	Naval and marine equipment	5,367,000 gross registered tons of shipping
		7,617 marine engines
IV	Foodstuffs	4,291,012 short tons
V	Industrial machinery and equipment	$1,095,140,000
VI	Materials and metal products	2,589,776 short tons of steel
		781,663 short tons of nonferrous metals
		1,018,855 miles of wire
		2,159,336 short tons of petroleum
		820,422 short tons of chemicals

Source: U.S. Dept. of State, *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945), pp. 20-28.

Category I included aircraft and aircraft equipment. A total of 14,018 aircraft was shipped under Lend Lease; these aircraft included pursuit planes, light bombers, medium bombers, one heavy bomber, transport planes, flying boats, observation planes, and advanced trainers. In addition, link trainers and a considerable quantity of aircraft landing mats and communications equipment were shipped.

Category II comprised military supplies of all types. Some 466,968 individual vehicle units were supplied to the Soviet Union. Combat vehicles included

[2] See anonymous manuscript, *op. cit.* n.1, in the Hoover Institution.

[3] Date from U.S. Dept. of State, *op. cit.* n.1. Figures are for "arrived," i.e., exports minus losses.

1239 light tanks, 4957 medium tanks, about 2000 self-propelled guns, 1104 half-tracks, and 2054 armored scout cars. The 2293 ordnance service vehicles included 1534 field repair trucks and 629 tank transporters. Trucks included 47,728 jeeps, 24,564 three-quarter-ton trucks, 148,664 one-and-one-half-ton trucks, 182,938 two-and-one-half-ton trucks, and smaller quantities of two-and-one-half-ton amphibian trucks, five-ton trucks, and special purpose trucks. Also shipped were 32,200 motorcycles and 7570 track-laying tractors with 3216 spare tractor engines. All equipment was provided with spare parts and ammunition in accordance with U.S.Army standards.

A total of 325,784 tons of explosives included 129,667 tons of smokeless powder and 129,138 tons of TNT.

Wireless communication equipment comprised a sizable portion of total shipments and included no less than 35,779 radio stations (one kilowatt and less). Related equipment included radio stations of higher power, radio locators, 705 radio direction finders, 528 radio altimeters, 800 radio compasses, 63 radio beacons, and large quantities of radio tubes, component parts, accessories, and measuring and testing equipment.

Construction machinery valued at over $10 million included $5,599,000 of road and aircraft construction equipment and $2,459,000 in tractor-mounted equipment, together with $2,099,000 worth of mixers and pavers and $635,000 worth of railroad construction equipment.

Railroad equipment included 1900 steam locomotives, 66 diesel-electric locomotives, 9920 flat cars, 1000 dump cars, 120 tank cars, and 35 heavy machinery cars, for a total of 13,041 railroad units.

Other military items shipped included 15 cableway bridges, five portable pipelines, 62 portable storage tanks, 100,000 flashlights with dry cells, and 13 pontoon bridges.

Category III comprised naval and marine equipment. Noncombat ships included 90 dry-cargo vessels, ten oceangoing tankers, nine Wye tankers, three icebreakers, 20 tugboats, one steam schooner, 2398 pneumatic floats, one motor launch, and two floating repair shops.

Combat ships sent to the Soviet Union included 46 submarine chasers (110 ft.), 57 submarine chasers (65 ft.), 175 torpedo boats in addition to another 24 torpedo boats supplied from the United Kingdom, 77 minesweepers, 28 frigates, 52 small landing craft, and eight tank-landing craft (and another two tank-landing craft from the United Kingdom) together with six cargo barges.

The marine propulsion machinery group included 3320 marine diesel engines, 4297 marine gasoline engines, 108 wooden gas engines, 2150 outboard motors, $254,000 worth of shafting and ship propellers, $50,000 worth of steering gear, 40 storage batteries for submarines, and parts and equipment (valued at $2,774,000) for marine propulsion machinery.

Special ship equipment included $1,047,000 worth of salvage stations and diving gear, $109,000 worth of jetting apparatus, one submarine rescue chamber, distilling apparatus valued at $36,000 and miscellaneous special shipping equipment valued at $44,000. Also sent were trawling equipment for minesweepers valued at $3,778,000, mechanical and electrical equipment for tugboats valued at $545,000, and mechanical and electrical equipment for ferry boats valued at $1,717,000. A large quantity of naval artillery and ammunition included 1849 Oerlikon guns and $2,692,000 worth of equipment for naval guns.

Over 4.2 million tons of foodstuffs was consigned in Category IV. These supplies included 1,154,180 tons of wheat, wheat flour, grain mill products, and seed; over 672,000 tons of sugar; 782,973 tons of canned meat, including 265,569 tons of "tushonka"; 730,902 tons of sausage, fat, butter, and lard; 517,522 tons of vegetable oil; and 362,421 tons of dried milk, eggs, cheese, and dehydrated products. Also sent were 9000 tons of soap and 61,483 tons of miscellaneous food products.

The shipments most significant to this study were in Category V—machinery and equipment valued at over $1 billion.

Groups V-1/3B included general-purpose engines and turbines, compressors, and pumps to a total value of $39,287,000.

Groups V-4/7 comprised equipment valued at $50,644,000, including crushing, screening, and mixing machinery ($8,048,000); conveyers and conveying systems ($1,651,000); marine winches ($460,000); cranes, derricks, hoists, and similar equipment ($33,272,000); and industrial trucks and tractors ($7,213,000).

Groups V-8 A/11 totaled $38,791,000, including fan and blower equipment ($3,702,000), mechanical power transmission equipment ($111,000), bearings ($25,813,000), and valves and steam specialties ($8,521,000).

Groups V-12/13B3 included general-purpose industrial machinery valued at $197,820,000. These groups comprised miscellaneous machinery ($4,508,000), electric rotating equipment for marine use ($1,867,000), electric rotating equipment for other uses ($17,700,000), military generator sets ($26,803,000), marine generator sets ($12,852,000), and other types of generator sets ($134,090,000).

Groups V-14/17 included $16,685,000 worth of electrical equipment. These groups comprised primary electrical power transmission equipment ($7,107,000), power conversion equipment ($6,923,000), marine secondary distribution equipment ($1,325,000), and motor starters and controllers ($1,260,000).

Groups V-18/22, totaling $5,902,000, included electric lamps ($101,000), miscellaneous equipment ($3,722,000), food products machinery ($735,000), textile industries machinery ($977,000), and pulp and paper industry machinery ($367,000).

Groups V-23/26, valued at $33,283,000, included printing trade machinery and equipment ($52,000), a tire plant from the Ford Motor Company ($8,675,000), rubber-working machinery ($115,000), wood-working machinery

($1,233,000), and metal-melting and heating furnaces ($23,208,000).

Groups V-27/30B, totaling $53,724,000, included blast and reverberating furnaces ($5,186,000), foundry equipment ($2,132,000), special industrial furnaces, kilns, and ovens ($3,268,000), several petroleum refinery plants ($42,610,000), and petroleum refinery machinery and equipment ($528,000).

Groups V-31/34B included special machinery for the glass industry ($671,000), special machinery for chemical manufacturing ($1,460,000), gas-generating apparatus ($13,677,000), miscellaneous specialized industrial equipment ($6,550,000), and cartridge manufacturing lines ($29,855,000). The value for this group totaled $52,213,000.

Groups V-35/39 included machine tools and metal-forming machinery valued at $404,697,000. These groups comprised machine tools ($310,058,000), rolling mills and auxiliary equipment ($25,356,000), drawing machines ($2,412,000), other types of primary metal-forming machinery ($304,000), and secondary metal-forming machinery ($66,567,000).

Groups V-40A/43B included welding and metal-working machinery valued at $15,199,000, comprising various welding machinery ($9,049,000), testing and measuring machinery ($2,830,000), miscellaneous metal-working equipment ($107,000), and various types of portable metal-working machines ($3,213,000).

Groups V-44A/47 comprised a total of $50,420,000 worth of various types of cutting tools and machine tool accessories. These groups included cemented carbide-cutting tools ($5,904,000), metal cutting tools ($34,878,000), other cutting tools and forming tools ($758,000), attachments and accessories for machine tools ($3,945,000), and tool room specialties and equipment ($240,000).

Groups V-48/52 included various types of agricultural machinery and drilling equipment. The total value of these groups was $51,570,000 and included agricultural machinery ($751,000), mining and quarrying machinery ($1,763,000), earth and rock boring and drilling equipment ($8,983,000), well and blast-hole drilling equipment ($9,023,000), and excavating and dredging machinery ($31,050,000).

Groups V-53/58C1 included miscellaneous equipment and machinery for a total value of $23,488,000, and comprised miscellaneous construction equipment ($797,000), office machines ($58,000), miscellaneous machinery ($1,195,000), teletype apparatus ($4,470,000), and 380,135 field telephone units ($16,968,000).

Groups V-58C2/59B, telephone and communications equipment valued at $28,630,000, included telephone and telegraph apparatus ($14,419,000), sound equipment ($543,000), automatic block and signaling system equipment ($10,880,000), industrial-type locomotives, cars, and spare parts for cars ($1,655,000), and mine-type locomotives and rail cars with appropriate spare parts ($1,133,000).

Groups V-60/63, valued at $3,885,000, included vehicle parts ($582,000), air conditioning and refrigeration equipment ($593,000), marine lighting fixtures

($1,045,000), other types of lighting fixtures ($421,000), and photographic equipment ($1,244,000). The photographic equipment group is interesting in that $393,000 of a total of only $1,244,000 for the group was en route to the Soviet Union as late as September 20, 1945; in other words, one-third of the allocated photographic equipment was en route to the Soviet Union after the end of the war with Japan.

Groups V-64A/67 included various types of scientific equipment to a total value of $12,431,000, comprising optical, indicating, recording, and control instruments ($6,902,000), navigation instruments ($727,000), professional and scientific instruments ($1,596,000), miscellaneous equipment ($396,000), and nonpowered hand tools ($2,810,000).

Groups V-68/71 consisted of miscellaneous tools and equipment valued at $22,493,000, and included mechanics' measuring tools ($3,672,000), marine power boilers ($90,000), industrial power boilers ($15,880,000), agricultural tractors ($2,773,000), and other miscellaneous equipment ($78,000).

These data show that Lend Lease supplies of industrial machinery and equipment to the Soviet Union between 1941 and 1945 were not only large in amount —i.e., in excess of one billion dollars—but also of a remarkably varied and extensive character and included equipment for all sectors of the civilian and military-industrial economy.

Category VI included materials and metal products. A total of 2,589,776 short tons of steel was shipped, and included 4857 tons of stainless steel wire, 3827 tons of special alloy wire, 56,845 tons of steel alloy tubes, 12,822 tons of stainless steel, 160,248 tons of cold-finished bars, 233,170 tons of hot-rolled aircraft steel, and large quantities of polished drill rod, armor plate, wire rope, pipe and tubing, wire nails, hot-rolled sheet and plate, railroad rails and accessories, car axles, locomotive car wheels, rolled steel car wheels, and other steel products. In addition, a total of 16,058 short tons of ferroalloys was shipped, including ferrosilicon, ferrochromium, ferrotungsten, and ferromolybdenum.

Shipments of nonferrous metals totaled 781,663 short tons, including a remarkable 339,599 short tons of base-alloy copper and large quantities of electrolytic copper and copper tubes. This group also included quantities of aluminum ingot and wire bar, and fabricated aluminum, zinc, lead, cadmium, cerium, cobalt, mercury, and nickel including 261 tons of pure nickel shapes.

Group VI-4A included a large quantity of miscellaneous metals and metal products including molybdenum concentrates, pig iron, and an incredible *one million miles* of telephone wire and submarine cable. The 2,159,336 short tons of petroleum products largely comprised aviation gas and gas-blending agents to raise the octane level of Soviet domestic gasoline. Large quantities of inorganic chemicals were shipped, including ammonium nitrate, caustic soda, potassium nitrate, soda ash, sodium cyanide, sodium dichromate, and similar basic chemicals. In the organic chemical field, shipments included quantities of acetone, butyl acetate, a large quantity of ethyl alcohol (359,555 short tons), ethylene glycol, glycerin, hexamine, methanol, phenol, and 113,884 tons of toluol (a base for manufacture of TNT).

Group VI-10C included $67,000 worth of compressed and liquefied gas. In addition about 12,200 tons of paints, varnishes, carbon, lampblack, and other pigments were shipped. Plastic shipments included 1139 tons of resins and 593 tons of cellulose film base; miscellaneous chemicals included ammonia rubber paste, boiler compounds, reagents, and chemicals used in the photographic industry.

Textiles included 102,673,000 yards of cotton cloth, 60,138,000 yards of woolen cloth, and 53,803,000 yards of webbing. In addition, quantities of tarpaulin, cordage, twine, and fish nets were supplied. Leather shipments included 46,161 tons of leather and $362,000 worth of specialized small lots of leather products.

Rubber shipments included large quantities of rubber products, among them shock absorber cord (166,000,000 yards), about seven million tires and tubes, and $7,784,000 worth of rubber hose.

In large-lot leather goods, 14,572,000 pairs of army boots, 221,000 pairs of ski boots, and other miscellaneous boots and shoes were shipped, in addition to leather apparel including leather jackets, belts, and miscellaneous leather goods.

Abrasives totaled 17,711 short tons, and abrasive products were valued at over $15 million.

One interesting item included in Groups VI-22A/22C comprised carbon and graphite—of interest because of possible utilization in atomic energy. Shipments of graphite powder totaled 3,017 tons; graphite and carbon electrodes totaled $20,933,000; and other graphite material totaled $1,532,000.

Finally, about 14,000 tons of paper and paper products comprised Groups VI-23A/24 with $1.8 million worth of photographic material, asbestos material, button, and miscellaneous other products.

U.S. Army equipment was shipped from the Persian corridor. This equipment included two truck assembly plants, 792 ten-ton Mack cargo trucks, 21 cranes, and 1751 short tons of 75-pound railroad rails plus accessories. The U.S. Army Air Force shuttle bases in the Soviet Union were turned over to the Soviet Union, and 51 storage tanks used by the British Army in the Caspian Sea area were transferred to the Soviet Union.

THE PIPELINE AGREEMENT OF OCTOBER 15, 1945

Undelivered Lend Lease material in inventory or procurement at the end of World War II was made available to the Soviet Union under the so-called "pipeline agreement" of October 1945. Under this agreement the Soviet Union undertook to pay the United States in dollars, with only a small amount of interest, for additional material.

The goods shipped under this agreement were valued at $222 million and comprised only industrial machinery and equipment with some spare parts. A large proportion of the equipment consisted of electrical generating stations, boilers, engines, motors, and transformers for the electric power industry. Other large shipments included machine tools—such as hydraulic presses, hammers, mechanical presses, shears, flanging machines, and bending machines. Large amounts of mining equipment included mine hoists, ball mills, jaw crushers, and hammer mills. The machine tool shipments comprised lathes of all types, including engine lathes, precision lathes, semiautomatic machines with special tools, universal machines, turret lathes, chucking machines, and large quantities of spare parts and specialized equipment ancillary to such machine tools. Spare parts for vehicles previously shipped under Lend Lease were also included in the agreement.[4]

The Soviet Union has not maintained its payments schedule under this agreement.

Table 1-2 TOTAL AMOUNT OWED AGGREGATE PAYMENTS, AND TOTAL OUTSTANDING ON SOVIET LEND LEASE "PIPELINE" ACCOUNT AS OF DECEMBER 31, 1967*

Obligation under agreement of October 15, 1945	$222,494,574.01
Interest accrued	$107,171,641.28
Total amount owed	$329,666,215.29
Principal paid through December 31, 1967	$47,023,534.57
Interest paid through December 31, 1967	$107,171,641.28
Balance to be repaid	$175,471,039.44
Past due (as of September 1968)	$ 77,024,968.00

Source: Letter from U.S. Department of State.

* This table does not include amounts due on the $11 billion Soviet Lend Lease account.

UNITED KINGDOM LEND LEASE TO THE U.S.S.R.

War material furnished by the United Kingdom to Russia—free of cost after Russia entered the war against Germany—was regularized in an agreement signed on June 27, 1942.

[4] The equipment lists were not published by the State Department, but see Schedules A and B deposited at the Hoover Institution.

By the end of May 1943, a total of 4690 complete aircraft had been sent to Russia, with appropriate supplies of spares, including engines, airframes, and other articles of equipment.[5] Other supplies shipped to Russia included material for all sections of the Soviet fighting forces: 1042 tanks, 6135 miles of cable, over two million meters of camouflage netting, and 195 guns of various calibers with 4,644,930 rounds of ammunition.

The United Kingdom also shipped the following between October 1, 1941, and March 31, 1946: 28,050 long tons of tin, 40,000 long tons of copper, 32,000 long tons of aluminum, 3300 long tons of graphite, and £1,424,000 worth of industrial diamonds.[6]

UNRRA SUPPLIES TO THE UKRAINE AND BELORUSSIA[7]

In August 1945 the United Nations agreed on a $250 million United Nations Relief and Rehabilitation Administration (UNRRA) program for Ukraine and Belorussia, and in a statement of rather twisted logic[8] promptly suspended payments for such supplies. After numerous delays, two small U.N. missions arrived

Table 1-3 UNRRA DELIVERIES TO BELORUSSIA AND THE UKRAINE

Categories	*Belorussian SSR* U.S. Dollar Equivalents	*Belorussian SSR* Gross Long Tons	*Ukrainian SSR* U.S. Dollar Equivalents	*Ukrainian SSR* Gross Long Tons
Food	$29,591,800	101,396	$99,437,700	315,748
Clothing, textiles, and footwear	7,044,200	5,784	17,207,700	16,225
Medical and sanitation	991,100	646	2,445,500	1,037
Agricultural equipment and seeds	5,412,100	8,050	16,988,900	38,069
Industrial equipment	17,780,800	25,977	52,119,500	95,970
Total	$60,820,000	141,853	$188,199,300	467,049

Source: G. Woodbridge, *UNRRA*, II (New York: Columbia University Press, 1960), p. 250.

[5] Source: Great Britain, *Accounts and Papers*, 1942-43, XI, Command 6483 (November 1943).

[6] U.S. Bureau of Mines, *Mineral Trade Notes*, (Washington) vol. 22, no. 6 (June 1946), p. 49.

[7] This section is based on George Woodbridge, *UNRRA* (New York: Columbia Univeristy Press, 1950), vol. II, pp. 231-56.

[8] The U. N. subcommittee granting the suspension gave the following reason for suspension of payment: "Information supplied to the Subcommittee by the representatives of the Byelorussian Soviet Socialist Republic indicated that in accordance with the constitutional provisions of the Union of Soviet Socialist Republics, this constituent republic has no foreign exchange

in Russia to administer the program; the missions reported that supplies were equitably distributed, although with no indication that they originated with the United Nations, and mission reports were submitted concerning their distribution. By March 1947 the supply program was about 99.61 percent fulfilled, only $982,700 remaining of the one-quarter billion dollar allotment.

Top priority was given to fats, oils, and meats. These were followed by industrial equipment, with emphasis on equipment for restoration of public utilities and communications together with equipment for basic industries such as peat extraction equipment, a brick-making plant, an asphalt plant, and a mineral wool plant. Almost half of the industrial procurement program was devoted to "protocol goods," mainly electric power stations ordered by the U.S.S.R. in the United Kingdom under the Third Protocol of 1942 but not delivered by 1945. Industrial goods not requiring manufacture (e.g., small locomotives, raw materials, electrical systems, and military vehicles) were by and large delivered before the end of 1946.

SOVIET REQUESTS AND SOVIET RECEIPTS

The Soviet view of Lend Lease in historical perspective is highly deprecatory. A. N. Lagovskii, for example, suggests that the first deliveries arrived only in February 1942, in very insignificant quantities, and "even this delivery was far from being first class."[9] After pointing out that the United States subsequently increased its deliveries to a total of "several billions," Lagovskii suggests that very little was in the form of needed tanks and aircraft and that the U.S.S.R. was "one of the best economically developed countries in the world" on the eve of World War II.[10] Lagovskii concludes that deliveries were "very modest" and that the "Soviet Armed Forces defeated the Fascist German Armies with domestic weapons, developed by our designers, engineers, and workers at our plants."[11]

Other Soviet accounts also maintain that Lend Lease was a minor factor in defeating the German invaders, and no mention has been found in any of them of the deliveries of over $1 billion of industrial equipment.

A comparison of Soviet requests with actual U.S. deliveries does not support

assets of its own, such assets being entirely in the hands of the government of the Union of Soviet Socialist Republics. Nevertheless, in view of the great destruction in the Byelorussian Soviet Socialist Republic, the Subcommittee recommends that the government of the Byelorussian Soviet Socialist Republic be considered at this time not to be in a position to pay with suitable means of foreign exchange for relief and rehabilitation supplies which the Director General will make available." Woodbridge, *op. cit.* n.7, p. 234.

[9] A. N. Lagovskii, *Strategiia i Ekonomika*, 2d edition (Moscow, 1961), pp. 113-14.

[10] *Ibid.*, pp. 116-17.

[11] *Ibid.*, pp. 115-16.

the Soviet position in any manner whatsoever. For example, the initial Soviet request for 3000 pursuit planes was sizable; however, the combined U.S. and British offers under the First Protocol were 2700 pursuit planes, obtained by stripping every other front of its requests. Initial Soviet requests for tanks were for 9900 light and medium tanks, and combined U.S. and British supply on the First Protocol was 4700 tanks. Other items were filled, and indeed overfilled. For example, the Soviets initially requested 20,000 submachine guns—they were offered 98,220 under the First Protocol alone.[12]

We may therefore conclude that Lend Lease with its associated and supplementary postwar programs injected about $1.25 billion worth of the latest American industrial equipment into the Soviet economy. This figure does not include the value of semifabricated materials, foodstuffs, industrial supplies, and vehicles of indirect benefit. This industrial equipment comprised machines and technologies generally in advance of Soviet wartime capabilities (as will be described in later chapters), and the greater proportion was of significant value to the postwar economy.

[12] Based on data in anonymous, *op. cit.* n.1, p. 30. A comparison of the other protocols and Soviet requests could be constructed from the data given in Robert H. Jones, *The Roads to Russia* (Norman: University of Oklahoma Press, 1969), pp. 119, 167.

CHAPTER TWO

World War II Reparations for the Soviet Union

OBJECTIVES OF THE SOVIET REPARATIONS POLICIES

A prime objective of the Soviet Union during World War II was to exact from its enemies the maximum of reparations in kind to rebuild the war-torn and occupied areas of Russia. U.S. Secretary of State Edward J. Stettinius recalled the great importance attached to such reparations: "Stalin, on the question of German reparations, spoke with great emotion, which was in sharp contrast to his usual calm, even manner."[1]

Only those reparations acquired in the form of plants and equipment transferred to the U.S.S.R. from enemy countries come within the scope of this study.

Table 2-1 SUMMARY OF ORGANIZATIONAL FORMS USED BY THE SOVIET UNION TO TRANSFER REPARATIONS AFTER 1944

	Capital transfers (reparations in kind)	*Trophy brigades (war booty)*	*Joint stock companies (financial penetration)*
Italy	Yes	No	No
Austria	Yes	Yes	Yes
Manchuria	Yes	Yes	A few only
Finland	Yes	No	No
Korea	Probably No	No	Yes
Japan	No	No	No
Rumania	Yes	Yes	Yes
Hungary	Yes	Yes	Yes
Bulgaria	Yes	—	Yes (a few)
Germany (East)	Yes	Yes	Yes
Germany (Western zones)	Yes	No	No
Yugoslavia	—	No	Limited

Source: J. P. Nettl, *The Eastern Zone and Soviet Policy in Germany, 1945-50* (London: Oxford University Press, 1951); and N. Spulber, *The Economics of Communist Eastern Europe* (New York: The Technology Press of M.I.T., and John Wiley & Sons, 1957).

[1] E. R. Stettinius, Jr., *Roosevelt and the Russians: The Yalta Conference* (New York: Doubleday, 1949), p. 263.

Some other forms of reparations—the "trophy brigades", for example, and the operation of plants in occupied areas on Soviet account like the SAGs (Soviet companies in East Germany) and the SOVROMs (Soviet companies in Rumania)—are not fully discussed, as they do not fall directly within the scope of our examination.[2]

Capital goods and technology that were transferred to the U.S.S.R. under the reparations agreements and that contributed both industrial capacity and technology will be described on a geographic basis in this chapter. Various chapters in Part II include descriptions of the impact of reparations on individual sectors of the Russian economy.

In monetary terms, reparations claims were substantial; in fact, a figure of $20 billion in 1938 dollars is commonly cited as the Soviet objective. The claims can be approximately and more cogently summarized on a country-by-country basis as follows:[3]

Germany	$10,000 million (plus one-third of the German fleet)
Austria	400 million
Finland	300 million
Italy	100 million (plus one-third of the Italian fleet)
Rumania	300 million
Bulgaria	70 million
Hungary	300 million
Manchuria	800 million (allocated to the Chinese reparations account but arbitrarily removed by the U.S.S.R.)

The figure of $20 billion for total Allied reparations, of which about one-half was to go to the U.S.S.R., was apparently arrived at with only passing objection from the United Kingdom and none from the United States. The original Molotov submission at the Yalta conference was that the amount be fixed at $20 billion with $10 billion to go to the U.S.S.R.[4] Stettinius reported that he himself suggested 50 percent should go to the U.S.S.R.[5], but that there was no final agreement on total absolute amounts:

[2] These are discussed in two excellent books. See J. P. Nettl, *The Eastern Zone and Soviet Policy in Germany, 1945-50* (London: Oxford University Press, 1951) for Germany, and Nicolas Spulber, *The Economics of Communist Eastern Europe* (New York: The Technology Press of M.I.T. and John Wiley & Sons 1957), for excellent, very detailed material on the other East European countries.

[3] Estimates of actual, in contrast to planned, transfers suggest a total of about $10 billion. For example, the U.S. Central Intelligence Agency stated: 'The economic gains accruing to the U.S.S.R. as a result of the European bloc arrangements was greatest during the 1945-55 period when direct and indirect reparations netted the U.S.S.R. an amount estimated at roughly 10 billion dollars.' It should be noted that this excludes Manchuria and possibly Finland. U.S. Congress, *Comparisons of the United States and Soviet Economies*, Joint Economic Committee, Sub-Committee on Economic Statistics, Prepared by the Central Intelligence Agency in Cooperation with the Department of State and the Department of Defense, Supplemental Statement on Costs and Benefits to the Soviet Union of Its Bloc and Pact System: Comparisons with the Western Alliance System, 82nd Congress, 2d session (Washington, 1960).

[4] Stettinius, *op. cit.* n.1, p. 165.

[5] *Ibid.*, p. 231.

> It should be understood that there was absolutely no commitment at Yalta that the total sum of reparations should be twenty billion and that fifty percent should go to the Soviet Union. We made it clear that these figures were merely a basis for discussion.[6]

Stettinius added that Russia claimed "incorrectly" that Roosevelt agreed to the $20 billion figure.[7] It is noticeable that no one suggested a measure of relative war damages as a basis for reparations, nor were any engineering or economic studies made to support relative damage claims.[8]

According to one authority, J. P. Nettl:

> It is clear that the Soviet authorities were working on a separate plan, prepared before the long drawn-out discussions in the Allied Control Council had even begun. The plan was in operation at a time when the Western Reparations Agency had only begun to register the individual claims of participating powers and was tentatively having particular works earmarked for dismantling.[9]

The method used by the Soviets to arrive at specific country reparations demands differed according to Soviet military and political relationships with the respective countries. Reparations from Germany, Austria, and Italy were settled at discussions by the Big Three; the Soviet share was first taken out on a priority basis by the Moscow Reparations Commission and the balance transferred to an Allied Reparations Commission in Brussels for further distribution, including a second cut for the U.S.S.R. This arrangement worked well—for the Soviet Union.

Finland, Rumania, Hungary, and Bulgaria made bilateral peace agreements with the U.S.S.R. and their reparations were also determined by bilateral agreements. Manchurian industry was actually a charge against the Chinese reparations account; however, the Soviets unilaterally moved into Manchuria just before the end of war in the Far East and removed some $800 million worth of equipment before the U.S. Inspection Commission arrived.[10]

The Soviet reparations program, as pointed out by Nettl, contained definite indications of detailed long-range planning with clearcut objectives, and although each country (Finland, Hungary, Rumania, Germany, Italy, Korea, and Manchuria) was treated differently, some basic parallels can be drawn.

First, the reparations programs were designed to supply capital goods to the Soviet economy, but only modern units of technology were to be supplied.

[6] *Ibid.*, p. 266.
[7] *Ibid.*, p. 231.
[8] *Ibid.*, p. 231. The UNRRA studies of damage in the Soviet Union were not based on first-hand information, and are extremely vague.
[9] Nettl, *op. cit.* n.2.
[10] Edwin Pauley, *Report on Japanese Assets in Manchuria to the President of the United States, July 1946* (Washington, 1946).

Obsolescent plants were ignored. The intent was to gear acquisitions to the future needs of the Soviet economy.

Second, there are some unusual parallels. For example, the Finland reparations program was similar to that of Korea, while the German program was similar to that of Manchuria. There is no question that the Soviets had a plan, but scattered evidence also suggests they tried to cover their steps and obscure the plan. In Manchuria, for example, they encouraged Chinese mobs to wreck the plants after Soviet dismantling had removed desirable equipment.[11]

Third, equipment choices are interesting as they parallel deductions about weaknesses in the Soviet economy; however, such choices puzzled the Pauley Mission engineers in Manchuria, who could not understand, for example, why the Soviets left electric furnaces and cement kilns and removed ball bearings.

SALVAGE VALUE OF DISMANTLED PLANTS

It has been widely suggested that dismantling of plants and removal to the U.S.S.R. was wasteful, inefficient, and of minor economic and technical value.

Statements of a general nature can be found by American officials concerned with Soviet policy in the late 1940s. For example, Walter Bedell Smith, U.S. Ambassador in Moscow, made the following comment:

> The destructive and unskilled methods used by the Soviet Army in dismantling German industrial plants had been enormously wasteful, and it had proved difficult for the Russians to reestablish these plants in the Soviet Union.
>
> Foreigners who traveled by rail from Berlin to Moscow reported that every railroad yard and siding was jammed with German machinery, much of it deteriorating in the rain and snow.[12]

A similar statement was made by Lucius Clay, U.S. military governor in Germany:

> The Soviet Government soon found that it could not reconstruct these factories quickly, if at all. Reports verified by photographs reaching U.S. intelligence agencies in Germany showed that almost every siding in East Germany, and many in Russia, contained railway cars filled with valuable machine tools rusting into ruins.[13]

Closer observation may be gleaned from Fritz Löwenthal,[14] a former Com-

[11] *Ibid.*
[12] W. B. Smith, *My Three Years in Moscow* (Philadelphia: J. B. Lippincott, 1950), p. 224.
[13] Lucius D. Clay, *Decision in Germany* (New York: Doubleday, 1950).
[14] Fritz Löwenthal, *News from Soviet Germany* (London: Victor Gollancz, 1950), p. 207.

munist official in charge of the Control Department of the Central Legal Administration in the Soviet Zone:

> In Odessa, Kiev, Oranienbaum, Kimry, and other places, where the dismantled factories were to be reassembled, it often turned out that vital machinery was missing or had been damaged beyond repair, as the dismantling is invariably carried out by the Russians at top speed and without proper care.[15]

Vladimir Alexandrov, a Russian refugee, makes even stronger statements. For example: "The dismantling of German industry . . . was characterized mainly by the almost complete absence of any overall direction, particularly with regard to the technical questions involved in dismantling complicated industrial equipment."[16] Alexandrov adds that shortage of railroad equipment, disorganized loading, weather, and general inefficiency greatly reduced the value of the dismantled equipment.

Other writers have viewed this inefficiency as the reason for a change in Soviet policy and the establishment of the SAGs to provide current reparations for the Soviet economy in lieu of the transfer of capital equipment. For example, Almond reports the following:

> At first they believed this purpose [i.e., the transfer of capital equipment] to be served best by the removal to Russia of large quantities of industrial equipment. It soon became apparent, however, that the Russians generally lacked the skilled labor and technical know-how required to dismantle, reassemble, and operate this equipment efficiently; consequently, this method of exacting reparations proved to be even more wasteful than would normally be expected. Soviet policy then switched to reparations out of current production. Roughly one-third of the industrial capacity remaining in the zone was transferred to Soviet ownership, but left in place to be operated for Soviet account using German labor, fuel, and raw materials.[17]

Two conclusions can be drawn from the foregoing statements: (1) the Soviets were hasty and unskilled and consequently may have damaged machinery and equipment, and (2) weather, particularly rain, may have corroded machinery.[18]

On the other hand, Nettl observes: "Against this is the fact that the Soviet

[15] *Ibid.*

[16] Robert Slusser, ed., *Soviet Economic Policy in Postwar Germany* (New York: Research Program on the U.S.S.R., 1953), p. 14.

[17] Gabriel A. Almond, *The Struggle for Democracy in Germany* (Richmond: The William Byrd Press, 1949), p. 158.

[18] Rainfall in Eastern Europe tends to be less than in Western Europe and precipitation for the years 1945-48 was normal. Average rainfall at Berlin from 1938 to 1950 was 594.7 mm per year; in 1946 it was slightly below this (570.6 mm) and in 1945 and 1947 slightly above (629.8 and 626.9 mm, respectively), *World Weather Records, 1941-50*, (Washington, U.S. Weather Bureau), p. 677.

Government had great experience of removing and reassembling complete factories. Much was done during the war, but the principle goes back to Tsarist days!"[19] Examination of the evidence of installation of equipment in the Soviet Union suggests that the Soviets did indeed reerect these plants in the U.S.S.R. and that the plants in fact made a significant contribution to Soviet industrial development in the late 1940s and early 1950s.

The amount of waste, however, cannot be determined on the basis of the evidence at hand. As the physical removals were numerous, it is essential to determine accurately the possibilities of successful dismantling in order to arrive at a more accurate assessment of its potential contribution to the Soviet economy. If dismantled plants could not be reerected in the U.S.S.R., or if they were lost or heavily damaged in transit, then regardless of how many plants were dismantled and transferred, the economic impact would be insignificant.[20] Some consideration is therefore given to this question, and the arguments are summarized in the next sections.

The first factor that has to be taken into account is the condition of the plant as inherited by Soviet occupation forces, particularly whether Allied bombing—extremely heavy in the later phases of the war—had damaged factories beyond usefulness. Reports of the U.S. Strategic Bombing Survey, a series of highly detailed postwar ground examinations of 25 target plants, concluded that large tonnages of bombs had not, for several reasons, reduced these plants to a completely unusable condition. The effect of heavy bombing was to halt production temporarily, not to destroy productive capacity. For example:

> Physical damage studies point to the fact that machine tools and heavy manufacturing equipment of all kinds are very difficult to destroy or to damage beyond repair by bombing attacks. Buildings housing such equipment may be burned down and destroyed but, after clearing away the wreckage, it has been found more often than not, that heavy equipment when buried under tons of debris may be salvaged and put back into operation in a relatively short time and with comparatively little difficulty.[21]

Since the Soviets transported only less damageable items (e.g., machine tools and equipment rather than utility lines, steel-fabricated structures, and

[19] Nettl, *op. cit.* n.2, p. 205.

[20] This is a technical question. The economics of dismantling, as many commentators have suggested, are obscure. For example, John Hynd, M.P.: "I have never been able to understand the economics of putting 2000 men at work for twelve months—2000 man years— dismantling a rusty old steel factory, breaking it up, marking up the parts, packing them up into crates, and sending them to some other country, where it will probably take two or three years to rebuild the factory, and when, in four or five years' time, someone will have an out-of-date and rusty factory, whereas, if we had left it in Germany producing steel, we should probably have been able to build in the same time, and without any loss, a new modern, well equipped up-to-date factory" (Great Britain, *Parliamentary Debates*, October 27, 1949, p. 534).

[21] U.S. Strategic Bombing Survey, *Aircraft Division: Industry Report*, no. 84, January 1947.

gas holders) it may be asserted that strategic bombing had very little effect, and probably reduced the number of even the most desirable machine tools available for reparations by only about ten percent.

The next question concerns the extent of damage incurred in dismantling and removal procedures. Most Western commentators on dismantling have stated that Soviet dismantling policy was inept and wasteful, and that ultimately the Soviets were induced to switch to a policy of leaving industry in place to be operated by captive companies on Soviet account. This may be a rather superficial view.

At the end of hostilities in Europe the Russians had a great deal of experience in dismantling and the West had very little—this assertion may be highlighted by examining those categories which were subject to little dismantling. The Soviets concentrated on plants containing equipment and machines that could be safely transported. Close comparison of removals in Manchuria and East Germany indicates that almost 100 percent of removals had a high salvage value and were easily removed and transported, i.e., machine tools, precision instruments, and small items of equipment *not* made of fabricated sheet metal. On the other hand, the Western Allies in Europe appear to have concentrated their removals on plants with a relatively low salvage value. One cannot, for example, satisfactorily remove an iron and steel plant to another location, which is exactly what the Allies tried to do. In fact, the Western Allies reduced German steel capacity by 25 percent and concentrated removals in this sector.[22] Although the Soviets did try cutting up and removing cement kilns in Manchuria, the mistake was not repeated in East Germany.

Soviet proficiency in dismantling and shipping plants to Russia is exemplified by events in 1944 in Persia. There the United States used two truck assembly plants (TAP I and TAP II) to assemble U.S. trucks that had been "knocked down" before on-shipment to the U.S.S.R. under Lend Lease. Almost 200,000 trucks were finally assembled in these two plants. Apart from the vehicles assembled, the plants themselves were allocated to the Soviet Union under the Lend Lease agreement, and on December 7, 1944, orders arrived to dismantle and transfer to Russia. A Soviet Acceptance Committee arrived three days later. One plant was divided into small segments, each in charge of one U.S. officer, one Soviet officer, and one interpreter. By January 17, 1945, the entire plant had been dismantled, labeled, loaded onto 115 flatcars, and shipped by rail to the U.S.S.R. Thus in a little over four weeks what U.S. Army spokesmen described as a "considerable consignment" was handled with no trouble. The second plant followed in April on 260 flatcars and was handled with equal dispatch.[23]

[22] See n. 20, comments of Mr. Hynd, M. P.

[23] T. H. V. Motter, *The Persian Corridor and Aid To Russia* (Washington: Department of the Army, Office of the Chief of Military History, 1952).

It should be noted also that 20 years later, on the testimony of Juanita Castro Ruz (sister of Fidel Castro of Cuba), Cuban sugar mills were "dismantled and shipped to the U.S.S.R. as collateral for Cuba's imports of Soviet arms and ammunition."[24]

Therefore, we may have imputed to the Soviets the same mistakes we made ourselves due to lack of experience in dismantling and removing plants. Further, although dismantling is a very inefficient method of developing capacity, the Soviets may have partly avoided or at least offset this factor by long-range planning and greater dismantling experience gained in the 1940-42 movement of more than 1300 large industrial plants behind the Urals, including all aircraft, tank, and motor plants; 93 steel plants; 150 machine tool plants; and 40 electrical plants.[25]

Thus the change in policy in May 1946, when the Soviets announced that dismantling in the Soviet Zone was almost completed, was probably not the result of "inefficiency" but of a knowledge born of experience that remaining plants could not be removed successfully and would better serve the Soviet purpose by operation in place.

We can learn something of Soviet dismantling policy by examining those plants left in place and *not* removed to the U.S.S.R. Five dismantling patterns emerge:

1. Plants with a low salvage value were not removed *in toto*, although individual pieces of equipment and instruments from such plants were selectively removed. Thus the Soviets avoided removing iron and steel furnaces and cement kilns, for example.
2. Machines and equipment with a high salvage value and a high value-to-weight ratio were prime targets for removal. Thus machine tools of all types, textile, papermaking, and food processing machinery, instruments from all industries, and electrical equipment received first priority. Such equipment can be easily removed, easily prepared for shipment, and easily crated and loaded, and it withstands transportation relatively well.
3. The first two observations are modified in one important way: choice of removals was selective in terms of obsolescence. This came out clearly in Manchuria, where the older machines were almost always left and the more modern machines always removed.
4. Selective removals were supplemented by items in short supply in the U.S.S.R., particularly rubber conveyer belts (used for shoe repair), electric motors of all types and sizes, hand tools, laboratory equipment, and hospital equipment.

[24] U.S. House of Representatives, *Annual Report for the Year 1965*, House Committee on Un-American Activities, 89th Congress, 1st session (Washington, 1966).

[25] R. H. Jones, *The Roads to Russia* (Norman: University of Oklahoma Press, 1969), p. 222.

5. The planned nature of the removals is emphasized in several ways. It is particularly notable that sufficient equipment to produce the power needed for the dismantling operation was left in place; a casual program would have removed such equipment.

It has been suggested that much reparations equipment was damaged in removal or that bad packing resulted in damage in transit. Contrary evidence can be drawn from two areas, Manchuria and Germany. The Pauley Mission obtained photographs and information concerning the dismantling of Manchurian equipment. The work was undertaken by Soviet troops under the direction of officers who were presumably civilian specialists temporarily in army uniform. Photographs of these troops at work indicate that they were young, but their work appears, from the photographs, to have been methodical. The equipment was removed from its bases, placed on wood skids, and then crated. Heavy damage was done to factory walls only to remove equipment. American engineers on later inspection trips noted several points which lead to the conclusion that the dismantling was not done in great haste. Certain plants were subjected to dismantling several times at intervals of several months. (See Table 2-2.)

Table 2-2 THE SOVIET DISMANTLING SCHEDULE IN MANCHURIA (MAJOR PLANTS ONLY)

Manchurian Plant	*Reported start of dismantling*	*Reported finish of dismantling*
Mukden Main Arsenal	August 15, 1945	March 7, 1946
Manchuria Machine Tool Co.	August 20, 1945	November 14, 1945
Manchurian Gas Co.	August 20, 1945	December 1945
Mukden Refinery	August 21, 1945	February 1946
Fouhsin Power Plant	August 26, 1945	November 1945
Japanese Army 1st Fuel Depot	September 15, 1945	November 10, 1945
Fushun Power Plant	September 20, 1945	October 30, 1945
Molybdenite Mine	Two weeks in September 1945	
Manchuria Machine Tool Co.	September 1945	November 1945
Manchu Wire Rope Co.	Mid-September 1945	Mid-November 1945
Manchu Iron Co.	September 1945	February 1946
Southern Manchurian Railway Co. Repair Shops	October 12, 1945	October 25, 1945
Nippon Air Brake Co.	October 12, 1945	October 25, 1945
Manchu Rubber Co.	October 12, 1945	November 19, 1945
Manchurian Light Metal Co.	October 1945	Early November 1945
Tafengmen Power HEP	Three weeks in October 1945	
Anshan Teto Transmission Tower Co.	October 1945	November 1945
Taiping Hospital	End October 1945	End November 1945
Manchu Otani Heavy Ind. Co.	November 1945	November 1945

Source: Reconstructed from Edwin Pauley, *Report on Japanese Assets in Manchuria to the President of the United States, July 1946* (Washington, D.C., 1946), Appendix 3.

Sometimes the Soviets made it more difficult for later repair work, e.g., by bending over hold-down bolts; such effort is unlikely to be expended in a hasty operation.

Photographs of the crates and the crating process in Germany suggest careful work under Soviet supervision.[26] Crates were marked for Stankoimport, an organization with extensive experience in importing foreign equipment. There is no reason to suppose these shipments would not be handled like any other Soviet imports of machinery. It also must be borne in mind that Soviet practice is to place complete responsibility on the individual in charge, with harsh penalties for failure, and there is no reason to believe that any other procedure was followed in the reparations removals. There was certainly pressure on the 70,000 or so individual German and Chinese laborers recruited to assist in removals.

Another factor to be considered is whether damaged equipment could have been restored to its former usefulness; and there is evidence that Soviet engineers have exerted great ingenuity in such efforts.[27] A practical view of the possibility of this type of recovery was seen in a 1946 German exhibition in the British sector of Berlin with the theme "Value from under the Ruins." Exhibits included lathes, stamping dies, presses, gears, and even more delicate apparatus such as electrical equipment, typewriters, sewing machines, and printing machines retrieved from under debris (where they had lain for two years or more) and returned to original working order. Acid baths and abrasives were used to remove rust, high-penetration oils freed interior working parts, and badly damaged parts were replaced. Precision bearings were brought back by electrodeposition of chromium, and sandblasting was used on larger metal parts.[28] This, then, is a practical example of recovery of *delicate* equipment subjected to far greater abuse and more adverse conditions than any equipment removed from Germany to the Soviet Union. There is no reason why Soviet technicians could not have performed as well on weatherbeaten equipment or on equipment damaged in transit.

Support for this argument may be derived from reports on German equipment moved during World War II across national frontiers and sometimes underground to avoid bombing damage. For example, in a claims letter from Bussing NAG Flugmotorenwerke to Reichsluftfahrtministerium in July 1944 the company—obviously for claims purposes putting on the worst front—stressed that moving caused a lot of wear and tear, but "this damage was done chiefly when the machines were being moved into the salt mines." Further explanations suggest that chemical action in the salt mines and operation by unskilled labor did

[26] *A Year of Potsdam* (n.p.: Office of Military Government for Germany (U.S. Zone), Economics Division, 1946).

[27] See p. 30 below.

[28] "Recovery of Machinery from Ruins," *British Zone Review* (Hamburg), April 26, 1946 p. 15.

more damage to the equipment than lowering it into the mines, although many pieces had to be up-ended for this purpose.[29]

In general, it is suggested that pessimistic interpretations of Soviet ability to make good use of reparations equipment are not founded on all the available evidence. In fact, reparations equipment was a valuable addition to the Soviet economy.

ORGANIZATIONAL STRUCTURE OF THE GERMAN REPARATIONS PROGRAM

The organization of German reparations was from start to finish favorable to the Soviet Union. The initial Soviet share was determined by the Moscow Reparations Commission, whose work was undertaken in "strict secrecy," with Dr. Isadore Lubin as the U.S. representative on the Moscow Reparations Committee.

The Allied Control Council for Germany at Potsdam, through its Coordination Committee, made allocations of reparations in the Western zones of Germany; plants and equipment in the Soviet Zone were not handled through the Allied Control Council, only by the Soviet authorities. The Coordination Committee allocated reparations from the "Western portion" between the Soviets and an Inter-Allied Reparation Agency (IARA). The Soviets then dismantled their allocations immediately, while the remaining 18 allies had to wait until further distribution had been determined by the IARA.

In this manner the Soviets, by virtue of having only to bid against IARA and not 18 individual allies, had the cream of Western zone plants as well as all plants in the Soviet Zone; even at the IARA level, bargaining was bilateral rather than multilateral (Figure 2-1).

Finally, under the program known as "Operation RAP" the Soviets were given priority in removing Western zone plants allocated under this preferential procedure, so that at the end of 1946, 94 percent of shipments from the U.S. Zone had been sent to the Soviet Union.

The formal Soviet claim in the Western zones was determined as follows (Section 4 of the allocation agreement):

> (a) 15 percent of such usable and complete industrial capital equipment, in the first place from the metallurgical, chemical and machine manufacturing industries, as is unnecessary for the German peace economy and should be removed from the Western Zones of Germany in exchange for an equiva-

[29] U.S. Strategic Bombing Survey, *Bussing-NAG Flugmotorenwerke*, Number 89, GmBH (Brunswick, Germany, January 1947), pp. 9-10.

lent value of food, coal, potash, zinc, timber, clay products, petroleum products, and such other commodities as may be agreed upon.

(b) 10 percent of such industrial equipment as is unnecessary for the German peace economy and should be removed from the Western Zones, to be transferred to the Soviet Government on reparation account without payment or exchange of any kind in return.

Removals of equipment as provided in (a) and (b) above shall be made simultaneously.[30]

Figure 2-1 ALLIED ORGANIZATIONAL STRUCTURE FOR GERMAN REPARATIONS

Moscow Reparations Committee	—	Selected 50 percent for U.S.S.R. in Eastern Europe
Allied Control Council for Germany (Coordination Committee)	—	Selected 25 percent for U.S.S.R. in West Germany
"Operation RAP"	—	Priority for Soviets

Source: Inter-Allied Reparation Agency, *Report of Secretary-General for the Year 1946* (Brussels, 1946), annex X, pp. 61-62; Germany, Office of Military Government (U.S. Zone), Economics Division, *A Year of Potsdam: The German Economy Since the Surrender* (n.p.: OMGUS, 1946).

In return for equipment dismantled under Section 4(a) the Soviets agreed to make reciprocal deliveries of raw materials valued at 60 percent of the equipment received from the Western zones. In October 1947 the U.S.S.R. presented a first list of reciprocal commodities, which was accepted, and deliveries were duly made.[31] In May 1948 the U.S.S.R. presented a second list of commodities, also accepted by the Western Allies. A dispute then arose over delivery points and the Soviets made no further deliveries.

Therefore, the Soviets delivered a total of 5,967,885 RM (1938: about \$1.5 million) against a commitment of the 50 million RM which would represent 60 percent of the value of industrial equipment received by the Soviet Union under Section 4(a). In other words, the Soviets paid only 12 percent of their commitment for reparations received under Section 4(a).

REPARATIONS PLANTS SHIPPED FROM WESTERN ALLIED ZONES TO THE SOVIET UNION

A total of 25 percent of industrial plants in the Western Allied zones was allocated to the U.S.S.R. under Sections 4(a) and 4(b) of the allocation agreement,

[30] Inter-Allied Reparation Agency, *Report of Secretary-General for the Year 1949* (Brussels, 1950), p. 3.

[31] For a list of Soviet reciprocal deliveries see *ibid.*, p. 17.

and dismantling of these plants was expedited on a priority basis. The Soviet allocation status as of November 30, 1948, is given in Table 2-3.

Table 2-3 PLANTS FROM WESTERN ZONES ALLOCATED TO THE U.S.S.R. AS OF NOVEMBER 30, 1948

Zone of occupation	*War plants*	*Reparations plants*
U.S. (the RAP program)	20	4½
British	6	4½
French	3	1
	29	10

Source: Germany, Office of the Military Government (U.S. Zone), *Report of the Military Governor,* November 1948, p. 25.

Probably the most important single plant dismantled for the Soviet Union was the Bandeisenwalzwerk Dinslaken A.G. in the British Zone.[32] This plant was the largest and most efficient hot- and cold-rolled strip mill on the European continent. The effect of the removal on German productive capacity was a reduction of 15 to 30 percent in strip steel, 20 percent in sheet steel, and 50 percent in tinplate strip steel.[33] Another important steel plant removed to the Soviet Union was Hüttenwerk Essen-Borbeck; dismantling required the services of 3000 workers over a period of two years to prepare for shipment.[34]

By August 1, 1946, a total of 156 plants in the U.S.Zone had been confirmed for reparations by the economic directorate of the Allied Control Council; of these, 24 had been designated in October 1945 as "advance reparations" under the swift appraisal plan known as Operation RAP. As described officially, "this [designation] represented an attempt to make available in the shortest time possible a number of reparations plants to the Soviet Union and the Western Nations."[35] The dismantling status of these "advance reparations" plants as of September 1, 1946, suggests that the Soviet Union indeed benefited. Inasmuch

[32] Wilhelm Hasenack, *Dismantling in the Ruhr Valley* (Cologne: Westdeutscher Verlag, 1949).
[33] *Ibid.*
[34] *Ibid.*, p. 51. The Hüttenwerk Essen-Borbeck plant was still being dismantled in May 1949; see *British Zone Review*, May 20, 1949, and *Neue Zuercher Zeitung*, December 10, 1947. Note these are rolling mills, not blast furnaces with low salvage value.
[35] *A Year of Potsdam, op. cit.* n.26, p. 35. The *New York Times* reports on this question are not accurate. For example, see *New York Times Magazine*, December 7, 1947, p. 14: "Also there was a short period when, for technical reasons, the American zonal authorities gave priority to the shipment of a small amount of equipment to the Soviet zone, a situation that resulted in such misleading headlines as "Russia Obtains 95 percent of Reparations from U.S. Zone." This statement is, of course, inconsistent with the evidence presented here. The same issue also reports (p. 56) that U.K. and U.S. reparations shipments to the U.S.S.R. stopped in May 1946. However, shipments were continuing as late as February 1948 according to Dept. of State *Bulletin*, February 22, 1948, p. 240. In May 1949 the Borbeck plant was still being dismantled for the U.S.S.R.; *British Zone Review*, May 20, 1949.

as 95 percent of all dismantling shipments up to the end of 1946 went to the Soviet Union and the U.S.S.R. was allocated twenty-four and one-half plants, it could be argued that the RAP program existed virtually for Soviet benefit. (see Table 2-4.)

The RAP operation moved swiftly. Dismantling of the huge Kugelfischer ball bearing plant in Bavaria for the U.S.S.R. started only on March 1, 1946, but the first shipment of equipment—which was the first shipment of reparations equipment from the U.S. Zone to any destination—was made on March 31, 1946. By August 1946 a total of 11,100 tons of reparations had been made from the RAP plants allocated to the U.S.S.R.[36] Of 40,374 tons of reparations equipment shipped from the U.S.Zone in 1946, the Soviet Union received 38,977 tons, or 94.3 percent.[37] In all, nearly one-third of reparations removals from the U.S. Zone of Germany went to the Soviet Union. Between March 30, 1946, and March 31, 1947, a total of 209,655 tons of equipment (valued at RM 190,279,000, 1938 prices) was removed. Of this total, 66,981 tons (valued at RM 45,246,000) went to the U.S.S.R.[38]

Other removals from Germany during 1944-51 can be understood only in the context of the way in which occupations took place within the inter-allied zonal borders. The U.S. Army had stopped at the Elbe River while the Soviets occupied the whole of Berlin,[39] and this worked in favor of the Soviet dismantling policy.

The historic and geographic factors have been treated in great detail elsewhere and may be but briefly summarized here. In the closing days of the war the Soviet armies moved up to the Elbe River, facing the U.S. and British armies, and occupied the whole of Berlin including what were to become the U.S., British, and French sectors of the city. They then proceeded to strip Berlin of its industry, including the highly important electrical equipment factories, *and including plants in all sectors*. This removal was probably completed by June 1945 because when the Western Allies suggested moving into their Berlin zones—the Soviets in turn to occupy the whole of their zone west of the Elbe—the Soviets asked only for a few days delay, until July 1.

In the meantime, i.e., from late April to July 1, 1945, the Americans and British maintained industry in their territory, so that when the Soviets moved into the rest of their occupation zone they received yet more factories including a highly important sector of the aircraft industry and, of course, the Nordhausen

[36] *A Year of Potsdam*, *op. cit.* n. 26, p. 37.

[37] *New York Times*, January 23, 1947, p. 13.

[38] *Report of the Military Governor*, Office of the U.S. Military Governor (Germany), no. 45, March 1949.

[39] See Cornelius Ryan, *The Last Battle* (New York: Simon and Schuster, 1966), on the "drive to Berlin" controversy. The official U.S. Government account of this controversy is soon to be published under the title *The Last Offensive*.

Table 2-4 STATUS ON ADVANCE REPARATIONS PLANTS FOR THE U.S.S.R. AT THE END OF 1946

Plant No.	Name of plant	Location	Product	Dismantling started	Percent dismantled at end 1946
1	Kugelfischer Georg Schaefer	Schweinfurt, Bav.	Ball-bearings	1 Mar. 46	97*
2	Bayerische Motorenwerke No. 1	Munich, Bav.	Aircraft engines	1 Mar. 46	82
3	Deutsche Schiffs- & Maschinenbau AG (Deschimag shipyards)	Bremen (Werk Weser)	Ship-building	1 Mar. 46	27
4	Grosskraftwerk AG	Mannheim, W/B	Power plant	—	—
5	Kloeckner-Humboldt-Deutz	Oberursel, Gr. Hesse	Diesel engines	15 Nov. 45	61
6	Fritz Mueller	Oberesslingen, W/B	Machine tools	3 Oct. 45	5
7	Bohner & Koehle	Esslingen, W/B	Machine tools	8 Oct. 45	4
9	Hensoldt & Soehne	Herborn, Gr. Hesse	Fire control	10 Oct. 45	100
10	Gendorf	Gendorf, Bav.	Power plant	16 Jan. 46	40
11	Hastedt	Bremen	Power plant	17 Oct. 45	88
12	Toeging AG Innwerk	Toeging, Bav.	Power plant	11 Feb. 46	8
13	Daimler-Benz (Goldfisch) (underground)	Mosbach, W/B	Aircraft engines	1 Mar. 46	80
14	Bayerische Motorenwerke No. 2	Munich, Bav.	Aircraft engines	2 Oct. 45	100
15	Fabrik Hess. Lichtenau	Hess. Lichtenau, Gr. Hesse	Explosives	6 Feb. 46	24
16	Deutsche Schiffs- & Maschinenbau AG	Bremen-Valentin	Ship-building	1 Jan. 46	100
17	C.F. Borgeward	Bremen	Torpedoes	22 Jan. 46	62
18	Norddeutsche Huette AG	Bremen-Oslebshausen	Steel manufacturing	—	0
19	Hahn & Tessky Indexwerke	Esslingen, W/B	Automatic screw machines	25 Oct. 45	60
20	Fabrik Kaufbeuren	Kaufbeuren, Bav.	Explosives	19 Oct. 45	100
21	Fabrik Aschau	Muehldorf, Bav.	Explosives	27 Oct. 45	30
22	Fabrik Ebenhausen	Ebenhausen, Bav.	Explosives	15 Oct. 45	100
23	Wehrmacht ordnance plant	Strass, Bav.	Shell loading	1 Mar. 46	100
24	Wehrmacht ordnance plant	Geretsried-Wolfratshausen, Bav.	Shell loading	1 May 46	2
25	Wehrmacht ordnance plant	Deschnig, Bav.	Shells	1 Mar. 46	100

Source: *A Year of Potsdam*, (n.p.: Office of Military Government for Germany [U.S. Zone], Economics Division, 1947), p. 36.

* U.S.S.R. portion only.

V-1 and V-2 rocket plants. Thus the Allied drive to the Elbe gave the Soviets the opportunity, willingly taken, to acquire the extensive German electrical equipment industry in Berlin[40] and find the German aircraft industry waiting intact when the zonal frontiers were rearranged a few weeks later.[41]

PLANT REMOVALS FROM THE SOVIET ZONE OF GERMANY

At the end of 1944 a special committee was organized under the Soviet Council of Ministers and under the leadership of Malenkov. Its twin tasks were the dismantling of German industry and the expansion of Soviet industry by the use of the equipment removed.[42] The committee's central headquarters in Moscow was staffed by members of the Central Committee of the Communist Party of the Soviet Union and divided into departments with staff drawn from Soviet industry, given military ranks. As individual targets were located, instructions passed to military units for actual dismantling then were carried out by German prisoners of war and local labor under Soviet officers.[43]

Dismantling of East German industry began with the arrival of the second wave of Soviet forces, first in Berlin (all zones) and then throughout the provinces of Silesia, Brandenburg, Thuringia, and Saxony.

Although the facts of dismantling have been strictly censored by the Soviets and no Allied observers were allowed into the Soviet Zone at the time, information of reasonable accuracy has filtered through the Iron Curtain. In particular the SPD (Sozialdemokratische Partei Deutschlands) in West Germany collected dismantling information on a plant-by-plant basis and published this information in 1951.[44] Further, reports by former Soviet officials add to our knowledge, although some of these leave the impression of being more enthusiastic than accurate.

Dismantling involved several thousand plants and included the best of industry

[40] For a description see U.S. Strategic Bombing Survey, reports by A. G. P. Sanders, Capt. Nichols, and Col. Ames on electrical equipment targets in Berlin, July 1945.

[41] In the interval of two months numerous U.S. and British intelligence, army, navy, air force, and civilian teams explored the technical side of Germany industry in the Soviet Zone. This exploration was conducted in the following directions: (a) interviewing German technicians, (b) acquiring papers and materials for reports on technological and economic structure, (c) obtaining drawings, instruments, and samples, and (d) acquiring V-1 and V-2 samples and engine samples. There were no equipment removals. The plants were left intact, and some were even repaired for the Soviets. So the Soviets obtained the productive capacity *intact*, but did not obtain engineers or papers. The papers were acquired under the FIAT programs.

[42] Slusser, *op. cit.*, n. 16, p. 18.

[43] Some 10,000 local Germans were assigned to dismantle the brown coal plants at Regis-Breitingen, and another 5000 dismantled the Lauta works at Hoyersworda; 12,000 Germans were used at the Giessches Erben works; and 20,000 were used at the large plant at Brona. Löwenthal, *op. cit.* n. 14, pp. 182-85.

[44] G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik*, (Bremen: F. Trüjen, 1951).

moved to East Germany during the war to avoid Allied bombing. All together, a total of about 12,000 trainloads of equipment was removed to the U.S.S.R.

Table 2-5 REDUCTION OF INDUSTRIAL CAPACITY BY DISMANTLING IN THE SOVIET ZONE OF GERMANY

Industry	*1936 Production*	*Nettl's percentage estimate of capacity reduction*	*Equivalent in tonnage terms*
Vehicles	532,706 units	65	346,259
Cement	1,687,000 tons	40	674,800
Rubber goods:			
Tires	176,000 units	70-80	123,000-140,800
Tubes	148,000 units	70-80	103,600-118,400
Paper and cardboard	1,195,000 tons	40	478,000
Cellulose	205,400 tons	40	82,160

Sources: J. P. Nettl, *The Eastern Zone and Soviet Policy in Germany, 1945-50* (London: Oxford University Press, 1951), p. 202. Wolfgang F. Stolper, *The Structure of the East German Economy* (Cambridge, Mass.: Harvard University Press, 1960), pp. 146, 180, 196, 207.

Details of this dismantling in the Soviet Zone have been included in the chapters on industrial activities (chapters 8 through 24).

DEPORTATION OF GERMAN SCIENTISTS AND TECHNICIANS

One significant aspect of the reparations transfer process was the deportation of German scientists and technicians to the Soviet Union, on a mass scale concentrated in the fall of 1946. The major program was completed during the night of October 28, 1946, when trainloads of Germans from aircraft and armaments plants were moved with their families and furniture to the Soviet Union.[45]

Deportations were concentrated among the staffs of key German plants. According to Fritz Löwenthal, more than 300 scientists, technicians, and skilled workers were deported from Zeiss; 26 chemists, seven engineers, and several skilled mechanics were co-opted from the Leuna works; and technicians and workers were drawn from the Junkers works at Dessau, the Oberspree cable works in Niederschoenweida, the Schott glass works in Jena, the optical works in Saalfeld and Poessneck, and the Gera workshops.[46] Löwenthal also cites

[45] For descriptions of deportation, see Löwenthal, *op. cit.* n. 14, and V. L. Sokolov, *Soviet Use of German Science and Technology, 1945-1946* (New York: Research Program on the U.S.S.R., 1955).

[46] Löwenthal, *op. cit.* n. 14, pp. 203-4.

a U.S. Navy report to Congress stating that 10,000 German scientists and technical specialists had been absorbed into Soviet industry by May 1947.[47]

These German workers began to filter back home in the early 1950s together with German, Austrian, and Italian prisoners of war and deportees. In January 1952 *The Times* (London) reported that there was a continuing flow of Germans from the optical and precision instruments industries: "It seems to show that Russia can now do without these craftsmen."[48] The report particularly noted the return of 310 highly skilled workers from the Zeiss works in Jena, after five years in Russia. It is probable that all German deported workers were returned by 1957-58.

REPARATIONS FROM FINLAND, 1944 TO 1955

The Finnish-Soviet Peace Treaty of December 17, 1944, required Finland to transfer goods to the Soviet Union valued at $300 million in 1938 prices over a period of eight years. The amount was similar to that for Hungarian and Rumanian reparations, but in the Finnish case there was little Soviet interference in the manufacturing and delivery—this being entirely a Finnish responsibility whereas in Hungary and Rumania the Soviets formed "joint companies" to carry out the task. Some 60 percent of the indemnity comprised metallurgical and engineering products, the balance being ships, cable, and wood products—amounting in all to a considerable proportion of the Finnish national product.[49]

The technical nature of this huge indemnity required Finland to establish major new industries and to expand engineering industries that were of only negligible importance before the war. This was done with credits and equipment from the United States and Sweden, and thus provides some excellent examples of "indirect transfers."

A. G. Mazour sums up Finnish achievements in reparations deliveries to the U.S.S.R. as follows: "Mere survival was a miracle. To meet the obligations and still manage to survive was an achievement which commands profound respect and admiration."[50] Jensen has calculated the reparation payments as a percentage of net national product as follows:[51]

[47] *Ibid.*, pp. 205-6.
[48] *The Times* (London), January 29, 1952, p. 4g.
[49] Bartell C. Jensen, *The Impact of Reparations on the Post-war Finnish Economy* (Homewood, Ill: Richard D. Irwin, 1966). See also A. G. Mazour, *Finland Between East and West* (Princeton: Van Nostrand, 1956), p. 173.
[50] Mazour, *op. cit.* n. 49.
[51] Jensen, *op. cit.* n. 49, p. 18.

Year	*Reparations as percentage of NNP*	*Reparations as percentage of state expenditures*
1944	0.3	0.7
1945	7.6	20.9
1946	4.8	13.7
1947	4.1	13.7
1948	3.2	10.7
1949	3.2	10.8
1950	1.6	6.1
1951	1.8	6.8
1952	1.1	4.1

The major deliveries under the program comprised about two-thirds of Finland's prewar ship tonnage plus considerable new construction. Ships transferred included 70 cargo vessels, one tanker, seven passenger ships, two icebreakers, and 15 barges from the merchant marine. In addition, substantial new deliveries of wooden and metal ships were required. During the first four years of the reparations period Finland delivered 143 new ships and two floating docks valued at $25.8 million, while the program for the second four years called for 371 ships and two docks valued at $40.2 million.[52] In all, about 359,000 gross registered tons of shipping with a total valuation of $66 million in new ships and $14 million in existing ships was delivered, requiring a significant expansion and modernization of the Finnish shipbuilding industry.[53]

The next largest category, comprising $70.7 million, was made up of industrial equipment and a number of complete plants. Among other things, this segment included 17 complete industrial plants to establish mills for the production of prefabricated wooden houses. This is of particular interest because instead of themselves supplying a plant specification, the Soviets requested that the Finns supply it (the delays involved in this procedure subjected Finland to a monthly fine of $45,000 payable in supplementary deliveries). The plants delivered (Table 2-6) were complete with sawmills, lumber kilns, conveyers, power plants, and repair shops.[54]

The remaining major categories included 2600 km of power cable, 34,375 tons of bright copper wire, and 1700 km of control cable ($12.9 million), pulp and paper products ($34.9 million), and wood products ($28 million).[55]

[52] J. Auer, *Suomen sotakorvaustoimitukset neuvostoliitolle* (Helsinki: Werner Söderström Osakeyhtiö, 1956), p. 318.

[53] *Ibid.*, p. 327; for a listing of ships by type see Urho Toivola, *The Finland Year Book 1947* (Helsinki, 1947), p. 84.

[54] Toivola, *op. cit.* n. 53, p. 335.

[55] *Ibid.*, pp. 84-85.

Table 2-6 COMPLETE INDUSTRIAL PLANTS SUPPLIED TO THE U.S.S.R. UNDER FINNISH REPARATIONS

Number of plants	*Description*	*Capacity per plant, annually*
3	Sulfite cellulose	40,000 tons bleached cellulose
2	Cardboard mills	58,000 tons cardboard
2	Woodpulp mills	50,000 tons woodpulp
4	Paper mills	30,000 tons paper
17	Prefabricated houses	1800 houses (each 50 square meters)
6	Plywood plants	12-15,000 cubic meters
2	Woodflour mills	2000 tons

Source: Urho Toivola, *The Finland Year Book 1947* (Helsinki, 1947), pp. 84-85.

REPARATIONS FROM JAPAN

In contrast to Manchuria, no reparations have been traced as originating in Japan for the Soviet Union.

Owen Lattimore had responsibility for developing and writing the machine tool and aluminum sections of the Pauley Mission report on Japanese reparations.[56] He makes only one reference to a possibility of Soviet reparations from Japan: "Although I do not believe that the U.S.S.R. should assert a substantial claim for reparations from Japan, nevertheless certain plants and machine tools may well be made available to the U.S.S.R."[57] Lattimore's reasoning was that the equipment might be allocated to the Soviet Union because the low economic development of the Far East would make absorption of Japanese industrial equipment and capacity difficult for Far Eastern countries and that China and the Philippines were not ready to receive reparations.[58] This argument was presented to the Far East Committee of January 12, 1946. There is no evidence, however, that the U.S.S.R. ever received the 850,000 machine tools Lattimore estimated were available in Japan for reparations purposes.[59]

REMOVALS FROM MANCHURIA

The 1946 Pauley Mission in Manchuria was organized in April 1946 under the instructions of President Truman. The mission included qualified American

[56] Edwin W. Pauley, *Report on Japanese Reparations to the President of the United States, November 1945 to April 1946* (Washington, April 1, 1946).

[57] *Ibid.*, pp. 11-12.

[58] Lattimore's logic is elusive. Low development suggests a *requirement* for machine tools; furthermore, the Soviet Union also had a relatively low level of development.

[59] Pauley, *op. cit.* n. 56, p. 3.

civilian engineers and industrial specialists from General MacArthur's headquarters in Japan.

From a base established at Mukden, inspection trips were made to important industrial and mining centers: Mukden, Fushun, Liaoyang, Anshan, Penhsihu, Kungyuan, Chinchow, Chinhsiao, Pehpiao, Fu-hsien, Hulutao, Kaiyuan, Ssupingchieh, Hsin-an, Changchun, Kirin, Harbin, and Mutankiang. Dairen, however, was not visited because permits were not granted by the Soviet Government or the local authorities; Antung was not visited because the Chinese Communists refused permission.

The four objectives of the Pauley Mission were as follows: (1) to survey Japanese assets in Manchuria subject to reparations; (2) to ascertain the productive capacity of Manchurian industry; (3) to estimate if immediate reparations removals from Japan could be utilized to improve or rehabilitate Manchurian industry; and (4) to prove or disprove reports that crippling removals had been made.

Manchuria has many natural resources, and the Japanese had created an extensive industrial structure there on the basis of these resources. The defeat

Table 2-7 REDUCTION IN CAPACITY OF MANCHURIAN INDUSTRY BY SOVIET REMOVALS

	Pauley Report[a]		*Japanese statistics*[b]	
Industry	*Cost of installations dismantled and removed*	*Percentage reduction in capacity*	*Cost of installations dismantled and removed*	*Percentage reduction in capacity*
Electric power	$201,000	71	$219,540	60
Coal and coke	50,000	90	44,720	80
Iron and steel	131,260	50-100	204,052	60-100
Nonferrous metals	10,000	75	60,815	50-100
Railroad	221,390	50-100	193,756	50-100
Machinery	163,000	80	158,870	68
Petroleum	11,380	75	40,719	90
Chemical	14,000	50	74,786	33
Cement industry	23,000	50	23,187	54
Textiles	38,000	75	135,113	50
Pulp & paper	7,000	30	13,926	80
Radio	25,000	20-100	4,588	30
Total	$895,030,000		$1,174,072,000	

Sources: [a]Edwin Pauley, *Report on Japanese Assets in Manchuria to the President of the United States, July 1946* (Washington, 1946). A report published by the Chinese Association for the United Nations, *A Report on Russian Destruction of Our Industries in the North-eastern Provinces* (Taiwan, 1952), has considerably higher figures of destruction than Pauley, but does not include such detailed inspection reports as characterize the Pauley Mission report. [b]*The Ashwan Steel Plant* (Hong Kong: Union Research Institute, 1956), Communist China Problem Research Series.

of Japan caused disruption of production centers and trade channels and upset the entire economic structure of the Far East; Soviet occupation further disrupted the industrial structure.

The findings of the Pauley Commission were that the wrecked condition of Manchurian industry evident between the time of the Japanese surrender and the visit of the Pauley Mission was due directly to Soviet removals and pillage, and to a lesser extent to indirect consequences of the Soviet occupation. The Soviets had concentrated their efforts on certain categories of supplies, machinery, and equipment: functioning power-generating and transforming equipment, electric motors, experimental plants, laboratories and hospitals, and the newest and best machine tools. The wrecked condition was due mainly to Soviet removals and partly to Soviet failure to preserve order.[60] (See Table 2-7.)

At the Fushun power plant, four 50,000-kw steam-electric generators plus the condensers, auxiliary equipment, stokers, and drums were removed. Thirty-four low-voltage transformers for electric furnaces were taken from the aluminum plant at Fushun (there were 36 transformers at the plant, but two outside on skids were left behind), and the Sodeberg electrodes were removed.

All machine tools from the Fushun coal hydrogenation plant were removed.

From the Manchu iron works (Anshan) power house, one 25,000-kw Siemens Halske turbogenerator and one 18,000-kw turbogenerator were removed, leaving 30,500 kw of capacity in place. From the plant's boiler house, four complete boilers with equipment were removed plus equipment for two more boilers. All rolling equipment was removed from the blooming mill. Ball mills and motors were removed from the sponge iron plant. Magnetic separators were removed from the iron ore treating plant; bearings on the roasting kiln were removed; chargers, pushers, and valve mechanisms were taken from the coke ovens; motors and trolleys from the blast furnace stockyard crane and skip hoists, and blowers and auxiliaries for six of the nine blast furnaces were also removed.

Practically all the machine tools and electrical equipment, seven cranes, and all electric motors were removed from the Mitsubishi machine plant in Mukden. In addition, all equipment (except one large press) and three overhead cranes were removed from the forging shop; cranes, machinery, and a large electric furnace were taken from the foundry. All equipment from the welding shop and all equipment for manufacturing steel tubes were taken from the seamless tube mill at the Mitsubishi plant.

Equipment removed from the coal hydrogenation research institute included high-pressure compressors, machine tools, and the distillation apparatus. All

[60] For example, one report states: "Mukden, the largest city in Manchuria, has been left without power for light, water, and other utilities, endangering the health and lives of its two million inhabitants." *"Selected Photographs from Pauley Mission to Manchuria: June 1946,"* Special Collection in the Hoover Institution, Stanford University.

machinery (except lens polishers and some grinders) was removed from the optical instrument plant at Mukden.

Boilers and heavy rubber processing equipment were taken from the belt-making building of the Manchu Rubber Company (Liaoyang), as were tire manufacturing equipment, hydraulic presses, rubber mills and collandars as well as bicycle tires, power and transmission belt manufacturing equipment, and machines for the manufacture of shoes and raincoats.

All tire-making machinery was removed from the Toyo Rubber Tire Company operation at Mukden, all cotton spinning equipment from the tire cord plant, and four nitrators for picric acid removal together with four centrifuges from Arsenal 383.[61]

REPARATIONS FROM ITALY

Under the Soviet Treaty of Peace[62] with Italy it was agreed that reparations amounting to $100 million were to be paid during a period of seven years. The reparations were to include part of Italy's "factory and tool equipment designed for the manufacture of war material"; part of Italian assets in Rumania, Bulgaria, and Hungary with certain exceptions; and part of Italian current production together with one-third of the Italian naval fleet.[63]

REPARATIONS AND REMOVALS FROM AUSTRIA

An estimated $400 million worth of capital equipment was removed by the Soviets from the Soviet zone of Austria in 1945-46.

The Austrian oil industry was exclusively in the Soviet zone, as were many finishing industries and most of the electrical industry. At Zistersdorf in Lower Austria, Soviet occupation forces removed and shipped to Russia about $25 million worth of oil well supplies and equipment. The Alpine Monton company in Styra, with steel plants at Donawitz and finishing plants at Kreiglach and Kindberg, had much of its equipment removed by the Red Army—all together 75 trainloads, including a new blooming mill, two 25-ton electric furnaces, one turbogenerator, and hundreds of machine tools.

There was extensive removal of equipment from the electrical equipment industry, including the wire and cable industry where almost all production facilities fell into Soviet hands. The two Vienna electrical plants, Simmering

[61] *Ibid*. Photos for this report were taken by U.S. Signal Corps during the inspection of Japanese industries by American industrial engineers.

[62] United Nations *Treaty Series*, vol. 49, no. 747 (1950), pp. 154 *et seq*.

[63] For details see Giuseppe Vedovato, *Il Trattato di Pace con l'Italia* (Rome: Edizioni Leonardo, 1947), pp. 127-30, 317-31, 363, 561.

and Engerthstrasse, were partially dismantled by the Soviets. The Goertz Optical Works, the leading manufacturer of optical lenses, was seized and removed in 1946.

In transportation industries the plant of Weiner Lokomotiv Fabrik, a manufacturer of locomotives, was dismantled and one thousand of the twelve hundred machine tools in the plant were shipped to Russia. The largest of Austria's motor vehicle producers, Steyr-Daimler-Pusch A.G., suffered extensive equipment removals (however, the largest agricultural machinery producer, Hofherr-Schrandz, was left intact and operated under Soviet control). Numerous plants in the clothing, fertilizer, and chemical industries also had extensive equipment removals to the Soviet Union.

In addition to the dismantling and removal, major deliveries of goods to the Soviet Union were required by the treaty under which Austria regained her independence. The value of such deliveries, largely industrial and transportation equipment, totaled $150 million in six years (plus ten million metric tons of crude oil valued at about $200 million in ten years).[64]

REPARATIONS AND REMOVALS FROM RUMANIA

Under the armistice signed September 12, 1944, Rumania agreed to provide Russia with reparations valued at $300 million, in addition to acceding to Soviet annexation of Bessarabia and Northern Bucovina. The Soviets then proceeded to remove the entire Rumanian Navy plus 700 ships, barges, and tugs comprising the major part of the Rumanian merchant marine, about one-half the country's rolling stock, all automobiles, and large quantities of equipment from the Rumanian oil fields.

Particular emphasis was placed on removal of oil refineries and equipment owned by American and British companies. In November 1944, the following was reported to the U.S. Secretary of State:

> The Russians have been working with all possible speed, even at night, to remove oil equipment of Astra Romana, Stela Romana, and another oil company in which both British and American companies are interested. This equipment is being taken to Russia.[65]

In addition, 23,000 tons of tubes and casing was removed from oil company warehouses. The Soviets claimed that this material was actually the property of German companies sent to Rumania during the war and therefore was not

[64] *The Rehabilitation of Austria, 1945 to 1947* (Vienna: U.S. Allied Commission for Austria, [1948?]; F. Nemschak, *Ten Years of Austrian Economic Development, 1945-1955*, (Vienna: Association of Austrian Industrialists, 1955), p. 8.

[65] U.S. Dept. of State, *Foreign Relations of the United States*, vol. IV (1944), p. 253.

owned by the American and British companies. In any event, Andrei Vyshinsky, then the Soviet assistant people's commissar for foreign affairs, suggested it comprised only a small amount of the equipment required for rehabilitation, and "the amount of equipment was so small it might be written off as a minor Lend Lease shipment."[66]

It was later reported that the Russians had occupied more than 700 factories in Rumania, and that considerable amounts of industrial equipment and supplies including oil drilling equipment, actually the property of British and American oil companies, were being removed to Russia.[67]

Diplomatic protests by the United States led to the establishment in 1945 of a Joint U.S.–Soviet Oil Commission to consider the problem. This commission was dissolved in August 1947 without apparently arriving at any agreement. It was then stated that the Soviets had removed 7000 tons of equipment at the end of 1944 from Romana-Americana, a U.S. subsidiary of Standard Oil of New Jersey. This equipment was valued at $1,000,000.[68]

There is no question that there were sizable Soviet equipment removals from occupied areas after World War II; a minimum value figure in excess of $10 billion in 1938 prices can be set for equipment thus removed. The unresolved question concerns the usefulness of such removals in the U.S.S.R.

The argument against usefulness, which also assumes irrationality on the part of the Soviets, is built on no hard evidence except observations of rusting equipment along rail lines from Germany to the U.S.S.R.

On the other hand, the fact that dismantling was spread over a number of years suggests that there was a continuing demand for the equipment. We can also trace delivery of important processes and equipment to the U.S.S.R., and the Berlin Ambi-Budd plant negotiated back to the West was found to have been carefully numbered and guarded for a period of some years although not used by the Soviets.

Furthermore, by the time the war ended the Soviets had extensive experience in dismantling, and after the war they took pains to disguise their intentions and actions. In Manchuria there is evidence that Chinese mobs were encouraged to loot buildings after Soviet removals, and it is not unlikely that such decoy actions were undertaken in Germany.

It is concluded, therefore, that the Soviets removed extensive industrial capacity from a number of countries under a carefully planned program executed with reasonable care. This capacity had the potential to make a significant contribution to Soviet postwar industrial production, and this contribution will be examined in more detail in Part II.

[66] *Ibid.*, p. 263.
[67] *Ibid.*, vol. V (1945), pp. 542, 629.
[68] U.S. Dept. of State, *Bulletin*, August 3, 1947, p. 225.

CHAPTER THREE

Trade as a Transfer Mechanism

The prime means for transfer of Western technology to the Soviet Union has been through normal channels of commerce. Since 1918 Russian foreign trade has been a state monopoly, and this monopoly power has been utilized in a superbly efficient manner to direct the most advanced of Western technological achievement to the Soviet economy. Its monopolistic position, of course, allows the Soviet state to play one foreign country against others and individual Western firms against firms in all other countries in the acquisition process.

Table 3-1, based on United Nations data, presents the percentage of machinery and equipment (U.N. category SITC 7) contained in total Soviet trade with major Western countries between 1953 and 1961. The most significant observable feature is the consistently large percentage that SITC 7 forms of total Soviet imports. Although the high point (97.56 percent of 1959 Danish exports to the U.S.S.R.) is today unusual, the percentage is usually in excess of 60 percent of Soviet imports from almost all major Western industrialized nations, and percentages in excess of 70 percent are not unusual.

Figure 3-1 presents data for the single year 1959 in schematic form and indicates at a glance the high proportion of machinery and equipment from all Western countries. Figure 4-2 illustrates the significant lack of Soviet capital goods exported to the West; only Greece imported Soviet machinery and equipment in 1959. The Soviet Union normally exports machinery and equipment only to underdeveloped areas as part of barter deals; even foreign assistance projects financed by the Soviets have a major foreign machinery component.[1]

In the 1920s and 1930s over 90 percent of U.K. and German shipments to the Soviet Union came within the SITC 7 category; since that period such high percentages are less frequent, but they have remained sizable enough over a period of almost 50 years to suggest the key relationship between trade and Soviet industry.[2]

[1] See chapter 7.

[2] Even well informed commentators have taken positions directly opposed to this factual presentation. For example, Senator Jacob Javits of New York comments: "Trade with the West as a general matter, must necessarily be a marginal factor in the performance and potentialities of the Soviet economy." *Congressional Record, Senate*, vol. 112, pt. 9 (89th Congress, 2d session), May 24, 1966, p. 11233.

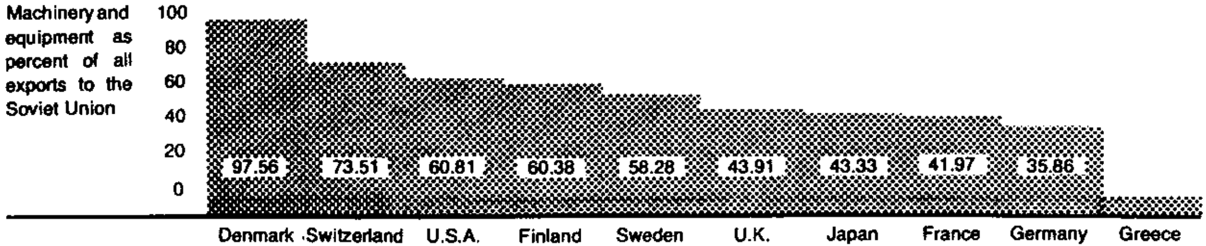
Table 3-1 PERCENTAGE OF TOTAL EXPORTS TO THE SOVIET UNION COMPRISING MACHINERY AND EQUIPMENT (SITC 7), FROM 1953 TO 1961

Country	*1953*	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*Average 1953-1961*
Switzerland	—	—	—	—	—	—	73.51	83.41	91.50	84.73*
Sweden	46.90	62.62	61.02	70.40	55.04	54.47	58.28	39.93	49.21	54.17
Finland	—	48.14	58.25	53.43	50.23	47.89	60.38	61.74	46.25	53.29
Denmark	25.48	2.47	68.64	95.78	42.72	39.10	97.56	78.93	40.64	50.04
Germany	58.13	75.80	64.03	54.24	37.40	69.29	35.86	44.32	56.52	49.87
United Kingdom	53.97	39.52	46.37	37.09	28.53	25.12	43.91	53.54	62.87	43.95
Austria	93.86	50.92	83.94	5.55	54.16	47.15	32.20	42.30	45.68	42.56
United States	17.65	0.93	2.89	59.49	12.71	19.95	60.81	48.82	36.78	41.86
Netherlands	12.32	44.27	63.76	60.08	69.36	2.72	9.87	44.39	36.58	39.50
France	2.56	9.95	23.27	52.98	21.45	25.80	41.97	48.69	52.24	38.16
Japan	—	—	15.96	84.43	14.20	15.81	43.33	29.01	39.12	32.53
Italy	16.09	31.05	15.36	2.10	13.58	10.94	11.08	21.90	32.46	20.42
Norway	—	9.49	—	0.16	0.07	0.62	0.33	0.06	5.42	2.12

Source: *U.N. Yearbook of International Trade Statistics* (New York, 1958).

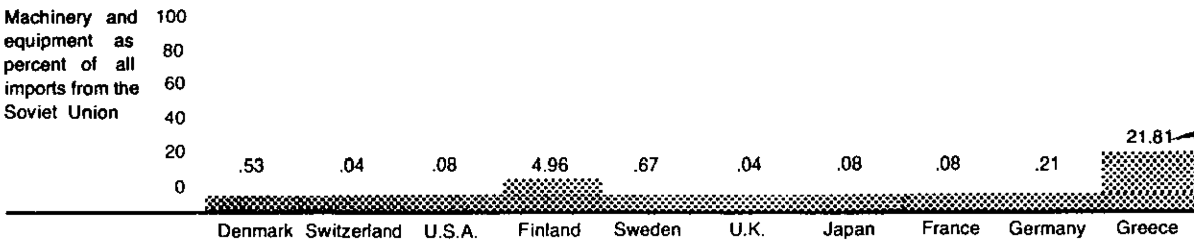
* Three years only.

Figure 3-1 EXPORTS OF MACHINERY AND EQUIPMENT, AS PERCENTAGE OF TOTAL TRADE, FROM CAPITALIST COUNTRIES TO THE SOVIET UNION (1959)



Source: United Nations, *Commodity Trade Statistics*, Statistical Papers, series D, vol. IX, no. 4 (January-December 1959).

Figure 3-2 EXPORTS OF MACHINERY AND EQUIPMENT, AS PERCENTAGE OF TOTAL TRADE, TO CAPITALIST COUNTRIES FROM THE SOVIET UNION (1959)



Source: United Nations, *Commodity Trade Statistics*, Statistical Papers, series D. vol. IX, no. 4 (January-December 1959).

The following selection of trade agreements made by the Soviets with Western nations illustrates that Soviet exports consist almost entirely of raw materials:

Date and trade agreement	Soviet exports under the trade agreement
1953 Denmark trade agreement	"Wheat, oil cake, soya beans, cotton, timber, pig iron, asbestos, apatite concentrate." (U.N. *Treaty Series*, vol. 125, no. 2292, p. 10)
1956 Japan trade agreement	"Lumber, coal, mineral ores, oil, metals, fertilizer, asbestos and fibers." (*Japan Times* [Tokyo], October 20, 1956)
1957 Denmark trade agreement	"Grain, apatite concentrate, potash, pig iron, coal, coke, petroleum products, timber, cotton, chemicals, agricultural equipment, 150 autos, 150 motorcycles." (U.N. *Treaty Series*, vol. 271, no. 3912, p. 132)
1959 United Kingdom trade agreement	"Grain, timber and timber products, wood pulp, manganese ore, asbestos, ferro-alloys, non-ferrous metals, minerals, fertilizers, flax and other goods." (U.N. *Treaty Series*, vol. 374, no. 5344, p. 305)

This pattern of Soviet foreign trade, a consistent pattern since about 1922,[3] may then be seen as essentially an exchange of raw materials for Western technology.

More detailed examination of the impact pattern on a country-by-country basis for the period after 1945 illustrates the manner in which the Soviet foreign trade monopoly has been superbly used to induce a flow of modern technology into the Soviet economy to fill numerous gaps and offset persistent shortfalls in the planning process. Complementary to this process has been a propaganda campaign, obviously very effective, to obscure the exchange pattern. This campaign has succeeded to the extent of informing U.S. State Department statements to Congress and the public.[4]

UNITED KINGDOM AS A SUPPLIER OF CAPITAL GOODS TO THE SOVIET UNION

The first postwar trade and payments agreement between the U.S.S.R. and

[3] See chapter 21, Sutton I: *Western Technology . . . 1917 to 1930*; cf. Sutton, "Soviet Export Strategy," in *Ordance*, November-December 1969. A complete list of Soviet trade agreements at June 1, 1958, may be found in *Spravochnik po vneshnei torgovle SSR* (Moscow: Vneshtorgizdat, 1958), pp. 91-92.

[4] See, for example, testimony of former Secretary of State Dean Rusk, U.S. House of Representatives, *Investigation and Study of the Administration, Operation, and Enforcement of the Export*

the United Kingdom was signed at Moscow on December 27, 1947.[5] The agreement included both short- and long-term arrangements. Under the short-term arrangement the Soviet Union agreed to supply from its 1947 harvest 450,000

Table 3-2 UNITED KINGDOM DELIVERIES TO THE SOVIET UNION UNDER THE 1947 TRADE AGREEMENT

Deliveries under Schedule I			*Deliveries under Schedule II*		
Item Number	*Quantity*	*Description*	*Item Number*	*Quantity*	*Description*
1	1100	Narrow gauge 750-mm locomotives	1	£150,000 value	Scientific and laboratory apparatus
2	2400	Flat trucks, 750-mm	2	4	Pile drivers mounted on pontoons
3	2400	Winches (2 and 3 drums)	3	4 sets	Winding gear
4	210	Excavators	4	1	Electro dredger
5	54	Caterpillar loading cranes	5	18	Ball mills for copper ore grinding
6	250	Auto timber carriers	6	8	Ball mills for grinding apatite
7	14	Tugs	7	3	Rod mills for grinding ores
8	4	Dredgers	8	8	Spiral type classifiers
9	200	Locomobiles	9	2	Gyratory crushers
10	150	Mobile diesel electric generators, 50 kw	10	3	Railway steam cranes
11	24	Steam power turbine stations, 500 kw	11	48	154-kv Voltage transformers
12	£1,050,000 value	Plywood equipment	12	6	Complete distributing sets
13	£400,000 value	Timber mill equipment	13	45	Isolating switches (154 kv)
			14	10	Oil purifying apparatus
			15	300	100-kw electric motors

Source: Great Britain, *Soviet Union No 1 (1948)* Command 7297, (London: HMSO, 1948).

Control Act of 1949, and Related Acts, 87th Congress, 1st session, October and December 1961, (Washington, 1962), and *ibid.*, 2d session, Hearings, part. III, 1962.

[5] Published as Great Britain, *Soviet Union No. 1 (1948)*, Command 7297 (London: HMSO, 1948).

tons of barley, 200,000 tons of maize, and 100,000 metric tons of oats. In return the United Kingdom agreed to ensure the supply of 25,000 long tons of light rails with fishplates, nuts, and bolts, with an additional 10,000 tons to be supplied from U.K. military surpluses.

The long-term arrangement was more extensive. It included U.K. delivery of materials listed in Schedules I and II (Table 3-2) and supplies of wheat, pulses, pit props, cellulose, and canned goods from the Soviet Union in exchange for oil well tubes and tinplate from the United Kingdom.

Schedules I and II consist entirely of equipment and machinery. Two separate categories may be isolated: (1) sizable quantities of such equipment as narrow-gauge locomotives, flat trucks, winches, auto timber carriers, locomobiles, and generators—clearly intended for production purposes; and (2) four pile drivers, sets of winding gear, two gyratory crushers, and three railway steam cranes—materials in much smaller quantities for which it is unlikely the Soviets had production uses in mind. The spare parts and maintenance problem for a few equipment items is too great to make such purchases worthwhile; these items were probably intended for examination and technical information on British manufacturing methods.

Two major agreements were made with British companies a few years later, in 1954. In January of that year, 20 trawlers valued at $16.8 million were ordered from Brooke-Marine, Ltd. The specifications for these trawlers included the most advanced features available in the West (see chapter 21). In May 1954 a $19.6 million agreement was made with Platt Brothers for supplying textile equipment (see chapter 15).

Another five-year trade agreement between the United Kingdom and the Soviet Union came into force on May 24, 1959.[6] Again, in exchange for raw materials[7] the Soviet Union agreed to place orders with British firms:

> ... for equipment for the manufacture of synthetic fibres, synthetic materials and manufactures from them, and also other types of equipment for the chemical industry; equipment for the pulp and paper industry; forging, stamping and casting equipment; metalworking machine tools; equipment for the electro-technical and cable industry; equipment and instruments for the automation of production processes; pumping, compression and refrigeration equipment; equipment for sugar beet factories and other types of equipment for the food industry; equipment for the building industry, light industry and other branches of industry as well as industrial products and raw materials customarily bought from United Kingdom firms.[8]

There was also a comparatively small exchange of consumer goods in the agreement, to the value of $2 million.

[6] United Nations, *Treaty Series*, vol. 374, nos. 5323-5350 (1960), p. 306.
[7] See page 43.
[8] *Op. cit.* n. 6, p. 308.

The 1959 agreement was extended for another five years in 1964, and the quotas for the ten years between 1959 and 1969 provided for a continuing supply of United Kingdom technology to the U.S.S.R. This included machine tools, earthmoving equipment, mechanical handling equipment, equipment for the Soviet peat industry (there is no peat industry in the United Kingdom), mining equipment, gas and arc welding equipment, chemical, refrigeration and compressor equipment, and a wide range of scientific and optical instruments.[9]

The use to which some of this equipment has been put may be gleaned from a Soviet booklet published by NIIOMTP (Scientific Research Institute for Organization, Mechanization, and Technical Assistance to the Construction Industry) detailing the technical characteristics of British construction equipment.[10]

GERMANY AS A SUPPLIER OF CAPITAL GOODS TO THE SOVIET UNION

The German-Soviet trade agreements of the 1950s comprised the exchange of German equipment and machinery for Soviet raw materials, continuing the prewar pattern. For example, the 1958 trade agreement called for West Germany to export to the Soviet Union "mainly ... capital goods, including equipment for mining and the metallurgical industry, heavy and automatic machine tools for metalworking industries, equipment for the chemical industry, whaling factory ships."[11]

The German-Soviet trade agreement of December 31, 1960, affords a good example of the general composition and implementation of German-Soviet trade; this agreement provided for mutual trade from January 1, 1961, through December 31, 1963, and the form in which it was to be carried out. Two lists, A and B, were attached to the agreement providing commodity quotas for imports into both Germany and the Soviet Union, and both governments agreed to take "every measure" to enable fulfillment of these quotas. List A, comprising German imports from the Soviet Union, consists entirely of foodstuffs (grain, caviar, fish, oilcake, and vegetable oils), lumber products (sawed timber, plywood, and cellulose), and mineral materials (coal, iron ore, manganese, chrome, and particularly platinum and platinum group metals.). No products of a technological nature are included among German imports from the Soviet Union.

[9] For a complete statement of the quotas and the agreement see Peter Zentner, *East-West Trade: A Practical Guide to Selling in Eastern Europe* (London: Max Parrish, 1967), pp. 152-57.

[10] V. M. Kazarinov and S. N. Lamunin, *Zarubezhnye mashiny dlia mekhanizatsii stroitel'nykh rabot*, (Moscow: Niiomtp, 1959).

[11] *East-West Commerce* (London), May 7, 1958, p. 11.

List B, comprising commodity quotas for imports from West Germany into the U.S.S.R. for the years 1961 to 1963, consists almost entirely of goods of a technical nature. Table 3-3 lists the machinery and equipment items included

Table 3-3 COMMODITY QUOTAS FOR IMPORTS FROM WEST GERMANY TO THE U.S.S.R. UNDER THE TRADE AGREEMENT OF DECEMBER 31, 1960

Commodity	*Value (In DM)*
Machine tools for metal cutting (turning lathes, grinding machines, gear cutting machines, jig-boring machines, vertical lapping machines, machines for the processing of piston rings, component parts for passenger cars and tractors)	31,000,000
Machines for noncutting shaping (mechanical and automatic presses for the metal powder industry, embossing machines, hydraulic stamping presses, vacuum presses, forging manipulators, casting machines)	10,000,000
Power equipment and apparatus for the electrical engineering industry (water eddy brakes, furnaces, diesel power stations, silicon rectifiers for electric locomotives, electric dynamometers)	10,000,000
Coal mining equipment, equipment for metallurgical and petroleum industries (coal preparation plants, equipment for open-pit mining, agglomeration plants, rolling mills for cold rolling of tubes, rapid-working cable percussion drilling plants, loading machines)	110,000,000
Equipment for the food industry, including three complete sugar factories	126,000,000
Refrigeration plants	52,000,000
Equipment for light industries	5,000,000
Equipment for the chemical industry, Complete plant for production of polypropylene Crystallization of sodium sulfate (four plants) Hydraulic refining of benzene (one plant) Production of di-isozyanatene (one plant) Production of phosphorus (one plant) Production of simazine and atrazine (one plant) Manufacture of foils from viniplast (two plants)	11 complete plants
Equipment for the cellulose and paper industry (vacuum evaporating plants, supercalenders)	26,000,000
Equipment for the building materials industry (veneer plants [Ueber-furnieranlagen] for pressed boards made of wood fiber, assembling machines, equipment for the production of mineral wood)	21,000,000
Pumping and compressor plants (pumps and compressors of various kinds, glassblowing machines, ventilators)	63,000,000
Equipment for the polygraphic industry	10,000,000
Equipment for the cable industry	15,000,000
Fittings and component parts for high-pressure pipelines	44,000,000
Main track electric locomotives	20
Ships	157,000,000
Miscellaneous apparatus, including precision instruments and optical apparatus	16,000,000
Miscellaneous equipment, including special-type automobiles	21,000,000

Source: U.S. Senate, *East-West Trade*, Hearings Before the Committee on Foreign Relations, 88th Congress, 2d Session, March 13, 16, 23 and April 8, 9, 1964, p. 110.

in List B; these items, totaling 717 million DM, comprise machine tools and advanced equipment for the mechanical, mining, chemical, paper, building material, and electrical industries. The list also includes eleven complete plants for the chemical industry not included in the total of DM 717 million. The remaining DM 600 million of the agreement comprises specialized iron and steel products—rolled stock and tubes, for precisely those areas in which the Soviet Union is backward.

Thus the 1960 German-Soviet agreement is an excellent example of the nature of Soviet trade with industrialized countries. The Soviet Union imports from Germany goods with a technological component or of unusually difficult technical specification, and in return provides raw materials produced with equipment formerly imported from Germany and other Western countries.

ITALY AS A SUPPLIER OF CAPITAL GOODS TO THE SOVIET UNION

Italy has been a major supplier of industrial equipment to the Soviet Union since the 1920s. The 1953 Italian-Soviet agreement, for example, required the export of Italian machinery for manufacture of steel plate, textiles, foodstuffs, electrical cables, and fibers. Also under this agreement Italy contracted to supply cargo ships, refrigerated motor ships, tugs, cranes, and equipment for thermal electric stations.[12]

The Italian-Soviet trade agreement for 1958 required a far greater quantity of Italian industrial equipment, including equipment for complete production lines and plants. A partial list of the equipment supplied by Italian firms is as follows:[13]

530 interior and centerless grinders
25 horizontal boring machines with mandrels of 75-310 mm
44 repetition turret lathes
20 automatic thread-cutting machines of the "Cridan" type
43 vertical milling machines with table measuring 500 by 2500 mm
75 die-casting machines
26 crawler-mounted diesel electric cranes with grab buckets having a capacity of 25 to 50 tons
Cranes and excavators (470 million lire)
Two water turbines of 10,000 kw
Pressure pipe for hydroelectric power stations (610 million lire)
Three throttle valves for hydroelectric power stations
Three hydraulic brakes
Spares for thermoelectric power stations (625 million lire)

[12] *The Times* (London), October 28, 1953.
[13] *East-West Commerce*, V, 4 (April 8, 1958), 9.

One plant equipment for manufacture of sugar from molasses
10 production lines, complete, for tomato puree
Two production lines for tin boxes with tongue and key
Machinery for light industry (5500 million lire)
One cement manufacturing plant, complete with ovens
One plant for manufacture of reinforced concrete poles for electric transmission lines and lighting purposes.
One machinery plant for manufacture of asbestos cement tubes
Spare parts for ships (235 million lire)
High-frequency tools (780 million lire)
Miscellaneous machines (4700 million lire)

SCANDINAVIA AS A SUPPLIER OF CAPITAL GOODS TO THE SOVIET UNION

Finland has been a major supplier of equipment to the Soviet Union since 1945. For example, no less than 95 percent of all ships manufactured in Finland since World War II have been on Soviet account.

Major deliveries under the Finnish reparations agreements[14] were continued throughout the 1950s and 1960s by annual trade agreements. In exchange for Soviet raw materials, Finland was committed to supply not only ships but power plant equipment (including 25 boilers annually from 1956 to 1960), woodworking and paper-making equipment including complete plants for manufacture of paper and cardboard, plants for manufacture of cellulose, sawmills, veneer-making plants, frame saws, and wood planers. Hoisting equipment, including large bridge cranes, railway cranes, and freight elevators, comprise a significant portion of Finnish supplies.[15]

Sweden has been an important supplier of equipment for the Soviet chemical, food, and building industries under annual trade agreements since 1946. For example, the 1950 trade agreement between Sweden and the Soviet Union called for Swedish delivery of the following equipment[16]:

Equipment for building industry and manufacture of building materials (Sw. Kr. 23,500,000)
Equipment for food industries (Sw. Kr. 9,000,000)
Equipment for chemical industry (Sw. Kr. 12,000,000)
Power and electrotechnical equipment (Sw. Kr. 6,500,000)
One unit of mine elevator gear

[14] See chapter 2.
[15] United Nations, *Treaty Series*, vol. 240, no. 3403 (1956), pp. 198-204.
[16] *East-West Commerce*, V, 4 (April 8, 1958), 6.

Four units of excavating machinery and spare parts for deep drilling machinery (Sw. Kr. 1,300,000)
Spare parts for ships (Sw. Kr. 1,300,000)
Miscellaneous machinery and equipment (Sw. Kr. 3,250,000)

Denmark has also been a major supplier of equipment, particularly of diesel engines and cargo ships. The 1959 Danish-Soviet Trade Agreement included the following items of equipment:[17]

Cargo ships of 11,500 tons d.w. carrying capacity and with a minimum speed of 17.5 knots
Refrigerator ships of 1500 tons d.w.t.
Ship's equipment and spare parts (3,500,000 D. Kr.)
Components and parts for ships' diesel motors (6,000,000 D. Kr.)
Machinery for chemical industry and equipment (26,000,000 D. Kr.)
Machinery and equipment for food industry (17,000,000 D. Kr.)
Machinery and equipment for manufacture of cement and other building materials (3,500,000 D. Kr.)
Various machinery and equipment (3,500,000 D. Kr.)
Instruments and electronic apparatus (7,000,000 D. Kr.)

JAPAN AS A SUPPLIER OF CAPITAL GOODS TO THE SOVIET UNION

During the decade of the fifties, Japan, unlike the Soviet Union, developed a first-rate capability to build and export complete plants using in a few cases an indigenous Japanese technology (as in the case of Kanekalon) or more often an adapted or licensed foreign technology. Although Japan at first lacked experience in certain areas (e.g., the ability to guarantee complete performance for a plant in contrast to performance of individual items of equipment), this ability was gained during the 1960s.

Thus the late 1950s saw the beginning of a considerable export of advanced Japanese equipment to the Soviet Union. The first postwar trade and payments agreement between the Soviet Union and Japan was signed concurrently with the joint declaration ending the state of war between the two countries on October 19, 1956.[18]

The trade agreement provided for most-favored national treatment and included a list of products to be exported by each country. Soviet exports were, typically, raw materials, with a small quantity ($1 million) of metal cutting

[17] *Ibid.*, VI, 9 (September 28, 1959), 6.
[18] *Japan Times (Tokyo), October 20, 1956.*

equipment. On the other hand, Japanese exports to the Soviet Union were almost completely in the form of machinery or equipment, with significant proportions of specialized metal products. Marine equipment included two herring packing ships, two tuna fishing boats, and two floating cranes, in addition to marine diesels presumably for installation in Soviet vessels; also provided were ten sets of canning facilities for crab-packing ships and ten for salmon and trout. Moreover, provision was made for Soviet ship repairs in Japanese yards. Other transportation equipment included 25 locomotives (diesel, electric, and steam) with 25 passenger and freight cars in addition to 100,000 kw of mercury rectifiers for Soviet electric locomotives.

Other general machinery included mobile cranes and textile machinery, communications equipment, and various machine tools. Specialized metals included rolled steel products, tin plates, steel wire, and uncoated copper wire and cable. Various medical supplies and fiber yarns made up the balance.

A subsequent Japanese-Soviet trade agreement (1959) further demonstrated the continuing Soviet interest in Japanese capital goods—for example, in paper mills, cold storage plants, chemical plants, and related areas. About 60 percent of the later agreement comprised export of Japanese plants and equipment in exchange for Soviet raw materials.

Japanese exports may be described, then, as falling into two categories: advanced machinery, particularly transportation equipment; and specialized materials related to sectors where the Soviet Union has a very limited and antiquated capacity. Some exports, such as mercury rectifiers for electric locomotives and marine diesels, reflect sectors in which the Soviets have known weaknesses.[19]

EAST EUROPEAN COUNTRIES AS SUPPLIERS OF CAPITAL GOODS TO THE SOVIET UNION

The communist countries of Eastern Europe have been consistent and major suppliers of machinery and equipment to the Soviet Union since 1945. After extensive dismantling in 1945-46, the SAGs and similar joint stock companies were used to ensure a continuity of equipment to the Soviet Union. In the 1950s supply was placed under annual trade agreements.

In 1953 East Germany signed a trade agreement that had as its chief component the provision to the Soviet Union of electrical equipment, chemicals, machinery for the manufacture of building materials, and mining equipment.[20] The 1957 East German trade agreement with the Soviet Union called for the supply of

[19] See below, p. 221. A good description of the 1960 exports is in *The Oriental Economist*, (Tokyo), October 1960, pp. 552-57.

[20] *The Times* (London), April 29, 1953.

rolling mill equipment, hoisting equipment, forges, presses, raw stock, and a large quantity of seagoing vessels and river craft.[21]

Under the agreements for 1960-65 supply, signed on November 21, 1959, East Germany was required to supply the Soviet Union with engineering products, refrigerated vans and trains, main line passenger coaches, passenger ships, fishing vessels, a number of complete cement plants, equipment for the chemical industry, machine tools, and forge and pressing equipment.[22]

Poland under its trade agreements with the Soviet Union has been a major supplier of machine tools and equipment, rolling stock, and oceangoing ships.[23] Czechoslovakia has probably been the most important East European communist supplier of equipment. The Skoda Works in Pilsen has been a prominent supplier of machine tools and diesel engines for marine and locomotive use. Other Czechoslovak plants have sent electric locomotives, power plants, and general industrial equipment.[24]

During negotiations between the U.S.S.R. and Yugoslavia in the summer of 1947 the Soviets agreed to grant Yugoslavia $135 million in capital goods, including iron and steel plants, coking ovens, refineries, a zinc electrolysis plant, a sulfuric acid plant, copper and aluminum rolling mills, and molybdenum processing installation.[25] The resulting agreement (July 1947), which specified in great detail the equipment to be provided by the U.S.S.R. to Yugoslavia, included equipment of obvious Western origin, such as Dwight-Lloyd belts, Blake and Symons crushers, Dorr concentrators, Dorko pumps, Abraham filter presses, Sirocco ventilators, Sweetland filter presses, Dix hammer crushers, MacCully crushers, Junkers saws and Geller saws.[26] This was in addition to unnamed equipment for which, from material presented elsewhere, we know that the Soviets utilized a Western design—i.e., drill rigs, sulfuric acid and plant equipment, furnaces, rolling mills, and so on. However, concerning this 1947 agreement Vladimir Dedijer, a former member of the Yugoslav party central committee, comments: "The agreement was a mere ruse, for the Soviet Union had no intention of honoring it.... Of the 135 million dollars promised, the Soviet Union sent us installations valued at only $800,000."[27]

Since the 1950s Yugoslavia has been a supplier of advance equipment to the U.S.S.R., including numerous large and fast cargo ships and scarce copper sections.

[21] *East-West Commerce*, IV, 3 (March 12, 1957), 12.
[22] *Ibid.*, VI, 12 (December 8, 1959), 11-12.
[23] *Ibid.*, V, 5 (May 7, 1958), 7.
[24] *Ibid.*, V, 1 (January 3, 1958), 9.
[25] V. Dedijer, *Tito* (New York: Simon & Schuster, 1953), p. 288.
[26] United Nations, *Treaty Series*, vol. 130, no. 1732 (1952), pp. 374 *et seq*.
[27] Dedijer, *op. cit.* n. 25, pp. 288-89.

WESTERN RESTRICTIONS ON TRADE WITH THE SOVIET UNION

Attempts by Western countries to restrict export of goods with a strategic value to the Soviet Union have taken two main legislative forms. One is exemplified in the U.S. Export Control Act of 1949 and similar national acts in allied countries, and the other in the Mutual Defense Assistance Control Act of 1951 (known as the Battle Act) in the United States.

The Battle Act represents an attempt to prevent export of strategic items with capability of strengthening the military power of the Soviet Union from Western countries to the Soviet Union. At the time the act was introduced, at the end of the 1940s, the Free World had legislative control over export of strategic materials. The Battle Act provides for United States participation in the coordination of these national controls through an informal international committee, meeting in Paris and known as CoCom (Coordinating Committee). Essentially, the act reinforces the system of international controls in effect prior to its enactment and provides a link with U.S. strategic trade controls under the Export Control Act of 1949.

The Battle Act forbids U.S. aid to any country that knowingly permits shipment of strategic items to the Soviet bloc when such items are listed for embargo by the administrator of the act, i.e., by the State Department. The CoCom embargo lists are not made public, but the United Kingdom has published from time to time an embargo list as it relates to British exports to the Soviet bloc. This list gives an idea of the erosion that has taken place in restrictions since 1950. For example, on August 15, 1958, it was announced in the United Kingdom that certain goods had been freed from CoCom embargo control:

> All electrical generating machinery (other than mobile generators of more than 5 mw); all electrical motors (except those specially designed for submarines); all turbines; spectrographs, spectrometers (other than mass spectrographs and mass spectrometers); X-ray diffraction and electron diffraction equipment; electron microscopes; radio valve making machinery (except certain advanced types and those designed specially for making embargoed types of valves); civilian vehicles and aircraft; compressors and blowers; many types of machine tools; and ships (with certain restrictions on speed).[28]

The U.S. State Department for its part has never requested the President to apply sanctions under Section 103(B) of the Battle Act, and scores of violations have been made by Western countries without imposition of the sanctions required by law. In fact, inasmuch as the Battle Act has been violated from its inception, it has never provided an effective restraint to the export of strategic goods

[28] *Electrical Review* (London), August 22, 1958, p. 342.

from the West to the Soviet Union.[29] It is arguable that the measure is simply a badly conceived instrument, that it is for various reasons unenforceable. But certainly lax administrative action and gross administrative ignorance concerning Soviet technical capabilities and the use of Western processes and technologies have been major contributory causes to its failure and to the decline of coordinated export control.

The Export Control Act of 1949 as extended and amended to 1969 (when it was replaced by the Export Administration Act of 1969), provides for restrictions on materials whose export may have an adverse effect on the national security of the United States. Section 3(a) provides that rules and regulations shall be established for denial of exports, including technical data, to any nation "threatening the national security of the United States" if the President determines that such export "makes a significant contribution to the military or economic potential of such nation."[30]

This power is administered by the Department of Commerce for most exports, by the Department of State for munitions, and by the Atomic Energy Commission for nuclear materials.

EFFECT OF WESTERN EXPORT CONTROL RESTRICTIONS

The general assessment appears to be that Western export controls have not been effective.[31]

An excellent example of their ineffectiveness may be found in the supply of transportation equipment to the Soviet Union and its subsequent use against the United States and its Asian allies in the Vietnamese war. Whereas the Battle Act of 1951 and the more restrictive Export Control Act of 1949 include an embargo on "transportation materials of strategic value," an analysis of merchant vessels utilized by the Soviet Union to carry armaments to South Vietnam[32] and leased by Poland to Red China for similar purposes indicates that such ships and technology were acquired after the passage of the two export control acts.

Of 96 ships known to have been used by the Soviets on the Haiphong run, 12 have not been identified since construction is too recent for listing in ship registers. Of 84 ships positively identified, only 15 were even partly built in Soviet yards, and one of these was a small tug on a one-way trip

[29] For further material, see Battle Act reports to Congress and Gunnar Adler-Karlsson, *Western Economic Warfare, 1947-67* (Stockholm: Almquist & Wiksell, 1968).
[30] U.S. House of Representatives, *op. cit.* n. 4, 1st session, October and December 1961, Section 3(a).
[31] Adler-Karlsson, *op. cit.* n. 29, pp. 83-139.
[32] The State Department has pointed out that the Soviet vessels carry the armaments while leased Western vessels carry the economic supplies.

to Haiphong. The other 69, all tankers and cargo ships, were built outside the U.S.S.R.

Of these 69 ships, only 13 were built before the Battle Act embargo of 1951—*in other words 56 were built after the embargo and outside of the U.S.S.R.* Six of the 13 built before 1951 are Lend Lease ships.

The most important component of a ship is its propulsion unit, i.e., its main engine. None of the 84 identified ships on the Haiphong run has a main engine designed and manufactured in the Soviet Union. (There is one possible exception, where complete positive identification of a Sulzer steam turbine has not been made.)

Small marine diesel engines (2000 hp and less) are made at the prerevolutionary Russky Diesel works in Leningrad, under a 1956 technical-assistance agreement with the Skoda firm of Prague, Czechoslovakia. Larger and of course more important marine diesel engines, up to 9000 bhp (the largest made in the U.S.S.R.), are of Burmeister and Wain (Copenhagen) design. Although Denmark is a member of NATO and presumably supports the NATO objective of an embargo on war materials to the Soviet Union, the Burmeister and Wain firm was allowed (in 1959) to make a technical-assistance agreement for manufacture of the B & W series of marine diesel engines at the Bryansk plant in the U.S.S.R. These diesels are massive units, each 60 feet long by 35 feet high and almost 1000 tons in weight, with obvious strategic value.

Under such circumstances it may be asserted that attempts to control export of strategic goods have not been successful. Indeed there has been a massive and identifiable flow of military equipment to the Soviet Union from Western countries through the CoCom control net. As each member of CoCom has a veto over any shipment, it appears that the information utilized by the State Department and comparable Allied government offices is grossly inadequate and inaccurate.[33]

[33] This argument is expanded in chapter 27.

CHAPTER FOUR

Technical Assistance and Foreign Prototypes

Formal technical-assistance agreements with the Soviet Union are far less publicized today than they were in the early 1930s and therefore little public information is forthcoming. This information scarcity is compounded by the refusal of the U.S. Departments of State and Commerce to release precise information concerning U.S. assistance to the U.S.S.R. It is estimated, however, that since the 1930s the Soviets have had about 100 technical-assistance agreements in force with Western companies at any given time. This assertion applied as recently as late 1968, and it is unlikely the situation has changed since then or will change in the foreseeable future.[1]

Quite apart from formally contracted technical assistance there is a transfer of assistance through the medium of equipment sales and installations. Sometimes provision for such assistance is included in a formal agreement to supply an installation. For example, the 1968 agreement whereby Olivetti of Italy (a subsidiary of General Electric) undertook to build a $90 million plant at Oryol, south of Moscow, for manufacture of automation equipment and office machines was an outgrowth of a technical-assistance agreement in 1965.[2] Another such agreement—one of many that could be cited—was that between the Soviets and Fisher-Bendix of the United Kingdom in 1967, under which the British firm agreed to provide technical documentation and know-how to produce the Bendix automatic commercial washer in the Soviet Union.[3]

However, in the final analysis, any sizable sale of plant or equipment entails technical assistance. Such a sale usually includes not only equipment but also assistance for preparation of the specification, installation, training, and start-up. This was the case in the misnamed "Fiat deal" in which the supply of U.S. equipment was supplemented by Italian technical assistance including the printing of training manuals (in Russian) for Russian operatives in Italian printing plants. Quite clearly, then, technical assistance need not be formalized into an agreement;

[1] *Business Week*, October 5, 1968, p. 124. According to this source, in 1968, "100-odd ... Western companies ... have technical accords with the Soviets."
[2] *Ibid.*
[3] *East-West Trade News* (London), III, 7 (April 15, 1967).

it is more realistically viewed as part of any sale of technology, regardless of whether or not it is the stated subject of a written agreement.

Apart from formal technical assistance, there is the allied consideration of Soviet imports of single items of equipment for use as prototypes. There is no question that the Soviet Union draws an almost unbelievably large quantity of such prototypes from the West, primarily from the United States and Germany. It might not be rash to assert that the Soviet Union attempts to purchase one of every major industrial product manufactured in the West for analysis and possible reproduction. Examples extracted more or less at random from Soviet imports from the United States in 1960 and 1970 illustrate the magnitude of this flow of single items. In the third quarter of 1960[4] the Soviet Union imported the following items from the United States (almost all single items):

	Value
Industrial power sweeper	$ 2,001
Gas turbine engine	17,830
Centrifugal separator	19,850
Ultracentrifuge	15,645
Analytical balance	1,993
Air compressor	83
Centrifugal pump	1,700
Fluid stream analyzers	28,500
Hard gelatin capsule machine	309,631
Hydraulic presses	27,273
Industrial sewing machine	1,508
Mixing and blending machines	4,538
Percussion type drill	95,000
Plastics molding press	12,490
Vertical turret lathe	95,970
Tracklaying tractor (and blade)	15,000
Beet harvester and topper	8,055
Haying machine	4,970
Police motorcycle (with accessories)	1,944
Potato planters	6,093
Airplane tug and engine starter	86,450
Klischograph	8,950
Wattmeters	596

These small-lot imports are almost certainly for design purposes. Indeed, there never has been export of more than one or two items to the U.S.S.R. of agricultural equipment of the types listed (beet harvesters, haying machines, potato planters, and tractors) since the early 1930s (with the exception of Lend Lease items charged to the U.S. Treasury). Single imports of such equipment, when continued

[4] U.S. Dept. of Commerce, *Export Control*, Fifty-third Quarterly Report (Third Quarter 1960), p. 10.

over a lengthy period and not followed by substantial orders, are clearly for prototype use.

Ten years later we find a similar pattern of Soviet imports. In the second quarter of 1969 the U.S.S.R. imported from the United States the following items:[5]

	Value
Airborne navigation equipment	$ 18,116
Electronic computer	169,334
Spectrophotometer	169,334
Diesel engines	13,495
Atmospheric furnace system	92,944
Water filtration system	54,128
Sweep generator	18,358
Industrial weighing scales	15,752
Radiation detection and measuring instruments	208,410
Automatic typewriter	6,800
Power sweeper	6,283

That this process of single-item import has extended over a considerable period of time is determined by examination of the statistics of Soviet foreign trade. Soviet Trade Group 145 is "Excavators and road construction equipment"; imports in this group from the United States have been as follows:[6]

	Value in rubles	*Estimated number of units*
1949-56	None	None
1957	80,000	2
1958	122,000	3
1959	46,000	1
1960	57,000	2
1961-65	None	None
1966	55,000	2

The tabulation shows that import of small batches or single units is followed by a gap with no imports and then small-batch imports are resumed.

The manner in which such single items are analyzed in the Soviet Union may be inferred from Soviet technical manuals. Such books fall into two basic categories: (1) those that describe in a detailed, comparative manner individual items of foreign equipment, and (2) those that describe the single item that

[5] U.S. Dept. of Commerce, *Export Control*, Eighty-eighth Quarterly Report (Second Quarter 1969), p. 12.

[6] Values taken from *Vneshniaia torgovliaia SSSR; Statisticheskii sbornik, 1918-1966* (Moscow, 1967), pp. 146-47; units calculated at approximately 25,000 to 45,000 rubles per unit.

has been chosen as the Soviet standard, i.e., for duplication on a large scale. Selected data from several such Soviet publications will make the argument clear.

Soviet technical literature has always contained a sizable number of books —usually paperbacks issued in editions of between 2000 and 10,000 copies—making comparative studies of foreign machines. The Soviet Academy of Construction and Architecture, for example, issued in 1959 a 62-page paperback entitled *Zarubezhnye mashiny dlia mekhanizatsii stroitel'nykh rabot*, consisting of a detailed examination of foreign mechanical equipment used in the construction industry. On pages 19-20 a detailed table provides comparative figures on capacity, load, type, and model of engine, speed (converted to kilometers per hour), number of speeds, and total weight in kilograms for 38 foreign models of mechanical dump cars. These models include Aveling-Barford (U.K.); Road Machines (U.K.); Benoto (France); Bates (U.K.); Dart (U.S.A.); Koering (U.S.A.); Orenstein Koppel (West Germany). In other words the Soviets acquired one of virtually every foreign dump car and made a detailed comparative study of characteristics. The booklet is complete with photographs and diagrammatic blowups of the mechanical features. Several of the more interesting Western models are examined in more detail by comparing such features as chassis construction, brakes, and engine characteristics. Finally technicoeconomic efficiency factors are calculated. It might be argued that such comparative studies may be a prelude to Soviet purchase, except that this type of equipment has not been imported in quantities larger than small batches of one to six since the 1930s and (as will be indicated later) Soviet equipment is based with only minor exceptions on such Western models.

A similar hard-cover publication (3400 copies) was a book issued in 1968, authored by N. N. Kalmykov and entitled *Burovaia tekhnika i tekhnologiia za rubezhom*. Pages 20 to 27 contain numerous photographs of United States tri-cone drilling bits—supposedly denied export from the United States to the U.S.S.R. under export control laws. Figure 7 illustrates the Globe Type S-3; Figure 8 the Globe Type SS-2; Figure 9 the Hughes Type OWV; Figure 10 the Smith Type SV-2; Figure 11 the Globe Type MHY-3; Figure 12 two views of the Type EM and two views of the Type EM-1C manufactured by Chicago-Pneumatic; Figure 13 the Reed Type YS and Type YM; Figure 14 the Security Type M4N; Figure 15 the Globe Type M-3; Figure 16 the Chicago Pneumatic Type ER-1; Figure 17 the Chicago Pneumatic Type ER-2; Figure 18 Security Types S4 and S-4T; Figure 19 the Reed Type YR; and so on.[7]

The rest of the volume is a detailed discussion of American oil well drilling equipment. Some of the diagrams suggest that copying of the equipment is the objective: for example, the diagram on page 199 compares tooth profiles

[7] The model letters were not transliterated from the original English to the Russian; therefore, they have not been transliterated into English but are given as in the Russian text.

on various tubes. In brief, the book is a clear comparative exposition of the technical features of U.S. oil well drilling equipment.

In the field of U.S. coal mining practice and equipment, a recent Soviet book is R. Yu. Poderni, *Ugol'niia promyshlennost' SShA* (Moscow, 1968; 2600 copies). This book contains comparative performance and technical data on U.S. equipment that would be difficult to find even in the United States. For example, pages 132-33 detail operating characteristics of all Bucyrus-Erie and Marion excavators currently in production; page 146 has comparative data on the seven walking draglines produced by the Marion Company, and is followed by details on the method used by the firm to calculate excavator productivity. If the book were to be translated into English it would provide a useful little manual for excavator and dragline operators in the United States. A similar book on mining practice also was published in 1968, entitled *Rekonstruktsiia, mekhanizatsiia i avtomatizatsiia shakht za rubezhom*, by K. K. Kuznetsov and others (Moscow, 1968; 2700 copies). This book provides information on development and mechanization of foreign mine shafts. The bibliography suggests the scope of Soviet acquisitions; it includes company catalogs and literature (that of the Hibernia and Westphalia firms) and company journals. Soviet interest is reflected in the issue of foreign developments in the field as "Express Information."

The refinement of technical details given in this type of book is suggested by the following translation of Table 1 in a publication entitled *Analiz rabot po avtomatizatsii pitaniia utkom tkatskikh stankov za rubezhom* by Yu. P. Sidorov (Moscow, 1968; p. 10). The table compares operating characteristics of foreign-made stitching machines:

Operating Angles of Automatics

Model of machine and firm	*Start stitching operations*	*Light (no load) stitching*	*Transfer to new bobbin*	*Shift spools*	*Full operating angle*
Northrop, England	311	2	14	33	49
Ruti, Switzerland	325	2	8	25	35
Draper, U.S.A.	312	9	13	26	48
Sohengo, West Germany	306	4	17	33	54
Saurer, Switzerland	320	4	10	26	40

In the electronic sector, one type of publication includes operating characteristics of foreign equipment, no doubt as a guide to purchases by Soviet organizations. For example, a booklet issued in 1968 includes details on over 2000 American, Japanese, East German, and West German transistors—*Zarubezhnye transistory shirokogo primeneniia*, by V. F. Leont'ev. Another type of publication includes data on utilization of equipment in the West and obviously provides more than mere information on available equipment. For example, G. G. Sitnikov's *Transzistornye televisory SShA i Iaponii* (Moscow, 1968) is a selection of articles either translated from American and Japanese sources, or detailing circuits reproduced from such sources; pages 68-70 are entitled "TV 120771 firmy EMERSON (SShA)."

These precise examinations of foreign abilities are by no means limited to technology in the narrow sense. They also include analyses of Western management systems. For example, one booklet of 143 pages (9000 copies printed) describes the operations of Olivetti–General Electric plants in Italy—N. A. Salomatin's *Organizatsiia i mekhanizatsiia upravleniia proizvodstvom na predpriiatiiakh italii* (Moscow, 1969). It provides information on the Italian plants of Olivetti–General Electric that would be difficult to find in a well-stocked Western business library. After a brief introduction (without the usual Marxist-Leninist prefixes), it discusses organization of production in each of the G.E. plants (with photographs), including reproduction of documents used, types and numbers of business machines, organization charts, work programs, and a small section on the use of the PERT management system.

An examination of plastics used in buildings, but compiled without benefit of the courtesy extended by Olivetti–General Electric at the plant level, is entitled *Polimernye stroitel'nye materialy* (Moscow, 1968). This 102-page booklet (7000 copies issued) details Western uses of plastics in building, and includes three rather bad color photographs and a discussion of products by trade name and physical properties.

With the help of such fairly common publications it is possible to trace import of foreign equipment in small batches, and its subsequent use first as prototype then as duplication of the prototype for series production of a "Soviet" machine or piece of equipment.

The Soviet production of electric locomotives provides an excellent example of this evolution. Small batches of electric locomotives were imported from the West in early 1930s—first General Electric and Brown-Boveri, followed in the 1950s by Skoda, Japanese mercury rectifiers, and Schneider-Alsthom locomotives from France. More recently these imports have been supplemented by batches of Krupp silicon rectifier electric locomotives and another group of Czech locomotives. Figure 4-1 illustrates the process by which these batches of imported prototype locomotives have been converted into Soviet classes of electric locomotives.

It is unlikely that export of technical data, a normal accompaniment to sales, by itself provides information for "copying." The Export Control Act of 1949 provides specific authority for controlling export of data for national security reasons, and in 1951 stringent controls were put on data for Soviet bloc destinations; since then validated export licenses have been required for shipment of data not generally available in published form. General license

Figure 4-1 FOREIGN ORIGINS OF SOVIET ELECTRIC LOCOMOTIVES

Date	*Foreign locomotive type imported*	*Number imported*	*Soviet utilization: Russian class*	*As prototype for*	*Date*
1930					*1930*
1932			*"S" Class*		*1932*
	General-Electric (U.S.A.)	29	Ss		
	Brown-Boveri (Italy)	7	Si		
1934				VL-19	*1934*
1936					*1936*
1938				VL-22	*1938*
1940				VL-22 (340 kw)	*1940*
1942					*1942*
1944	Electric locomotive axles (VI-1-108) U.S. Lend Lease				*1944*
1946				VL-22m (400 kw)	*1946*
1948					*1948*
1950					*1950*
1952				VL-8 (N-8)	*1952*
1954			*"NO" Class*		*1954*
	Skoda (Czechoslovakia) mercury rectifiers		N-60		
	silicon rectifiers		N-62		
	Japanese (mercury rectifiers only)		N-60 electric mechanical equipment	VL-23	
1956	Skoda (Czechoslovakia) mercury	50	chSl		*1956*
1958	Schneider-Alsthom (France)	40	F (T)		*1958*
1960	Schneider-Alsthom (France)		FP (TP)		*1960*
	Krupp (Germany) silicon rectifier	20	K		
1962	Skoda (Czechoslovakia)		chS2		*1962*
1964					*1964*
1966					*1966*
1968					*1968*
1970					*1970*

Legend: - - - - → Prototype development

——————→ Production

Sources: Association of American Railroads, *A Report on Diesel Locomotive Design and Maintenance on Soviet Railways* (Chicago: AAR Research Center, 1966); and Association of American Railroads, *Railroads of the U.S.S.R.* (Washington, D.C., n.d.).

GTDP permits export of data generally available in stores or by subscriptions, or of unpublished data "not directly and significantly related to design, production, and utilization in industrial processes" and available in academic institutions and laboratories.

It is also unlikely that firms would freely ship data to the U.S.S.R. given the Soviets' long history of retaining such material or making unauthorized use of it. Moreover since June 1959 all U.S. exporters of certain specified types of unpublished chemical data and services relating to petroleum and petrochemical plants and processes must obtain written assurances from the importers in friendly countries that neither the technical data nor the resultant machine, equipment, plant, process, or service is intended to be sent to a Sino-Soviet bloc destination or to Poland.

Thus in the third quarter of 1960 the Department of Commerce approved only 18 licenses for export of technical data to the Soviet bloc, including those for rolling mill accessory equipment, a phosphoric acid plant, compressors for urea plants, drawbenches for tubes and bars, superchargers for vehicles, and instructions manuals for communications equipment.[8] Given the restrictions and the limited exports of such data, then, it is probable that the import of prototypes provides the more valuable source for copying.

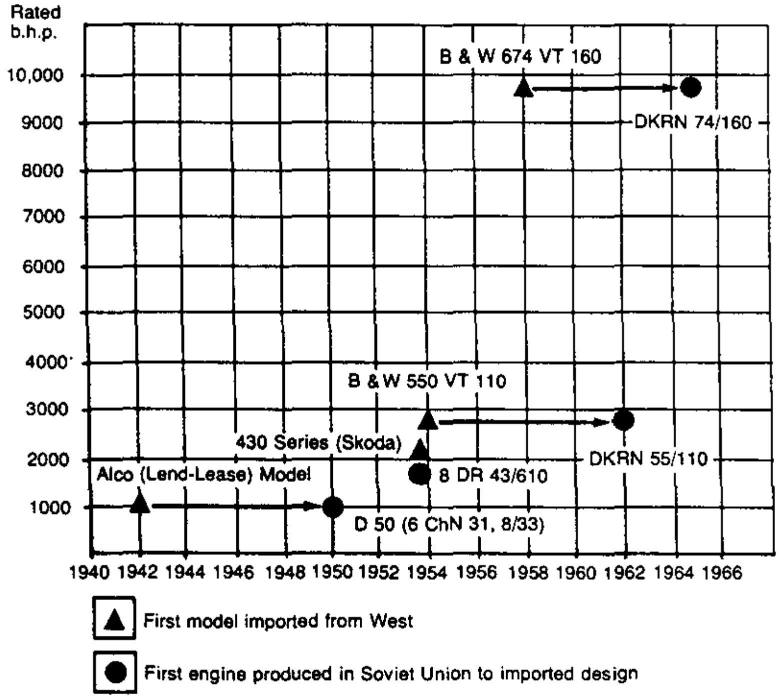
Import of prototypes and subsequent copying is advantageous to the Soviet Union in several ways: it minimizes internal research and development investment, provides a quick answer to the Party's demands for instant technology, and above all eliminates the cost of investing in processes that will fall by the wayside.

In a market economy numerous processes and products, perhaps several hundred alternatives for any one product, may move from invention to innovation and enter the marketplace for sale to consumers. Consumer demand and technical efficiency (or inefficiency) eliminate the least desirable, and normally there is only a relative handful of survivors. The elimination of those that fall by the wayside, those products and processes sometimes called the "wastes of competition," is, however, a necessary step along the road to achieving efficient economic and technical choices. Socialists may criticize the waste involved, but the alternative is either to choose a single process arbitrarily without going through the market or to depend on technology tested in a foreign market-place.

The time lag between selection of a specific foreign process and its subsequent production in the U.S.S.R. (via import of prototypes and copying) is significant. Figure 4-2 illustrates the approximate time lags for some of the more important types of marine diesels adopted from foreign designs; between six and eight years appears to be the average time between import of the first foreign model

[8] U.S. Dept. of Commerce, *op. cit.* n. 5, p. 7.

Figure 4-2 MARINE DIESELS: TIME LAGS IN CONVERTING FOREIGN TO SOVIET MODELS



Source: Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

and its initial production in the U.S.S.R. (The exception is produced under joint technical-assistance agreements set up in COMECON.) This lag is favorable when compared to the alternative of developing a suitable technology inside the U.S.S.R. without a background of research and development experience and without the guidance of the marketplace. There is little question that without such imports the Soviet Union (unless it were to effectively decentralize the innovative function and adopt a market economy) would have great difficulty in advancing from its present technological levels. It may be noted in this regard that even Yugoslavia, a socialist country with a quasi-market influence which supplies important technology to the U.S.S.R. (see the Skoda example cited in Figure 4-2), is itself still dependent on Western technology in the marine diesel sector.[9]

[9] More detailed information concerning marine diesels is given in chapters 6, 17, and 21.

We may infer from this brief discussion a point that will be further illustrated later: the degree of indigenous technical innovation in an economy appears to be directly related to the structure of the economy. The greater the influence of market forces, including a demand-supply price system, the profit incentive, and free entry and exit, the greater the degree of indigenous innovation. Conversely, the greater the degree of centralized technical decision-making and lack of personal profit incentive and disciplinary marketplace forces, the less the degree of indigenous innovation.

CHAPTER FIVE

Financial Aspects of Technical Transfers

Previous volumes of this study have only cursorily mentioned the financial means by which technical transfers have been effected. These financial factors are generally beyond the scope of this study, but a summary outline is perhaps in order at this point.[1]

The financing of technical assistance has not normally taken the form of government-to-government transfers; until recently, it was usually accomplished through private loans and credits guaranteed by a Western government, but several large French and German long-term loans in the late sixties may herald a change. Although the role of Western governments has been obscure it has also been fundamental: it is unlikely that individual Western firms, financial institutions, and banks would have continued to provide long-term credits or loans without government guarantees. For example, in discussing British Government support, Paul Einzig points out how the Soviets have reneged on payments. Soviet arrears on United Nations payments, he writes, are a breach of the "most solemn pledge imaginable," and "were it not for the guarantees given by the official Export Credit Guarantees Department most industrial firms would not dare to risk granting such credits and would find it difficult to finance them."[2]

[1] The relations between Western financial houses and the Soviet Union have been explored in the literature of only one country—France. Henry Coston, a well-known French writer of reference books, has also published detailed studies on French financiers and their financial support of the U.S.S.R. The following in Coston's "Lectures Françaises" series are of interest: *Entre Rothschild et Moscou; Les Financiers appuint l'Axe Paris-Moscou; L'Alliance avec Moscou; Les Allies capitalistes du communisme internationale; La Haute finance et les revolutions*. See also two longer studies by Coston: *Les Financiers qui menent le monde* (Paris: Librairie Française, 1958), and *La Haute Banque et les trusts* (Paris: Librairie Française, 1958).

A vast unexplored research field awaits some ambitious economist in the financial relations between American, British, and German financial houses and the Soviet Union. There is a great deal of raw archival material available for such a study or studies. The writer has been unable to locate any full-length published studies on these topics, and the article literature is limited to the subject of Western government financing of the Bolshevik Revolution; see for example George Katkov, "German Foreign Office Documents on Financial Support to the Bolsheviks in 1917," *International Affairs*, April 1956, pp. 181-89.

[2] *Commercial and Financial Chronicle* (London), February 20, 1964, p. 14. In a later article Einzig takes the British Government to task for favoring the Soviets over the Western countries;

The financing of U.S. equipment for the Volgograd automobile plant, to cite a recent example in the United States, was not of interest to private sources, and the original intent was to finance Volgograd through the Export-Import Bank. When this approach was rejected by Congress, other means were found by the administration to provide U.S. Government backing for construction of the largest automobile plant in the U.S.S.R. It is useful, then, to trace the main threads of such financing from the time of the Bolshevik Revolution to the present day, for without Western government and private assistance the technical transfers described in this analysis could not have taken place.

The Bolshevik Revolution itself was financed by "a steady flow of funds" from the German Foreign Ministry.[3] A memorandum to the German kaiser from Baron R. von Kuhlmann, minister of foreign affairs, dated December 3, 1917, reported that German objectives were to support the Bolsheviks financially in order first to remove Russia from the European war as an ally of Britain and France, and then "to provide help for Russia in various ways ... rehabilitation of the railways [and] provision of a substantial loan."[4] The first volume of this series describes how such German assistance was a key factor in bringing about Soviet recovery from the economic depths of 1922.

All banking institutions in the Soviet Union were nationalized under a decree of December 14, 1917. All banking business was declared to be a state monopoly, and all existing private joint stock banks and branches of foreign banks were merged into the State Bank. A subsequent decree, of December 2, 1918, liquidated foreign banks in the U.S.S.R.

Sometime before September 1919 the American-Russian Industrial Syndicate Incorporated was formed in New York by the financial interests of Guggenheim and Sinclair in order to trade with Russia.[5] The long-time interest in Soviet

he suggests that it is one thing to finance routine Soviet transactions but "it is a totally different thing for the British Government to go out of its way to provide additional special facilities for credits up to fifteen years to a maximum of £ 100 million for the exclusive benefit of the U.S.S.R. and other Communist countries." *Ibid.*, March 12, 1964, p. 11. Unfortunately, Einzig does not detail Soviet defaults; these are both numerous and substantial, although there is a prevailing myth to the contrary.

[3] Kuhlmann memorandum; see G. Katkov, "German Foreign Office Documents on Financial Support to the Bolsheviks in 1917," *International Affairs*, 32 (April 1956), 181-89. These "political funds" went through several routes to the Bolsheviks; one route was to the Nye Banken in Sweden and then to the Siberian Bank in Petrograd. The Nya Banken was headed by Olaf Aschberg, who was rewarded after the Revolution with the Russian Bank of Commerce concession in Russia. See also the roles of Alexander Israel Helphand (Parvus) and Kuba Furstenberg as reconstructed from German documents and other sources in Z. A. B. Zeman and W. B. Scharlau, *The Merchant of Revolution* (Oxford and New York, 1965). It should be noted on Parvus that his considerable wealth was acquired suddenly, and that no record exists as to its origins and no trace of it was found after his death.
Another flow of funds for revolution in Russia reportedly was from U.S. and European bankers (Schiff, Warburg, Guggenheim); see A. Goulevitch, *Czarism and Revolution* (Hawthorne, Calif.: Omni, 1962), pp. 230-34.

[4] Katkov, *op. cit.* n. 3.

[5] U.S. State Dept. Decimal File 316-126-50.

finance of the Guaranty Trust Company of New York also began in 1919, with a letter to the State Department inquiring about the legal status of Soviet banking institutions.[6]

In October 1921 the Soviet State Bank (Gosbank) was formed in Moscow with branches in Petrograd, Kassan, and elsewhere. Later in the same year the Guaranty Trust Company of New York was approached by Olaf Aschberg, a former director of the Nya Banken in Stockholm,[7] and the New York bank in turn went to the federal administration with a proposal to open exchange relations with Gosbank.[8] The views of Secretary of Commerce Herbert Hoover on this question were concisely stated: "This seems to me to be entirely in line with our general policy not to interfere with commercial relations that our citizens may desire to set up at their own risk."[9]

However, Charles E. Hughes, then U.S. secretary of state, pointed out that the Bolsheviks could acquire foreign credits by such an arrangement with the Guaranty Trust Company; and (although the secretary did not place much weight on this point) he suggested that the United States might not be able to protect representatives of Guaranty Trust in the Soviet state. Hughes concluded his memorandum: "Particularly I should like to know how it is proposed to secure an effective control of the use by the Bolsheviks of the foreign credits which would be made available in the new State Bank."[10] It was Hoover's subsequent recommendation that any such credits accruing to the State Bank be used for the purchase (question mark "purpose" in original memorandum) of civilian commodities in the United States, and thereby consistent with the humanitarian objectives previously established by the United States with respect to Bolshevik Russia.

In February 1922 overtures were also made to the Irving National Bank of New York to enter into business relations with the State Bank of the U.S.S.R.[11] This does not appear to have been pursued; the State Department files contain only a draft copy of an agreement between Guaranty Trust Company and Gosbank.[12] Under this agreement the Guaranty Trust Company assisted Gosbank in "establishing and maintaining an adequate system covering remittances from the United States of America to the Republic of Russia and [agreed to act] as its agent." The State Department took a noncommittal attitude and apparently disappointed Guaranty Trust Company because "it did not help them very much."[13]

[6] *Ibid.*, 58. Directors of Guaranty Trust at this time included W. Averell Harriman and Thomas W. Lamont; see Sutton I: *Western Technology ... 1917 to 1930*.

[7] U.S. State Dept. Decimal File 316-126-663.

[8] *Ibid.*, 136.

[9] *Ibid.*

[10] *Ibid.*, 141.

[11] *Ibid.*, 158.

[12] *Ibid.*, 160-169.

[13] *Ibid.*, 174.

This link with Guaranty Trust in the United States was followed in 1922 by the establishment of an international bank—the Russian Bank of Commerce in Moscow—by a foreign syndicate including the Krupp and Stinnes interests in Germany, and Danish, Dutch, Swedish, and American banks and banking institutions including Guaranty Trust. The head of the Russian Bank of Commerce was Olaf Aschberg.[14] The board of the concession included A. D. Schlesinger (formerly chief of Moscow Merchant Bank), Kalaschkin (chief of the Junker Bank), V. V. Ternovsky (former chief of the Siberian Bank), and Max May of the Guaranty Trust Company of New York. May was designated director of the foreign division of the new bank.[15] A report on an interview with him contains the following statement: "In his opinion, besides its purely banking operations, it [the concession] will of course largely finance all lines of Russian industries."[16]

At that time Aschberg had severed his connection with Nya Banken and was president of the Economic Bolaget bank in Stockholm, which acted as the Swedish representative of the Russian Commercial Bank. In Germany the Russian bank was represented by Garantie- und Credit Bank für den Osten of Berlin. At the end of December 1922 the U.S. legation at Riga referred to this Aschberg concession as the "only real effort made by a foreign group of capitalists" to finance the Soviet Union.[17] It was also pointed out that a group with German capital was working on a project—the Central Asiatic Financial Project—to finance German export trade in Turkestan.

There is in the State Department files an excellent contemporary report by A. Michelson entitled "Private Banks in the Republic of Soviets."[18] Michelson points out that the Russian Bank of Commerce, i.e., the bank operated by Aschberg and linked to Guaranty Trust in New York, was the largest such private bank in the U.S.S.R. and the first bank that had succeeded in establishing itself "partly through the assistance of foreign capital." Michelson adds the interesting comment that "there are, however, serious reasons to suppose that the capital of the Russian Bank of Commerce constitutes the sums belonging to the Bolsheviks themselves which are deposited with Swedish banks." This report also refers to Aschberg as an "agent of Soviet power for all sorts of its financial combinations." The Russian Bank of Commerce was clearly the largest such bank in terms of balances—232.6 million rubles in 1923 as compared to 128.8 million rubles for the Industrial Bank (Prombank) and 80.9 million for the Municipal Bank of Moscow. In March 1923, however, the Russian Bank of Commerce failed.[19] The U.S. Legation in Stockholm reported in 1924

[14] *Ibid.*, 209-211.
[15] *Ibid.*, 237; see Report 2437 from U.S. Legation in Stockholm, Sweden, October 23, 1922.
[16] *Ibid.*, 249.
[17] *Ibid.*, 264.
[18] *Ibid.*, 432. Michelson was general secretary of the committee of representatives of Russian banks in Paris.
[19] *Financial Times* (London), March 3, 1924.

that Aschberg had been dismissed from his connection with the Russian Bank of Commerce in Moscow and that "a large portion" of Soviet funds had been employed by Aschberg for investments on his personal account.[20]

The Gosbank, established in 1922, also depended heavily on foreign consultants for its establishment. Sweden's Professor Gustav Cassel, a leading European authority on banking who was appointed advisor to Gosbank in 1922, provided a public statement to the effect, "I do not believe in a negative policy.... To leave Russia to her own resources and to her own fate is simply folly."[21]

The creation of both Gosbank and the Russian Bank of Commerce was made in close consultation with European and American bankers. For example, in May 1922 Wittenberg, head of the National Bank of Germany, acted as consultant in the Soviet Union,[22] and in October 1922 a group of bankers including Aschberg, Wittenberg, and Scheinmann (chief of Gosbank) arrived in Stockholm to conduct further negotiations with foreign banks.

Finally, an agreement between the Guaranty Trust Company of New York and Gosbank was signed on August 1, 1923. It was agreed that all transactions would be in dollars, with the Guaranty Trust Company acting as a clearing house.[23] The Guaranty Trust Company so advised the Department of State in a letter dated September 14, 1923.[24] Thus the Guaranty Trust was uniquely connected with the establishment of banking in the U.S.S.R. and the financing of trade with the West.

BANQUE COMMERCIALE POUR L'EUROPE DU NORD

In January 1923 it was reported that the Soviet Union had acquired all the shares of the Chinese Eastern Railway formerly held by the Russo-Asiatic Bank; two French financial institutions, the Société Générale and the Banque de Paris et Pays Bas, were the main owners of the Russo-Asiatic Bank.[25] By June 1923 the Soviets had acquired 60 percent of the shares of the Russo-Asiatic Bank while French holders retained the balance.

Negotiations between representatives of the Soviet Union and French banking interests for the formation of a joint Franco-Soviet bank in France broke down in May 1925. Thereupon the Soviets purchased a small bank in Paris, Banque Commerciale pour les Pays du Nord, with a main office in Paris. This bank, founded in 1920 by Russian banker A. Khaiss with a capital of one million francs, was purchased in 1921 by the Wissotski interests, important prerevolution-

[20] U.S. State Dept. Decimal File 316-126-534.
[21] *Ibid.*, 235-236.
[22] *Ibid.*, 182.
[23] *Ibid.*, 424.
[24] *Ibid.*, 459.
[25] *Ibid.*, 285.

ary Russian merchants. The reported purchase price paid by the Soviets to the Wissotskis was £130,000 sterling.[26]

After purchase of the bank the brothers D. V. Wissotski and F. Wissotski continued to serve on the board temporarily, while two new directors, Volidsky and Sharov, were appointed to represent Soviet interests; also appointed as directors were Reisen and Iablokov, two former officers of the Azov Bank; Coön, formerly chairman of the Trade and Industry Bank; and Kempner, formerly of the Central Mutual Credit Bank. The American Consulate in Paris reported on August 20, 1925, that the Soviet intention was to issue new stock on the French market and so indirectly secure foreign participation in the enterprise.

During the 1930s the Banque Commerciale was accused of financing Communist Party activities in France. By 1964 there had been a slight name change and assets had grown to $562 million. There were 268 employees, of whom only three were Russian. A similar bank in London, also founded in the early 1920s, was the Moscow Narodny Bank, which had a remarkable growth from only $24 million in assets in 1958 to $573 million in 1964; by the late 1960s this bank was the fourth largest dealer among the London banks in the Eurodollar market. Only the five directors were Russian, the balance of 200 employees being British.

In 1966 the Soviets opened the Woxchod Handelsbank in Zurich, Switzerland. The Soviets also own an insurance company in Vienna (Garant Versicherung) and have attempted to convert it into a full-fledged banking operation. The Austrian Government has so far objected to such operations on the grounds that Garant Versicherung has illegally bought into Western companies to influence their commercial policies.[27]

Thus although Western skills are still heavily utilized in banking, the scene of operations has been transferred from the Soviet Union, where foreign banks are forbidden to operate, to Europe and the United States, utilizing foreign employees under Russian control. One of the key advantages to the Soviets is that such penetration assists the task of influencing and directing the trade policies of Western firms on sales of Western technology to the Soviet Union.

CHASE NATIONAL BANK[28]

In the 1930s the Chase National was one of four American banks and financial houses to institute relations with the Soviets (in addition to Equitable Trust, Guaranty Trust, and Kuhn, Loeb). Its role in the twenties and the thirties

[26] *Ibid.*, 803-804.

[27] *Forbes*, February 15, 1967, p. 60.

[28] Chase National merged with Bank of Manhattan (a former Kuhn, Loeb bank) March 31, 1955, to become Chase Manhattan Bank. Directors of the Chase Manhattan Bank (1968) are David Rockefeller, Eugene R. Black, Roger M. Blough, John T. Connor, and C. Douglas

has been described.[29] There was a close connection between Chase and the Soviets in the pre-World War II days; for example the advisor to Reeve Schley (director and vice president of Chase National Bank) was Alexander Gumberg, reportedly a Bolshevik agent.[30] The Chase Bank also acted as an agent for the Soviets in the 1930s,[31] and in 1930 Amtorg accounts, according to the U.S. Treasury, were "all with the Chase Bank."[32] Today Chase Manhattan (the merged Chase National and Manhattan banks) is Moscow Narodny's correspondent in New York; hence the ties appear to continue.

The Chase Manhattan Bank is controlled by the Rockefeller interests. Nelson A. Rockefeller, governor of the State of New York, is also the prime founder of the International Basic Economy Corporation (IBEC), which in 1967 made an agreement with Tower International, Inc., headed by Cyrus Eaton, Jr., of Cleveland to further transfers of U.S. technology to the Soviet Union. As this agreement was reported, "The joint effort contemplated by International Basic Economy and Tower is seen as combining the investment skills and resources of the Rockefellers and the special entree to Soviet-bloc officialdom that Tower enjoys."[33]

U.S. CREDITS FOR FINLAND: ADMINISTRATIVE SCHIZOPHRENIA

While this study is limited chiefly to the technical and economic aspects

Dillon. Most if not all appear to be proponents of expanded trade with the U.S.S.R. For John T. Connor see U.S. Senate, *Export Expansion and Regulation*. Hearings before the Subcommittee on International Finance, 91st Congress, 1st session (Washington, 1969), pp. 183-85; for Dillon (former Secretary of the Treasury), see U.S. Senate, *Government Guarantees of Credit to Communist Countries*. Hearings before the Committee on Banking and Currency, 88th Congress, 1st session, November 1963 (Washington, 1964), pp. 74-109.

29 See Sutton, I, pp. 90, 207-9, 226, 262, 277-78, 289-91. The links between Western financial houses providing financial assistance to the Soviet Union might be worth exploring. For example, Equitable Trust signed an agreement in London on March 7, 1923, to act for Gosbank (U.S. State Dept. Decimal File 316-126-295); a director of Equitable Trust was Otto Kahn, who was a director of Kuhn, Loeb, which has been prominent in financing of Russian business. Directors of Guaranty Trust included Thomas W. Lamont (of Morgan interests) and W. Averell Harriman, who also had other business connections with the U.S.S.R. The evidence appears to suggest (although the author has not explored the topic) that a comparatively small group of bankers and financiers has been consistently associated with Soviet financing. At least these are the names that turn up in the fifty-year history; it may simply be that more information is on record concerning their financial houses. (A study of the financial links between the West and the Soviet Union would be a fascinating and worthwhile topic for a doctoral dissertation.)

30 *Guide to the Manuscripts of the State Historical Society of Wisconsin* (Madison: Wisconsin State Historical Society, 1957), p. 57. On Gumberg, see Robert Bruce Lockhart, *British Agent* (New York and London: G. Putnam's Sons, 1933), p. 220.

31 *Congressional Record, House*, vol. 77, pt. 6, 73d Congress, 1st session, June 15, 1933, p. 6227.

32 U.S. Senate, *Morgenthau Diary (China)*. Committee on the Judiciary, (Washington, 1965), p. 70.

33 *New York Times*, January 16, 1967.

of transfers, it may be instructive to examine in more detail a sample case of U.S. Government assistance to the U.S.S.R.

Credits from the United States were used to modernize and expand the wood products and paper industries of Finland after World War II; and the output of these industries was sent to the U.S.S.R. as reparations. There is a divergence between contemporary accounts of U.S. intentions and actions as recorded in the State Department files (at least in the declassified portions). While it was denied that there was any intent to grant U.S. credits to enable Finland to make Soviet reparations, in practice the United States advanced credits for precisely that purpose in a case that affords a well-documented example of foreign government assistance to the U.S.S.R.

In 1945 the *New York Times* noted that it was unlikely the United States would grant a Finnish request for a $150 million loan; such a grant was deemed undesirable as it would be used to develop industry to pay Soviet reparations.[34] Two weeks later, however, the Export-Import Bank granted a $5 million cotton credit and a $35 million general credit.[35] In the following month (January 1946) Secretary of State James Byrnes telegraphed American Chargé Hulley in Finland concerning the manner in which he should inform the Finnish authorities of the Bank actions:

> You should carefully emphasize that the credit has no political implications but has been granted entirely on the basis of economic considerations, and within the framework of our policy which you have repeatedly stressed to Finns that we do not propose to contribute directly or indirectly to reparations payment by Finland; that the purpose of credit is to facilitate the resumption of U.S.–Finnish trade.[36]

Later in the year there was a series of communications from the State Department to Finland advising that further loans could not be given or even considered. In one telegram (August 9, 1946) Hamilton, U.S. minister in Finland, indicated that the Finnish Government had been informed it would be a mistake for a Finnish mission to go to the United States with too optimistic a feeling, as the Export-Import Bank had many demands upon it.[37] This was followed by an urgent telegram (Acheson to Hamilton): "Further credit Eximbank out of question at this time" and "visit of mission to U.S. most undesirable and should be indefinitely postponed,"[38] and by another (Hamilton to Acheson): "[I have] strongly advised Finnish Government against mission to U.S.A. also

[34] *New York Times*, December 1, 1945, 7:3.
[35] U.S. State Dept. Decimal File 860d.51/1-1446: telegram.
[36] *Ibid.*
[37] *Ibid.*, 860d.51/8-946: telegram, Hamilton, August 9, 1946.
[38] *Ibid.*, Acheson to Hamilton, August 12, 1946.

advised against Graesbeck [head of the Finnish financial mission] proceeding to U.S.A. in private capacity."[39]

These telegrams, however, were followed by a grant of a $20 million long-term credit, a $12 million short-term credit, and a $5 million credit for industrial goods.[40] And contrary to the published assertions, the credits granted to Finland were in large part specifically for equipment that was virtually certain to be used to manufacture reparations goods for the Soviet Union. For example, the $20 million long-term credit of January 1948 was for

> machinery, equipment and materials required for recovery of export production in the lumber, pulp and paper industry. These materials include wood-working machinery, hydroelectric equipment, iron and steel, spare parts for trucks, lead, coal, and petroleum products.[41]

There is no question that the State Department was informed that these credits would be used to modernize and expand the pulp industries. A Memorandum of Conversation dated December 12, 1946, concerning the discussion between the Finnish delegation headed by Graesbeck and two State Department officials (Havlik and Cleveland)[42] raised a question about the low level of Finnish exports of chemical pulp and commented, "Mr. Graesbeck's explanation of ... the run-down state of the machine equipment was not entirely satisfactory."[43] However, the meeting culminated in a suggestion that the Finns go to the Export-Import Bank. The consensus of the U.S. participants, after the departure of the Finnish delegation, was that a "small" loan of $20 to $25 million should be granted. One month later a $20 million loan was granted for the purchase of industrial machinery and equipment for the lumber and pulp and paper industries.

The U.S. export figures to Finland for the years 1945-48 reflect these credits and their use to purchase equipment for the manufacture of Soviet reparations. Sweden had provided credits for Finnish reconstruction in 1944 and 1945 to the amount of Kr150 million; Sweden's share of total Finnish imports was 51.3 percent in 1945 and only 10.0 percent in 1946 as the credits ran out.[44] On the other hand, the U.S. share of total Finnish imports was zero in 1945 (when no financing was available) and 19.4 percent in 1946 as financing became available under the Export-Import Bank credits.[45] Out of $59 million in 1947, just under $11 million was U.S. machinery and just under $5 million steel products—both categories required for the Finnish industrialization plan needed

[39] U.S. State Dept. Decimal File 860d.51/8-1446: telegram. Hamilton to Acheson, August 14, 1946.
[40] See Table 5-1.
[41] *New York Times*, January 23, 1947, 13:3.
[42] U.S. State Dept. Decimal File 860d.51/12-1246.
[43] *Ibid.*
[44] Urho Toivola, *The Finland Year Book 1947* (Helsinki, 1947), p. 261.
[45] *Ibid.*

to meet Soviet reparations demands. In the following year (1948) U.S. exports to Finland declined to $36 million but the proportion of machinery increased by almost 40 percent to over $14 million, including $5.5 million of industrial machinery. Thus American machinery, financed by the Export-Import Bank, was acquired by Finland to manufacture reparations for the Soviet Union.[46] (See Table 5-1.)

Table 5-1 CREDITS GRANTED TO FINLAND BY THE UNITED STATES, 1945-47

Date	*Government agency in the United States*	*Amount authorized*	*Details*
December 1945	Export-Import Bank	$5.0 million	Cotton credit
December 1945	Export-Import Bank	$35.0 million	General credit
January 1947	Export-Import Bank	$37.0 million	$20 million long term $12 million short term $5 million credit for industrial goods
February 1947	Export-Import Bank	$2.5 million	Credit
May 1947	Foreign Liquidation	$10.0 million	Credit to purchase surplus property overseas
September 1947	War Asset Administration	$10.0 million	Credit to purchase surplus in U.S.
Total 1945-47		$99.5 million	

Source: New York Times, December 1, 1945, 7:3; January 23, 1947, 13:3.

In the 1960s direct government-to-government financing came to the forefront. Germany advanced $400 million to the Soviet Union to purchase oil pipeline at 6 percent over 12 years coupled with assistance to pump natural gas into Germany. Italy financed about $400 million of the U.S.–VAZ automobile plant.[47] The largest single such transaction was made in early 1970 under the Pompidou Government in France; this agreement provided a credit of $810 million to the U.S.S.R. to finance five years' purchases of French machinery and equipment; the credits were for seven to eight and a half years, but interest rates were not announced.[48]

[46] The large proportion of Finnish output accounted for by reparations in the lumber, pulp, and paper fields, and in shipbuilding, may be found in Toivola, *Ibid.*, pp. 187-209.

[47] *Washington Post*, March 14, 1970, pp. A1, A15.

[48] *Ibid*. The interest rate is of some significance. This was an era of world investment opportunities at 8 percent; previous French credits were granted at 5.95 percent and it was reported the Soviets were pressing to bring even this low rate down. If Pompidou had granted lower rates (or even 5.95 percent in the light of world conditions in 1970) there would indeed have been widespread criticism. It does appear on the basis of the skimpy evidence publicly available, however, that the French, British, German, and Italian (and perhaps the U.S.) governments have been willing to grant more favorable terms to the U.S.S.R. than to their own citizens.

CHAPTER SIX

Patterns of Indirect Technical Assistance to the Soviet Union

There are several reasonably well-defined patterns of indirect transfer of technology to the Soviet Union apart from the direct transfers that are the subject of the bulk of this three-volume series. These important indirect transfers pose particular problems for enforcement of export control laws; indeed the existence of indirect transfers has been cited as a prime reason for the difficulty of reaching inter-allied agreement on export control. This difficulty in turn is urged by proponents of more assistance to the U.S.S.R. as a reason for further abandonment of control.

Flows of technology may be broadly categorized as follows:

A. Technology originating in the United States and transferred

1. directly from the United States to the Soviet Union, as in the "Transfermatic Case"
2. indirectly from the United States to an East European communist country, then retransferred to the U.S.S.R. either as technical assistance under COMECON[1] specialization agreements or in the form of equipment manufactured in Eastern Europe and supplied to the U.S.S.R.
3. indirectly from the United States to Europe and then to the U.S.S.R.
4. as direct assistance to an East European plant making equipment for the Soviet Union, i.e., contributing to their operative efficiency for technological exports to U.S.S.R.

B. Technology originating in Europe and Japan and transferred

1. directly to the U.S.S.R., as in the Burmeister & Wain technical-assistance agreement of 1959
2. indirectly through East Europe, as were M.A.N. (West Germany) engines built under license in Poland and exported in Polish ships to the U.S.S.R.
3. as European assistance to East European countries contributing to their capability to supply technology to the U.S.S.R.

[1] COMECON is the Council for Mutual Economic Assistance. An excellent review of its structure and function is M. Kaser, *Comecon: Integration Problems of the Planned Economies*, 2d edition (London: Oxford University Press, 1967).

It is these indirect flows that are briefly considered in this chapter.

DIRECT TRANSFERS OF TECHNOLOGY ORIGINATING IN THE UNITED STATES AND EUROPE

An excellent example of technology originating in the United States and directly transferred to the Soviet Union may be found in the "Transfermatic Case" of 1960-61. This case involved the proposed U.S. sale to the Soviet Union of two Transfermatic machines valued at $5.3 million. The units involved are multi-stage transfer machines for complete process machining of an engine—milling, boring, broaching, drilling, etc. Although the initial Department of Defense position was against granting the license on the grounds it would make a significant contribution to Soviet technology, in the final analysis U.S. Defense Secretary Robert McNamara decided on the basis of his own knowledge of such equipment that the application could go forward. Similar cases decided at about the same time involved Bryant Automatic grinders equipped with high-frequency grinding spindles, and automatic bore grinders for use in the manufacture of internal combustion engines. All these cases embodied a technology significantly advanced beyond that in the Soviet Union at 1960.[2]

More typical than these major transactions decided at a high political level are the smaller exports of U.S. technology. One of thousands of possible examples involved the December 4, 1961 licensing for shipment to the U.S.S.R. of eight flame detectors and industrial instruments. The shipments reportedly were for use in a plant to produce titanium dioxide. The rationale for export of such flame detectors was that industrial instruments of this type could be readily obtained by the Soviet Union from Western Europe.[3]

An example of direct transfer of technology from Europe to the Soviet Union is embodied in the Burmeister & Wain technical-assistance agreement of 1959 to transfer large marine diesel engine technology to the U.S.S.R. Thus the large marine diesels produced at the Bryansk plant in the Soviet Union are of Burmeister & Wain design. Burmeister & Wain technology is also transferred to the Soviet Union indirectly, through East European communist countries. For example, Polish marine diesel engines are based largely on the designs of Sulzer in Switzerland and Burmeister & Wain in Denmark, both of which firms have technical licensing agreements with Polish organizations.

[2] See p. 224 for more data.

[3] U.S. House of Representatives, *Investigation and Study of the Administration, Operation and Enforcement of the Export Control Act of 1949, and Related Acts*, Hearings before the Select Committee on Export Control, 87th Congress, 1st session (Washington, 1962), pt. I, p. 411.

TECHNICAL COOPERATION AGREEMENTS WITH SOCIALIST COUNTRIES

Numerous agreements aimed at strengthening technical cooperation among socialist countries and with European countries were made by the Soviet Union in the decades of the 1950s and the 1960s and provided vehicles for transfer of Western technology. These included agreements with Yugoslavia (April 26, 1955),[4] East Germany (April 26, 1956),[5] Finland (July 17, 1954),[6] Hungary (June 28, 1956),[7] United Kingdom (May 24, 1959),[8] (December 1, 1959),[9] and (January 9, 1961).[10]

Article I of such treaties is exemplified by the Soviet-Yugoslav agreement of 1955:

> The Government of the Federal People's Republic of Yugoslavia and the Government of the Union of Soviet Socialist Republics shall strive to develop scientific and technical cooperation between the two countries by exchanging the experience and technical achievements of the two Contracting States in industry, mining, construction, transport, agriculture, and other fields of economic activity, in the interest of each Contracting State.[11]

Article II usually specifies the manner by which the transfer shall be effected, i.e., through the "reciprocal communication of technical documentation and the exchange of relevant information, including patents and licenses, in accordance with the provisions in force in each of the Contracting States."[12]

The transfer in the Yugoslav case was to be conducted by the exchange of experts, students, and researchers and by the provision of documents and materials. The final articles in the treaty specify the technical details of funding, location of commissions, and similar matters.

The basic agreement was established with the creation of COMECON (Council for Mutual Economic Assistance, formed in January 1949), but it was not implemented for a number of years. Its purpose is to exchange economic experience, extend technical assistance, and generally render mutual economic assistance among socialist countries; it also provides for the bilateral technical-assistance agreements, or specialization agreements, among socialist countries

[4] United Nations, *Treaty Series*, vol. 378, no. 5423 (1960).
[5] *Ibid.*, vol. 259, no. 3692 (1957).
[6] *Ibid.*, vol. 240, no. 3403 (1956).
[7] *Ibid.*, vol. 259, no. 3700 (1957).
[8] *Ibid.*, vol. 374, no. 5344 (1960).
[9] *Ibid.*, vol. 351, no. 5032 (1960).
[10] *Ibid.*, vol. 404, no. 5810 (1961).
[11] *Ibid.*, vol. 378, no. 5423 (1960).
[12] Ibid.

(Table 6-1). These agreements provide the organizational structure for transfer of Western technology indirectly to the Soviet Union from Eastern Europe.

The specialization agreements made under COMECON and the resultant bilateral agreements (as reported in Western sources) are surprising in that, with the exception of agricultural and raw materials which comprise the bulk of Soviet exports, the listed specializations for production by the Soviet Union often are in sectors where this study has revealed a definite technical lag on the part of the Soviet Union.

The listed specializations do include all technologies mastered by Soviet engineers and those in which there has been a degree of indigenous progress, i.e., blast furnaces, open-hearth steel, heavy-section rolling mills, steam turbines over 100,000 kw, large generators, power plants, and heavy tractors.[13] Although in greater part based on foreign technology, these are sectors where the Soviet Union in the early 1960s was standing on its own feet.

On the other hand, the specialization agreements involve some technical areas where the Soviets are decidedly weak and backward. For example, very large long-distance pipe lines, synthetic rubber, large-capacity cement mills, printing industry equipment, synthetic fiber production equipment, heavy diesel and electric locomotives, passenger automobiles, and specialized ships all are areas where the Soviet Union is backward and requires continuing dependence on imported technology.[14]

Production of both synthetic rubber and plastics is retarded in the Soviet Union. The bulk of synthetic rubber capacity at 1960 was either the prewar SK-B or the Dupont Nairit process; similarly, plastics were few in number, poor in quality, and utilized a great deal of imported equipment or Soviet copies of foreign equipment. In neither of these industrial processes has the Soviet Union any new or worthwhile production equipment for export.

Ships are listed as a Soviet COMECON specialty, although three-quarters of the Soviet mercantile fleet and four-fifths of its marine propulsion units have been built in foreign yards. Large marine and locomotive diesels are also listed, although the Soviets lag badly in both. Equipment for the printing industry and synthetic fiber industries is currently imported, and Lavsan and Nitron fibers use British equipment.

Forging equipment is a known area of Soviet backwardness. Cement factories of large capacities are bought abroad. In 1970 steel sheet rolling mill and finishing equipment was at the U.S. 1930 level. Passenger cars were the subject of the so-called "Fiat agreement" in 1966.

[13] Not all shown on Table 6-1; see Heinz Kohler, *Economic Integration in the Soviet Bloc*, (New York: Praeger, 1965), pp. 138-40.

[14] *Ibid.*, pp. 138-40. For evidence see the following: long-distance pipelines, p. 130; synthetic rubber, p. 153; cement mills, p. 170; printing equipment, p. 329; synthetic fiber equipment, p. 178; locomotives, p. 248; passenger automobiles, p. 191; and specialized ships, p. 282. Compare with Table 6-1.

Table 6-1 COMECON SPECIALIZATION FOR HEAVY INDUSTRIAL EQUIPMENT

	U.S.S.R.	*Bulgaria*	*Czechoslovakia*	*DDR*	*Hungary*	*Poland*	*Rumania*
Oil drilling equipment	X	X					X
Oil refinery equipment	X						X
Rolling mill equipment	Heavy section iron rolling mill trains, heavy rolling mill trains		Heavy section iron rolling mill trains, wire-rod mill trains[a]	Continuous and semicontinuous wire-rod mill trains, leaf-metal and tube rolling mills[b]	Wire-rod mill trains	Light section mill trains, small rolling mill trains	
Coal industry equipment	Single-bucket excavators and shovel excavators for open-pit mining[c]		Multi-bucket excavators, stackers, over-burden trans-porter bridges[d]			Coal combine equipment, open-pit lignite, coking plants	
Lignite industry equipment				Multi-bucket excavators for open-pit mining, briquette factories[e]			
Cement factory equipment	Furnace capacity of over 1,000-2,000 t/day		Furnace capacity up to 800 t/day	Furnace capacity of 1,000-2,000 t/day			Furnace capacity of 400-450 t/day
Sugar factory equipment			X	X		X	
Aluminum production equipment					X		
Forging and pressing equipment	X		Heavy	Light		Heavy	

Heavy machine tools	Specialized, such as turret head lathes, long planing machines[f]	Specialized, for making ball bearings, lathes, drills	Highly mechanized automatic, precision, such as duplicating milling machines[g]	Specialized, such as open front vertical drills	Specialized, such as complete wheel set machining lathes, horizontal presses[h]	Specialized, such as knee and column type milling machines
Gas pipes	Very large, long-distance	Large, long-distance	Small, long-distance			
Marine diesels		Large	Large, 4,000-5,000 hp		4,000-5,000 hp ship diesel engines	
Diesel engines (excl. marine diesels)				X		
Blast furnaces	X	X			X	
Complete factories for reinforced concrete					X	

X = Specialization in all equipment in category

[a] Medium and fine sheet metal rolling mills

[b] Rolling mill trains, light section iron rolling mill trains and drawing die mill trains

[c] Coking plants, coal combines, coal cutting machines

[d] As well as soft coal mining equipment

[e] Burden transporter bridges, stackers, conveyor bridges, rotary bucket excavators with a cutting power of 80 kg/cm

[f] Machine tools for ball bearings

[g] Honing machines, thread grinding machines, gear hobbing machines, pipe cutters, pipe thread cutters, ball and roller bearings machine tools, lathes

[h] Up to 250 tons, cold pressure automatics, horizontal face plate lathes, roll grinding machines, toothed-wheel grinding machines for ball bearings

[i] Transverse planing machines, long planing machines with wide bench

Source: H. Köhler, *Economic Integration in the Soviet Bloc* (New York: Praeger, 1965).

It is interesting to note, therefore, that most of the categories claimed for Soviet specialization fall into one or the other of the two extremes—that which the Soviet Union has mastered and technically does reasonably well and that where it is decidedly backward and behind other bloc members, who themselves turn westward for technology.

The asserted existence of a COMECON category of Soviet specialization in sectors where the Soviet Union is ill equipped for specialization is confirmed by trade figures for the Soviet Union with East European countries. Table 6-2 expresses machinery and equipment as a percentage of total trade between the U.S.S.R. and various East European communist countries; the category of machinery and equipment of course comprises the most important category of products included in specialization agreements. With all East European socialist countries taken as a group, just over 42 percent of their total exports to the Soviet Union comprise machinery and equipment. On an overall basis, only 13 percent of Soviet exports to these countries comprises machinery and equipment; this 13 percent also includes exports to relatively backward countries, such as Bulgaria. In other words, East European countries in general are three times more important as shippers of machinery and equipment to the U.S.S.R. than is the U.S.S.R. as a shipper of equipment to those countries. This certainly suggests a relative technical backwardness in the Soviet Union in machinery and equipment. This pattern is highlighted by exports of the most important equipment producers: 62 percent of East German exports to the U.S.S.R. comprise machinery and equipment, over 58 percent of Hungarian exports are of this nature, and almost 45 percent of Czech exports.

Although the COMECON specialization and technical-assistance features relate to documentation and engineering assistance, not to physical movements of machinery, these trade figures do support the assertion of Soviet backwardness, as trade figures must broadly parallel relative technical capabilities. It would be unlikely that the Soviet Union is a major importer of machinery and at the same time provides extensive technical assistance for that machinery; such might apply in one or two special cases (e.g., in the provision of documentation for a specific machine), but not over the broad range of technology indicated. In any event, we know from other sources that the listed Soviet technical specializations which are in fact East European technical specializations, involve areas where these East European countries are receiving technical assistance from Western firms. For example, ship equipment is the subject of "hundreds" of technical-assistance agreements between Western firms and East European countries;[15] these firms are major builders on Soviet account although "specialized ships" are listed as a Soviet category under COMECON.

This question will now be examined in more detail.

[15] John D. Harbron, *Communist Ships and Shipping* (London, 1962), p. 108.

Table 6-2 MACHINERY AND EQUIPMENT AS PERCENTAGE OF TOTAL SOVIET TRADE WITH EAST EUROPEAN SOCIALIST COUNTRIES IN 1960

Country	*Percentage of machinery and equipment in total exports to the U.S.S.R.*	*Percentage of machinery and equipment in total imports from the U.S.S.R.*
All Socialist countries of Eastern Europe	42.36	13.52
East Germany	62.19	3.59
Hungary	58.39	22.57
Czechoslovakia	44.97	9.5
Poland	31.32	11.31
Bulgaria	16.36	13.52
Rumania	8.33	22.13
Yugoslavia	14.58	26.00

Source: P. I. Kumykin, ed., *50 Let sovetskoi vneshnei torgovli* (Moscow, 1967), pp. 108-38.

TECHNICAL ASSISTANCE FROM CZECHOSLOVAKIA TO THE SOVIET UNION

In December 1947 a scientific and technical cooperation agreement was signed between the U.S.S.R. and Czechoslovakia. It has been renewed at annual intervals with changes in the direction and focus of the technical cooperation. The agreement provides for extensive exchange of both personnel and documents. During 1956, for example, Czechoslovakia granted documentation to the Soviet Union on processes for leatherworking and shoemaking machinery, glass blocks, measuring and medical instruments, piping insulation, turbine blades, railroad wagons, locomotives, heavy diesel engines, and automobile engines:

> Over 100 Soviet experts acquainted themselves in Czechoslovakia with the production of sanitary equipment. Groups of experts from 16 Union Republics visited Czechoslovakia in order to study the manufacture of different kinds of footwear, artificial fibers, building structures, pumps, compressors, etc.[16]

In turn the Soviet Union passed over documentation for production of raw rubber, aluminum, phenol, steel works, coke and chemical plants, an aluminum wide-sheet mill, a plant for manufacture of penicillin and streptomycin, and high-voltage cables.[17]

In 1957 the Soviet Union assisted in the construction of an atomic reactor

[16] *Czechoslovak Economic Bulletin* (Prague), February 1957, pp. 17-19.
[17] *Ibid.*, p. 18.

and a cyclotron and Czechoslovakia in turn passed to the Soviet Union documentation for mine, metallurgical, machine tool, and other equipment:

> The Czechoslovak factories and research institutes will acquaint Soviet experts with the technology of production, for example, of turbines for high heads, high-pressure pumps, the production of heat-treated steel, diesel engines, equipment for the manufacture of artificial leather and with the application of light ferroconcrete constructional units.[18]

Some interesting observations may be made about the exchange. There is little question that Czechoslovak diesels, electric locomotives, and other equipment sent to the Soviet Union are of top quality. Skoda diesels compete in the world market against Western-made diesel engines. On the other hand, some of the Soviet grants seem out of place. In 1957, for example, the Soviet Union sent instructions for the manufacture of calculating machines and steel tubes—two of the most backward fields in the U.S.S.R. To be sure, it also gave assistance in open-hearth furnaces and coke ovens—areas in which Soviets have made design progress based on classical Western processes.[19]

The Skoda Works at Pilsen provides an excellent example of indirect U.S. assistance via an East European communist country to the Soviet Union. The Skoda plant is the most important single industrial unit in Czechoslovakia and a prominent manufacturer of diesel engines, armaments, and heavy industrial equipment. Czechoslovakia itself is the fourth largest world producer of diesel engines, of which 80 percent are exported, the largest buyer being the Soviet Union.

Under terms of the 1956 scientific and technical cooperation agreement with the Soviet Union, Skoda sends technical assistance to the Soviet Union in the field of diesel engines and specialized machine tools for making ball bearings, lathes, and drills, together with heavy equipment for forging and pressing. This type of equipment is a specialty of the Skoda plant, which also has an agreement with the Simmons Machine Tool Corporation of Albany, New York. Simmons is an old, established machine tool company specializing in the design of large automatic and numerically controlled special-purpose machines. Under the agreement Simmons equipment is built by Skoda in Czechoslovakia and marketed under both the Simmons name and specification in the United States and also as a joint Simmons-Skoda line. Included in the Simmons-Skoda line are such machine tools as heavy-duty lathes (40-inch to 13-foot-diameter swing), vertical boring mills (53-inch- to 60-foot-diameter swing), horizontal boring mills (five-, six-, eight-, and ten-inch bar diameter), rotary tables from 78.74 by 78.74 inches to 14.9 by 18 feet, planer-type milling

[18] *Ibid.*, p. 19.
[19] See p. 123 below.

machines, and roll and punch shaft grinders.[20] In 1961 an electronic computer valued at $68,600 was exported to the Skoda Works in Pilsen in Czechoslovakia for use in payroll processing and stock control.

Thus it may be seen that a prominent East European communist organization supplying both armaments and specialized heavy equipment to the Soviet Union is able to take direct advantage of the most advanced U.S. technology. Thus, indirectly, advanced U.S. technology is made available to the Soviet Union.

The nature of Czechoslovak exports to the U.S.S.R. indicates the technical assistance provided. In 1957 the Czechs installed a large turbocompressor refrigerator plant at Stalingrad. The plant is one of the most modern in the world with a capacity to supply 30 ice rinks.[21] In the same year the following were shipped: several small rolling mills; two rotary cement kilns with a capacity of 500 tons every 24 hours; Tesla BS 242 electron microscopes; and 40 cooling plants. One of the most interesting contracts in 1958 was to supply the U.S.S.R. with 55 complete automatic cement packing plants, each unit capable of filling 1000 bags of 50 kg every hour.[22] Between 1945 and 1960 Czechoslovakia supplied the U.S.S.R. with equipment for 21 complete sugar mills.[23] In 1959, 20 pig slaughtering lines, 60 diesel electric shunting locomotives, seven vessels for a pressure of 320 atmospheres, another 140 refrigerator units, and similar equipment were sent.[24]

SPECIALIZED ASSISTANCE FROM YUGOSLAVIA

Much of Yugoslav trade with the Soviet Union (Table 6-3) is in specialized metal commodities and fabricated metal units, partly restricted under export control laws for direct sale to the U.S.S.R. by Western countries. The most prominent Yugoslav example is that of copper. During the decade of the fifties copper was on export control lists for the U.S.S.R.; Yugoslavia, a one-time exporter of copper to the United States, then became a net importer of U.S. copper and channeled its own copper production to the Soviet Union in the form of copper products and wire.

A letter to Congress from Frederick G. Dutton, an assistant secretary in the Department of State (dated July 30, 1962), indicated that during 1957 and 1958 Yugoslavia made a number of exports to the Soviet Union of items prohibited under the Battle Act, Title 1. These shipments included semifinished copper

[20] *Thomas' Register*, 59th edition (1969), vol. VII, p. 988; the agreement is reported in European League for Economic Cooperation, *Economic Industrial, Scientific and Technical Cooperation Between the Countries of Eastern and Western Europe* (Brussels, 1967), p. 43.

[21] *Czechoslovak Foreign Trade* (Prague), no. 2, 1957.

[22] *Ibid.*, no. 6, 1958.

[23] *Ibid.*, no. 1, 1959.

[24] *Ibid.*, no. 4, 1959.

products valued at $5.3 million, cable valued at $1 million, electric motors and generators valued at $355,600, machine tools valued at $175,400, and a small quantity of lubricating oil. On January 9, 1959, the President directed continuation of U.S. assistance to Yugoslavia despite these breaches in the CoCom limitations.[25]

Table 6-3 COMMODITIES SUPPLIED BY YUGOSLAVIA TO THE U.S.S.R., DURING JANUARY 1960-SEPTEMBER 1961

	January-December 1960		*January-September 1961*	
Commodity	*Weight, kilograms*	*Value, thousands $**	*Weight, kilograms*	*Value, thousands $**
Copper rods	153,709	206.0	27,686	26.0
Copper plates	—	—	129,234	127.0
Copper tubes and piles	—	—	12,847	16.0
Tubes, pipes, plates, and sheets of copper alloys	—	—	28,929	23.0
Castings and forgings of copper alloys	6,267,978	7,445.0	4,885,762	5,213.0
Welding electrodes	998,000	245.0	1,471,946	364.0
Electric transformers	1,707,130	1,191.0	507,333	1,191.0
Power cables	12,524,760	6,273.0	10,501,015	4,800.0
Installation material	40,818	101.0	73,195	563.0
Installation wire for power current	1,537,577	1,306.0	516,283	563.0
Winding wire	695,183	858.0	372,899	423.0
Low-tension cable	3,450,044	1,711.0	1,491,037	665.0
Other electric equipment	13,223	71.0	—	—

Source: Statistika Spoljne Trgovine SFR Jugoslavije za 1960 godinu
*$1 = 300 dinars.

POLISH ASSISTANCE IN SHIPBUILDING

The COMECON technical agreements provide for Polish specialization in shipbuilding, marine diesel engines, and auxiliary-ship plant technologies. This technology is subsequently sent to the U.S.S.R. as finished products of Polish industry, i.e., ships and engines, as well as in the form of technical documents and prototypes.[26]

[25] U.S. House of Representatives, *op. cit.* n.3, 2d session, pt. 3 (Washington, 1962), p. 662.

[26] See chapter 21 for Polish ships supplied to U.S.S.R.; see also U.S. Naval Institute *Proceedings*, (Annapolis, Md.), January 1970.
For example, "... the Polish auxiliary industry which supplies equipment for shipbuilding, actively participates in the works concerning unification and specialization of the production shipbuilding equipment, which are carried out in the Engineering Commission of COMECON." *Polish Technical Review* (New York), no. 2, August 1964, p. 21.

Table 6-4 WESTERN LICENSE AGREEMENTS FOR SHIPBUILDING TECHNOLOGY WITH POLISH SHIPBUILDERS (IN FORCE AS OF 1964)

Polish company	*Western licensee*	*Technology*
Marine Equipment Plant (at Rumia)	Burmeister & Wain (Denmark)	Heat exchangers for marine power plants
Marine Equipment Plant (at Rumia)	Sulzer (Switzerland)	Silencers for main and auxiliary engines
Marine Equipment Plant (at Rumia)	Fiat (Italy)	Oil, water, and air coolers for Cegielski marine engines
ZAWO (at Slupsk)	Gustav F. Gerdts (West Germany)	Automatic steam traps for marine boilers
Hydroster Works	Baader (West Germany)	Fish processing plants
Gdynia Yards	C. Plath (West Germany)	Electronavigation equipment
Gdynia Yards	AEC (U.K.)	Gyropilots
Cegielski	Sulzer (Switzerland)	Electric power generators
Zgoda	Sulzer (Switzerland)	BH-22, BAH-22
	IMO (Sweden)	Vertical and horizontal screw pumps
	A/B Separator (Sweden)	Oil separators

Source: *Polish Technical Review*, no. 2, 1964, pp. 15-21; no. 3, 1967, pp. 9-11.

The first Polish oceangoing ship was built in 1948—the year of the takeover by the Polish Workers' Party—and since then the industry has expanded at a very rapid rate. In 1964, for example, there were no fewer than 90 plants in Poland making shipbuilding equipment, and Poland has been the leading foreign supplier of ships to the Soviet Union. It is, then, an important channel for indirect technical transfer of Western technology to the U.S.S.R.

Polish shipyards are a major supplier of ships for the Soviet merchant marine; in fact, three-quarters of Polish exports to the U.S.S.R. consist of rolling stock and ships,[27] and the level of ship purchases has been maintained over a period of many years. In general, Poland sells twice as much machinery to the U.S.S.R. as she purchases from the U.S.S.R.

Main diesel engines produced by Polish marine engine builders in 1960 were of two types: Burmeister & Wain, produced by Cegielski, the largest Polish engine builder, and Sulzer-type diesels produced by Zgoda. Referring to the Sulzer RD engines, the *Polish Technical Review* states:

[27] Alfred Zauberman, *Industrial Progress in Poland, Czechoslovakia, and East Germany, 1937-1962* (New York: Oxford University Press, 1964), p. 301.

> The RD engines are of comparatively new construction; however exploitation has already confirmed their high value. The best proof ... is the fact that the Sulzer firm took in 1963 the first place in world production of engines of this class. The exploitation results of RD engines produced with great care by H. Cegielski show that they equal the generally known and valued Swiss products.[28]

In addition, a wide range of other marine equipment, including all major shipboard mechanical equipment items, has been produced for Polish companies under foreign licensing arrangements; some of the more important agreements are summarized in Table 6-4. This Western technology has been transferred to the U.S.S.R. in two ways: as components of finished ships and as the export of component parts of Polish manufacture. Soviet use of this equipment is exemplified by Soviet ships on the Haiphong supply run to North Vietnam in the mid to late 1960s. Further, in the same period Polish-built ships were leased to Red China or used directly by the Polish Government to assist North Vietnam.

EAST GERMAN TECHNICAL ASSISTANCE TO THE U.S.S.R.

H. Mendershausen has cited the following examples of Western exports to East Germany that are utilized in Soviet end products[29]: copper sheet and tubes, special steel valves, measuring instruments, plastic sheet, nickel wire, bronze alloy used in mobile and stationary liquid-oxygen plants for Soviet missile sites at Karaganda, ball bearings from Switzerland for hammer crushers for use in Soviet cement plants; aluminum-plated metal and glass for electronic tubes from the U.S.A.; germanium from West Germany for machinery; crankshafts and valve springs from West Germany for marine diesel engines; and electrical parts for Soviet electrical equipment.

Mendershausen concludes that machinery imports from the West in great part equip East German production facilities and so make possible the highly developed East German metal fabricating industry and its extensive export programs. For example:

> The machinery-building divisions of this industry are the mainstay of East Germany's export trade. Heavy and general machinery, vehicles, and ships bulk large in export to the Soviet Union and the bloc countries.[30]

The Krupp concern of Essen has concluded several agreements with East European countries which significantly increase their ability to produce machinery

[28] *Polish Technical Review*, no. 2, August 1964, p. 22.
[29] Horst Mendershausen, *Dependence of East Germany on Western Imports* (Santa Monica: RAND Corp., July 17, 1959), Report no. RM-2414, pp. 36-39.
[30] *Ibid.*, p. 31.

for Soviet trade. One agreement with Hungary was for a $12 million plant to produce machine tools and truck engines in Budapest; the output from this plant is marketed throughout Eastern Europe. Another agreement provided for manufacture of machines from semifinished iron and steel in Poland; Krupp furnished the machinery but retained its ownership and sent technicians. Compensation in this case is in the form of part of the plant's production.[31]

AN EXAMPLE OF INDIRECT TRANSFER OF A TECHNOLOGY: MARINE DIESELS

The East European shipbuilding yards are major suppliers of ships to the Soviet Union. These yards are also recipients of significant technical assistance—in all major ships' components—from West European countries. Thus indirectly the Soviet Union again is a recipient of European technical assistance. Marine diesel engines may be taken as an example to illustrate this process of transfer.[32] (See Figure 6-1.)

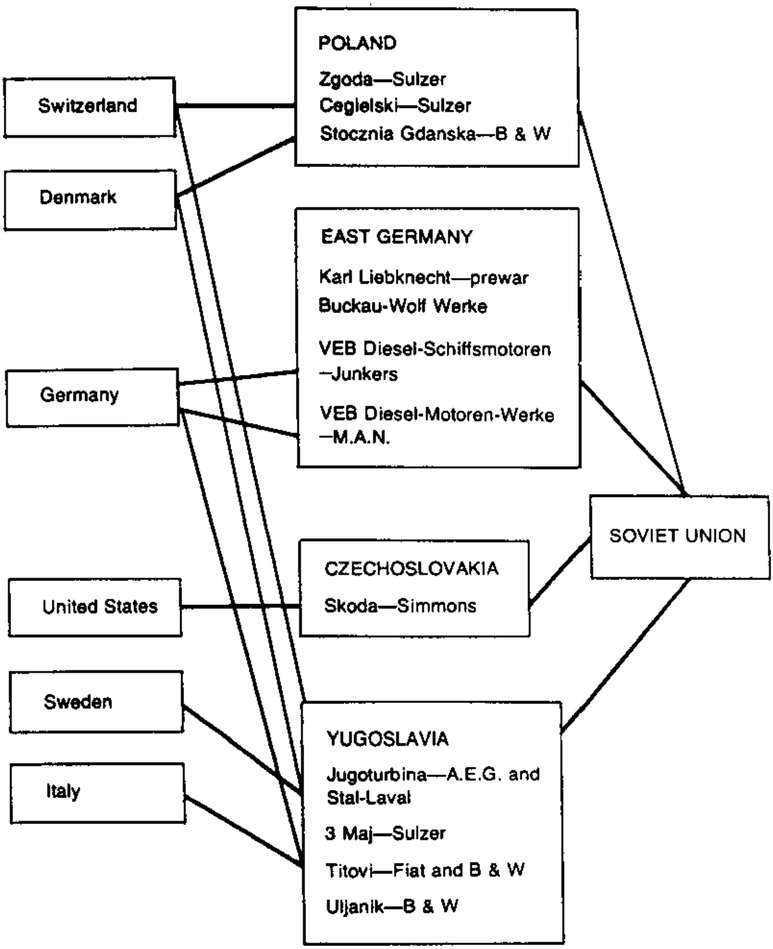
The Burmeister & Wain company of Copenhagen, manufacturer of marine diesels, has a technical-assistance agreement with the U.S.S.R. to build B & W marine diesels at Bryansk.[33] The company also has a technical-assistance agreement with Polish shipbuilding organizations for Burmeister & Wain engines.[34] Thus Stocznia Gdanska, most of whose output goes to the U.S.S.R., produces the B & W model 63-VT2BF-140 under license; a total of 355,000 hp was produced in 1968.[35] The two other Polish engine builders, Cegielski and Z.U.T. Zgoda, have technical-assistance agreements with Sulzer of Switzerland to produce Swiss Sulzer diesels up to 15,000 bhp (Cegielski) and 3000 bhp (Zgoda).[36] These agreements, concluded in 1956, are for production of the RSAD type, now the RD-76.[37] Cegielski also has a technical-assistance agreement with Fiat of Italy.[38]

Ships built in East Germany have marine diesels built either by VEB Diesel-Motoren-Werke Rostock or VEB Maschinenbau Halberstadt; both plants have technical-assistance agreements with M.A.N. of West Germany[39] to produce the M.A.N. model K6Z 57/80 marine diesel.

The four marine engine builders in Yugoslavia also have agreements with

[31] European League for Economic Cooperation, *op. cit.* n.21, pp. 44-45.
[32] The Soviets provide the Poles with hard currency to purchase ship equipment of this type on their behalf.
[33] *East-West Commerce* (London), VI, 2 (February 10, 1959).
[34] *Ibid.*, VI, 9 (September 28, 1959).
[35] *International Shipping and Shipbuilding Directory*, 1968, (80th edition; London: Benn Brothers), p. 455.
[36] *Ibid.*
[37] Harbron, *op. cit.* n. 16, p. 112.
[38] *Ibid.*, p. 109.
[39] *Ibid.*, p. 199.

Figure 6-1 INDIRECT TECHNICAL ASSISTANCE TO THE U.S.S.R. VIA EASTERN EUROPE: THE CASE OF MARINE DIESEL ENGINES



Sources: John D. Harbron, *Communist Ships and Shipping* (London, 1962); *International Shipping and Shipbuilding Directory, 1968* (80th edition; London: Benn Brothers).

Western countries. Titovi Zavodi Litostroj manufactures B & W and Fiat engines under license; "Uljanik" Brodogradiliste I Tvornica Dizel Potora at Pula manufactures B & W marine engines under license; the 3 Maj plant manufactures Sulzer marine diesels under license;[40] and the Jugoturbina plant manufactures Sulzer and A.E.G. turbines under license. These plants provide the total Yugoslav marine-engine building capacity, and are the source of engines for Yugoslav ships built on Soviet account.

It is particularly interesting that B & W (which provides technical assistance for the Bryansk plant in the U.S.S.R. and in the Yugoslav, Polish, and Finnish plants building engines on Soviet account) depends on U.S. technology for its engine-designing facilities. In 1967 Burmeister & Wain installed extensive computer facilities in its electronic data processing department for "extensive calculations for shipbuilding and design and construction of diesel engines."[41] This equipment comprised a Univac 1107 system with central processing and two Univac 1004 computers. Thus diesel engines for Soviet ships are designed with the aid of American computer equipment.[42]

[40] *International Shipping and Shipbuilding ..., op. cit.* n. 35, p. 458.
[41] *Shipping World and Shipbuilder* (London), July 20, 1967, p. 1249.
[42] See p. 318.

CHAPTER SEVEN

Western Equipment and Soviet Foreign Aid

On the assumption that Soviet construction work abroad will throw light on Soviet engineering and technology without the screen of censorship, attention should now be given to the most important of Soviet foreign aid projects—the Bhilai steel plant in India and the Aswan Dam in Egypt. Both projects were heralded as triumphs of Soviet engineering, and without question each has been a key factor in the economic development of the recipient country. Indeed, Aswan will have a fundamental influence on Egypt unparalleled in that country's thousands of years of recorded history.

Both projects had higher priority than any but military projects. The Soviet engineers and equipment utilized were the finest that could be obtained in the U.S.S.R.; in both cases the Soviets preferred to undertake construction using only Soviet equipment, and in the case of Aswan this was written into the first Soviet-Egyptian agreement. In Bhilai and Aswan, then, we have not only two prominent examples of modern Soviet engineering but also reasonably free access to uncensored information on Soviet construction methods and their results.[1]

THE BHILAI STEEL PROJECT IN INDIA[2]

In January 1945 the Indian Government appointed a panel of iron and steel industry experts to consider expansion of the Indian steel industry. The recommendations of the panel included construction of a major integrated plant at Bhilai in Madhya Pradesh. Construction started in 1955 with $130 million of financing from the U.S.S.R. to be repaid by India in 12 annual installments at 2.5 percent annual interest; capacity was planned as 1.3 million tons of ingot steel annually with possible expansion to 2.5 million tons.

A significant feature of the Bhilai project was that 90 percent of the erection work was done by Indians under the supervision of Soviet engineers. In June

[1] The best available technical description is a special supplement of *Indian Construction News* (Calcutta), VIII, 10 (October 1959).

[2] *Ibid.*, pp. 46-49.

1959 about 60,000 Indians were employed under 700 Soviet engineers and 854 Indian engineers.

All civil engineering work at Bhilai was handled by private contractors, the leading company being Hindustan Construction Co., Ltd., which had a contract for more than 80 percent of the excavation and concrete work, in addition to installation of underground communications. The company supplied from its own equipment resources the central batching plant, shovels, scrapers, bulldozers, cranes, and dump trucks. Photographs in *Indian Construction News*[3] indicate clearly the American origins of this equipment—Le Tourneau-Westinghouse, Northwest, Euclid division of General Motors, and so on.

An article by N. B. Lobotsky, Deputy Chief Engineer at Bhilai, comments: "Civil work is of paramount importance in constructing a steel works, and very often it is progress of civil work which determines a further success of various kinds of erection and special work."[4] Thus although Bhilai was designed by Gipromez (and is therefore a typical American layout),[5] Indian companies undertook the basic civil engineering, including the massive excavation needed for iron and steel works and the placement of 600,000 cubic meters of concrete in foundations and construction of concrete buildings.

In short, the excavation and concrete work—those project phases which later, at Aswan, were to cause the Soviets acute embarrassment—were undertaken at Bhilai by private Indian contractors. Ultimately the problem was similarly resolved at Aswan: 93 percent of excavation was handled by Egyptian contractor Osman Ahmed Osman, although originally it had been planned as 100 percent Soviet work.[6]

The Bhilai installation consists of three large standard blast furnaces, six large open hearths, and a merchant rolling mill. It utilizes the very simplest of iron and steel manufacturing techniques, producing only a narrow range of mild-carbon steel products. Its output may be described simply as production of the maximum tonnage of a limited range of the simplest steel shapes. Capacity is 770,000 tons of steel products annually comprising the following:[7]

Rails	110,000 tons
Heavy structurals	284,000
Sleeper bars	90,000
Rounds & squares	121,000
Flats	15,000
Billets	150,000
	770,000 tons

[3] *Ibid.*, p. 40.
[4] *Ibid.*, pp. 42-43.
[5] See above, p. 128 (below).
[6] Supplement, *Indian Construction News*, *op. cit.* n.1, p. 26.
[7] William A. Johnson, *The Steel Industry of India* (Cambridge, Mass.: Harvard University Press, 1966), p. 157. Johnson also points out that the ability to roll heavy sections for long rolling periods means little downtime and reflects favorably in output figures. The actual capacity

The plant produces mild-carbon steel shapes only—it does not produce flat-rolled products, wire, or alloy or tool steels, all of which require extensive finishing facilities including pickling, annealing, cold-rolling and other equipment, facilities in which the Soviet Union is noticeably backward.

Furthermore, even for this limited product range there are numerous restrictions imposed by the equipment; one of the most far-reaching in terms of Indian development is the small range of rolled sizes. The Bhilai mill can be compared (Table 7-1) with the Monterrey mill in Mexico, a small plant producing only 240,000 tons of steel products a year, but roughly in the same categories, and supplying a similar market in an underdeveloped country. Monterrey, however, produces a far greater range of sizes and offers a greater choice of products, although its smaller mill is confined basically to the types of steel products produced by Bhilai. The notable point is that although Bhilai has three times greater capacity than Monterrey, the Mexican mill can supply a greater range of sizes for every finished product, and this applies particularly to angles and flats.

Table 7-1 COMPARISON OF PRODUCTS FROM BHILAI MILL (INDIA) AND MONTERREY MILL (MEXICO)

Type of steel product	*BHILAI*		*MONTERREY*	
	No. of sizes	*Range of sizes*	*No. of sizes*	*Range of sizes*
Rails	8	24 – 105 lb/yd	11	12 – 112 lb/yd
Beams	10	100x50 – 600x210 mm	13	76 - 381x152mm
Channels	8	41x32 – 400x100 mm	10	76x35-300x60mm
Angles	34	40x40x5 – 80x80x12 mm	128	19x19x3 – 152x102x25mm
Flats	27	50x8 – 100x20	227	12x3 - 355x51mm
Rods	3	6, 8, 10 mm	11	6 – 38 mm
Rounds and squares	16	20 – 63 mm	51	6 – 101 mm

Sources: Bhilai mill: Hindustan Steel, Ltd., "List of Products from Bhilai Steel Plant," supplied by Bhilai Steel Plant, Public Relations Dept., January 1969.
Monterrey mill: Cia. Fundidora de Fierro y Acero de Monterrey, S.A., *Manual para constructores* (Monterrey, Mexico, 1959).

This interpretation of Bhilai's limited capabilities is shared by W. A. Johnson, who comments: "Bhilai rolls the simplest of products, heavy sections, which require less reprocessing than the lighter sections rolled by Durgapur and the flat-rolled products by Rourkela."[8]

of the plant is well in excess of rated capacity; i.e., there is a built-in excess capacity, enabling the plant to fulfill its targets with ease.

[8] See Table 7-2.

Table 7-2 LOCATION OF TRAINING FOR ENGINEERS AND SKILLED WORKERS FOR THE BHILAI PROJECT

	Soviet Union	*Private Indian firms*			*Indian Government works*		
		Tata Iron and Steel Co., Ltd.	*Indian Iron and Steel Co., Ltd.*	*Other firms*	*Mysore Iron and Steel Works*	*Bhilai*	*Total*
Junior engineers	109	—	—	—	—	2	111
Graduate trainees	188	—	—	—	—	35	223
Operative trainees	231	108	16	—	45	190	590
Skilled worker trainees	29	52	4	670	40	234	1029
Artisan trainees	—	—	—	—	—	50	50
Vacation trainees	—	—	—	—	—	10	10
Total (numbers)	557	160	20	670	85	521	2013
Total (percent)	26.67		42.23		30.10		

Source: *Indian Construction News* (Calcutta), October 1959; based on table on page 114.

Training of engineers and skilled workers for Bhilai was divided between the U.S.S.R. (about 26 percent, mainly engineers), Bhilai itself (about 25 percent, mainly operatives), and private and Indian Government firms (the remainder).[9] (See Table 7-2.)

Therefore, Bhilai may be described as a steel mill producing a very limited range of the simplest of steel products, with a typical American layout. Further, the civil engineering work and some of the training during construction were handled by private Indian contractors.

THE ROLE OF EGYPTIAN CONTRACTORS AND FOREIGN EQUIPMENT IN BUILDING THE ASWAN DAM

Construction of the Aswan High Dam was financed by the Soviet Union between 1958 and 1963 to the extent of $552 million at 2.5 percent interest. This loan was disbursed as follows:[10]

December 27, 1958	$100 million repayable over ten years for construction of the first stage of dam
August 27, 1960	$225 million repayable over ten years for the second stage of dam construction
Summer 1962	$170 million for additional construction work
June 18, 1963	$57 million for the hydroelectric power equipment
Total	$552 million

A series of international disputes, combined with Gamal Nasser's persistent determination to build the dam, led to the initial 1958 Soviet offer, which was promptly accepted by Egypt. The original German design, drawn up by Hochtief-Dortmund in the early 1950s, was inherited by the Soviets and studied in Moscow. Major changes were proposed in May 1959. These changes were considered by an international consultant board previously appointed by the Egyptian Government; this board in turn strongly advised against two of three Soviet proposals. The Soviets ignored further advice from the international board —as their contract gave them every right to do—and proceeded to plan and build according to their own ideas.

There is little question that the Soviet design changes made sense, although as finally built the dam looks little different from the original German elevation

[9] This chapter is limited to chiefly the examination of two projects; but our hypothesis might well be tested with respect to all overseas Soviet projects, although these were not numerous before 1960. For example, it is reported that the Soviet-built hotel at Inya Lake (Burma) has Otis elevators and Westinghouse air conditioning; see Victor Lasky, *The Ugly Russian* (New York: Trident 1965), pp. 21-2.

[10] B. R. Stokke, *Soviet and Eastern European Trade and Aid in Africa* (New York: Praeger, 1967), p. 83.

design. The main Soviet changes involved work methods and shifting the axis of the dam about 600 yards south; in fact, the sluicing method of moving sand suggested by the Soviets (and rejected by the international board) worked well in practice.

The Soviet engineers insisted that Aswan should be an example of state enterprise and therefore initially refused to subcontract to private Egyptian companies. Also, rather than adhere to the ten-year schedule planned by Hochtief-Dortmund, the Soviets reduced the construction schedule time to eight years.

The first years of work involved only the operational sequence of drill, blast, dig, load, and dump. The equipment needed for this sequence included drills, excavators, and dump trucks, and these items the Soviets supplied immediately in quantity.[11] Equipment problems began almost at once; by mid-1961 only 900,000 cubic yards of rock excavation was completed, instead of a planned three million yards. Soviet trucks broke down, Soviet-made tires were slashed by the granite rock, and while the old-fashioned Ulanshev excavators held up (except for the bucket teeth) the Soviet drills did not—so the Aswan Dam project headed into a major construction crisis.[12]

After a great deal of government-level discussion the excavation and concrete contracts were let to two private Egyptian companies: General Enterprises Engineering Company, run by Osman Ahmed Osman, and the Misr group.[13] The Misr contract covered the concrete work on the tunnels and the power station. The Osman contract, granted to Arab Contractors, Ltd., was of fundamental importance. Only one million yards of the 14 million cubic yards to be moved had been excavated by the Soviets; the Osman company handled the other 13 million yards under this contract. In other words, 93 percent of the Aswan Dam rock excavation was handled by a private Egyptian company, not by the Soviet construction force.[14]

Studies by Osman's Egyptian engineers pinpointed the Soviet dump trucks, only 77 percent as efficient as Western models, as the key to the problem. Subsequently, 54 British Aveling-Barford 35-ton dump trucks were hastily imported to supplement the 100 Soviet 25-ton dump trucks already at work. There was continual friction between Soviet and Egyptian engineers,[15] but the

[11] Construction equipment supplied by the U.S.S.R. included 16 electric excavators (4 to 5 cubic meters shovel capacity), 90 small excavators, 160 dump trucks of 25 to 30 tons capacity, 1600 drilling machines of various sizes, 75 bulldozers, 150 trucks, 140 passenger cars, 100 buses, 80 cranes of various capacities, 80 movable air compressors, 15 tugboats, 13 Hooper barges of 200 to 500 tons' capacity, and 11 sets of equipment for hydraulic movement of sand. *The High Dam, Miracle of XXth Century* (Ministry of the High Dam, Cairo Information Department: January 9, 1964), pp. 16-17.

[12] T. Little, *High Dam at Aswan: The Subjugation of the Nile* (London: Methuen, 1965).

[13] Arab Contractors, Ltd., with the Aswan Dam contract is a subsidiary of General Enterprises Engineering; the latter is partially financed by the government but operates as a privately owned company.

[14] Little, *op. cit.* n.12, pp. 100-4.

[15] *Ibid.*, p. 111.

private contractors held to their schedule. In the face of Soviet objections, overruled by Nasser, Soviet equipment was supplemented by foreign compressors, Atlas Copco (Sweden) drills (with Swedish engineers to supervise the drilling work), and two Ruston-Bucyrus excavators. A British engineer from Dunlop of the United Kingdom was brought in to find a solution for the shredding Soviet truck tires, and workmen were set to chipping away sharp rock edges. At one point late in 1963, "the U.A.R. Government begged Aveling-Barford to give them extraordinary priority by allowing more dump trucks, then at sea and bound for another destination, to be diverted to Egypt."[16] At the final ceremony, however, this British and Swedish equipment was hidden away from inquisitive eyes.[17]

There is no question that injection of private Egyptian companies using imported Western equipment into the Aswan Dam project turned a crisis into a schedule met on time.[18] A similar problem had been avoided at Bhilai in India by using imported Euclid dump trucks operated by the Hindustan Construction Company from the start of construction.

OTHER SOVIET PROJECTS IN THE UNDERDEVELOPED WORLD

It is notable that the Soviet Union has not undertaken to construct large-scale industrial projects elsewhere. Such socialist-sponsored projects have been handled by East European nations, although sometimes the financing has been provided by the U.S.S.R. in a three-way arrangement.

In Syria, the largest communist project under way at the end of the 1950s was a petroleum refinery constructed by Czechoslovakia at Homs. Built at a cost of $15 million financed on long-term credits, and having a capacity of one million tons, the plant has Czech equipment and supervision although some Russian engineers supervised parts of the construction.[19] East Germans and Bulgarians erected other projects in Syria in the 1950s while Soviet material assistance appears to have been confined largely to armaments.

In the Far East, although large Soviet offers of assistance were made in 1958 to Indonesia, the only two completed bloc projects in 1958 were a Czechoslovak tire factory and an East German sugar plant.[20]

[16] *Ibid.*

[17] *Ibid.*, p. 213.

[18] "The violent overhaul that the project needed was led by an Egyptian, Osman Ahmed Osman, forty-eight, the prime contractor and a master at getting big projects done under primitive conditions. Over the objections of the Russians, Osman supplemented their faulty equipment with better British and Swedish gear ... Osman became the hero of Aswan." *Fortune*, January 1967, p. 130.

[19] U.S. Dept. of State, *The Sino-Soviet Economic Offensive in the Less Developed Countries* (Washington, 1958), p. 55.

[20] *Ibid.*, p. 79.

In general, at the end of the fifties there had been large Soviet offers,[21] but except for Aswan and Bhilai, actual assistance had been confined mainly to military supplies.

Thus Soviet construction under its technical-assistance programs appears to generate more propaganda than transfer of indigenous Soviet technology. Bhilai had all civil engineering handled by Indian firms, and much training was handled at Bhilai or by private Indian Government firms. The chief Soviet contribution was in supplying equipment for a simple integrated facility with restricted rolling capabilities, and that based on typical American layouts. At Aswan the Soviets started excavation, but after 7 percent of the work was completed the civil engineering was contracted to two private Egyptian companies utilizing imported Swedish and British equipment.

These two large-scale projects, both of which received the highest nonmilitary priority, confirm the general conclusions of this study concerning weaknesses in Soviet engineering and technology.

[21] Raymond F. Mikesell and Jack N. Behrman, *Financing Free World Trade with the Sino-Soviet Bloc* (Princeton: Princeton University Press, 1958), p. 158. See Appendix Table II for a list of such offers from January 1953 to 1958.

Part II

Technical Transfers and Their Role in Soviet Industry

CHAPTER EIGHT

Western Origins of Mining and Excavating Equipment

Four fields of mining and excavating activity have been selected for consideration in this chapter: underground coal mining, the most important mining activity in the Soviet Union; iron ore beneficiation, important because of the nature of Russian iron ores; peat excavation, a typically Soviet industry; and the development of earth excavating equipment.

At the end of the 1920s imported German mining machinery was largely replaced by imported American machinery and still later by duplicates of this American machinery, in some cases manufactured in the U.S.S.R. under technical-assistance agreements with U.S. manufacturers. This practice has extended historically and in terms of equipment beyond the four mining activities considered in this chapter. A typical example, which also reflects the U.S. origins after 1930, may be found in production of dredges. By July 1932, some 22 new American Yuba-type dredges were sent to various placer gold fields in the Soviet Union;[1] these included three of 13.5-foot capacity, twelve of 7.5-foot capacity, and seven of 3.5-cubic foot capacity. The larger dredges were capable of handling 566 tons of sand per hour and were used in the Lena, Alden, and other Siberian fields. Steam and electric thawing apparatus was installed by American engineers hired from Alaskan gold mines, and five American-design cyanide plants were built in Siberia. U.S. hydraulic nozzles, steam shovels, cranes, scrapers, heated sluices, and other equipment also were imported.

Beginning in 1930 attempts were made to manufacture such equipment in the Soviet Union. In an earlier agreement with the Union Construction Company, an American firm, drawings and specifications had been supplied for gold dredges, and a similar agreement was made in 1932 with the Yuba Manufacturing Company, also American, for platinum dredges. A section of the Krasnyi Putilovets plant was set aside for the manufacture of the large Yuba dredge and three or four smaller dredges a year were manufactured at Votkinsk and Irkutsk. The production program of Soviet plants called only for duplication

[1] *Far Eastern Review* (Manila, Shanghai) April 1933, p. 168.

of U.S. and German equipment. For example, the production program of the Irkutsk plant in 1933 called not only for American-type dredges and power excavators, but also for 60 Black model ore crushers, 20 Simons model ore crushers, 2000 Koppel ore cars, and 2000 Anaconda ore cars.

These imports and Russian domestic copies were supplemented by heavy equipment imports under the Lend Lease program (see Table 8-1) and the October 1945 "pipeline" agreement.

Table 8-1 LEND LEASE EXPORTS OF MINING AND EXCAVATING EQUIPMENT TO THE U.S.S.R.

Lend Lease category no.	*Description*	*Total exports (arrived, after losses)*
V-4	Crushing, screening, and mixing machinery	$8,048,000
V-49	Mining and quarrying machinery	1,763,000
V-50	Earth, rock boring, and drilling equipment	8,983,000
V-51	Well and blast-hole drilling machinery	9,023,000
V-52	Excavating and dredging machinery	31,050,000
V-59B	Mine locomotives	1,133,000
Total		$60,000,000

Source: U.S. Dept. of State, *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945).

In 1945 300 Russian coal mining engineers were sent to locate and dismantle equipment in the German brown coal region. This equipment was transferred to the Moscow brown coal mining basin. Some equipment went elsewhere; for example, eight single-bucket excavators were sent to Tashkent.[2] Excavating equipment totaling 200,000 to 220,000 cubic meters daily capacity was removed to the U.S.S.R., as was coal mining equipment with a daily capacity of 40,000 to 45,000 tons and briquette-making capacity of 16,000 to 18,000 tons daily.[3]

Major imports of mining equipment have continued since World War II. One major U.S. mining equipment manufacturer, Joy Manufacturing Company of Pittsburgh, received a Lend Lease contract from the U.S. Government in 1944 to supply 600 long wall coal cutters for the Donbas mines and has continued to sell equipment for the coal and potash mining sectors since that time.[4] In

[2] Robert Slusser, ed., *Soviet Economic Policy in Postwar Germany* (New York: Research Program on the U.S.S.R., 1953) p. 84.

[3] *Ibid.*, p. 85.

[4] U.S. Senate, *East-West Trade*, A Compilation of Views of Businessmen, Bankers and Academic Experts; Committee on Foreign Relations, 88th Congress, 2d session, November 1964 (Washington, 1964), p. 81. The company name is omitted in the testimony but the facts suggest it was the Joy Manufacturing Company.

1963 the company received a $10 million contract—the eighth—for 30 continuous miners for potash mining,[5] and the following year it received another $5.5 million contract for combines, loading equipment, and self-propelled trolleys for potash mining.[6] Company representatives subsequently made an interesting statement before Congress concerning Soviet copying of their equipment designs:

> The Russians have copied our machines, but apparently there is not high enough priority on coal mining machinery in Russia to make a real effort in copying even for their use within the U.S.S.R. We know this because they continue to buy from us machines of which we know they have made copies.[7]

Recent Soviet technical manuals have descriptions and photographs of these "Soviet-Joys." For example, the self-propelled trolley VSD-10 manufactured at the Voronezh mining equipment plant from 1966 onward is a copy of the Joy self-propelled trolley.[8]

Where other countries have the preferred technology the Soviets are aware of it. For example, Canada is the traditional world leader in asbestos milling and processing equipment; Soviet mills were provided technical assistance by Canadian companies in the 1920s and 1930s[9] and in more recent times Canadian firms have continued to keep Soviet asbestos mills abreast of Western technology. In 1964, for example, Lynn MacLeod Engineering Supplies, Ltd., of Canada supplied $7.8 million in asbestos processing equipment for the Urals asbestos mills with technical assistance and company technicians for installation of the equipment.[10] It is interesting to note that a U.S. embargo on one component was overcome quite simply: "...the company eventually decided to use a Canadian-built product made under a licensing agreement with a U.S. company."[11]

Therefore we can trace a history of import of foreign mining equipment—with U.S. equipment usually the preferred equipment—and only partially successful domestic duplication of this equipment. Lack of total success in duplication is of particular interest in those sectors which are of relatively greater importance in view of Russian resource conditions; peat recovery and iron ore beneficiation are two such sectors and are considered below.

[5] *Congressional Record, House of Representatives*, August 23, 1963.

[6] *Los Angeles Times*, September 14, 1964.

[7] U.S. Senate, *East-West Trade, op. cit.* n. 4, p. 82. A notation is added that copies of the companies' equipment were on exhibit at the permanent industrial exposition in Moscow.

[8] For the VSD-10 see *Gornye mashiny dlya dobychi rud* (Moscow, 1968), and compare to the Joy self-propelled trolley in A. S. Burchakov *et al.*, *Tekhnologiia, mekhanizatsiia i avtomatizatsiia proizvodstvennykh protsessov podzemnykh razrabotok* (Moscow, 1968), p. 329.

[9] See Sutton I, pp. 108-12; and Sutton II, pp. 184, 368.

[10] *Wall Street Journal*, February 19, 1964, 12:6.

[11] *Ibid.*

FOREIGN ORIGINS OF UNDERGROUND MINING EQUIPMENT IN THE COAL INDUSTRY

The coal mining industry, by far the most important of all mining industries in the Soviet Union, is mechanically almost completely based on foreign technical developments. Fortunately, we have a series of excellent reports by the National Coal Board of the United Kingdom that describe this technical diffusion from the West,[12] although this was not the prime purpose of the reports. Furthermore, in the words of one NCB report: "It must be appreciated ... that the Report emphasizes what is best in Soviet mining technique and does not elaborate on much that was seen which was well below the standard of modern British practice."[13]

Of the 391 million tons of coal produced in the Soviet Union in 1955, about 319 million tons was hard coal mined underground, only 7.5 million tons was open-pit mined, and the balance was brown coal. A large number of power-loading machines were in operation in the late 1950s, and Table 8-2 gives the total number of such machines, mostly face power loaders based on the frame-jib design, held in stock and in use in Soviet coal mines in the late 1950s with their Western prototypes. The in-use number is about twice that utilized in British mines in 1956-57.

Underground mining equipment in the Soviet coal industry is based completely on foreign models.[14] The variations, described below, are essentially either simplifications of foreign models or models which omit ancillary equipment or functions forming part of the original foreign machine.

The most commonly seen coal face cutter loader in the Soviet Union is the Donbass 1. There were 1411 in stock in 1956, and according to Soviet literature this model was widely used in the late 1960s.[15] There are six variants of the Donbass, all manufactured at Gorlovka—the Donbass 1; a more powerful version, the Donbass 2; the Donbass 6; a Donbass thick-seam machine; and the Gornyak, the thin-seam version. The Donbass 7 variant has a picked drum "rather similar to that recently developed for the Meco-Moore."[16] The Donbass in all its variants is essentially the British Meco-Moore. The main difference

12 *Report by the Technical Mission of the* [U.K.] National Coal Board, *The Coal Industry of the U.S.S.R.*, pt. 1 (London, 1957); pt. 2 of this report consists of appendices.

13 *Ibid.*, pt. 1, p. i.

14 This conclusion is confirmed under current conditions (1969) by Vasiliy Strishkov of the U.S. Bureau of Mines, and is consistent with the National Coal Board reports: "The mining equipment and processes used in the Soviet mineral industry are standard—usually patterned on early American and West European models"; and "Studying, copying, and extensive application of Western technological progress and equipment in the Soviet mineral industry will be the main trend in the improvement of mineral industry technology." Letter to writer, May 6, 1969, from U.S. Bureau of Mines.

15 V. N. Khorin *et al.*, *Ugol'nyi kombain "Donbass-1G"* (Moscow, 1969).

16 U.K. National Coal Board, *op. cit.* n. 12, p. 26.

Table 8-2 POWER LOADING MACHINES IN SOVIET COAL MINES (AS OF APRIL 1, 1956)

1	*2*	*3*	*4*	*5*
	Number of Machines		*Percentage*	
Type of machine	*Held*	*In use*	*in use*	*Western prototypes*
COAL FACE MACHINES				
Donbass 1	1411	954	83.61	Meco-Moore
Donbass 2	11	3	27.27	Meco-Moore (more powerful Donbass 1)
Donbass 6	6	2	33.33	Meco-Moore (thick-seam version)
Gornyak	414	265	64.01	Meco-Moore (thin-seam version)
UKT 1-2	177	112	63.28	Colmol (or) Korfmann
UKMG	142	66	46.68	U.K. multi-jib design
Shakhter	81	60	74.07	Meco-Moore variations
	2242	1462	60.75	
OTHER POWER LOADING MACHINES				
Heading loaders:				
PK-2m (brown coal)	191	116	60.73	Joy Continuous Miner
ShBM-1 (tunneler)	26	17	65.39	Soviet prototype
	217	133	61.20	
Dirt loading:				
UMP	620	401	64.68	—
PPM 2-3	493	312	63.29	Conway Shovel
EPM 1	1808	1303	72.07	Eimco – 21
PML 5	1075	858	79.81	Eimco – 40
PMU	49	21	42.88	U.K. gathering arm loader
	4045	2895	70.32	
Coal loading machines:				
All types	777	534	68.86	—
(including GNIZ-30)	49	38	77.55	—
	826	572	69.25	

Source: United Kingdom, National Coal Board, *The Coal Industry of the U.S.S.R.*, Report by the Technical Mission (London, 1957), p. 24. Column 5 added from text.

is that the Russian Donbass cuts one way only, and is then flitted back along the coal face in a new track, while the original Meco-Moore machine is turned at the end of each cut. The Meco-Moore was originally designed in 1930 by Mining Engineering Co., Ltd., of the United Kingdom. It was developed throughout the 1930s and received a stimulus in 1941 from increased wartime demand for coal. As of September 1956 some 155 Meco-Moore cutter loaders were in operation in the United Kingdom compared to 1224 Russian Donbass models based on a prototype Meco-Moore.[17]

In describing the less common coal face machines, the U.K. National Coal Board team reported that the UKMG cutter loader was "basically similar to our multijib design," with a slight difference in the cutter chains, and with no separate loading mechanism.[18] The same team reported with reference to the UKT 1 and 2 cutter loaders that "the general design of the machine is similar to the Colmol or Korfmann—and it loads coal in a similar manner—but it is single ended and there are no proposals in hand for making it double-ended."[19] Other cutter loaders under development were the K-26, described as similar to the Dosco,[20] and the A-2 plow of the Löbbehobel type with a support system similar to the Dowty Roofmaster.[21] Vasiliy Strishkov, a U.S. observer, comments on coal plows:

> In 1950, West Germany introduced a high-speed coal plough. But coal ploughs were not introduced in the Soviet Donets basin mines until 1962. It took 12 years for the U.S.S.R. to study, copy, and produce coal ploughs.[22]

Similar observations were made on other machines. The PK-2m brown coal cutter loader is described as similar to the Joy Continuous Miner (supporting the company's own observations) except that the cutter head swings horizontally, not vertically.[23] The most popular loaders are the rocker-arm type corresponding to the Eimco-21 and Eimco-40, with a smaller unit, the PPM-2, equivalent to the Conway Shovel. Of the PMU-1 the report noted: "This is railmounted, and the significant difference between it and British machines is that two conveyors are used."[24]

The winding systems in coal mine shafts use Ward-Leonard controls, the most modern being at Gorlovka, but no automatic winders, except one Ward-Leonard, have been seen.[25] A report of a French Cement Industry delegation noted that Ward-Leonard 250- to 300-kw controls are made at the Urals plant.[26]

[17] R. Shepherd and A. G. Withers, *Mechanized Cutting and Loading of Coal* (London: Odhams Press, 1960), p. 311.
[18] U.K. National Coal Board, *op. cit.* n. 12, p. 28.
[19] *Ibid.*, p. 29.
[20] *Ibid.*
[21] *Ibid.*, p. 30.
[22] Strishkov, *loc. cit.* n. 14.
[23] U.K. National Coal Board, *op. cit.* n. 12, pp. 32, 34, 41.
[24] *Ibid.*, p. 43. See also *Gornye ...*, *op. cit.* n. 8, for a Russian description of these machines with place and date of manufacture.
[25] U.K. National Coal Board, *op. cit.* n. 12, p. 58.
[26] *L'Industrie cimentière en U.S.S.R.*, Compte rendu de mission 9-28 avril 1960 (Paris, 1960), p. 33.

Flotation machines used in coal concentration plants are to a great extent based on French and U.S. designs and imports. As of 1964 there were 230 such machines operating in the U.S.S.R.[27] Of these, 104 were Fm-2.5 or FF-4 based on the French "Minemet," while eight were apparently Minemet Model NS-1500. These units are built in France by the firm of Minère et Meto, and in the U.S.S.R. at Novo-Irminskoi.[28] Another seven units were Airlift; the remaining 77 machines were Giprokoks Model 51-52 and KhGI-57—apparently also based on Minemet models.[29]

Plants manufacturing and repairing coal mining equipment were noted as modern and well equipped. In the case of the Prokopevsk Lamp Works, the NCB delegation noted "a large proportion of the equipment was seen to be of Continental or American manufacture."[30] Of the Rutchenkovsky Zavod the delegation said: "The majority of the machines installed are of American and Continental manufacture."[31]

In sum, in underground coal mining, the largest mining industry in the U.S.S.R., we find almost complete technical dependence on Western equipment—although a great deal of research and experimental work has been undertaken in Soviet research institutes.

BENEFICIATION OF IRON ORE

The Soviet Union has made considerable investment in upgrading facilities for iron ore, particularly to convert low-grade ores into blast-furnace charge. A brief summary of these developments suggests great dependence on Western, and in this case primarily German and American, practice. The 1959 report of the American Steel and Iron Delegation[32] concluded that "the equipment is standard—usually patterned after early American models."[33] In the late fifties there were 40 iron-ore beneficiation plants in the U.S.S.R., and the more advanced were visited by the delegation. Where magnetic separation can be used, "they have definitely settled on rotary kilns developed originally by the Lurgi company in Frankfurt."[34] The standard 150 by 11-foot kiln has a capacity

[27] N. G. Bedran, *Flotatsionnye mashiny dlia obogashchaeniia uglia* (Moscow, 1968), p. 5.
[28] *Ibid.*, pp. 57, 108-9.
[29] *Ibid.*, pp. 82-83.
[30] U.K. National Coal Board, *op. cit.* n. 12, p. 62
[31] *Ibid.*, p. 65. The close watch maintained on the U.S. coal mining industry is apparent in the Russian technical literature. See, for example, R. Yu. Poderni, *Ugol'naia promyshlennost' SSha* (Moscow, 1968), and K. K. Kuznetsov, *Rekonstruktsiia, mekhanizatsiia i avtomatizatsiia shakht za rubezhom* (Moscow, 1968).
[32] *Steel in the Soviet Union*, Report of the American Steel and Iron Ore Delegation's Visit to the Soviet Union May and June 1958 (New York: American Iron and Steel Institute, 1959).
[33] *Ibid.*, p. 58.
[34] *Ibid.*, p. 57.

of 1000 tons per day. For nonmagnetic ores, i.e., oxidized ores, the Soviets have decided on reduction roasting followed by separation. For this purpose two pilot Lurgi-type kilns served as pilot plants and it was planned in the late 1950s to build 50 similar kilns in the Krivoi Rog basin alone,[35] thus standardizing on Lurgi kilns for both magnetic and nonmagnetic ores.

For sintering iron ores, the German Lurgi-type machine is used as the standard. It is based on drawings for a 537-square-foot machine purchased from Lurgi and similar drawings for a 805-square-foot Lurgi machine from Czechoslovakia, the Czechs having passed on their purchased Lurgi drawings.[36]

Crushers for iron ore are patterned after American models; the 60-inch primary crushers, although strengthened, are "definitely patterned after an American model."[37] Cone crushers are of the Symons type with both long and short head varieties.[38] Most of the pumps for sand pumping "are patterned after a well-known American sand pump."[39] Internal drum filters "look very much like American types"; however in the late 1950s the Soviets intended to replace these with magnetic-type vacuum filters developed in Scandinavia.[40] The standard magnetic separator for wet work "is the American-type belt machine with a 55-inch belt."[41] The delegation report comments that at one of the plants the manager "took some pains" to point out the name plates on the machines (i.e., "made in the U.S.S.R."), but the report noted that "very few original developments in the concentrating equipment were seen."[42]

[35] *Ibid.*, p. 58.

[36] *Ibid.*, p. 109-10. No essential differences between the Soviet and the Lurgi sintering plants were seen. Sinter comprises about 60 percent of total furnace feed in the U.S.S.R. "In 1928 the Russians built a Swedish-type sintering plant equipped with movable pans (apparently what is known as the Holmberg system), and in 1931 the first continuous Dwight-Lloyd type plant was built in Kerch. Experiments showed that the continuous system had about 30 percent advantage over the Swedish system. Since that time all plants built in the Soviet Union were of the continuous Dwight-Lloyd type." *Ibid.*, p. 107.

[37] *Ibid.*, p. 58.

[38] *Ibid.*

[39] *Ibid.*

[40] *Ibid.*

[41] *Ibid.*, p. 59.

[42] *Ibid.* It should be remembered that the delegation visited only a few "advanced" plants. The position appears to have remained the same in 1963. Although the Indian Iron and Steel Delegation did not specifically mention origin of Russian processes, those processes described by that delegation are similar to those mentioned in the earlier American report. See National Productivity Council India, *Iron and Steel Industry in U.S.S.R. and Czechoslovakia* (New Delhi: National Productivity Council, 1963), pp. 44-45.

Other comments by the U.S. delegation include (at Magnitogorsk): "Plant equipment observed is based on original American models. The cone crusher is a 7-foot Nordberg ... Wet magnetic separators are all of the American Crockett belt type ... seldom used in new installations in the U.S.A." (p. 78). And (at the Kuznetsk concentrator): "The group was shown an automatic regulating and recording device for controlling the pulp density of the classifier. In design it appeared to be similar to one developed by Masco." "There are four magnetic separators for each section, all of them being of a modified Crockett belt type." "There are two filters per section. These are of the Dorrco internal drum type ... manufactured in East Germany." Two Lurgi kilns were being installed. American Iron and Steel Institute, *op. cit.* n. 32.

THE PEAT INDUSTRY IN RUSSIA

The Soviet Union has large deposits of peat and is the most important industrial user of fuel peat in the world. Six methods of production are used: elevator, scraper elevator, dredge-excavator, hydraulic (hydropeat), hydraulic-elevator, and milling.

The elevator and scraper elevator methods account for a small percentage of production. The dredge-excavator method was in use before the Revolution, as was the hydropeat method, developed by two Russian engineers. The hydraulic-elevator method combines the hydraulic method with an elevator installation. The milling method is undertaken with cultivators and milling machines towed behind tractors.[43]

Although the peat industry is primarily a Russian industry it has seen a good deal of transfer of technology. (See Table 8-3.) In the 1920s unsuccessful attempts were made to use foreign machines in bulk drying, and the Typermas machine was developed on Caterpillar tracks. For machines used in excavating large canals, foreign excavators and dredges manufactured by Marion, Weser-Hutte, and other foreign firms were the basis of Soviet excavators P-075, LK-0.5A, and E-505.[44]

Table 8-3 THE PEAT INDUSTRY METHOD OF EXTRACTION (1913 TO 1950)

	(given as percentage of total)				*(tonnage expressed in 1000 gross tons)*			
	1913		*1930*		*1940*		*1950*	
Method	*tons*	*%*	*tons*	*%*	*tons*	*%*	*tons*	*%*
Hydropeat	—	—	1797	21.7	9050	28.2	9040	25.3
Hydroelevator	—	—	90	1.1	1240	3.9	1000	2.8
Milling	—	—	186	2.2	5130	16.0	8280	23.2
Excavator (bagger)	—	—	40	0.5	961	3.0	5960	16.7
Elevator	1537	92.2	4054	48.8	9649	30.1	7350	20.6
Cutting	131	7.8	2139	25.7	6025	18.8	4070	11.4
Percentage mechanization	—	0	—	25.5	—	51.1	—	68.0
Total production	1688	—	8306	—	32,055	—	35,700	—

Source: G. Kazakov, *The Soviet Peat Industry* (New York: Praeger, 1956), pp. 217-18.

[43] George Kazakov, *Soviet Peat Resources* (New York: Research Program on the U.S.S.R., 1953), pp. 140-47.

[44] George Kazakov, *The Soviet Peat Industry* (New York: Praeger, 1956).

The standard Instorf elevator installation has been used since 1927. The Soviet SE-3 scraper-elevator installation, first built in 1938, consists of a dragline excavator combined with parts and motors from the standard elevator machine.

Mechanization of the bagger operation was undertaken by use of Ekelund excavators and other foreign machines, such as the Wieland. This was followed by the development of Russian designs—the Pankartov and the Biryukov baggers which in turn were replaced by the Instorf excavator, which is the standard excavator.

After 1950 the TE.P-2 excavator was introduced. This is a single-row multibucket excavator mounted on Caterpillar tracks and with a processing unit patterned on a Jeffrey crusher used in the Canadian peat industry.

The hydropeat method uses a water jet to flush out the peat and incorporates equipment of foreign origin—for example, the Ludlow type water valves, and NF-14 pumps patterned after American pumps.[45]

In peat loading, the UKL machine for loading peat onto rail cars is modeled on the U.S. Joy loader. In milling peat, equipment of German origin is used in addition to Randall-type harrows.[46]

THE ORIGINS OF SOVIET EXCAVATORS

We know from the Gorton Papers at the Hoover Institution that in the early 1930s Soviet planners consulted American engineers on the most suitable types of Western excavators to be copied and then proceeded, with U.S. assistance, to study, copy, and produce these machines in series.[47]

In 1931, for example, the Machine Building Trust collected data from those organizations using draglines and finally settled on five models; specifications of these models were then circulated to U.S. engineers for comments on suitability and numbers needed for 1932 and 1933. By 1932 choice had settled on five specifications:[48]

Model I: 4-cu. yd. bucket (3 cu. meters); total weight 12-13 tons, boom length 26-36 (8-11 meters); dumping radius, 15-16 ft. (4.5 to 5 meters); 30-40 hp on crawlers.

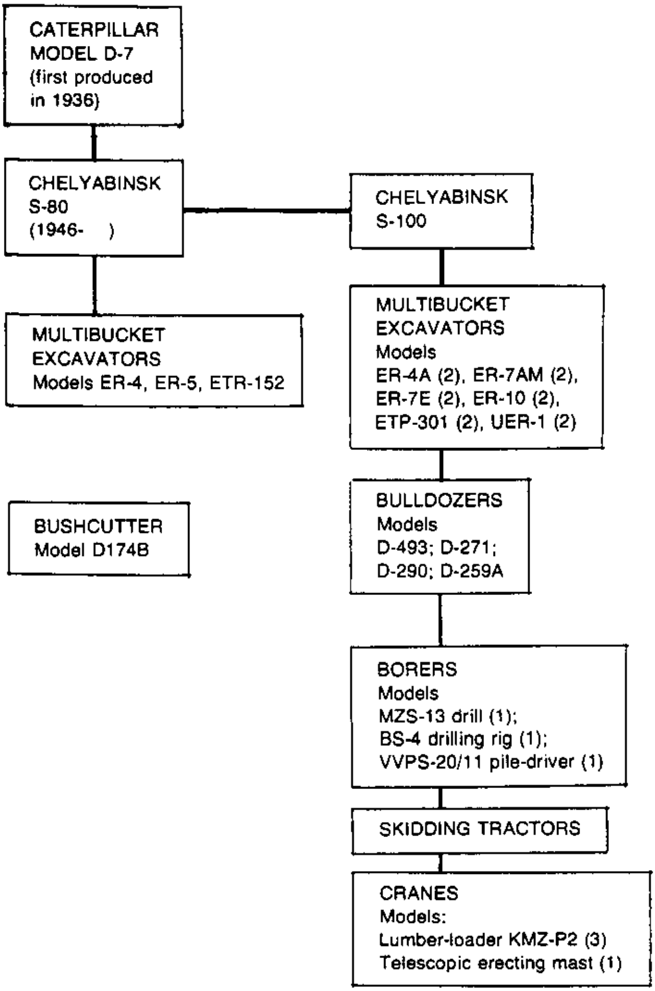
Model II: 0.97-cu. yd. bucket (0.75 cu. meter); boom length, 21 ft. (6.5 meters); dumping radius, 36 ft. (8 meters); weight, 35 tons.

Model III: Shovel clam shell bucket and crane; weight, about 65 tons; crawlers boom 25 ft. (7.6 meters); bucket 1.5 cu. yd. (1.15 meters).

Model IV: Shovel clam shell bucket and crane; weight, 120 tons crawlers; boom, 46 ft. (14 meters); dumping radius, 53 ft. (10 meters).

[45] *Ibid.*, pp. 76-85.
[46] *Ibid.*, p. 108.
[47] Sutton II, pp. 294-95.
[48] Gorton Papers, Hoover Institution Special Collections.

Figure 8-1 DEVELOPMENT OF SOVIET TRACTORS AND EQUIPMENT FROM THE CATERPILLAR D-7 TRACTOR



Sources: P.S.Neporozhnii, *Electrification and Power Construction in the U.S.S.R.* (Jerusalem: Israel Program for Scientific Translations, 1965), pp. 135-37; Ya. B. Lantsburg, *Spravochnik molodnogo mashinista keskavatora,* 2d edition (Moscow, 1968), p. 27.

Model IVa: Dragline for rocks, 3.2 cu. yd. (2.5 meters); weight, 120-130 tons; dumping radius, 36 ft. (11 meters).

These became the Soviet standard dragline excavators, and are based on the U.S. Marion and various German machines.

The Caterpillar D-7 tractor, first produced in the United States in 1936, became the Soviet S-80 in 1946 and the S-100 crawler tractor in the 1950s. The S-80 and the S-100 were then used as base models for a wide range of other Soviet equipment used in industries ranging from mining and lumber to construction. Figure 8-1 illustrates the origins of this equipment in relation to the Soviet S-80 and S-100 tractors. The ER-4, ER-5, and ETR-152 multibucket excavators were based on the S-80 tractor[49] and were replaced by another range of multibucket rotary excavators, the ER-4A, the ER-7AM, the ER-7E, the ER-10, the ETR-301, and the UER-1, all constructed on a C-100 tractor base. The two remaining models of multibucket rotary excavators are based on the T-74 tractor (the ETR-141) and the T-140 (the ETR-131).[50]

Bulldozers D-493, D-271, D-290 and D-259A—including most bulldozers produced in the U.S.S.R.—are based on the S-100 tractor base.[51] The MZS-13 drill, the BS-4 drilling rig, and the VVPS-20/11 pile driver are mounted on an S-100 tractor.[52] A telescopic erection mast is also mounted on a S-100 tractor chassis; and in the lumber industry numerous pieces of equipment, including the KMZ-P2 lumber loader, are based on the S-100.[53]

In sum, then, the range of mechanical handling equipment used in a wide range of industries is based on a single tractor chassis, the S-100 (earlier the S-80), derived from a prewar Caterpillar tractor model, the Caterpillar D-7.

[49] M. I. Kostin, *Ekskavatory: Spravochnik* (Moscow, 1959).

[50] Ya. B. Lantsburg, *Spravochnik molodnogo mashnista keskavatora* (Moscow, 1968), p. 27.

[51] M. D. Artamonov, *Tiagovye i dorozhnye mashiny na lesozagotovkakh* (Moscow, 1968), p. 303-6.

[52] P. S. Neporozhnii, *Electrification and Power Construction in the U.S.S.R.* Jerusalem: Israel Program for Scientific Translations, 1965), pp. 135-37.

[53] Alexis J. Pashin of Yale University has concluded on the basis of personal observation that "all the major equipment" in the logging industry "was either of foreign manufacture or copies, with some relatively slight modifications." This observation was made in 1958, but Pashin considers it holds good for 1968. Pashin also adds: "The same applies to the equipment we saw in the sawmills, plywood plants, and pulp and paper mills. All the major pieces of equipment were either of foreign make or obvious copies." Letter to writer, February 19, 1968.

CHAPTER NINE

Western Assistance to the Nonferrous Metal Industries

CANADIAN ASSISTANCE FOR NICKEL PRODUCTION

The first Russian nickel plant started production in February 1934 at Ufa in the South Urals with a capacity of 3000 tons annually. The Ufa plant, based on oxide ores, uses methods similar to those in the nickel plants of New Caledonia and Germany. It also processes oxidized nickel ores. The second Russian nickel plant started operations in 1935 at Rezh, near Sverdlovsk; this plant is also based on oxide ores and uses a similar process to produce nickel matte, which is transferred to the Ufa plant.

A third nickel plant, also based on nickel oxide ores, began operating in the 1930s in the Orsk and Aktyubinsk raions. The Orsk plant has a capacity of 10,000 tons of nickel per year and utilizes four Dwight-Lloyd sinter strands,[1] with electrorefining "similar to Canadian and Norwegian practice."[2]

The Pechenga plant, formerly called Petsamo, processes one quarter of Soviet nickel. This plant was developed and built by Petsamon Nikkeli Oy, a subsidiary of International Nickel Company, and taken over by the Soviets; it has three electric furnaces with a capacity of 1800 tons of concentrate per day with electrorefining at Monchegorsk.

Norilsk (started in 1940) and Monchegorsk (started in 1950) are also based on sulfide ores and Canadian practice, i.e., concentration by flotation, smelting to matte in electric furnaces, converting, and separation by flotation and electrorefining. These plants refine about one half of Soviet nickel, using processes based on International Nickel patents, while electrorefining at Monchegorsk is similar to Canadian and Norwegian practice.[3]

[1] Germany, Wehrmacht, Oberkommando: Microfilm T 84-127-8116, Captured German Documents.

[2] J. R. Boldt, Jr., *The Winning of Nickel* (Princeton: D. Van Nostrand, 1967).

[3] U.S. Patent 2,419,973 of 1947; U.S. Patent 2,425,760 of 1947; and U.S. Patent 2,432,456 of 1947. The flotation separation of copper nickel ores is attributed in Soviet literature to I. N. Maslenitskii and L. A. Krichevskii, although it is clearly based on International Nickel patents. Compare the flow sheet in *Journal of Metals*, XII, 3 (March 1960); K. Sproule, *et al.*, "Treatment of Nickel-Copper Matte," and I. P. Bardin, *Metallurgiya SSSR (1917-1957)* (Moscow, 1958; Jerusalem: Israel Program for Scientific Translations, 1961).

THE COPPER MINING AND SMELTING INDUSTRY

The technical assistance provided by American engineers to the Soviet copper mining and smelting industry was described in a previous volume.[4] No new locations had been established by the early 1960s, when production of refined copper reached an estimated total of 416,000 tons per year.[5] This capacity was achieved by expanding the already large plants built by Arthur Wheeler Corporation, Southwestern Engineering Corporation, and German firms in the 1930s; the Sverdlovsk refinery is still the largest Soviet refinery, followed by the Balkash refinery.

Copper is a subsector for which the Soviets have released very little hard data; it is surmised that major problems exist within the industry. For example, the Soviets are processing both oxide and sulfide ores by the same techniques; consequently, the recovery rate from oxide ores doubtless has been very low. There is also evidence that the metal content of the ore is declining, probably reflecting inadequate exploration methods. The recovery rate may also be declining.

This deficiency apparently has been offset by metal imports. Between 1954 and 1959 the Soviet Union purchased almost 550,000 tons of unwrought copper and copper wire from Free World countries—about 20 percent of total supply. This purchase was apparently necessary despite 391,711 tons of copper under Lend Lease, i.e., about seven years' supply at estimated 1940 rates of production, and in addition to over one million miles of copper wire and cable.[6] Imports rose at the end of the fifties to 150,000 tons in 1958 and 125,000 tons in 1959, and remained at high levels in the 1960s.[7]

Export control at first limited the form in which copper could be imported, but after August 1954 CoCom removed restrictions on wire of 6 millimeters and less in diameter; in August 1958 CoCom removed embargo on all forms of copper. Soviet copper exports to satellite countries have been balanced by imports of goods from those countries containing an equivalent amount of copper.

ALUMINUM PRODUCTION IN THE U.S.S.R.

In contrast to the Free World practice of using only bauxite ores for the production of aluminum, the Soviets use both bauxite and nonbauxite (nepheline, alunite, and sillimanite) ores—probably because of geological conditions rather than by technical choice. The nonbauxite deposits are low grade but can be

[4] See Sutton II, chapter 4.
[5] Confidential source.
[6] U.S. Dept. of State, *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945).
[7] *Vneshniaia torgovlia SSSR: Statisticheskii sbornik, 1918-1966* (Moscow, 1967).

openpit mined and are near power sources; the major factor militating against the use of nonbauxite deposits is the difficulty met in developing a usable technology. About 30 percent of Soviet aluminum is probably derived from nonbauxite ores which also yield byproducts for use in manufacture of cement and caustic soda. (See Table 9-1.)

Table 9-1 MINES, ALUMINA PLANTS, AND ALUMINUM PLANTS IN THE U.S.S.R. (WITH ALUMINUM PLANT PRODUCTION)

Mine	*Type of ore*	*Alumina plant*	*Aluminum plant*	*Annual plant production (1000 metric tons)*
Goryachegorsk	Nepheline	Achinsk	Stalinsk	160
			Krasnoyarsk	n.a.
			Irkutsk	n.a.
Arkalyk	Bauxite	Pavlodar	Pavlodar	n.a.
Boksitogorsk	Bauxite	Boksitogorsk	Volkhov	25
			Nadvoitsy	20
			Kandalaksha	20
Kyakhta	Sillimanite	n.a.	Irkutsk	n.a.
Severouralsk	Bauxite	Krasnoturlinsk	Krasnoturlinsk	120
		Kamensk	Stalinsk, Zaporozhye	60
			Yerevan	20
			Sumgait	60
			Stalingrad	100
Zaglik	Alunite	Kirovabad	Kirovabad	n.a.

Source: Confidential.

The conventional Western methods, i.e., Bayer and lime-soda sinter processes, are utilized for production of the 70 percent of alumina produced from bauxite. Development work on a process for producing alumina from nepheline goes back to at least 1929[8] but such a process was not in full use until the mid 1950s; up to 1955 all production of alumina was still from bauxite, in spite of claims that Volkhov utilized the nepheline process in 1932.[9]

The standard electrolytic method of reducting alumina to aluminum is used in Soviet plants, although there has been some discussion of a new electrothermal technique[10] at Irkutsk by which sillimanite is reduced directly to aluminum and silumin. It is likely that a percentage of equipment now in general use

[8] The Leningrad Institute of Applied Chemistry was working on the problem in 1929, apparently with help from American engineers. F. N. Stroikov, *"Alumina from Nepheline"* (mimeographed), is in the Stanford University Engineering Library. Presumably this translation was made for use by American engineers. See also Bardin, *op. cit.* n. 3, on the metallurgy of aluminum. A limited-edition review by Theodore Shabad, *The Soviet Aluminum Industry* (New York: American Metal Market, 1958), also has useful information.

[9] See Sutton II, pp. 57-60.

[10] *Izvestia*, December 20, 1960.

Table 9-2 ALUMINUM AND MAGNESIUM WORKS REMOVED FROM GERMANY TO THE U.S.S.R., 1945

Name of German plant	*Production*	*Annual capacity*	*Extent removed to U.S.S.R.*
Aluminiumhutte Bitterfeld der I.G. Farbenindustrie A.G. (Aluminiumwerk GmbH), Bitterfeld	Aluminum metal	35,000 tons (1943)	100 percent
Aluminium-Schmelzwerk, Bitterfeld der Metall-Gesellschaft A.G., Bitterfeld	Aluminum metal and castings	not available	80 percent
Aluminiumwalzwerk, Bitterfeld	Rolled aluminum	35,000 tons (1943)	80 per cent
Aluminiumwalzwerk, Aken	Rolled aluminum	10,000 tons (1943)	Part
Leipziger Leichtmetall-Werk Rackwitz (Bernard Berghaus Co.), nr. Leipzig	Aluminum and magnesium metal	10,000 tons (1944)	Part
Leichtmetallhutte, Aken. (I.G. Farbenindustrie A.G.)	Magnesium metal	8,000 tons	Part
Leichtmetallhutte (Magnesiumwerk), Stassfurt	Magnesium metal	12,000 tons	Part
Magnesiumwerk und Elektronbetriebe der I.G. Farbenindustrie, Bitterfeld	Magnesium metal	5,500 tons	80 percent
Aluminiumwerke Carl Ziegmann, Fischbach	Aluminum metal	70,000 tons	Part
Aluminiumhutte Lautawerke, Lauta	Aluminum metal	100,000 tons	Part
Aluminium-Prazisionsgub A.G., Potsdam-Babelsberg	Rolled aluminum	—	Part
Aluminium-Schmelzwerk Lautawerk, Lauta	Aluminum foundry	—	Part
Havelschmelze Velten, Aluminium-Schmelzwerk	Aluminum foundry	—	Part
Veltner Leichtmetallgieberel GmbH, Velten	Aluminum foundry	—	Part

Sources: G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik*, (Bremen: F. Trüjen, 1951); Great Britain, Ministry of Economic Warfare, *Economic Survey of Germany* (London: Foreign Office, n.d.).

is from Czechoslovakia; it was reported in the early sixties that the Czechs had "financed construction" of aluminum plants in the Soviet Union and received aluminum in exchange.[11]

In the production of more sophisticated aluminum metals, recourse is certainly to Western technology. For example, in 1969 the Glacier Metal Company (a

[11] Alfred Zauberman, *Industrial Progress in Poland, Czechoslovakia, and East Germany, 1937-1962* (New York: Oxford University Press, 1964), p. 225

member of the Associated Engineering group in the United Kingdom) installed a Soviet plant under an $8.4 million contract for the production of tin-aluminum bimetal strip for automobile and tractor bearings.[12]

After World War II the Soviets removed fourteen German alumina and aluminum-metal rolling and casting plants totally or in part to the U.S.S.R.[13] (See Table 9-2.) The most important alumina plant was the Vereinigte Aluminium-Werke A.G. plant at Lauta; it used the Bayer process (100,000 annual metric tons) with a small capacity using the Goldschmidt process (8000 metric tons annual capacity).

REMOVAL OF THE GERMAN MAGNESIUM ALLOY INDUSTRY TO THE SOVIET UNION

During World War II almost all the German magnesium alloy industry was concentrated around Bitterfeld, near Leipzig in the Soviet Zone of Germany, where it was founded in the late nineteenth century by I. G. Farben. The capacity of this industry in 1943 was 31,500 tons per year.[14] Most of the magnesium smelting, casting, and rolling capacity was therefore in plants operated by I. G. Farbenindustrie, and most of it was removed to the U.S.S.R.[15]

The industry was not damaged in World War II, and was visited by various Combined Intelligence Objectives Subcommittee (CIOS) teams in June 1945; their reports give an accurate indication of the technical state of the industry as it was taken over by the Soviet forces. The Metallguss Gesellschaft at Leipzig, partly removed to the Soviet Union, was a foundry casting light metal alloys and producing high-grade magnesium-alloy castings for aircraft engines as a licensee of I.G. Farben. Production averaged 400 metric tons per month of aluminum castings and 150 tons per month of magnesium-alloy castings; four-fifths of the output went to parts for Junkers engines and the balance for BMW engines.[16]

The Leipziger Leichtmetall-Werk GmbH at Rackwitz, near Leipzig, was a fabricator of aluminum and magnesium alloys with a capability of producing 200 metric tons of magnesium-alloy sheet per month and 50 tons of magnesium-alloy extrusions per month. The extrusion shop had four large presses and the capability to draw duraluminum wire. Two I.G. Farben plants, one at Aken and the other at Stassfurt, each had the capability to produce 12,000 tons of

[12] *Wall Street Journal*, November 1, 1969, 14:4.

[13] G. E. Harmssen, *Am Abend der Demontage: Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen, 1951).

[14] Great Britain, *Ministry of Economic Warfare, Economic Survey of Germany* (London: Foreign Office, n.d.), p. 90.

[15] Harmssen, *op. cit.* n. 13, pp. 94-95.

[16] Edward Johnson and Robert T. Wood, *The Magnesium Alloy Industry of Eastern Germany*, CIOS Report no. XXXIII-21, p. 6.

magnesium per year; both plants contained presses and extrusion equipment for aluminum tube.

The most important magnesium works was the I.G. Farben plant at Bitterfeld—also largely removed (80 percent) to the Soviet Union. The CIOS team reported on this plant as follows:

> 'For many years in Germany the I.G. Farbenindustrie plant at Bitterfeld had been the fountainhead of research and development work on magnesium alloys and by far the most important producer. It can be said that these works is the birthplace of the modern magnesium industry. Many of the techniques used in fabricating magnesium alloy and much of the physical, chemical and engineering data on magnesium and its alloys originated in Bitterfeld.[17]

There were two press buildings at Bitterfeld, each containing extrusion as well as forging presses. These major equipment items gave the Soviets a significant capability in magnesium forging. The older press building of Bitterfeld contained the following equipment:

a) 6000-ton Eumuco forging press

b) 3500-tons Schloemann extrusion press capable of extruding ingots up to 350 mm. in diameter

c) 1000-ton vertical tube extrusion press made by Hydraulic Duisberg

d) 300-ton forging press

e) 600-ton forging press

f) 5 small old extrusion presses

The new press building at Bitterfeld contained even more significant equipment:

a) A 5000-ton Eumuco extrusion press for ingots up to 450 mm in diameter

b) A double-acting air hammer made by Eumuco rated at 8000 meter-kilograms

c) Forging rolls by Eumuco for propellers

d) A 15,000-ton forging press made by Schloemann

e) A 30,000-ton forging press made by Schloemann[19]

This equipment can be used for the production of large magnesium and aluminum forgings, such as aircraft engine bearers and aircraft landing wheel forgings for use in the aircraft and space industries.

Massive use of this German technology generated some criticism in the 1950s. For instance, one Soviet metallurgist, B.S. Gulyanitskii, commented, "After the end of the War, Soviet specialists had the opportunity to acquaint themselves in detail with German and Japanese magnesium industry.... Some

[17] *Ibid.*, p. 41.
[18] *Ibid.*
[19] *Ibid.*

workers of the magnesium industry showed a tendency to redesign the national magnesium industry, completely imitating German technology."[20]

Thus we may conclude that Soviet nickel and copper smelting and refining processes are derived from Canadian, American, and Norwegian practices.

About 70 percent of Soviet alumina is produced by the Bayer and lime soda processes, and about 30 percent by a Soviet process based on nepheline; major difficulties have accompanied the use of the latter process. There were extensive removals of aluminum rolling and magnesium rolling and fabricating equipment from Germany at the end of World War II, and since that time imports of equipment have originated in Czechoslovakia and in Free World countries.

[20] *Ibid.*

CHAPTER TEN

Western Assistance to the Soviet Iron and Steel Industry

BLAST-FURNACE DESIGN AND OPERATION SINCE 1950

The U.S.S.R. relies heavily on blast furnaces to produce pig iron. Since Soviet industry generates comparatively little scrap, steel plant input is predominantly liquid pig iron from blast furnaces; by contrast, the United States practice uses pig iron and scrap in various proportions depending on location and relative prices.

M. Gardner Clark has discussed the development of blast-furnace design in the U.S.S.R.,[1] where until 1955 there were three basic furnace designs. The first, developed in about 1930 by the Freyn Company of Chicago, had a capacity of 930 to 1000 cubic meters and a nominal daily output of 1000 tons of pig iron. The second (1935-36) basic design was by Gipromez, with the earlier assistance of the McKee Corporation of Cleveland as consultants, and had a capacity of 1100 cubic meters. The third basic design of 1300 cubic meters came shortly thereafter and was worked out completely by Gipromez. During World War II there was a temporary reversal to a 600-cubic-meter design, and although a 1500-cubic-meter furnace was designed during that period by Gipromez, postwar construction continued in the three basic designs of the 1930s.

According to P. A. Shiryaev,[2] only one operating furnace in 1951 had a useful volume of 1370 cubic meters, i.e., the third, all-Gipromez, design. In other words, up to 1951 all Soviet blast furnaces except one were of the basic 1930 design, for which the McKee and Freyn firms acted as consultants.

In the late 1950s there was considerable discussion in Soviet engineering circles concerning larger furnaces with capacities of 1513, 1719, and 2286 cubic meters (the last designed by Giprostal), and Shiryaev has tables on the technical and economic efficiency of such designs.[3] According to the calculations

[1] M. Gardner Clark, *The Economics of Soviet Steel* (Cambridge, Mass.: Harvard University Press, 1956), p. 64-69.
[2] P. A. Shiryaev, "The Economic Advantages of Large Types of Blast Furnaces" in *Contemporary Problems of Metallurgy*, A. M. Samarin, ed., (New York: Consultants Bureau, 1960), p. 236.
[3] *Ibid.*

of Shiryaev and Ramm, there is little doubt that the large design (2286 cubic meters) is efficient in terms of cost. However, as was pointed out by American consultants in the 1930s, large-capacity blast furnaces have problems not reflected in the theoretical calculations; in particular, there are raw-material feed problems and physical problems connected with the ability of coke to withstand increased stack pressures. The Russians have built seven of the larger design, each producing 3000 tons of pig iron per day[4] although designed to produce 4000 tons per day.[5]

BLAST-FURNACE INNOVATIONS

Metallurgists have known since 1871 that raising blast furnace gas pressures substantially increases the rate of smelting. Application of top pressure began in both the United States and the U.S.S.R. during World War II, and widespread adoption of the technique came in both countries in the early 1950s. According to data in an article by V. G. Voskoboinikov, adoption started in the United States, but the U.S.S.R. quickly caught up, and by 1956, 51 furnaces with high top pressure were operating in the U.S.S.R. against only 28 in the United States.[6] Rapid adoption in the U.S.S.R. was undoubtedly due to the fact that output could be increased 5 to 10 percent with a comparatively small investment and simple equipment modifications; introduction was helped by a concentrated research effort.

Early studies in Belgium and at the U.S. Bureau of Mines noted two offsetting drawbacks to the use of oxygen in blast furnaces (as distinct from its use in open-hearth furnaces)—the cost of oxygen, and the detrimental effect on furnace linings. According to M. Gardner Clark, the Soviets repeated these tests in the 1940s, came to the same conclusions, and dropped this line of development. Later, in January 1963, the Voest Company of Austria received $10 million in lieu of patent rights for use of the Linz-Donawitz oxygen refinement process.

Direct reduction can be achieved by a number of comparatively recent processes—there are more than 30 variants—that circumvent the blast furnace. Their useful features are lower capital costs, lower minimum capacities, the ability to use noncoke fuels, and the ability to use low-grade ores. Although Germany had commercial direct-reduction operations before World War II, the process did not make headway until the 1950s.

The early German plants were moved to the U.S.S.R. in 1945, and the U.S.S.R. has since purchased further direct-reduction plants.

[4] *Wall Street Journal*, April 17, 1963, 14:3.
[5] N. G. Cordero, ed., *Iron and Steel Works of the World*, 3d edition (London: Quin Press, 1962), p. 771.
[6] V. G. Voskoboinikov and L. I. Slephushova, "Blast Furnace Operation at Increased Gas Pressures" in *Samarin, op. cit.* n. 2, p. 190.

Table 10-1 DISPOSAL OF 29 KRUPP-RENN DIRECT-REDUCTION PLANTS

Plant no.	*Original location*	*Date built*	*Date moved to U.S.S.R.*
1	Barbeck	1935	1945
2	Frankenstein	1935	1945
3	Watenstedt-Salzgitter	1941	1945
4	Czechoslovakia	1943	Still in place
5 to 29	Japan, Korea, and Manchuria	1935-45	All in Korea and Manchuria moved to U.S.S.R. in 1945-46

Source: The Krupp-Renn Process, for Production of Iron Without Metallurgical Coke Using Fine-grained Fuel and for the Economical Processing of Low-grade High Silica Ores (Essen, n.d.).

CONTINUOUS CASTING OF STEEL

Soviet attempts to apply continuous casting on a wide scale in an attempt to circumvent the blooming-mill stage demonstrate clearly both the political pressure for innovation in the Soviet Union and one of the pitfalls implicit in centrally decreed innovation.

Continuous casting of metals has been under development since Sir Henry Bessemer's original patent in 1858; by eliminating the need for the soaking pits and the blooming mill it offers the promise of large savings in capital costs and greater metal yields. The B. Atha Company in the United States produced file steel by continuous casting from about 1890 to 1910, but up to 1950, commercial applications of continuous casting were limited mainly to nonferrous metals, and particularly to aluminum. (All U.S. aluminum today is continuous-cast.) The first large-scale Western commercial steel installation was for alloy steels at Atlas Steel in Welland, Canada, in 1954, and by 1959 a total of 25 plants were operating on a development or commercial basis in at least 12 countries. In 1959 the U.S.S.R. had three development plants and probably three in production.[7] These were plants of the Junghans-Rossi type.[8]

The advantages of continuous casting are numerous if the process can be used on a production scale. Quality of cast slabs and blooms is good, although considerable difficulties have been encountered with continuous-cast rimming steels. The yield is excellent, with a ratio of liquid steel to slab of about 94 to 97 percent, compared with the conventional yield of 85 percent using a

[7] In 1963, one source stated only three plants were operating in the U.S.S.R. This is probably conservative, but see *Wall Street Journal*, April 17, 1963.

[8] *Institute of Metals Journal* (London), March 1958, p. 182; *Metal Progress (Cleveland, O.), May 1959, p. 106.*

blooming mill. Capital costs are decidedly lower, especially in small plants; both capital and operating costs for a blooming mill may be four times greater than with continuous casting.

In the early 1950s Soviet weaknesses in certain areas of iron and steel production became pressing. Rolled flat products (i.e., sheet and strip steel) comprised 20 percent of total rolled products in 1940[9] and increased to only 25 percent by 1955. By comparison, in the United States the 1940 ratio was over 45 percent, and in 1955 probably over 60 percent. A number of studies[10] have indicated that the percentage requirements of flat-rolled steel products increases with industrialization. In other words, the relative demand for sections (e.g., bars and structurals) declines, and the relative demand for sheet steel (for use in automobiles, appliances, galvanizing, pipe, and tinplate) increases as industrial development progresses. However, flat-rolled products require a much greater investment in processing and finishing facilities (pickling, annealing, cold rolling, skin pass mills, galvanizing, and tinning lines) than do section products. Apart from the magnitude of the investment involved, there are indications that the Soviets have not fully appreciated the technological gap they have to bridge between hot-rolled sections and flat cold-rolled products.[11]

The prospect of having to make substantial investments in rolling mill equipment and new techniques prompted a search for less expensive alternatives. Continuous casting was one promising alternative, which was recognized by Gipromez and other design bureaus; development work on the process began at the Central Research Institute for Ferrous Metallurgy in Moscow in 1938. The Krasny Oktyabr Works (1951), Novo Tula (1955), and Kirov (1956) continued this work. In 1956 continuous casting was presented to the Twentieth Congress of the CPSU as a possible means of leap-frogging Western technology: the lower capital costs would avoid heavy investment in blooming mills, sim-

[9] R. H. Jones, *The Roads to Russia* (Norman: University of Oklahoma Press, 1969), p. 20. Soviet production of steel was 20 million tons in 1940 and only 8.8 million tons in 1942; 2,589,766 tons of steel were sent between 1941 and 1945 under Lend Lease. Although this appears only a small fraction of Soviet output, Jones comments, "Appearances are deceiving. Most of the Lend Lease steel comprised specialty steels such as high-speed cold steel, cold-finished bars, hot-rolled aircraft steel, tinplate, steel wire, pipe and tubing, and hot-rolled sheets and plates. More than one-fifth of the Lend Lease steels included railroad rails and accessories. In other words, Russia imported specialty steels, freeing her mills from the expense and time involved in their production." Jones adds that the $13.2 million worth of equipment for their steel mills enabled the Soviets to increase the output of carbon steel ingots by 2.5 million tons per year.

[10] Various reports of the Economic Commission for Europe and Economic Commission for Latin America (United Nations).

[11] For example: "Of the cold-rolled sheets from rimming steel ingots at the Novosibirsk plant, 50 percent of the sheets were classified in the second grade ... due to ... small scabs ... measuring 0.5-3 mm wide and 200-300 mm long with a thickness of up to 0.2 mm." G. V. Gurskii, "The Continuous Casting of Steel" in *Samarin, op. cit.* n. 2, p. 285. No Western mill would classify this defect as a "second"; laminations of this magnitude are classified as scrap.

plified construction would reduce lead time required for development of more powerful blooming mills, and excellent yield offered the promise of increasing steel output per ruble of investment.[12] There is no doubt that by 1956 considerable progress had been made in solving problems connected with continuous casting of tonnage steels, but by Western engineering standards the process developed was not suitable for application in large plants. Western engineers were in general agreement that the process was then limited to alloy steels with a high hot strength. Inland Steel, for example, considered the process, and *Iron Age* reported: "In 1956 ... Inland decided in favor of conventional equipment and against continuous casting ... there was not sufficient time available to master all the problems."[13]

In 1956, then, continuous casting was under consideration in both the West and the U.S.S.R. for large-tonnage plants. Engineering opinion in the West was against adoption; on the other hand, the process was adopted in the Soviet Union.

Stal' reports that by 1961 ten installations had been brought into use, including pilot plants and single-strand units with limited capacity.[14] A rough estimate is that probably about one-half million tons was poured by continuous casting in the U.S.S.R. in 1961, with an absolute maximum of one million tons; directives of the party congress had called for 12 to 15 million tons to be poured by this method in 1961. By 1962 no Soviet plant was entirely dependent on continuous casting; i.e., the soaking-pit blooming-mill stage was retained in all steel plants. The cost to the Soviets in trying to meet the goals set by the party must have been considerable because of the investment in continuous casting plants, the continued demand for blooming mills and soaking pits which necessitated running two methods simultaneously in the same plant, and the lead time lost in blooming-mill development. In particular, it was known in 1956 that continuous casting was not suitable for rimming steels, which are preferred for reasons of quality in flat-rolled products, and for which Soviet production capacity is notably weak. By 1962 the problems connected with rimming steels had not been solved in either the U.S.S.R. or the United States.

[12] "Capital investment for the construction of continuous pouring installations is repaid in less than one year. With continuous pouring there is no need for blooming mills [or] the building of such costly premises of open-hearth plants as the mold yards and shops for ingot stripping. Continuous pouring of steel will become widespread in the sixth five year period. It was pointed out at the 20th Congress of the CPSU that if 12-15 million tons of steel are poured by the new method in 1960, which is fully feasible, this will yield an additional million tons of rolled stock (by cutting down losses and waste) and a saving of 2,000 million rubles." Lazar Roitburd, *Soviet Iron and Steel Industry* (Moscow: Foreign Languages Publishing House, 1956).

[13] *Iron Age*, May 18, 1961.

[14] S. K., "The Twenty-second Congress of the CPSU and the Soviet Iron and Steel Industry," *Stal'* (English version), no. 7, July 1961.

STEEL ROLLING TECHNIQUES IN THE SOVIET UNION

Although there was no attempt after World War II to remove complete iron and steel plants under reparations to the U.S.S.R., there was a great deal of selective removal—particularly of rolling mills and finishing equipment. The Hüttenwerk Salzgitter A.G. was dismantled between 1945 and 1950;[15] in fact, Alfred Zauberman estimates that four-fifths of East German metallurgical capacity was dismantled[16] (although this may have been restricted to specialized units). Plate rolling mills, tube facilities, coal washing plants, and special steel facilities in Manchuria were completely dismantled,[17] but blast furnaces were not removed and other facilities were only selectively removed.

Well after the war the U.S.S.R. was still turning out a large proportion of its limited production of steel sections on hand-bar mills; in 1956, for example, only 53 percent of rolled steel sections was produced on modern mills, leaving 47 percent to be produced on the old-type "in-train" hand mills. These figures indicate a considerable lag in technology. The hand-bar mill is very limited in both speed and capacity; continuous and semicontinuous mills have replaced "in-train" mills almost completely in the West. The only use for the hand-bar mill in the United States during the last 50 years or so has been possibly in limited rollings of special products; e.g., it is probably used for wrought iron. Even in Europe such mills are rare.

By far the weakest part of the Soviet iron and steel industry is in the production of flat-rolled products, i.e., hot- and cold-rolled sheet and strip as well as coated sheet and strip. For such production the choice of techniques is essentially between continuous or semicontinuous sheet and strip mills (including Steckel mills) and the obsolete hand-sheet mill or pack mill.[18] In 1960, the United States had 39 continuous wide hot-strip mills, all with extensive additional cold-rolling and finishing facilities; at the same time Japan had five, the United Kingdom four, and Mexico two wide strip mills. In 1960 the U.S.S.R. had only five continuous or Steckel-type mills.[19]

This lack of wide strip rolling facilities is reflected in the composition of Soviet steel output. The share of sheet steel in all rolled products was 25 percent

[15] *Germany, 1945-1954* (Cologne: Boas International Publishing Co. [1954?]), p. 493.

[16] Alfred Zauberman, *Industrial Progress in Poland, Czechoslovakia, and East Germany, 1937-1962* (New York: Oxford University Press, 1964), pp. 174, 187.

[17] Edwin W. Pauley, *Report on Japanese Assets in Manchuria to the President of the United States, July 1946* (Washington, 1946).

[18] The hand-sheet mill has a few uses in the West today; it is used in the United Kingdom and Belgium for blue planished sheets, and in the United States probably only for high-silicon electrical sheets.

[19] Based on Iron and Steel Institute, *Production of Wide Steel Strip* (London, 1960), p. 75.

in 1955, but of this only 23 percent came from continuous or semicontinuous mills.

Table 10-2 suggests a heavy dependence on Western technology in the five wide strip mills operating in the U.S.S.R. in 1960: three are of Western manufacture. The first Russian-built continuous sheet mill was installed not in Russia but at Nowa Huta in Poland.[20] The tinplate mill for this plant was supplied by U.S. firms "financed from American credit."[21] The reported operating troubles of the Russian-made mill[22] would suggest in the context of our study that the Soviets installed their first mill in Poland to avoid domestic production interruptions from an inadequately engineered mill.

Table 10-2 ORIGINS OF SOVIET CONTINUOUS WIDE STRIP MILLS AS OF 1960

Mill	*Type*	*Width, inches*	*Origin*
1. Zaporozhtal	Continuous	60	U.S. (United)
2. Kuibyshev	Continuous	50	U.S. (United)
3. Magnitogorsk	Continuous	96	U.S.S.R. (Kramator)
4. Chelyabinsk	Semicontinuous	72	German (Steckel)
5. Voroshilov	Continuous	96 (?)	U.S.S.R. (?)

Source: Great Britain, Iron and Steel Institute, *Production of Wide Steel Strip* (London, 1960).

Note: There is also evidence of an old 50-inch German semicontinuous mill (from reparations) at Nizhni Tagil. A prototype Kramator reversing mill with furnace coilers is located at Lipetsk.

Thus it is concluded that there is a heavy Soviet dependence on Western technology in the production of flat-rolled steel from continuous and semicontinuous mills. It should be noted that the development, construction, and operation of this type of mill requires far greater technical sophistication than do the facilities for pig iron or steel production. "Shock" methods applied to wide strip mill scheduling would be chaotic, as shock methods cannot be applied to the more sophisticated technologies where tight control of specification is easily lost and a delicate balance must be maintained between the subsystems.

THE STEEL PIPE AND TUBE INDUSTRY

The two basic techniques in pipe and tube manufacturing are the seamless and welded tube processes. The earliest seamless techniques were variants of

[20] M. Gardner Clark, "*Report on the Nowa Huta Iron and Steel Plant Named After Lenin, Near Cracow, Poland*" (Ithaca: School of Industrial and Labor Relations, Cornell University, September 1957), mimeographed.

[21] Zauberman, *op. cit.* n. 16, p. 193.

[22] Clark, *op. cit.* n. 1.

the Mannesman skew rolling principle using a mandrel; present-day Stiefel mills, plug mills, and continuous seamless mills are based on Mannesman rolling principles and account for about 60 percent of Soviet tube production. The push-bench techniques, now obsolete, and the extrusion process for small-diameter special-alloy tubes are also of German origin.

The second main group of manufacturing techniques is a variant of the welded seam process, and accounts for the remaining 40 percent of Soviet tube output. The Fretz-Moon technique of continuous butt welding originated in the United States in the early 1920s; submerged electric-arc welding for large-diameter tubes and electric-resistance welding (ERW) were developed at a later date, although ERW did not come into widespread use until after World War II.

Most techniques in use in the world today conform to one of these two basic Western methods, one German and one American. An examination of Soviet methods indicates that all plants use one of these methods (except Lipetsk, which uses a spun-cast process of unknown origin). Moreover in 1962 Soviet pipe and tube plants not only were based on Western technology but to a great extent were using Western equipment. The Soviet heavy-machinery-building

Table 10-3 PROCESS USED IN SOVIET PIPE AND TUBE MILLS IN 1963

Plant	*Process*	*Product*
Taganrog	Pilger	Oil Pipe
Novomoskovsk	Pilger	Large-diameter oil pipe
Zhdanov	—	Seamless pipe and tube to 14 inches
Dnepropetrovsk	Stiefel	Seamless tubes
Dnepropetrovsk (Karl Liebknecht)	Pilger	—
Nikopol	Stiefel Mannesman	Small-diameter tube
Pervouralsk	Stiefel Rockrite	Tubes for oil and chemical industry
Chelyabinsk	Fretz-Moon	Oil and gas pipes to 38 inches in diameter
	Stiefel	—
	Pilger	—
	Electric resistance	—
	Weld mill	—
Kamensk-Uralskiy	Draw bench type	Pipe to 75 mm diameter
Viksa	Electric weld mill	—
Lipetsk	Spun cast	—
Rustavi	Mannesman (U.S.-built)	—
Sumgait	Seamless mills	—
Novosibirsk	Electric weld mills	—

Source: Economic Commission for Europe, *The European Steel Pipe and Tube Industry* (Geneva, 1955); M. Gardner Clark, *The Economics of Soviet Steel* (Cambridge, Harvard University Press, 1956); M. G. Cordero, *Iron and Steel Works of the World*, 3d edition (London: Quin, 1962).

plants do not appear to have completely mastered the art of building tube-rolling machinery, or else it has been found more advantageous to import Western equipment. There has been a limited development of new techniques, in effect modifications of the basic methods, by TsKBMM, and "authors' certificates" have been awarded to some Soviet designers, but the scope of this work is not extensive.

Table 10-3 indicates the process used in 15 Soviet tube and pipe plants.

In 1960 the Soviet Union apparently could not produce a tube mill of any type capable of manufacturing steel tube greater than 400 mm in diameter.[23] This observation is confirmed by examination of the equipment contained in the most important Soviet tube mills. The Chelyabinsk tube mill, the largest in Europe with a production in excess of one million tons of tubes and pipes per year, has equipment completely of Western origin. Chelyabinsk has four Fretz-Moon mills for production of butt-welded tube between 3/8 and three inches in diameter; the strip heating furnaces in the Fretz-Moon mill were built from Salem Engineering drawings, and the leveling and uncoiling machines were made by Aetna Standard Company.[24] The Stiefel mill shop produces tubes between three and four inches in outside diameter using the standard Stiefel mill. The Pilger mill shop produces large-diameter seamless tubes from 12 to 22 inches in outside diameter; the piercer is a rotary-type Mannesman followed by two Pilger mills built by Eisenwerk Witkovice in Czechoslovakia. The worn rolls are built up by welding with Krupp welding rod.[25] A newer plant, completed in 1959, produces welded pipe up to 820 mm (32.3 inches) in diameter by the U.S. submerged-arc process, and is the first plant of its type in the Soviet Union.[26]

Another important Soviet tube mill is at Rustavi (all Soviet seamless tube capacity is located at either Nikopol or Rustavi). The report of the 1956 British Iron and Steel Delegation indicated that the Rustavi mill was "orthodox in design and layout and generally typical of works built about 30 years ago."[27] The Nikopol mill was originally installed by a U.S. firm in the 1930s.[28] In 1956 two Russian-built electric-resistance welding mills also were installed in Nikopol; these have piercers of the Mannesman type followed by plug or Stiefel mills.

[23] V. L. Agre, *Tekhnicheskii progress v chernoi metallurgii SSSR; Prokatnoe i trubnoe proizvodstvo* (Moscow, 1962). This is an excellent compendium of technicoeconomic information.

[24] *Iron and Steel Making in the U.S.S.R., with Special Reference to the Urals Region*, A Report to the British Iron and Steel Federation by a British Steel Delegation, (Rochester, Kent: Staples, 1956), p. 66.

[25] *Ibid.*, p. 67.

[26] *Ibid.*, p. 65.

[27] *The Russian Iron and Steel Industry*, A Report Prepared by a British Steel Mission to the U.S.S.R., Special Report No. 57 (London: Iron and Steel Institute, April 1956), p. 19. The reader should also see Yu. F. Shevakin, *Stany kholodnoi prokatki trub* (Moscow, 1966); and L. I. Spivakovskii, *Ekonomika trubnoi promyshlennosti SSSR* (Moscow, 1967).

[28] See Sutton II, p. 74.

SOVIET CONTRIBUTIONS TO METALLURGY

According to J. H. Westbrook, writing in 1961 after a visit to seven Soviet metallurgical laboratories,[29] the Soviets are more interested in exploiting the properties of compounds than in improving or understanding their nature. Says Westbrook:

> In the superalloy field, despite a large amount of research on nickel, cobalt, and iron-based superalloys, Soviet scientists are apparently without any unique advances or developments of their own. This observation is even more surprising in that they have had full knowledge of both the empirical and theoretical developments of the Western world. Most of their work is descriptive—it has not been (and, in most instances, *cannot* be) correlated with particular models of deformation or fracture.[30]

Westbrook then identifies three areas in which the Soviets have made unique contributions in the field of materials processing, although a decade later there is contradictory evidence as to whether the Soviets have been able to maintain their position in these fields:

1. friction welding
2. electroslag melting (for ingots of special alloys)
3. powder rolling

Westbrook also notes that laboratories in the early sixties were well supplied with equipment of foreign origin: "... they have a considerable amount of foreign-made equipment as well as Russian of foreign designs."[31] After pointing out that his delegation saw Russian-built copies of General Radio Variacs, Simpson meters, Du Mont oscilloscopes, and L & N recorders, Westbrook continues: "... they appear to concentrate on one design, their own or that of someone else, and then build and use large numbers of identical units."[32]

Soviet work in electroslag welding (where, unlike arc welding, the heat is obtained by passage of electric current through a bath of molten slag) came to fruition in about 1960 with the attainment of an ability to weld parts up to a thickness of 2⅜ inches using one electrode.[33] The process was immediately licensed to the Swedish firm Esab.[34] Russian work in friction welding by V. I. Vill led to publication of his textbook *Friction Welding of Metals* by the American Welding Society in 1962, although there is some question whether the Soviets have maintained any significant advance over current U.S. knowledge

[29] J. H. Westbrook, "High Temperature Materials in the Soviet Union," *Metal Progress* (Cleveland, O.), February 1962.
[30] *Ibid.*
[31] *Ibid.*
[32] *Ibid.*
[33] *Welding Journal* (London), February 1959, pp. 132-34.
[34] *East-West Commerce* VI, 3 (March 31, 1959), 8.

and methods.[35] Continued Soviet imports of furnaces for heat treating of metals from the 1930s through the 1960s also suggests that Russian work in metals processing has been somewhat uneven.[36]

Thus we may conclude, as have other observers,[37] that at the end of the 1960s Soviet technology in ferrous metallurgy industries is an adaptation of Western technology, although much Soviet work and effort have been devoted to developing this technology.

The classical blast furnace has been increased in volume and top pressure has been introduced. Sintering strands are Dwight-Lloyd to Lurgi drawings; coke ovens are modified Koppers-Becker[38]; and direct reduction is Krupp-Renn.

In steelmaking we find expansion in the size of the classical open-hearth furnaces with indigenous technological improvements. Oxygen convertor practice is Austrian and continuous casting Junghans-Rossi; blooming mills are basically United and Demag. Rolling techniques and finishing facilities in general are backward (except where modernized by imported equipment) and approximate the U.S. level of the 1930s.

[35] Appreciation is due E. Strickland for this information; see U.S. Patent 3,460,734 of August 12, 1969.

[36] A number of controlled-atmosphere heat-treating furnaces have been supplied from the United States and from Birlec, Ltd., in England; see *East-West Commerce*, IV, 9 (September 30, 1957), 14, and V, 11 (November 29, 1958), 3.

[37] Clark, *op. cit.* n. 1, p. 272: "We can say that the spectacular technical progress of the Soviet iron and steel industry in recent years has been almost exclusively in the realm of adoption, modification and improvement of inventions and innovations pioneered by the Western world."

[38] See pp. 141-43.

CHAPTER ELEVEN

Western Origins of Petroleum and Allied Industries

THE TURBODRILL: AN INDIGENOUS DEVELOPMENT

In the field of oil well drilling the turbodrill is a distinct Soviet innovation and quite different in principle from the U.S. rotary drill. In the 1960s over 80 percent of Russian oil well drilling was undertaken by the turbodrill method, which utilizes a hydraulic drive at the bottom of the drill hole in contrast to mechanical transmission through a string of steel pipes used in the rotary process.[1] It appears, however, that the method has not proved completely satisfactory: in 1960 it was recommended that development work be resumed on rotary drilling, a recommendation no doubt dictated by overheating problems with turbodrills as geological conditions necessitated ever deeper holes.

Russian turbodrills were tested by Dresser Industries of Texas specialists, who concluded that the drills did not offer any advantage over prevailing U.S. rotary techniques. Robert W. Campbell, whose work on the economics of the turbodrill is by far the most exhaustive, concluded:

> There is no denying that the turbodrill did make a very great contribution to the improvement of Soviet drilling performance, and the conclusion of our critique is not that the turbodrill was a mistake. Rather it is that the turbodrill could have made an even greater aid to improved drilling performance if the designers of this technology had better understood the correct economic criteria for design decisions.[2]

The interesting point is that while the Soviet Union was converted to the rotary technique in the 1920s by American companies,[3] a decision was made in the 1930s to convert to the indigenous turbodrill, and to a lesser extent to the electrodrill[4] (rarely used outside the U.S.S.R.). This decision, defective

[1] The best technicoeconomic discussion of Soviet drilling practice in English is Robert W. Campbell, *The Economics of Soviet Oil and Gas* (Baltimore: Johns Hopkins Press, 1968); see especially the appendix to chapter 5, "Economics of the Turbodrill."

[2] *Ibid.*, p. 120.

[3] Sutton I: *Western Technology ... 1917 to 1930*, pp. 23-25.

[4] The electrodrill in a Russian development similar to the turbodrill and dating back to the 1920s; in the 1960s it accounted for no more than 1 percent of total Soviet drilling footage.

on economic grounds (*vid.* Campbell), left the Soviets with major technical problems in the face of increasing deep-drilling requirements.

On the other hand, the work that has been done in the U.S.S.R. on rock bits, both core and cone types, follows American practice. For example in 1940 the Carter Oil Company in the United States began work on cone bits, first on a four-cone version and then on a three-cone version. Testing was started by Carter in 1948 and the technology was licensed to The Hughes Tool Company in 1956 although no tool based on the Carter principle has been made commercially.[5] The Soviets started experimenting with a two-cone bit in 1950 that had a "striking resemblance" to Carter's tools and methods.[6] The first Soviet bit No. DV-5 had a diameter of ten and three-quarter inches in working position and less than six inches collapsed, and "the Soviet method of lowering, connecting, disconnecting, and raising the retractable bits closely followed the Carter technique."[7]

U.S. ORIGINS OF REFINERY PROCESSES

Refinery capacity was expanded during World War II with significant assistance from Lend Lease.[8] Initial Russian requests for refinery equipment, handled by President Roosevelt and Harry Hopkins, included "crude distillation, cracking and stabilization plants; an aviation lubricating oil plant; a high-octane gasoline unit; and gasoline absorption plants."[9] These facilities were approved by September 1942 and required $41 million in equipment plus the services of 15 U.S. engineers.[10] Russian representatives inspected the ten "newest" refineries in the United States, and a program was established for training Russian engineers and operators in the use and maintenance of the equipment.[11]

At least 150,000 tons of equipment was sent under the program to build four new refineries, two with catalytic cracking and alkylation equipment; equipment for the production of 100-octane aviation gasoline was later added to

[5] *Petroleum Week* (Chicago), August 14, 1959, p. 25. Comparative diagrams in the text of this article.
[6] *Ibid.*
[7] *Ibid.*, p. 29. For details of the continuing Soviet interest in U.S. rotary drilling technology and bits, see N. N. Kalmykov, *Burovaia tekhnika i tekhnologiia za rubezhom* (Moscow, 1968).
[8] Sutton I, pp. 35-40, and Sutton II, pp. 81-90, for data concerning pervasive U.S. assistance in 1928-44.
[9] U.S. Dept. of the Interior, *A History of the Petroleum Administration for War, 1941-1945* (Washington, 1946), p. 269.
[10] U.S. Dept. of State, *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945), p. 16. The figure of $41 million is too low; final figures were probably closer to $100 million for refineries. See U.S. Dept. of the Interior, *op. cit.* n. 8, p. 270, and add subsequent shipments under the "pipeline agreement."
[11] U.S. Dept. of the Interior, *op. cit.* n. 9, p. 270-71.

the other two refineries.[12] In all, U.S. assistance was provided for seven refineries between 1942 and 1946. Between $14 and $15 million worth of equipment was shipped for refineries at Guriev, Orsk, Kuibyshev, and Krasnovodsk, with an unknown amount of equipment for refineries at Syzran, Sterlitamak (Novo Ufa), and Moscow.[13] These American acquisitions became the basis for Soviet construction.

The Soviets have standardized the design of domestic-built refineries, and new capacity comprises completely integrated units with attendant secondary facilities. The Type A standard refinery has an annual crude oil charge of about 2.8 million tons and the more common Type B has an annual crude oil charge of 6.6 million tons; these are multiples of the smaller Type A unit. (See Table 11-1.) One refinery, that at Omsk, consists of three Type B standard units. Design also includes standardized process schemes dependent on the specification of the available crude oil:

Type I: For crude oil under 1.9 percent sulfur, producing fuel and lubricating oils—atmospheric and vacuum primary distillation, thermal cracking, catalytic cracking, catlytic reforming, lubricating oil production, and asphalt production.

Type II: For crude oil with less than 1.9 percent sulfur, producing fuel only—atmospheric and vacuum primary distillation, thermal cracking, catalytic cracking, and catalytic reforming.

Type III: For crude oil with over 2.0 percent sulfur—atmospheric distillation.[14]

The 1960 U.S. Oil Delegation was able to acquire sufficient data to construct flow diagrams and so isolate the standard process schemas described above. The basic flow sheets are those of Lend Lease installations known to have U.S. equipment, e.g., Novo Kuibyshev (Type A), Novo Ufa (Type A), Novo Baku (Type B), and Syzran (Type B). Further, R.E. Ebel has described Novo Ufa as "U.S. wartime design,"[15] and according to the Petroleum Administration for War Kuibyshev and Syzran were destinations for U.S. Lend Lease instal-

[12] *Ibid.*, and U.S. Dept. of State, *op. cit.* n. 10, p. 16, appendixes A and B "Pipeline Agreement." There was a significant amount of other petroleum assistance both in export of petroleum products and in oil field equipment.

[13] U.S. Dept. of the Interior, *op. cit.* n.9, p. 270. The figures given in this source for Syzran, Sterlitsmak, and Moscow are incomplete; they do not take account of shipments under the "pipeline agreement" of October 1945. A rather interesting example of the attempt to imitate American practice is the reprinting in book form of the standards of the American Petroleum Institute, particularly those relating to pumps, compressors, tubes, and casing. See *Rukovodstvo po trubam neftianogo sortamenta i ikh soedineniiam, primeniaemym za rubezhom (Spravochnoe posobie)* (Moscow: Standardy Amerikanskogo Neftianogo Instituta, 1969).

[14] *Impact of Oil Exports from the Soviet Bloc*, A Report of the National Petroleum Council, vol. II, October 4, 1962 (Washington, 1962), pp. 143-44. Also see *Chemische Technik* (Berlin), XIII, 7-8 (July-August 1961), 473-76.

[15] Robert E. Ebel, *The Petroleum Industry of the Soviet Union* (New York: American Petroleum Institute, June 1961), p. 118.

lation.[16] Thus we can trace domestic Soviet refinery construction to U.S. design and technology.

Table 11-1 MAJOR SOVIET REFINERIES BUILT BETWEEN 1945 AND 1960

Refinery	*Year of probable start*	*Year of finish*	*Final capacity (million metric tons*	*Origin of refinery*
Novo Baku	1948	1952-53	7.1 (increment 1950-60)	Type B standard
Kuibyshev No. 2	1947	1950	25.0	U.S. Lend Lease (Houdry)
Novo Ufa	1948	1951	12.5	U.S. Lend Lease (Houdry)
Chemilovsk	1950	1955	12.5	n.a.
Syzran	pre-1946	1950	7.0	U.S. Lend Lease
Salavat	pre-1946	1954	3.2	n.a.
Novo Ishimbay	1953	1955	2.6	Type A standard
Novo Gorki	1951	1958	2.6	Type A standard
Omsk	1949	1955	18.9	3 of Type B standard
Stalingrad	1946	1957	6.6	Type B standard
Perm	1951	1958	6.6	Type B standard
Fergana	1949	1958	6.6	Type B standard
Novo Yaroslavl	1953	1960	6.6	Type B standard
Ryazan	1952	1960	6.6	Type B standard
Angarak	1954	1960	12.6	2 of Type B standard
Kritovo	1958	1960	2.6	Type A standard
Pavlodar	1958	1960	6.6	Type B standard
Polotsk	1958	1960	6.6	Type B standard
TOTAL			149.7	

Source: *Impact of Oil Exports from the Soviet Bloc; A Report of the National Petroleum Council* (Washington, D.C., 1962), vol. 2, p. 150.

Just after World War II part of the German Leuna-Merseburg brown-coal synthetic gasoline plant was installed at Dzerzhinsk (Gorki) to produce avgas and nitrogen.[17] In 1953 East German companies supplied equipment for a synthetic gasoline plant, at Lake Baikal, producing 20,000 barrels per day.[18] In 1956 two refineries in the Arctic Circle near the Taimyr Peninsula installed U.S. equipment.[19]

A considerable quantity of oil processing equipment has been imported by the U.S.S.R. since World War II from Czechoslovakia, including sufficient

[16] U.S. Dept. of the Interior, *op. cit.* n. 9, p. 270.
[17] *Petroleum Refiner* (Houston), vol. 35, no. 9, p. 421. See p. 139 below.
[18] *Ibid.*
[19] *Ibid.*

capacity for several refineries, presumably for the standard Soviet Types A and B. Until June 1957 Czechoslovakia had manufactured and shipped the following units:[20]

Four cracking plants	1,460,000 tons/yr.
Two AVT plants	4,380,000 tons/yr.
Four GFU plants	1,460,000 tons/yr.
Five thermal cracking units	1,825,000 tons/yr.
Eleven AVT plants	12,045,000 tons/yr.

Moves to upgrade early U.S. technology were made in the first part of the 1960s. In 1963 Harold Wilson, the British prime minister, reported that the U.S.S.R. wanted to purchase a complete oil refinery in the United Kingdom and was prepared to pay $280 million for the installation.[21] In 1966 a contract was let to a French company, Société Gexa, for a gasoline plant; no further data were given except that the contract was valued at $13 million.[22] Presumably this acquisition will become the basis for further domestic construction in the refinery sector.

DEVELOPMENT OF NATURAL GAS UTILIZATION

The Soviet Union has rich resources of natural gas located some distance from consuming centers; this focuses attention on the development of a transmission system to move gas to the larger cities, and particularly to the industrial areas. Although writers do not agree on the exact figures, it is apparent that the length of pipelines in operation increased from about 4000 kilometers in the mid 1950s to about 40,000 by 1966.[23] Campbell has said: "In the Soviet Union the length of the city distribution network is only about two-thirds of the transmission system, whereas in the United States it is about double the length of the transmission system."[24] This implies, as Campbell points out, a low domestic utilization of natural gas.

Two factors of interest for this study are the diameter of the pipeline, as

[20] *Czechoslovak Foreign Trade* (Prague), June 1957.
[21] *Wall Street Journal*, June 14, 1963, 2:3.
[22] *Wall Street Journal*, June 27, 1966, 9:3.
[23] There is a discussion of this question in Campbell, *op. cit.* n. 1, chapters 7 and 10. Also see, J. Chapelle and S. Ketchian, *URSS, seconde producteur de petrole du monde* (Paris: Publications de l'Institut Français du Pétrole Collection, Science et Technique du Pétrole No. 4, 1963), pp. 258-63, for details on pipelines, maps, and listing of gas deposits. An incisive first-hand description of the situation in 1961 is contained in American Gas Association, Inc., "*U.S.S.R. Natural Gas Industry*," the report of the 1961 U.S. delegation to the Soviet natural gas industry. There is more information on city distribution methods in National District Heating Association, *District Heating in the Union of Soviet Socialist Republics* (Pittsburgh, 1967).
[24] Campbell, *op. cit.* n. 1, p. 208.

the Soviets have definite restrictions on size of pipe rolled,[25] and the use of compressors. The longest lines have been built with imported pipe. The first line, Saratov-Moscow (843 kilometers), completed in 1946, had U.S. Lend Lease assistance; the 1951 Dachava-Kiev-Moscow line was built with 20-inch (720-mm) pipe supplied by A. O. Smith in the United States[26] and as of 1962 it was the only pressure-welded line in the Soviet Union. The Moscow-Stavropol line (1020 mm) utilized pipe purchased from Phoenix-Rheinrohr in West Germany,[27] and Swedish welding rods.

The inability to produce requisite sizes of compressors has been a major drawback and has forced reliance on either imported compressors or the use of field pressure, thus reducing the effectiveness of transmission systems. The first line, Saratov-Moscow, with daily capacity of 80 million cubic feet, was equipped with 24 U.S. compressors of 1000 hp installed in six booster stations.[28] Campbell points out that lines have operated without compressors and cites the intention to install seven million kilowatts of compressor capacity on 26,000 km of line built between 1959 and 1965 (actually there was only one million kilowatts of compressors in the 28,500-kilometer system as of January 1, 1964).[29] The problems facing the Soviets in the field of compressors, and particularly in securing the desired mix of compressor types, are described by Campbell; suffice to note for our purpose that the original standard compressor 10GK-1 is a copy of the U.S. unit supplied for the Saratov-Moscow line,[30] and other mechanical units appear to be based on American types. For example, the 1961 American Gas Association Delegation reported a turbine unit in one new station: "The machine is very similar, except for its combustion system, to our Westinghouse W-52 PM- 5000 hp units"; and then the report adds the comparative data for the two units.[31] Further, while commenting on possible use of gas turbines, one Russian reportedly stated

> ... he would like to obtain information on gas turbine experience from a maintenance and operating standpoint in the United States. The only gas turbine with which they have had any extensive experience was a Brown-Boveri.[32]

The overall conclusion of the American Gas Association Delegation was: "In general it can be stated that the techniques of recovery, transportation, and utilization of natural gas in the U.S.S.R. are far behind those in the United States."[33] This conclusion was confirmed in 1970 when an agreement was

[25] See chapter 10.
[26] American Gas Association, Inc., *op. cit.* n. 23, p. 10.
[27] *Ibid.*, pp. 12-13.
[28] *The Oil Weekly* (Houston), November 5, 1945, p. 5.
[29] Campbell, *op. cit.* n. 1, p. 154.
[30] *Ibid.*
[31] American Gas Association Inc., *op. cit.* n. 23, p. 28.
[32] *Ibid.*, p. 25.
[33] *Ibid.*, p. ii.

signed with the Mannesmann-Thyssen concern of Essen, Germany, to supply 1.2 million metric tons of 52-inch-diameter pipeline for a total value of $327 million to carry natural gas from Siberia to Germany. Production of 52-inch-diameter pipe was not possible in the U.S.S.R. in 1970.[34]

THE GERMAN HYDROGENATION PLANTS

Soviet removals from the German petroleum industry after World War II were concentrated on a relatively few German plants for the production of liquid fuels and lubricating oils by the hydrogenation of brown coal. In general, liquid fuel plants were only partly removed.

The largest unit, a hydrogenation plant near Szczecin, Poland, with a capacity of 600,000 tons per year, was removed to the U.S.S.R.[35] The only unit in Germany reported as completely removed was the Brabag (Braunkohle-Benzin A.G.) at Magdeburg-Rothensee,[36] with a capacity of 220,000 tons per year including 120,000 tons of aviation fuel.[37] A smaller plant, Mineralölwerk Lutzkendorf (Wintershall A.G.), was 80 percent removed;[38] this plant was a producer of primary products from petroleum residues and tars, with a capacity of less than 50,000 tons per year.[39] The dozen or so other synthetic plants, although not greatly damaged by Allied bombing,[40] were only partially removed.[41]

In Austria the oil fields were not dismantled, but they were operated on Soviet account until the 1950s.[42]

REMOVAL OF THE GERMAN BROWN COAL BRIQUETTING INDUSTRY

Germany has large deposits of brown coal which requires drying and briquetting before use. The raw material is disintegrated by rollers, pressed to remove water, and passed through driers into briquetting machines. Since the coal itself

[34] *San Jose Mercury* (San Jose, Calif.), February 2, 1970.
[35] Alfred Zauberman, *Industrial Progress in Poland, Czechoslovakia, and East Germany, 1937-1962* (New York: Oxford University Press, 1964), p. 154.
[36] G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen, 1951), p. 94, no. 3.
[37] CIOS XXXII-107, *I.G. Farbenindustrie A. G. Works, Leuna*, p. 137M.
[38] Harmssen, *op. cit.* n. 36, no. 9.
[39] CIOS, *op. cit.* n. 37.
[40] U.S. Strategic Bombing Survey, *Oil, Chemicals and Rubber Division, Team 46, Plant Report No. 2: Braunkohle Benzin A. G.*, Zeitz, Germany; Braunkohle Benzin A.G., Boehlen, Germany; Wintershall A.G., Luetzkendorf, Germany (July 24, 1945).
[41] Harmssen, *op. cit.* n. 36, pp. 94-106.
[42] *Germany, 1945-1954* (Cologne: Boas International Publishing Company, [1954?]), p. 476.

contains a substantial quantity of bitumen, cementing material is not required.[43] German production of brown coal briquettes in 1938 was over 44 million metric tons—about 98 percent of the world's total production.

Russia possesses similar large deposits of brown coal in an area to the south of Moscow. The German brown coal briquetting plants were therefore of considerable interest, and 27 major plants from the Soviet Zone of Germany were removed to the U.S.S.R. (See Table 11-2.)

Table 11-2 LOCATION AND CAPACITY OF MAJOR GERMAN BRIQUETTING PLANTS COMPLETELY REMOVED TO THE U.S.S.R. IN 1944-46

German owner	*Location of plant*	*Number in Harmssen*	*1937 production (000 metric tons)*
Eintracht-Braunkohlenwerke A.G.	Werminghoff	16	790
Deutsche Erdöl	Regis-Breitingen	17	1200
Babina-Braunkohlenverwertung (Hermann-Mine)	Muskau	18	76
Ilse Bergbau A.G.	Hoyerswerda (Erika, Anna-Mathilde, and Renate-Eva plants)	22 60 61	2772
Bergwitzer Braunkohlenwerke	Bergwitz	34	230
Concordia	Nachterstedt	35	
Riebechsche Montanwerke	Deuben Profen Paul	36 37 38	2013
Braunkohlen- und Brikettindustrie A.G. (Bubiag)	Mückenberg	39	1659
Eintracht Braunkohlenwerke A.G.	Welzow	57-58	800
Hallesche Pfännerschaft	Senftenberg	59	267
	Total 1937 Production		9,807

Source: G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik*, (Bremen: F. Trüjen, 1951), p. 78 *et seq*.

Of these 27 plants, fourteen, with an annual briquetting capacity of almost 10 million tons, were completely removed to the Soviet Union and another ten, with a capacity of 6.3 million tons, were partly removed.[44] In all, briquetting capacity of over 16 million tons was all or partly removed and the remainder put into SAGs to produce brown coal briquettes which were partly exported to the West

[43] U.S. Department of War, *Coal Mining Industry of Germany*, W.D. Pamphlet no. 31-204 (Washington, September 7, 1944), pp. 155-57.

[44] A.G. Sächsische Werke (SPD # 15, Espenhain); Deutsche Erdöl A.G. (SPD # 19, Zipsendorf); Deutsche Erdöl A.G. (SPD # 20, Gross-Zossen); A.G. Sächsische Werke (SPD # 21, Hirschfelde); Werchen-Weiszenfelser Braunkohlen A.G. (SPD # 40, Zeitz); Riebecksche Montanwerke (SPD # 42, Kupferhammer, Oberroblingen); Mitteldeutscher Stahlwerke (SPD # 43, Lauchhammer); Deutsche Grube A.G. (SPD # 44, Bitterfeld); Michel-Werke (SPD # 46, Witznitz); Senftenberger Kohlenwerke A.G. (SPD # 62, Meurostolln).

in 1946-48 and partly exchanged for reparations equipment for the Soviet Union.

Other plants with similar processes in Poland, i.e., Oberschlesesche Hydrierwerke A.G. at Blachownia, I.G. Farben Heydebreck works at Kedzierzynia, and Anorgana (New Rokita) at Brzeg Dolny, also were partly dismantled and shipped to the U.S.S.R.[45]

A typical Lurgi standard low-temperature carbonization plant was that of A. G. Sächsische Werke at Espenhain,[46] where bomb damage was relatively light. Operations were easily restored, including the brown coal plant that was equipped to recover 5-6000 bbl/day of liquid hydrocarbons from coking brown coal. Built in 1936-40 and completely modern, the plant processed about six million tons a year of brown coal in a briquetting plant with 37 plunger-type presses—the largest in Germany. Briquets were then charged into a typical Lurgi "Schwelerie" (low-temperature carbonization plant), from which about 1.4 million tons of coke was produced annually.

The 1944 output of this plant was as follows:

Brown coal briquets	2,696,000 metric tons
Tar from Schwelerie	297,000 metric tons
Coke from Schwelerie	1,400,000 metric tons
Fuel oil	42,778 metric tons
Diesel oil	14,699 metric tons
Hard wax	6,541 metric tons
Soft wax	4,676 metric tons
Electrode coke	7,080 metric tons
25 percent crude phenols	32,000 metric tons
Sulfur	22,000 metric tons
Carbolic acid	9,600 metric tons

It can readily be seen that these plants were effective units for converting low-grade brown coal, first into useful fuels and then by subsequent processing into various chemicals.

KOPPERS-BECKER COKE OVEN TECHNOLOGY[47]

Construction of Soviet coke oven batteries before 1933 was undertaken by German, French, and American companies.[48] No coke ovens or byproduct recovery equipment, except for prototype items, have been purchased abroad

[45] Zauberman, *op. cit.* n. 35, p. 232.

[46] CIOS XXVIII-23, *A.G. Sachsische Werke, Espenhain.*

[47] Readers interested in coke oven accessory equipment should compare the excellent detail in I. L. Nepomniashchii, *Koksovye mashiny, ikh konstruktsii i raschety* (Moscow, 1963), with any standard Western book on coke oven practice or, for a quick comparison, United States Steel Corp., *The Making, Shaping and Treating of Steel* (Pittsburgh, 1957), chapter 4.

[48] Described in Sutton II, pp. 115-19.

since 1933; Soviet efforts have been concentrated on duplicating the best of foreign technology, particularly the Koppers-Becker system developed by Koppers Company, Inc., and its foreign licensees.

Soviet design organizations—particularly Giprokoks—have undertaken considerable work to improve Western coke oven systems. Giprokoks has been constantly at work since the early 1930s modifying and improving the original Koppers-Becker designs, and this work forms a distinct pattern based on the Koppers-Becker system with cross-over flues.

Table 11-3 DEVELOPMENT OF SOVIET COKE OVEN CONSTRUCTION, 1945-60

Period	*Coking chamber dimensions, in mm* Width (average)			Coal charge in metric tons or chamber volume in cubic meters
		Height	Length	
1945	407 (16")	4,300 (14'-1¼")	13,120 (43'-½")	20.0 (716 cu.ft.)
1950	407 (16")	4,300 (14'-1¼")	13,830 (45'-4½")	21.2 (748 cu.ft.)
1956-1960	407 (16")	4,300 (14'-1¼")	14,080 (46'-2¼")	21.6 m³ (760 cu.ft.)
	450 (17¾")	5,000 (16'-5")	15,040 (49'-4⅛")	30 m³ (1060 cu.ft.)

Source: Walter Farr, "Development of Coke-Oven Techniques in the U.S.S.R.," *Gas Journal* (London), September 12, 1962, p. 313.

The first standardization of the Koppers-Becker system was the PKI, which was followed by a second standardization, the PK-2, again followed in 1942-47 by modifications and improvements of Koppers-Becker and Disticoque designs of the early 1930s. These comprised first the PK-42 produced in 1942, the PK-45 produced in 1945, and the PK-47 produced in 1947. The disadvantages of the Koppers-Becker design were isolated and analyzed, and from this work and ensuing modifications came the PK-2K system. The new system was first built on a large scale at Choku in 1947, and with recirculating flues at Krivorozhye in 1949; essentially, the PK-2K improved Koppers-Becker system is equipped with cross-over flues and double-rich gas flues, with recirculation of heating gases. This design turned out to be satisfactory and was adopted for widespread application in coke-oven batteries built in the 1950s and later. In 1955 the design, further modernized, resulted in the type PV R-46, of which the first operating battery was erected in 1959 at Dneprodzerzhinsk.

One of the major changes resulted from an evaluation of the dimensions of coke-oven chambers. World practice has been to accept an average width of about 18 inches (457 mm); the Soviet Union early adopted a standard of 16 inches (407 mm). (See Table 11-3.) The first battery of type PK-2K coke ovens at Khoku was built with 17¾-inch wide (450 mm) chambers, and during 1950-51 three further batteries were built with widths of 16 inches (407 mm), 17¾ inches (450 mm) and 20 inches (510 mm).[49] By the early 1960s Giprokoks was investigating the possibility of designing very large coke batteries, i.e., eight batteries with a capacity of up to seven million metric tons of coke per year.

Thus in coke oven practice we find the Soviets in the early 1930s obtained a cross section of Western technology which was installed in the Soviet Union by Western companies with Western equipment, and then proceeded to improve this Western technology. Improvements took the form of a consistent series of detailed experiments with coke ovens and analysis of operating results, and changes in oven design were developed on the basis of these results. However, the basic technology remains that of Koppers-Becker, with modifications to suit Soviet conditions.

[49] "Development of Coke Oven Techniques in the U.S.S.R.," *Gas Journal* (London), September 12, 1962, p. 311.

CHAPTER TWELVE

Western Assistance to the Basic Chemical and Fertilizer Industry

The Soviet chemical industry in 1960 reflected a very rapid growth in production of basic chemicals. Outside these basic chemicals, however—i.e. in such products as resins, herbicides, mixed fertilizers, plastics, general organics and petrochemicals—the overall production range was relatively small and the industry's progress had been insignificant.

Sulfuric acid is the most important of inorganic acids and probably the most important of all industrial chemicals; it enters into almost all industries. Its production in Russia increased from 121,000 tons in 1913 to just under 3,000,000 tons in 1953, 4,804,000 tons in 1958, and 8,518,000 tons in 1965. As has been indicated in an earlier volume,[1] the Soviets have utilized basic Western or Tsarist processes for the manufacture of sulfuric acid and have duplicated these processes in their own machine-building plants.

A recent Russian paper on sulfuric acid manufacture indicates that in the mid-1960s, 63 percent of sulfuric acid production was based on pyrites and carried out according to a standardized version of Western processes.[2] The Soviet process (utilizing fluidized bed roaster, electric precipitator, towers, and contact apparatus) is similar to contact processes in use in the West. No claim is made for Soviet innovation; rather the claim is made for the "intensification of operating units" based on Western processes. For example, "in 1930 the Soviet Union bought a small unit design (24 tons a day) for sulfuric acid production by the contact process. During the exploitation of the unit, Soviet specialists made some improvements, as a result of which its capacity was increased to 46 tons per day."[3] This scaling up of a process, similar to that noted in other industries, has been the sole form of Soviet innovation in sulfuric acid manufacture.

On the other hand, there is no indication that any great quantity of Western equipment has been imported for the Soviet chemical industry since World War II. In 1965 Nordac Limited of Uxbridge in the United Kingdom sold

[1] See Sutton II, pp. 109-12.

[2] United Nations Report E/CN.11/635, *Development Prospects of Basic Chemical and Allied Industries in Asia and the Far East* (New York, 1963), p. 518.

[3] *Ibid.*, p. 519.

a sulfuric acid concentration plant with a capacity of 24 tons per day of 78 percent sulfuric acid, but this contract appears to have been an exception.

In the production of the basic alkali—caustic soda—there has also been a rapid increase in Soviet production, from 55,000 tons in 1913 to 101,000 tons in 1933, to 448,000 tons in 1953, to 709,000 tons in 1958, and to 1,303,000 tons in 1965.[4] The traditional method of making caustic soda involves causticizing soda ash; this method has been replaced by a more modern method utilizing the action of an electric current on a brine solution, yielding chlorine as a byproduct. It is in the newer electrolyte process that we find Soviet dependence on the West: the Soviet electrolytic cell BGK-17 is an almost exact replica of the Hooker electrolytic cell.[5]

Although electrolyzer cells were on the embargo list in 1960, it appears that the Soviets were able to purchase sample cells and reproduce them in the Soviet Union. There is also a report that in 1960 a sodium hydroxide (caustic soda) plant was purchased in the West as well as a 24-ampere converting plant to be used in a chlorine unit.[6] Another source states that Krebs et Cie in France has supplied an electrolytic chlorine and caustic soda plant with a capacity of 200,000 tons per year.[7]

A substantial amount of standard equipment for producing alkali chemicals was obtained in Germany at the end of World War II. For example, the Deutsches Solvay Werke, an ammonia-soda works, was completely removed to the Soviet Union. Various producing plants with Billiter and mercury cells also were partly removed: the Bitterfeld North plant was 40 percent removed, the Wolfen plant was 40 percent removed, and the Goldschmidt plant was 80 percent removed to the Soviet Union.[8]

Therefore it may be seen that in the production of sulfuric acid, the large-tonnage commercial acid, and of caustic soda, the large-tonnage basic alkali, the Soviets have adopted and duplicated Western processes and in this manner achieved significant rates of increase in the output of basic chemical products.[9] However, as will be seen in following sections on the production of fertilizers and other types of chemicals outside this basic limited range (particularly in the organic chemicals), the Soviets have been forced to purchase capacity and

[4] G. Warren Nutter, *The Growth of Industrial Production in the Soviet Union* (Princeton: Princeton University Press, 1962), p. 423.

[5] Compare *50 [Piat' desiat] let sovetskaya khimicheskaya nauka i promyshlennost'* (Moscow, 1967), p. 168; and Charles L. Mantell, *Industrial Electro-Chemistry* (New York: McGraw Hill, 1940), p. 419.

[6] Samuel Pisar, *A New Look at Trade Policy Toward the Communist Bloc*, (Washington: Subcommittee on Foreign Economic Policy of the Joint Economic Committee, 1961).

[7] *Chemical Week* (New York), September 3, 1960, p. 42.

[8] CIOS XXXIII-31, *Investigation of Chemical Factories in the Leipzig Area;* and G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen, 1951).

[9] *Chemistry and Industry* (London), February 13, 1960.

technology in the West on an increasing scale as the economy feels the adverse effects of its restricted range of chemical production.

Another aspect of Western purchases has been the acquisition of chemical apparatus obviously for experimental and prototype use: in 1960 the British company Griffin & George, Ltd., sold 13 gas liquid chromatographs for analysis—an area in which the Soviets lag badly. And a vacuum-insulated liquid-oxygen storage tank was sold by a British company in 1960.[10] Moreover there have been heavy imports of centrifuges and other laboratory apparatus.

Thus the chemical sector lags in both commercial development of new chemicals and manufacture of the intricate apparatus required to research and produce these new chemicals on a pilot basis. For technical advance in chemistry the Soviets look to the West.[11]

WESTERN PURCHASE FOR KRUSHCHEV'S CHEMICAL PLAN

In the late 1950s, as we have seen, the Soviets lagged in all areas of chemical production outside the basics previously described. This lag inspired a massive purchasing campaign in the West between 1958 and 1967. In the three years 1959 to 1961 alone, the Soviet Union purchased at least 50 complete chemical plants or equipment for these plants from non-Soviet sources.[12] Indeed the American trade journal *Chemical Week* commented, with perhaps more accuracy than we then realized, that the Soviet Union "behaves as if it had no chemical industry at all."[13] Not only was the U.S.S.R.'s industry producing little beyond basic heavy chemicals but, of greater consequence, it did not have the technical means of achieving substantial technical modernization and expansion of product range.

According to the general pattern of this "turn-key" purchase program, the Soviets supplied buildings—largely of prestressed concrete of a standard design—and associated power stations, together with unskilled labor and Russian engineer-trainees. The Western firm supplied designs and specifications according to exacting Soviet requirements, and process technology, engineering capability, equipment, and startup and training programs. These contracts were package deals that provided even more than the typical Western "turn-key" contract. Such contracts, unusual in the West except perhaps in underdeveloped areas

[10] Pisar, *op. cit.* n. 6.

[11] The reader should consult *50 let ...*, *op. cit.* n. 5, the official Soviet summary of 50 years of chemical production in the U.S.S.R., with two factors in mind: (a) the extraordinary degree of omission, i.e., nonstatement of simple facts, and (b) mentally insert the factor of unstated Western assistance.

[12] *Chemical Week*, March 11, 1961, p. 53. For a list see *Chemical Week*, September 3, 1960, pp. 42-44.

[13] *Chemical Week*, March 11, 1961, p. 54.

lacking elementary skills and facilities, were very attractive and highly profitable to Western firms: although the Russians are hard bargainers, their plight was well known in Western business circles.

The overall extent of equipment acquisition for the chemical industry may be judged from the following figures relating to Soviet purchases of chemical equipment from West European countries between 1960 and 1963, three key years in the campaign:

West Germany	\$93 million
United Kingdom	\$123 million
Italy	\$72 million
France	\$61 million
Holland	\$20 million[14]

In the first stage of this program the Soviets placed sizable orders in West Germany under the 1958 trade agreement for plants to be constructed between 1958 and 1960. The larger plants under this program included an agglomerating plant from Lurgi A.G. with a hearth area of 75 square meters for sintering lead concentrates; a plant with a capacity of 6000 metric tons per year and valued at about \$5 million, for the production of paraxylol and dimethylterelphtalate; three plants by Lurgi for the manufacture of detergents from petroleum products; and three plants for whale oil extraction.[15] Between 1961 and 1963 additional plants were supplied for the manufacture of polypropylene, di-isocyanates, and phosphorus[16] and sodium sulfate; plants for the hydraulic refining of benzene, dimazine, and atrazine; and two plants for the manufacture of foils from viniplant.[17] Further plants included an acetylene-from-natural-gas factory using the BASF process, with a capacity of 35,000 tons per year; a plant to manufacture phthalic anhydride; and a 5000-ton-per-year plant for the manufacture of highly dispersed Aerosil.[18]

Between 1961 and 1963 Italian companies, in particular Montecatini, supplied plants for the manufacture of acetylene and ethylene from natural gas. They also supplied plants for titanium oxide (20,000 tons per year) and maleic anhydride ammonia, and probably other units.[19]

Complete chemical plants supplied from the United Kingdom included numerous units apart from those in textiles, synthetic fibers, rubber, plastics, and fertilizers discussed elsewhere.[20]

A particular lag filled by British companies may be noted in pesticides.

[14] *Chemical Week*, March 21, 1964, p. 27.
[15] *British Chemical Engineering* (London), August 1958, p. 452.
[16] *Economist* (London), April 1, 1961, p. 54.
[17] See p. 163.
[18] *Chemical Week*, September 3, 1960, p. 42.
[19] *Economist* (London), April 1, 1961, p. 54.
[20] For Western plants for these industries, see relevant chapters.

In 1961 a British consortium, Wycon Services (a joint Fison's Pest Control and Constructors John Brown unit), contracted for two chemical plants in Ufa, Bashkir ASSR, at a cost of $6 million. One plant, based on Fison's Harston works, was designed to produce MCPA, a hormone weed killer. It was to have the capacity to produce enough weed killer for 11 million acres of cereal.[21] The other plant was to produce DMEU (dimethylol ethyleneurea), a resin used in the manufacture of drip-dry fabrics; this unit, with a capacity of 12,000 tons per year of resin, was fully automatic and based on Whiffen & Sons, Ltd., technology.[22] In 1964 the same consortium established a third plant, one for the production of TRA weed killer with a capacity of 200 long tons per year.[23]

In January 1967 Sturtevant Engineering of Manchester received a contract for $1.5 million to build yet another plant to produce agricultural pesticides with complete technical assistance.[24] A few weeks later Thomas Swan & Son of Consett, Durham, was asked to tender a bid for a complete plant for a "chemical used in road building."[25] A unit for the production of two and one-half tons per hour of glaubers salts was supplied by Kestner.[26]

In 1964 a British company—Power Gas Corporation, Ltd.—was building a $14 million plant for the manufacture of acetic acid in the U.S.S.R.[27] In December 1958 Hydrotherm Engineering, Ltd., of London contracted to supply equipment including an automatic heating and cooling plant (with heat generators, circulating pumps, and control equipment) to be used in the manufacture of synthetic resins.[28]

Two plants for the production of sodium sulfate, an input for the paper and pulp industries, were erected by British companies. The first, built in 1958-59, utilized the Kestner centrifugal atomization system, and the Kestner Evaporator & Engineering Company, Ltd., supplied a large spray-drying plant, all motors, a drier, and conveyer equipment for a plant to manufacture 5000 pounds of sodium sulfate per hour.[29] Of the second plant, built by Simon-Carves, Ltd., in 1962-63, little is known except that Darchem Engineering, Ltd., supplied 180 feet of 54-inch-diameter mild-steel gas main lined with stainless steel to Simon-Carves for installation in the project.[30] Also in the early 1960s, Constructors John Brown, Ltd., this time jointly with another British company, Marchon

[21] *Economist* (London), April 1, 1961, p. 54.
[22] *Ibid.*, see also *Chemistry and Industry*, March 18, 1961, p. 349.
[23] *Business Week*, May 30, 1964, p. 52.
[24] *The Times* (London), January 11, 1967.
[25] *The Times* (London), January 20, 1967.
[26] *Chemical Week*, September 3, 1960, p. 42.
[27] *Chemical Week*, November 14, 1964, p. 23. Power Gas Corp., Ltd., has a long history of activity in the Soviet Union; see Sutton II, pp. 103, 288, 369.
[28] *British Chemical Engineering*, December 1958, p. 690.
[29] *Chemistry and Industry*, February 7, 1959, p. 202.
[30] *Chemistry and Industry*, May 12, 1962, p. 869.

Products, Ltd., designed, equipped, and started up two plants for the manufacture of raw materials for detergents under a $15 million contract.[31]

Numerous complete plants have been supplied from other European countries. Belgium has provided a plant for the production of acetylene from natural gas and another for ammonia synthesis.[32] France has supplied numerous plants, including one for the production of acetic anhydride (20,000 tons per year), one for the production of phosphoric acid (60,000 tons per year), one for the production of titanium dioxide (20,000 tons per year), and another for the production of detergents.[33]

A number of plants have come from unknown origins (i.e., reported but without data concerning Western origins). In 1960 for example, a plant was supplied for the production of synthetic glycerin (20,000 tons per year); another for ethyl urea (1000 tons per year); one for the production of synthetic fatty acids (5000 tons per year); one for the production of sodium tripolyphosphate; one for the production of carbon black (in addition to another supplied by Japan); and two for the production of germanium.[34]

The United States has not been a major supplier of chemical plants; however, it has supplied several for fertilizer and phosphoric acid production.[35] It was reported in 1965, for example, that the Food Machinery Corporation of San Jose, California, was to build, maintain, repair, and operate a carbon disulfide plant in the U.S.S.R. This chemical is used for the manufacture of viscose rayon, ammonium thiocyanate, formaldehyde resins, xanthates, and carbon tetrachloride.[36]

The Soviet Union appears to be backward in both the development and the utilization of pharmaceutical drugs. The U.S. Delegation on Hospital Systems Planning, which visited the Soviet Union between June 26 and July 16, 1965, recorded the impression: "Although the important pharmaceutical agents are available for the treatment of patients, hospital pharmacy is not nearly as significant an endeavor as it is in the United States."[37]

An earlier visitor to the Soviet Union had reported to the State Department as follows: "Most of the antibiotics research is applied rather than fundamental ... development (or redevelopment) of products already produced by the West."[38] George Brown of the Sloan-Kettering Institute for Cancer Research in New York also commented that "it was Soviet practice to get the

[31] *Chemistry and Industry*, October 15, 1960, p. 1310.
[32] *Chemical Week*, September 3, 1960, p. 42.
[33] *Ibid.*
[34] *Ibid.*
[35] *Ibid.*
[36] *Los Angeles Times*, January 18, 23, and 30, 1965.
[37] U.S. Dept. of Health, Education and Welfare, *Hospital Services in the U.S.S.R.*, Report of the U.S. Delegation on Hospital Systems Planning, Public Health Service, June 26-July 16, 1965 (Washington, November 1966), p. 36.
[38] *Chemical Week*, October 3, 1959.

production facts concerning pharmaceutical drugs from U.S. patents and literature and then to develop these same drugs through experimentation."

The Austrian company Grill & Grossman supplied a $154,000 penicillin production plant in 1960,[39] and there has been continuing import of medical instruments and supplies.

PROGRAM FOR EXPANSION OF FERTILIZER PRODUCTION

Up to 1960, Russian output of fertilizers was mostly in the form of low-quality straight fertilizers;[40] there was no production of concentrated and mixed fertilizers such as are used in the West, and the use of liquid-nitrogen fertilizers was limited to the irrigated cotton-growing areas of Central Asia. In the early 1960s and particularly after the disastrous 1962 harvests resulting from Khrushchev's New Land plan, a program was begun to step up the production of fertilizers. Logically it made more sense to spend foreign exchange on fertilizer plants than on imported wheat.

Part of the expansion program was the purchase from the Joy Manufacturing Company of Pittsburgh of mining equipment (for potash mining)[41] valued at $10 million. This was supplemented by the purchase of a modern large-scale fertilizer production plant in the West. As Ivan Volovchenko, the Soviet minister of agriculture, put it: "We are scouring Europe for machinery capable of providing a quick start to the chemicalization of our agriculture, especially by the production of fertilizers."[42]

The program actually was initiated in about 1961 when Werkspoor N.V. of Holland (see Table 12-1) concluded a contract to build three plants for the production of urea (carbamide); part of the equipment for these plants came from the United Kingdom—Power-Gas Corporation, Ltd., supplied three installations for the crystallization of high-purity urea, each with a capacity of 100 tons per day, by the Krystal process.[43]

Also in 1961 a Belgium firm, Société Belge, was awarded a contract to provide technology for two ammonia synthesis plants with the equipment to

[39] *Chemical Week*, September 3, 1960, p. 42.

[40] The only removal of a fertilizer plant from Germany to the U.S.S.R. in 1945-46 was the Pierteritz phosphate plant reported dismantled in 1945; see *Germany, 1945-1954* (Cologne: Boas International Publishing Company, [1954?]), p. 376.

[41] See chapter 8.

[42] *Wall Street Journal*, November 7, 1963, 1:6.

[43] *Chemistry and Industry*, June 3, 1961, p. 754. These processes turn up in Soviet technical literature; see for example, D.S. Petrenko, *Proizvodstvo sul'fata ammoniia* (Moscow, 1966). The Simon-Carves vacuum evaporator is described on p. 43, the Power-Gas "Krystal" crystallizator on p. 44. Another aspect of the Soviet response is current publication of technical material on foreign mixed-feed apparatus; for example, see A.S. Danilin, *Proizvodstvo kombikormov za rubezhom* (Moscow, 1968).

Table 12-1 FOREIGN PURCHASES OF FERTILIZER PLANTS AFTER 1960

Name of firm supplying plant	*Type of produced fertilizer*	*Year of contract*	*Annual capacity (metric tons)*
Union Chimique-Chemische Bedrijven (Belgium)	Phosphoric acid	1964	620,500
Union Chimique-Chemische Bedrijven	Sodium tripoly phosphate	1962	365,000
COMECON (Kingisepp)	Phosphate fertilizer	1964	1,700,000
Société Belge	Ammonia synthesis	1961	two plants
Werkspoor N.V. (Holland)	Urea (carbamide)	1961	three plants (total 658,800)
Mitsui (Japan)	Urea	1964	—
Montecatini (Italy)	Ammonia	1964	—
Woodall-Duckham Construction Co., Ltd. (U.K.)			
Newton Chambers & Co., Ltd. (U.K.)	Chemical fertilizer	1964	ten plants
Occidental Petroleum Corporation (U.S.)			

Sources: *Chemical Week*, October 24 and November 14, 1964; *New York Times*, September 27, 1964; *Wall Street Journal*, October 18, 1963.

be supplied by another Belgian firm.[44] Under the 1960 trade agreement with Italy several plants were supplied for the production of ammonia.[45]

Then in 1964 a contract was awarded to Union Chimique-Chemische Bedrijven of Brussels for a 620,500 ton per year plant for the production of phosphoric acid, and another plant to be built near Kuibyshev with an annual capacity of 365,000 tons of sodium tripoly phosphate.[46]

A joint development with a Soviet ''satellite'' was reported in the Kingisepp area, under which the mining and production equipment was provided by the satellite in return for fertilizer; this program had a starting capacity of 850,000 tons per year and projected expansion to 1.7 million tons per year.[47] Other such plants were built by Mitsui of Japan and Montecatini of Italy, although the largest was an announced series of ten fertilizer plants arranged by the Occidental Petroleum Corporation[48] and built by Woodall-Duckham Construction Company, Ltd., and Newton Chambers & Company, Ltd., of the United Kingdom.[49]

The chemical sector provides an excellent illustration of the link between

[44] *Chemical Week*, October 24, 1964.
[45] *Ibid.*
[46] *Ibid.*
[47] *Ibid.*
[48] *Ibid.*
[49] *Ibid.*

Soviet planning and Western technology and equipment. In 1960 the Soviets had achieved considerable rates of increase in chemical production by the duplication of standard Western equipment and processes in a few basic chemicals—particularly sulfuric acid and caustic soda. Figures reflecting these impressive increases tended to obscure the extremely limited range of chemical products. When practical demand forced manufacture of a wider range of chemicals the Soviets turned to the West for process technology, complete plants, and equipment.

In 1959-60 orders for more than 50 complete chemical plants were placed in the West and the trade journals catalogued these acquisitions;[50] this process continued throughout the 1960s with the expenditure of several billions on Western chemical equipment to provide everything from penicillin to germanium processing for transistors and to fulfill a massive program for the production of mixed and concentrated fertilizers.

The interesting phase of the acquisition has yet to come. Many of the processes acquired during the 1960s are complex units requiring a great deal of highly sophisticated technical skill in construction and operation. While automation will solve the operating problem it may not be easy to duplicate the plants as has been done with the Solvay process in caustic soda and the Herreshoff-Bauer system in the manufacture of sulfuric acid.[51]

[50] *Chemical Week*, September 3, 1960, p. 42.
[51] See Sutton II, pp. 110-12.

CHAPTER THIRTEEN

Western Assistance to the Rubber and Plastics Industries

SYNTHETIC RUBBERS INTRODUCED AFTER 1945

It was demonstrated in the second volume of this series that although the Soviets had an early start in synthetic rubber production with the Russian-developed, sodium-polymerized SK-B butadiene, this lead was not maintained, and during World War II U.S. plants and technology were imported under the Lend Lease program to supplement the low-quality and limited-use SK-B.[1] Apart from a small production of Thiokol, the only Soviet synthetic rubber until the import of Lend Lease plants and technology was a butadiene type polymerized by sodium.

There was a significant change in the structure of Soviet synthetic rubber production in the 15 years between the end of the war and 1960. By 1959 only 55 percent of synthetic rubber was polymerized with sodium from alcohol (SK-B), while chloroprene-using Lend Lease technology and equipment (Dupont-Neoprene) constituted only about 7 percent of the total; the bulk of the remaining 38 percent came from the introduction of copolymers or styrene-butadiene types (SK-S), and a small production of nitrile (SK-N) with pilot production of other types. There was no commercial production in the Soviet Union of butyl and polyisobutylene types in 1960.[2]

In terms of tonnage, the Soviet Union produced about 323,000 tons of synthetic rubber in 1960. Of this total, 177,327 tons was the original SK-B type based on alcohol, of very low quality and providing products of low wearing abilities; 104,975 tons was of styrene-butadiene copolymer including the oil-extended types; 23,256 tons was Dupont-Neoprene (now called Nairit); and the balance comprised small-scale pilot production of 8075 tons of nitrile (SK-N) and 8798 tons of other types. By contrast, 99,000 tons of butyl and 38,000 tons of nitrile rubber alone were produced in the United States in 1960.

In brief, the increment in Soviet production of synthetic rubber between

[1] See Sutton II, pp. 122-26.
[2] See Table 13-1.

1945 and 1960 consisted almost completely of copolymers; i.e., it was of the styrene-butadiene type, in the amount of 104,975 tons. This copolymer was developed by I.G. Farbenindustrie A.G., and was produced in Germany from 1935 onward as Buna-S. Buna-S accounted for 90 percent of German synthetic rubber production in World War II and was introduced into the United States under the government construction program of 1942. It was not produced in the U.S.S.R. during the war.

At the end of World War II the Soviets removed as reparations two large I.G. Farben synthetic rubber plants from Germany—the Buna-Werke-Schkopau A.G. and the Chemische Werke Hüls GmbH. The combined capacity of these plants was just over 100,000 tons of styrene-butadiene copolymers; so a reasonable presumption is that the Soviet copolymer capacity came from the Schkopau and Hüls plants. Sumgait and Yaroslavl seem the logical relocation sites in the U.S.S.R. on both technical grounds (the raw material base is butane from oil) and intelligence grounds (these are sites known to have received such plants in the early postwar period.)[3]

The remaining increment in production came from the Dupont chloroprene type. (See Table 13-1.) Part of the chloroprene capacity came from Manchurian removals. A new plant opened in 1944 to produce 750 tons per year—the Manchurian Synthetic Rubber Company at Kirin—was largely removed under the supervision of two Soviet officials, Major Sherishetsky and Major Diement. Removals were concentrated on the gas generators; the reaction equipment; the distillation, polymerization, and catalyst preparation equipment; and the rolling equipment.[4]

Thus in the period 1945 to 1960 the increment in Soviet synthetic rubber capacity came from Buna-S plants transferred from Germany under reparations, from Lend Lease capacity, or to a small extent from Manchuria. No new Soviet types were developed and placed in full production, although a close watch was kept and research work undertaken on new Western developments.[5]

Given this inability to produce modern synthetic rubbers, reliance was placed both on import of Western synthetics and on plants to produce new types.

[3] CIOS no. XXII-22, *Synthetic Rubber Plant, Buna Werke-Schkopau A.G.*, and compare to *50 [Piat' desiat] let sovetskaya khimicheskaya nauka i promyshlennost'* (Moscow, 1967), p. 346. Also see CIOS no. XXII-21 *Synthetic Rubber Plant, Chemische Werke-Hüls*; and *Germany, 1945-1954* (Cologne: Boas International Publishing Company), p. 37: "Hüls suffered much more than other companies from dismantling." Further, see *Chemistry and Industry* (London), May 16, 1959, p. 628, for an article of Russian origin that states that the chief type produced after World War II was the butadiene-styrene by continuous emulsion polymerization.

[4] Edwin W. Pauley, *Report on Japanese Assets in Manchuria to the President of the United States, July 1946* (Washington, 1946), p. 188.

[5] The general impression of Soviet backwardness in the rubber industry is confirmed by Edward Lane, Chairman of Seiberling Rubber Company, Akron, Ohio, who, after a trip to the U.S.S.R., stated he found industrial methods "very backward and far below ours." *Los Angeles Times*, July 20, 1964.

Table 13-1 SYNTHETIC RUBBER PRODUCTION TECHNOLOGY IN THE SOVIET UNION IN 1960 (BY TYPE OF RUBBER AND PLANT)

Plant	*Sodium polymerized butadiene (SK-B)*	*Styrene-butadiene copolymers (SK-S)*	*Nitrile (SK-N)*	*Chloroprene (neoprene)*	*Butyl and Polyiso-butylene*	*Others (including silicones)*
Kazan	Yes	—	—	—	—	—
Krasnoyarsk	Yes	—	—	—	—	—
Sumgait	—	Yes	Yes	—	—	—
Voronezh	Yes	Yes	—	—	—	—
Yaroslavl	Yes	Yes	Yes	—	—	—
Yerefremov	Yes	—	—	—	—	—
Yerevan	—	—	—	Yes	—	—
Process used	1. Original Soviet SK-B 2. U.S. wartime standard	I.G. Farbenindustrie (Buna)	Pilot production	Dupont (Neoprene or NAIRIT)	—	Pilot production
Percent produced by type	54.9	32.5	2.5	7.2	0.0	2.6
Quantity produced by type (metric tons)	177,327	104,975	8,075	23,256	0.0	8,798

Source: G. F. Borisovich, *Ekonomika promyshlennosti sinteticheskogo kauchuka* (Moscow: Khimiya, 1968), p. 37, for distribution by type. Tonnage calculated by author. For process and plants, see text.

Butyl rubber was deleted from U.S. export control in 1959,[6] allowing exports to the U.S.S.R., and a butyl plant utilizing Western equipment[7] came into pilot production in the 1965-66 period.[8]

In 1960 the Glasgow firm of John Dalglish & Sons, Ltd., implemented a "package deal" under which the firm supplied and erected in a new synthetic rubber plant in Siberia a series of machines for de-watering, drying, baling, wrapping, and packaging of synthetic rubber. This plant had a capacity of 70,000 tons of synthetic rubber per year.[9]

In 1961 the new synthetic rubber plants at Kursk and Ryzan received equipment installed and supplied by Von Kohorn International of White Plains, New York.[10]

In 1964 a Japanese consortium supplied a plant valued at $5.6 million to produce 8000 metric tons annually of rubber antioxidants; the consortium included the Fujinagata Shipbuilding Company, Kansai Catalyst, and Japan Chemical Machine Manufacturing Company.[11]

The Pirelli Company of Italy signed two contracts in 1968 with the Soviet organization Tekhmashimport of Moscow. The first contract with the Soviet organization was for supplying a plant, valued at over 800 million lire, for the manufacture of rubber latex thread. The second contract was to supply Russia with two complete plants for the manufacture of rubber latex gloves for surgical and industrial use; the amount of the transaction was about 750 million lire.[12] Pirelli was building about a dozen other plants in Eastern Europe and the Soviet Union in the late 1960s for such products as rubber tires, elastic yarns, and synthetic leather. In addition, a contract was concluded in 1967 for a $50 million plant to produce rubber parts for the Fiat 124 to be produced in the U.S.S.R., and negotiations were in progress for another plant to make tires for Soviet-Fiats.[13]

PRODUCTION OF CALCIUM CARBIDE AND ACETYLENE

Acetylene, a major input for synthetic rubber in the U.S.S.R., historically is produced from calcium carbide. Prewar Soviet calcium carbide capacity was

[6] U.S. House of Representatives, *Investigation and Study of the Administration, Operations, and Enforcement of the Export Control Act of 1949, and Related Acts*, Hearings before the Select Committee on Export Control, 87th Congress, 1st session (October and December 1961), pt. I, p. 333. Butyl, silicone, and nitrile rubbers were removed from embargo in the third quarter of 1959. Letter from Office of Export Control to writer, January 29, 1970.

[7] Confidential source.

[8] G. F. Borisovich, *Ekonomika promyshlennosti sinteticheskogo kauchuka* (Moscow, 1968), pp. 32, 37.

[9] *Chemistry and Industry*, December 19, 1959, p. 1609.

[10] *Chemical Week* (New York), March 11, 1961, p. 53.

[11] *Chemical Week*, November 14, 1964, p. 23.

[12] Communication from the Embassy of Italy, Washington D.C.

[13] *Business Week* (New York), July 13, 1968, p. 62. See also p. 200.

from Miguet-Perrou system furnaces installed in the 1930s[14] and having an annual capacity of about 80,000 metric tons.

A considerable addition to this capacity was made from reparations equipment removed from Germany and Manchuria. The I.G. Farben Buna-Werke at Schkopau, near Merseberg, produced its own calcium carbide by the electric furnace process for conversion into acetylene, in turn converted into acetaldehyde and butadiene.[15] Capacity was 298,255 metric tons in 1943[16] and the plant was largely removed to the Soviet Union.[17] Other calcium carbide capacity was removed from the Piesteritz works of Bayrische Stickstoffwerke A.G.,[18] which had a 1943 capacity of 155,570 metric tons[19]; the Mückenberg works of Elektrochemische Werke Dr Wacker GmbH using the Wacker dry process[20] with a 1943 capacity of 99,015 metric tons;[21] and a small plant at Spremberg, the Lanza GmbH, with a 1943 capacity of 22,550 metric tons.[22]

In Manchuria, at the Manchu Electrochemical Company, Ltd., in Kirin, the Soviets removed all the equipment from two plants including transformers and all auxiliary machinery, leaving only the electric furnace shells;[23] calcium carbide capacity of these plants was about 81,000 metric tons per year. The removal operation was supervised by Red Army Majors Sherishefsky and Diement, using Japanese technical assistance and local labor.[24]

About 500,000 metric tons of calcium carbide was made in the Soviet Union in 1960—the same as in 1953—and the major end use was the manufacture of acetylene; thus a large proportion of carbide capacity, and so ability to make synthetic rubber, can be traced to foreign origins. Even if reparations removals consisted only of machinery removals, excluding the furnaces, these machines would form the essential core of building efforts in the immediate postwar period.

As of 1953 there were numerous widely dispersed plants making calcium carbide—at Kirov, Yerevan, Kirovakan, Pipetsk, Voroshilovgrad, Leningrad, Kirovgrad, and Zaporozhe.[25] About one-half of the 1953 output of 500,000 tons was for synthetic rubber production, of which about one-third was made from calcium carbide.

14 See Sutton II, p. 156.
15 CIOS no. XXVIII-13, *Synthetic Rubber Plant, Buna Werke-Schkopau A.G.*
16 BIOS, *The Acetylene Industry and Acetylene Chemistry in Germany during the period 1939-45*, Survey Report no. 30, pp. 10-11.
17 G.E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen, 1951), p. 106, no. 36.
18 *Ibid.*, p. 106, no. 35.
19 *Ibid.*, p. 106, no. 70.
20 BIOS, *op. cit.* n. 16.
21 *Ibid.*
22 Pauley, *op. cit.* n. 4, appendix 10.
23 Pauley, *op. cit.* n. 4.
24 *Ibid.*
25 S. A. Miller, *Acetylene: Its Properties, Manufacture and Uses* (New York: Academic Press, 1965).

Acetylene has in more recent times been made from hydrocarbons rather than calcium carbide; in the United States in 1958 some 40 percent of acetylene was made from hydrocarbons and other Western countries were moving toward this ratio. For example, in 1958 Italy produced 35 percent from hydrocarbons; France and West Germany, 34 percent; and Japan, 20 percent.[26] The Soviet Union and East Germany continued to produce 100 percent of their acetylene from calcium carbide, reflecting relative technical backwardness compared to the more advanced capitalist nations. (See Table 13-2.)

Table 13-2 PRODUCTION OF ACETYLENE FROM CARBIDE AND HYDROCARBONS, 1958

(000 metric tons)

Country	*From carbide*	*From hydrocarbons*	Total	*Percentage of total carbide*
U.S.A.	230	150	380	60
Italy	82	45	127	65
France	115	37	152	76
West Germany	255	80	335	76
Japan	250	60	310	80
East Germany	266	—	266	100
U.S.S.R.	170	—	170	100

Source: D.W.F. Hardie, *Acetylene, Manufacture and Uses* (London: Oxford University Press, 1965), p. 46.

Further, backwardness in acetylene manufacturing technology has been isolated as the main reason for the generally retarded nature of the Soviet organic chemicals industry.[27] Although there has been a great deal of research into various acetylene chemistry fields the knowledge has not been exploited, and in 1960 a U.S. Commerce Department report predicted that "Soviet progress in plastics, drugs, synthetic rubber, adhesives, and chemical intermediates will be retarded."[28]

In 1960 one-half of Soviet acetylene was being utilized for welding and cutting—compared with only 20 percent in the United States; the balance in both countries was used for the manufacture of organic chemicals. In other words, quite apart from the inability to utilize improved methods of production of acetylene, the end uses of the product itself were not changed. Thus market pressures making for technical change in the acetylene industry apparently were absent.

[26] D. W. F. Hardie, *Acetylene, Manufacture and Uses* (London: Oxford University Press, 1965), p. 46.
[27] *Chemical and Engineering News*, November 28, 1960, p. 26.
[28] *Ibid.*, quoting U.S. Dept. of Commerce report.

Evidently a pilot plant built in 1958 using the Russian Grinenko process[29] was unsuccessful, because in 1964 three plants were under construction by Western firms, all using Western processes. One of these plants, with a 35,000-ton capacity for the production of acetylene from hydrocarbons, was using the BASF process (formerly known as the Sachsse method); another in Angarsh, Siberia, was to use the SBA process of Société Belge de l'Azote; and the third plant, also with a capacity of 35,000 tons, was built in the Urals by the Italian firm Montecatini and using the Montecatini process.[30]

Consequently, by briefly examining the interlocking nature of chemical processes—even in only one field of organic chemistry, i.e., synthetic rubbers and one of its inputs—we can perceive two weaknesses in the Soviet system. First there is a technical weakness, i.e., an inability to convert promising research into practical working commercial systems; second, there is an economic weakness, i.e., the lack of economic forces or pressures to bring about technical change.

It is unlikely that these weaknesses stem from lack of effort or ability in research. In October 1963 a group from the Confederation of British Industry visited the Synthetic Rubber Institute in Leningrad.[31] The group concluded that it was an institute of "high calibre," the staff was competent, and the research was "well organized"; further, "the equipment is modern and lavish with clean and well planned laboratories."

The Institute has an interesting history. Founded in the 1920s by S. V. Lebedev,[32] it handled the original successful research and pilot production of sodium-butadiene synthetic rubber. Its function has expanded over the years and by 1961 the institute was housed in a new building of 5500 square meters and had established several pilot plants, some able to supply several hundred tons of rubber for large-scale evaluation. A total of 940 persons worked at the institute itself and another 900 at the pilot plants. It was noted that there was a "wealth of standard equipment" including, for example, five spectrometers —one of which was British (Hilger) and one German.

The main purpose of the institute in 1963 was (a) to find synthetic rubbers to replace natural rubbers in all applications and (b) to produce rubbers with special properties. The materials under investigation in 1963 included stereorubbers, ethylene, propylene copolymers, butadiene acrylonitrile, silicone, and

[29] S. A. Miller, *op. cit.* n. 25, p. 474.

[30] *Ibid.* Also see Kirk-Othmer, *Encyclopedia of Chemical Technology* (New York: Wiley, 1968), vol. I, pp. 186-88. The SBA process is reported as the SBA-Kellogg process, but the Kellogg company (in the U.S.) denies having built a plant in Siberia in 1964; letter to writer, April 17, 1969. The process referred to is probably one developed by Société Belge de l'Azote et des Produits Chimiques du Marly of Liège, Belgium.

[31] Confederation of British Industry, "Synthetic Rubber Institute, Leningrad, 18th October 1963"; typescript of manuscript sent to writer.

[32] Sutton I, p. 122.

polyurethane rubbers. Work was also in progress on a variety of antioxidants, including Ionol (I.C.I.) and Santowhite (Monsanto Chemical Company) as well as some Soviet developments.[33]

Thus in 1963 the Synthetic Rubber Institute had a long operating history, excellent research facilities, and capable staffing. Yet despite these observations and despite early work in the field and the successes which fructified in the original SK-B, there has been a significant lag in Soviet development of synthetic rubbers.

WESTERN ASSISTANCE FOR RUBBER TIRE PRODUCTION

The manufacture of almost all motor vehicle tire production can be traced directly to equipment of Western origin and, if we take account of the Soviet practice of working plants on a three-shift continuous basis, it is possible that all rubber tires in the Soviet Union have been produced on Western-origin equipment. As of 1960 the tire production capacity of equipment known to have been supplied by Western firms was about 24 million tires annually. Soviet civilian production in 1960 was about 16 million tires; closing of obsolete capacity and production of tires for military use constituted the difference.

Table 13-3 provides an approximate statement of equipment origins for tire production. A more precise statement relating foreign equipment to individual

Table 13-3 SOVIET TIRE OUTPUT IN RELATION TO WESTERN EQUIPMENT SUPPLY

Years	*Foreign firms supplying equipment or complete tire plants*	*Source*	*Approximate annual capacity of this equipment supply*
1931-7	Seiberling Rubber Co., Inc.[a]	U.S.	3,000,000 tires
	Francis Shaw & Co., Ltd.	U.K.	
1944-5	Ford Motor Co.[b]	U.S.	1,000,000 truck tires
1945-6	Deka-Werke (German reparations)[c]	Germany	300,000 truck tires
1946	Manchu Rubber Co. – (Manchurian reparations)[d]	Manchuria	30,000 truck tires
1957	United Kingdom 'Rustyfa' consortium (Dnepropetrovsk)[e]	U.K.	15,000,000 tractor truck and equipment tires
1957	Chatillon Tire Cord	Italy	—
1959-1960	Simon Handling Engineers, Ltd., Krasnoyarsk[f]	U.K.	2,000,000 tractor, truck and equipment tires
1968	Pirelli Co.[g]	Italy	—

Sources: [a]Sutton I: *Western Technology . . . 1917 to 1930;* [b]Sutton II *Western Technology . . . 1930 to 1945;* [c]See p. 31; [d]Calculated as 75 percent of the Manchu plant capacity; [e]*Anglo-Soviet Trade,* supplement to *Manchester Guardian,* December 7, 1960, p. 12; [f]*Mechanical Handling* (London), January 1964; [g]*Business Week,* July 13, 1968 p. 62.

[33] Confederation of British Industry, *op. cit.* n. 31.

plants cannot be made, as Soviet censorship has carefully eliminated from published reports data concerning tire sizes produced at each plant (an indicator by which equipment could be traced back to its Western origins) or any statement concerning location of foreign-purchased equipment.

The first Russian rubber tire plant was installed by the Seiberling Rubber Company at Yaroslavl[34] and a second plant was installed by Francis Shaw & Company, Ltd., of the United Kingdom in the early 1930s.[35] During World War II a Ford Motor Company tire plant was transferred to the U.S.S.R. and became the Moscow rubber tire plant.[36] Bought by Lend Lease for $10 million in 1942, it included a power plant for steam and electricity, and was capable of producing one million military tires per year; most of the plant had been shipped by autumn 1944. Some American engineers went to Russia in February 1944 to give technical advice, but in October 1945 the plant still lacked necessary utilities—water, steam, electricity, and compressed air.[37] The Deka-Werke, a producer of truck tires, was transferred to the U.S.S.R. from Germany under the reparations agreements,[38] and the adjustable-size tire-forming machines—about 75 percent of capacity—with autoclaves and calendars were removed from the Manchu Rubber Company in Manchuria and transferred to the U.S.S.R. in 1946.[39]

Soviet tire output in 1949 was 5,680,000 automobile and truck tires—about the capacity of the above-named plants.

In the mid to late 1950s several major contracts were let to foreign firms to supply complete, highly advanced tire manufacturing plants. The largest of these contracts was to a consortium of six British firms, known as Rustyfa,[40] and involved a total contract of $40 million.

The first inquiries to British firms for a new, modern tire factory came in April 1956; concurrent approaches were also made to firms in France, Germany, and the United States. A five-man British mission from the Rustyfa consortium flew to Moscow in March 1957 to complete negotiations. (One firm in the consortium, Francis Shaw and Company of Manchester, had already equipped a Russian tire factory in the thirties.) Dunlop Advisory Service acted as consulting engineers, and undertook the engineering survey and plans for the factory.[41]

[34] Sutton I, p. 223.
[35] *Economist* (London), April 13, 1957, p. 171.
[36] Sutton II, p. 184.
[37] Robert H. Jones, *The Roads to Russia* (Norman: University of Oklahoma Press, 1969,) p. 223.
[38] Harmssen, *op. cit.* n. 17.
[39] Pauley, *op. cit.* n. 4, appendix 10, Plant Inspection Report 2-C-2.
[40] Other members were Crompton Parkinson, Lancashire Dynamo Holdings, David Bridge, Ltd., Mather & Platt, Francis Shaw, Ltd., Simon Handling. George King and Heenan & Froude were subcontractors; see Peter Zentner, *East-West Trade: A Practical Guide to Selling in Eastern Europe* (London: Max Parrish, 1967), p. 80.
[41] *Economist* (London), April 13, 1957, p. 171.

The Rustyfa plant at Dnepropetrovsk, with its annual capacity of 15 million tires, is one of the largest tire factories in Europe. The advanced nature of the equipment supplied for the plant is typified by the monitoring equipment supplied. In 1957 the British Iron and Steel Research Association (BISRA) announced the development of an advanced system of recording plant performance; in 1957 Digital Engineering Company, Ltd., a firm licensed to build and sell the system, was awarded a contract to supply the BISRA monitoring equipment for the Dnepropetrovsk plant. This equipment comprised 500 monitoring or "detection points," with a centralized counting apparatus and printers for recording information. Many of the geared motors and mechanical handling equipment came from Lancashire Dynamo and Crypto, Ltd., whose Willesden works made the largest single shipment in its history—298 crated items—in April 1960 to the Russian plant.[42]

TECHNICAL ASSISTANCE TO THE PLASTICS INDUSTRIES

The Russian plastics and resins industry is even more backward than the synthetic rubber industry. It was reported in 1960 by Russian engineers that the Soviet Union did not have, "and badly needed high-speed, continuous process production equipment,[43] that there was no production of polyvinyl chlorides and foam plastics (among other types), and that there was only small-scale pilot production of such products as plastic laminates and glass fiber products.[44]

This admission by a Soviet plastics delegation to the United States confirmed reports from an earlier American delegation to the U.S.S.R. While avoiding overt criticism of the plants visited and indeed any overall conclusions concerning technical capacity in the plastics industry, individual observations and comments in the U.S. report suggest that the Soviets were noticeably backward in all areas except thermosetting plastics for industrial use. The report stated that the U.S. delegates were "surprised" that there apparently was no production of such plastics as polyethylene and noted particularly the considerable number of "plants they were not able to see," such as a caprolactum-nylon plant,[45] a butanol plant,[46] or "any petrochemical operations."[47]

Equipment in the plastics products plants visited constituted a mixture of imported machines (the polyvinyl chloride—PVC—compounding equipment at Vladimir Chemical, the compression molding shop at Karacharovo, the urea

[42] *Electrical Review* (London), April 15, 1960, p. 747.
[43] *Engineering News-Record* (New York), 164 (January 21, 1960), 56.
[44] *Ibid.*
[45] *Report on visit of U.S.A. Plastics Industry Exchange Delegation to U.S.S.R.*, Society of the Plastics Industry, Inc., June 2 to June 28, 1958 (New York, 1958), p. 2.
[46] *Ibid.*, p. 59.
[47] *Ibid.*, p. 61.

resin shop at Carbolit) and Russian-made equipment (the presses at Leningrad Laminated Plastics, Carbolit, and Karacharovo). Some of the usual comments about "copying" were made, although this report contains fewer observations concerning equipment origins than do similar reports from other industries.

Backwardness in plastics was solved in the usual manner, i.e., by the purchase of complete plants from the West. In 1959 the West German firm Badische Anilin licensed production of its process for the manufacture of polyethylene to the U.S.S.R.,[48] and German firms are reported to have sold numerous other plants,[49] including a polyester glass fiber unit (5000 tons per year); a styrene and copolymer unit (5000 tons per year); high- and low-pressure polyethylene plants by Salzgitter Industriebau GmbH (each of 24,000 tons per year); a polypropylene unit (10,000 tons per year); a polyvinyl pyrrolidone unit (180 tons per year); a melamine plant (10,000 tons per year); two plastics foam plants (3000 tons per year each); a PVC sheet plant; a PVC cable plant (40,000 kg/hr capacity); a polyethylene sheet plant and a processing unit (about $1.5 million together); and two plants for the manufacture of polyethylene pipe.[50]

In the early 1960s a group of six plants was contracted to British companies. The Simon-Carves, Ltd., firm, a member of the Simon Engineering Group, received a contract in 1963 valued at $56 million to design, equip, and start up four polyethylene plants; two had a capacity of 48,000 tons each and two a capacity of 24,000 tons each, with completion due in 1966.[51] Financing of $36 million was on five-year terms and arranged by Lazard Brothers & Company, an affiliate of Lazard Freres, the investment bankers of New York.[52] The total capacity of the four plants equaled total British polyethylene capacity in 1964.

Two gas separator plants to provide ethylene for two of the Simon-Carves polyethylene plants were ordered from Humphries and Glasgow, a U.K. engineering firm; these plants had an annual capacity of 120,000 tons of ethylene, the raw stock for polyethylene. The contract was valued at $16.8 million[53] and used the I.C.I. high-pressure process. Part of the contract was subcontracted to English Electric, Tube Investments, and Taylor Controls.[54]

In 1961 Sterling Moulding Materials, Ltd., of Cheshire shipped $12.1 million worth of equipment for Russia's first polystyrene molding powder plant, a facility with a capacity of 10,000 long tons per year. The company supplied technical assistance, installation services, and startup of operations for the Soviet Union.[55]

[48] Horst Mendershausen, *Dependence of East Germany on Western Imports* (Santa Monica: RAND Corp.), RAND RM-2414, July 17, 1959, p. 39.
[49] See p. 147 above.
[50] *Chemical Week*, September 3, 1960, p. 40.
[51] *Wall Street Journal*, April 30, 1963.
[52] *Ibid.*
[53] See *The Times* (London), February 1, 1965, for Russian complaints concerning these plants.
[54] *Economist* (London), May 4, 1963, p. 456.
[55] *Chemical Week*, March 11, 1961, p. 53.

Another British firm supplied $210,000 worth of plastics mixing equipment —FKM 300 DK Lodige-Morton mixers made by Morton Machine Company, Ltd., for PVC and PVA (polyvinyl acetate) powders.[56] Other chemical-plant orders placed in the United Kingdom included a styrene and polystyrene unit (20,000 tons per year) supplied by P.G. Engineering and BX Plastics; a cellulose acetate plant (3000 tons per year) supplied by Industrial Plastics and East Anglia Plastics; and a styrene foam plant.[57]

In 1965 a French firm, Speichim, contracted to build a plastics plant in the U.S.S.R. using technology licensed from Stauffer & Company, the U.S. chemicals manufacturer. The process was for the production of vinyl chloride by cracking ethylene dichloride, and was transferred for a flat fee plus royalties.[58] A unit for manufacture of polyethylene cloth also was purchased in France.[59]

In 1964 a Japanese consortium installed a polyvinyl chloride plant at a contract price of $14 million with an annual capacity of 60,000 metric tons of PVC. The consortium included Toho Bussan, a subsidiary of Mitsui; Kureha Chemical for process technology; and Chiyoda Chemical for engineering work.[60] The Sekisui Chemical Company had earlier supplied a plant to manufacture polyvinyl pipe (1200 tons per year) and polyvinyl fittings (1200 tons per year).[61]

In 1969 Berner Industries of New Castle, Pennsylvania, supplied equipment for a plastics plant,[62] supplementing an earlier installation for plastic pipe by Omni Products Corp.;[63] the Japanese Mitsui group reportedly was negotiating another contract for an ethylene plant of 450,000 tons' capacity to use Lummus technology[64] (Lummus is an American firm). Valued at $50 million, the plant was scheduled for construction in Siberia.

We may conclude that while SK-B synthetic rubber is an original Soviet development, no internal engineering ability was developed to break away from exclusive use of this limited-use rubber. Thus Soviet chloroprene rubber today is Dupont, the styrene-butadiene copolymers are I.G. Farben; a plant for butyl rubber was supplied by Western companies, as was equipment for the production of other synthetics and rubber antioxidants, and for the processing of finished synthetic rubber.

[56] *Chemistry and Industry*, April 4, 1959, p. 464.
[57] *Chemical Week*, March 11, 1961.
[58] *Wall Street Journal*, July 22, 1965, 10:4.
[59] *Chemical Week*, March 11, 1961.
[60] *Chemical Week*, November 14, 1964, p. 23.
[61] *Ibid.*
[62] *Business Week*, September 20, 1969.
[63] *Chemical Week*, November 14, 1964, p. 23.
[64] *Wall Street Journal*, July 9, 1969. Installations of unreported origin include another PVC plant and a 3000-ton per year plant for tetrafluorethylene; see *Chemical Week*, November 14, 1964.

The Soviet production of acetylene, an input for synthetic rubber, was restricted in the 1950s to the calcium carbide process at a time when the Western world was moving into production of acetylene from hydrocarbons. The Soviets then bought three acetylene-from-hydrocarbon plants in the West, each utilizing a different process.

Rubber tire output has been traced to Western production equipment. Similarly, in plastics the Soviets have purchased production capacity for polyethylene, ethylene, polystyrene, and polyvinyl chloride—key plastics in the modern world. No indigenous large-scale plastics production has been traced, only pilot operations.

CHAPTER FOURTEEN

Western Assistance to the Glass and Cement Industries

WESTERN ASSISTANCE TO THE GLASS INDUSTRY

The glass industry provides one of the earliest examples of Soviet duplication of Western equipment after significant import of similar equipment. In 1929 the Lissitchansk glass factory installed 80 Fourcault sheet glassmaking machines.[1] The following April, in 1930, the Gusev glass plant in Moscow, with a capacity of 10,000 tons of window glass per year, installed ten new Fourcault sheet glassmaking machines, of which two were imported from Belgium but eight were Soviet-made copies of earlier imports.[2]

Fourcault machines were built from 1929 onward at the Moscow machine building plant, and an attempt was made to supply the equipment demands of the glass industry completely from domestic production.[3] However, the Soviet glass industry appears to have had more than the normal share of problems, whether equipped with foreign or domestic machinery. The Dagestanskii Ogni plant, equipped by a U.K. firm with Fourcault machines and with four Owens bottle-making machines capable of producing 20 million bottles per year, was able to produce only one and one-half million bottles per year, and this production was at a cost 11 times greater than estimated with 60 to 70 percent rejects.[4] In 1930, to help overcome technical problems, Steklostroi employed an American mechanical engineer, C. E. Adler, a specialist in the design of machinery for glass factories.[5]

Even as late as 1957, however, the industry journal *Steklo i keramika* (New York) was reporting numerous problems in the glass and ceramic industries. In the late 1950s the industry was reported to be greatly in arrears and with little innovative ability. These observations were coupled with recommendations that Western technology be adopted. One report specifically mentioned the Dagestanskii Ogni works and indicated that there the only design change from the

[1] *Die Chemische Fabrik* (Weinheim, Ger.), II, 52 (December 25, 1929), 541. See also Sutton I, p. 222, for equipment in the Bely Bychok Plate Glass Works built in 1927.

[2] *Economic Review of the Soviet Union* (New York), V, 8 (April 15, 1930), 162.

[3] *Glass and Ceramics* (Washington, D.C.), 1957, p. 379.

[4] Society of Glass Technology *Journal* (London), 1928, p. 198.

[5] Amtorg, *Economic Review of the Soviet Union* (New York), V, 3-4 (February 15, 1930), 57.

original machines had been a change in the bearings and belt drive—this being presented as "modern technology."

After World War II major plant facilities from the German glass industry, particularly the optical grinding and optical instrument industries, were transferred to the Soviet Union. These transfers included the famous optical plants at Jena with subsidiary plants at Berlin and Perna in Saxony. These plants were essentially the only optical glass and instrument manufacturers in Germany and in the year October 1943 to October 1944 produced a total of 1700 metric tons of clear transparent optical glass and 28 metric tons of colored filter glass.

The Karl Zeiss plant at Jena, 94 percent transported to the U.S.S.R.,[6] was modern and particularly well equipped, with over 100 diamond saws; two of these were 420 mm in diameter and capable of running at 900 rpm, giving a surface speed of 20 meters per second.[7] Zeiss manufactured many lines of optical and scientific instruments including optical comparators and projectors, micrometers, and lenses and prisms.[8] The main plant was reassembled at Monino, near Moscow,[9] and utilized Zeiss experts Eitzenberger, Buschbeck, and Faulstich to develop detector, remote control, and recording gear. Other optical glass and optical instrument firms removed to the U.S.S.R. included the Zeiss-Ikon A.G. works at Dresden; Elektro-Optik GmbH at Teltow, Berlin (100 percent removal); and a number of camera manufacturers.[10]

However, the transfer of the Zeiss and similar works did not guarantee transfer of German technical expertise. In 1930 the Moscow planetarium had been equippped by Zeiss,[11] and in 1965, twenty years after the Zeiss plants had been removed to Moscow, the rebuilt Zeiss plant in Jena provided a two-meter-diameter mirror for solar, planetary, and satellite observations at the Shemakinskaya observatory.[12] The backwardness in optical, and particularly spectroscopic, instruments was confirmed by Soviet academician S. L. Mandel'shtam: "The design and production of these important instruments lags behind our needs and world quality standards. We are forced to buy abroad, and these are among the most expensive instruments."[13]

Laboratory glass exemplifies this technical backwardness. Up to about 1930 only one type of laboratory glass was used: type "No. 23" developed by V.

[6] G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen, 1951), p. 105.

[7] CIOS no. XXVII-23, *Optical Grinding and Centering Equipment Used by Karl Zeiss, Jena, 1946.*

[8] *Machine Tools*, (Washington: U.S. Foreign Economic Administration, Interagency Committee on German Industrial and Economic Disarmament, July 1945), p. 48.

[9] Werner Keller, *Ost Minus West=Null* (Munich: Droemersche Verlagsanstatt, 1960), pp. 283, 357, 365.

[10] Harmssen, *op. cit.* n. 6, p. 105.

[11] Amtorg, *Economic Review of the Soviet Union*, V, 1 (January 1, 1930), 10.

[12] *Kommunist* (Yerevan), November 3, 1965, p. 1.

[13] U.S. Senate, *Soviet Space Programs, 1962-65; Goals and Purposes, Achievements, Plans, and International Implications*, Staff Report, Committee on Aeronautical and Space Sciences, 89th Congress, 2d session (Washington: U.S. Government Printing Office, 1966), p. 351.

Ye. Tishchenko in 1899 and used continuously from 1900 to the present day. Although having certain disadvantages as well as advantages over standard foreign laboratory glasses (Jena 1920 and Pyrex), its chemical endurance is such as to merit its continued use. After 1930 manufacture of four other types was added to No.23; these types were Pyrex, No.846, Neutral, and Improved White.[14] These five varieties provided enough flexibility for laboratory requirements until the 1950s, when a few additional standard types were manufactured; however, the varieties manufactured in 1968 mainly consist of the old, established types including the original No. 23, Jena 20 (German), and Pyrex and Superpyrex (U.S.), plus imported glass from Czechoslovakia (Simax, Sial, Neutral, and Palex).[15]

In 1963 a British research delegation that was able to visit the three-year-old Glass Research Institute in Moscow particularly noted one laboratory that "carries out pilot plant work on glass manufacture on a scale that is equaled by only two or three laboratories in the whole of the Western world." This laboratory contained four small glass-melting tanks, but the major equipment was a large furnace capable of melting 70 tons of glass per day for a new experimental centrifugal spinner for the production of cone or back section of a cathode-ray tube for television receivers. The delegation concluded that this machine had many novel features and "seems to be an advance on other machines of this type in use in the Western world;"[16] apparently, however, it never reached development stage.

Manufacture of window glass, the largest tonnage glass product, exemplifies the present pervasive utilization of Western technology. The Fourcault process, imported in the U.S.S.R. in the 1920s soon after it was developed in Belgium, is the basis for standard Soviet glassmaking equipment. In this process the glass is drawn vertically in a continuous manner through a partially submerged "boat" with a narrow slot in the center over asbestos-covered rolls. The Soviet VVS machine is a replica of the Fourcault process (Figures 14-1 and 14-2), even utilizing direct translations of the integral parts of the process—for example, the "boat" is termed *lodochka* (a literal translation). Although the Colburn glassmaking process is known and described in Soviet texts,[17] it is not known whether the process has been utilized in practice.[18]

[14] *The Glass Industry* (New York), XXVI, 5 (May 1945), 228.

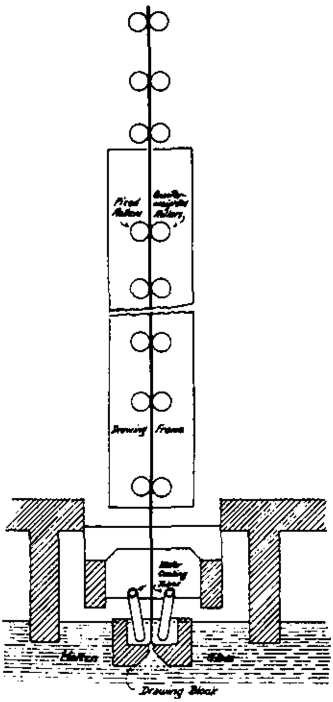
[15] *Spravochnik khimika* (Moscow) vol.V, 1968, pp. 333-34.

[16] *Visit to Glass Research Institute Moscow on 12th October, 1963*, Report by Confederation of British Industry, London, appendix E4. Unfortunately, no further trace of this machine has been found in the literature. See chapter 23 for technical assistance to the television industry; in 1967 the Soviets bought from France a pilot plant for manufacture of television tubes; *The Times* (London), February 1, 1967. Several months later Corning Glass in New York was reportedly negotiating for supply of glass, on which it holds patents, for color TV tubes to be used in this system; *Wall Street Journal*, May 23, 1967, 10:3.

[17] For example, I. I. Kitaigorodskii, *Tekhnologiia stekla* (Moscow, 1967), p. 336.

[18] This text also describes Soviet utilization of other Western glassmaking processes—for example, the Danner tube-making principle; *ibid.*, p. 418.

Figure 14-1 THE FOURCAULT PROCESS FOR SHEET GLASS MANUFACTURE

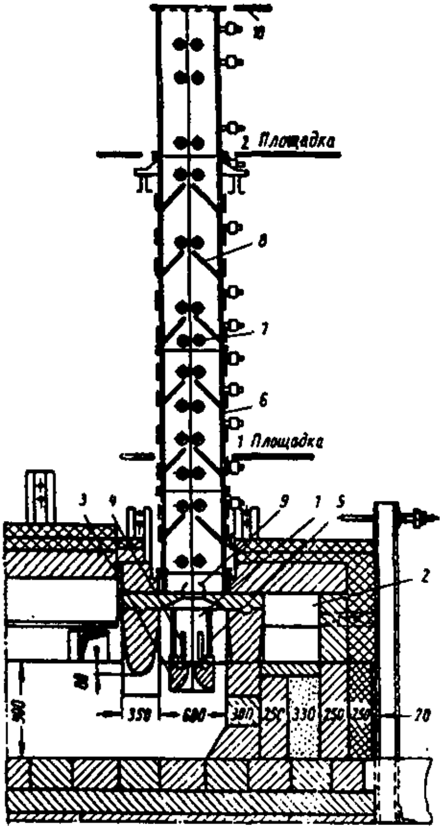


Source: Glass Industry, August 1928, p. 175.

In early 1967 the Soviet Union concluded a licensing agreement with Pilkington Brothers, Ltd., of Lancashire, England, to produce float glass in the Soviet Union. This is a new and revolutionary method of producing flat glass with a surface that does not need grinding after solidifying. By floating molten glass on a bed of liquid tin and making use of the solidification at different temperatures there is no requirement for rollers (as in the Fourcault process), which create imperfections requiring grinding. The agreement included supply of equipment by the Pilkington firm to a value of $4.2 million, sufficient to equip a plant to produce 50 million square feet of flat glass per year.[19]

[19] *Wall Street Journal*, March 30, 1967, 16:3.

Figure 14-2 SOVIET VVS MACHINE FOR SHEET GLASS MANUFACTURE



Source: I. I. Kitaigorodskii, *Tekhnologiia stekla* (Moscow, 1967), p. 319.

WESTERN ASSISTANCE TO THE CEMENT INDUSTRY

By and large the Soviets did not attempt to transport cement kilns to the Soviet Union under reparations, except for removals from Manchuria. (See Table 14-1.) The reduction in Manchurian cement capacity due to Soviet removals was approximately 890,000 metric tons with a replacement value of $17.8 million.

Table 14-1 MANCHURIAN CEMENT PLANTS REMOVED TO THE U.S.S.R.

Name	*Soviet removal or destruction*	*Metric tons capacity*	*Notes*
Harbin	none	110,000	Chicom territory
Mutanchiang	large	100,000	Chicom territory; Soviets removed equipment
Changtu	large	140,000	Chicom territory; Soviets removed equipment
Anshan	small	200,000	Some repairs needed
Miaoling	large	90,000	Equipment removed by Soviet Army.
Dairen	none	210,000	Under Soviet control
Kirin	large	260,000	Soviet Army removed almost all equipment
Chinhsi	small	150,000	50,000 metric tons capacity remaining
Fushun	small	210,000	80,000 metric tons capacity remaining
Liaoyang	small	180,000	90,000 metric tons capacity remaining
Penchihu	small	250,000	100,000 metric tons capacity remaining
Kungyuan	large	170,000	Soviets removed all equipment
Antung	large	130,000	Chicom territory; Soviets removed all equipment
Total		2,200,000 metric tons	

Source: Edwin W. Pauley, *Report on Japanese Assets in Manchuria to the President of the United States, July 1946* (Washington, 1946).

The Pauley Mission commented on the removals from six plants in the Fall of 1945 as follows:

> The six plants which suffered major removals by the Soviets were the most recently constructed and equipped with the newest machinery. The equipment which seemed to be particularly desired was the crushing, grinding, and pulverizing equipment, electric motors, generators, laboratory and testing equipment, and inter-plant haulage equipment. In one plant (Kirin) an attempt was made to cut the rotary kilns into sections and remove them. Fabricated fixtures were not ordinarily removed but they were usually badly damaged. Severe and wholly unnecessary damage to auxiliary equipment and buildings was characteristic of almost all stripped plants inspected by the Pauley Mission. There was a general appearance of complete devastation, probably due to the haste with which the Soviets were compelled to operate.... The nature of the removals has been such that restoration to former capacity of the plants affected will require almost complete rebuilding of the entire facilities.[20]

[20] Edwin W. Pauley, *Report on Japanese Assets in Manchuria to the President of the United States, July 1946* (Washington, 1946), pp. 217-18.

Equipment removals varied greatly and, as Table 14-1 reveals, extended even to plants under Chinese Communist control. At Fushun, Soviet removals were limited to office supplies and equipment, testing equipment, automotive vehicles, a considerable number of cement bags, and some cement; similarly, at the Anshan plant only some equipment was removed. At Kungyuan, however, a complete removal job was undertaken; railroad tracks were laid into the center of the 170,000-metric-ton capacity cement plant to facilitate loading of equipment onto rail cars, and parts of the buildings were destroyed to remove machinery. This was a portland cement plant with a typical dry process; the American engineer (N.M. Taylor) who inspected the plant for the Pauley Mission reported that the rock crushers, belt conveyers, and overhead cranes were removed completely; the drive mechanism from two 70-meter kilns was removed, as was the drive mechanism from five (of eight) ball-reduction mills. The coal pulverization plant, four bagging machines, and the steam turbine generator were also removed.

At Penchihu only the steam turbine generators and about one quarter of the electrical control equipment were removed; while equipment at the Kirin plant, a 220,000-ton-per-year portland cement producer, was almost completely removed, including a gyratory crusher, two hammer crushers, three material dryers, five clinker mills, three cold dryers, one coal mill, two rotary kilns (only the blowers were taken, the kilns were not removed), two waste heat boilers, two turbogenerators, 38 transformers, 107 electric motors, and 18 machine tools.

Of a total of 2.2 million tons capacity affected by Soviet removals, about 890,000 tons was completely removed to the U.S.S.R.; the balance suffered selective equipment removals.

In East Germany only one cement plant was removed—Zementwerk at Niedersachswerfen.[21] The great prize in Germany was the Magdeburg works of Krupp-Gruson A.G., before the war one of the world's leading manufacturers of heavy machinery and structural steel fabrication; its principal products included heavy machinery for crushing and grinding and complete cement manufacturing plants. According to the U.S. Strategic Bombing Survey, only about 10 percent of the equipment in this plant was destroyed and another 10 percent damaged.[22] Consequently, the Soviets received an advanced and almost complete plant for production of complete cement plants. The immediate task of the plant was to provide a cement-making capacity of six million metric tons per year for the Soviet Union.

Although the Soviets have standardized domestic production of cement plants they have continued to buy advanced technology on the world market. In 1959–60

[21] Harmssen, *op. cit.* n. 6, p. 107.

[22] U.S. Strategic Bombing Survey, *Friedrich Krupp Grusonwerke, Magdeburg, Germany*, January 1947.

the largest cement plant in the world was built in Siberia by the French company Société Fives-Lille-Cail of Paris. The company provided a complete cement manufacturing installation including two 19-by-575-foot kilns. Construction of the plant was supervised by French engineers with startup and performance tests conducted by the Fives-Lille-Cail company. The production capacity is 33,000 barrels of Type I portland cement per day from an unusual mixture of limestone and nepheline residues. The technology in this plant was certainly the most advanced in the world at the time the plant was built. For example, the grinding department, the largest in the world, produced two grades of portland cement in mills 10 feet 5 inches in diameter and 46 feet long, each unit weighing 260 tons, loaded with upwards of 170 tons of grinding media and designed to run at 19 rpm through 2500-hp helical reducers. The storage and bagging facilities reflected the plant's size and included 20 silos with a total storage capacity of 80,000 tons, i.e., 16 days kiln production.[23]

In general, a large number of Soviet cement kilns have been manufactured abroad, although there is domestic production of standard designs.[24] The extent of internal use of foreign designs may be broadly gauged from a report of the French cement industry delegation to the U.S.S.R. in 1960.[25]

The description of cement plants visited by that delegation suggests they contain a considerable quantity of Western-manufactured equipment and Western equipment copied in the Soviet Union. It was reported that the Vorovskoi plant, built in 1911 and modernized in 1930 and 1945, with a current production of 325,000 tons, uses four Smidth (Copenhagen) furnaces; the crusher equipment was Krupp and Smidth with one crusher from the "Urals plant" (probably Uralmash).

At the Sebriakov plant near Stalingrad, with its annual production of one million tons of cement considered one of the most modern plants in the Soviet Union, it was noted that the crushing plant used 12 Wilfley-type pumps, with furnaces by Tellman in East Germany; the power station equipment was from Tempella in West Germany, and three turbo-alternators came from Skoda in Czechoslovakia. The crushing equipment was built in the Urals.

At the Novorossisk plant, founded in 1880 and expanded over the years, the delegation noted a considerable quantity of equipment of Western origin. The Novorossisk combinat comprises four plants: the October, with a capacity of one million tons per year; the Proletariat, with a capacity of 1,150,000 tons per year; the October Victory, with a capacity of 300,000 tons; and the First of May, also with a capacity of 350,000 tons. The Proletariat plant was not visited by the delegation, but it reported concentrators with Smidth Folax

[23] *Rock Products* (Louisville, Ky.), May 1959, pp. 128-31. See also E. I. Khodorov, *Pechi tsementnoi promyshlennosti* (Leningrad, 1968), p. 90.

[24] E. I. Khodorov, *op. cit.* n. 23, pp. 82-83.

[25] *L'Industrie cimentière en U.R.S.S.*, Compte rendu de mission 9-28 avril 1960 (Paris, 1960).

equipment. The October Victory plant was not visited. Equipment at the October was reported to be five Krupp crushers, five crushers manufactured in the Urals, and five Dorr-type silos of 500 cubic meters; the furnaces were identified as Tellman (Magdeburg). The First of May plant had four Lepol-type firing units, two standard Polysius (East Germany) granulators, and one large Polysius granulator; the plant uses a dry process of the Lepol type with equipment furnished by Polysius at Dessau and Magdeburg; the bagging machinery is from Smidth.

In the Soviet glass industry, the large-tonnage window glass sector is based on the Belgian Fourcault process with recent addition, with British equipment and technical assistance, of a Pilkington Brothers, Ltd., float glass unit. Glass tubing manufacture uses the Danner process, and laboratory glass production appears to consist of a limited range of types including a number of U.S. and Czechoslovakian glasses, and, notably, the Russian No.23 Tishchenko formula developed in 1899. Optical glassmaking is technically backward.

The cement industry utilizes a significant proportion of foreign equipment. The most advanced mills (for example, in Siberia and Sebriakov) utilize extensive foreign equipment in the kiln and crusher sections. Soviet domestic production of cement plants is of the standard type with no observable departures from world practice.

CHAPTER FIFTEEN

Western Technical Assistance to the Textile, Synthetic Fiber, and Pulp and Paper Industries

TEXTILES AND CHEMICAL FIBERS

Western assistance to the textile industry in the 1920s has been described in the first volume of this series.[1] In addition to the technical assistance in the period 1929-1931 provided by Lockwood Greene, a U.S. firm, and French technical assistance for the manufacture of viscose, there was a large supply of U.S., British, and German machinery for textile plants. The Kirovsky combine received textile equipment from the United States valued at $800,000 in 1930,[2] the Krasnaya Shelk textile plant received U.S. equipment in 1928,[3] and the large textile combine at Ivanovo-Voznesensk received 100,000 spindles, mostly from the U.K. firm of Tweedales and Smalley of Manchester, with warping machines from Schlafhorst of München Gladbach in Germany.[4] The Schlafhorst company also supplied warping machines for the Shuya Melange textile mill in 1932.

Some textile mills were also directed by foreign engineers. For example, in 1930 Samuel Fox was hired as a mechanic at $510.00 per month with a group of other American mechanics and sent to Baku to erect and start operation of a textile plant equipped with machinery from the United States. Fox directed the installation of equipment and later became director of the mill.[5]

Textile plants from East Germany were removed to the Soviet Union in 1945-46. Two large artificial silk spinning operations in Saxony (the Pirna and Sehma plants of Fr. Küttner A.G.) were completely removed to the U.S.S.R.,[6] and two Brandenburg units, the Premnitz plant of Agea and the Kurmärkische Zellwoll-AG plant at Wittenberge, both artificial silk producers, were removed, the former about 50 percent and the latter about 80 percent. Regular spinning mills appear to have been only partly dismantled; eight plants

[1] See Sutton I, pp. 231-33.
[2] Amtorg, *Economic Review of the Soviet Union* (New York, II, 11 (June 1, 1930), 224.
[3] *Ibid.*, V, 16-17 (September 1, 1930), 351.
[4] U.S. State Dept. Decimal File 861.5017/1c/684.
[5] U.S. State Dept. Decimal File 861.5017/Living Conditions/144, March 25, 1930.
[6] All data in this section from G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen, 1951), p. 109.

in Saxony, three in Thuringia, and one in Mecklenburg were partly removed to the U.S.S.R. Of the nine weaving mills removed from Saxony, only one, the Mechanische Weberei at Grimma, was completely removed. Similarly, only six finishing operations were affected by dismantling—none was reported completely removed.

In 1954 an upgrading process began, and a large contract was granted Platt Brothers of the United Kingdom for the supply of $19.6 million worth of machinery to equip plants in the cotton, worsted, spinning, weaving, and finishing sections of the industry; numerous textile machine firms in Yorkshire and Lancashire participated in supply.[7] In 1958-59 Courtaulds, Ltd., supplied machinery and technical assistance for several rayon and cellulose acetate plants;[8] Fawcett Preston & Company of Bromborough, Cheshire, secured an order for nine pulp-steeping presses and two fiber-baling presses to be incorporated in this rayon plant;[9] and Kestner Evaporator & Engineering Company, Ltd., supplied Keebush equipment to Courtaulds for installation in the plants.[10]

In 1959 a plant for the production of rayon was supplied by Vickers-Armstrongs (Engineers), Ltd., and Highpolymer and Petrochemical Engineering Company, Ltd., for a total value of $7 million,[11] with $1 million worth of instrumentation supplied by Honeywell Controls, Ltd., a subsidiary of the U.S. firm.[12] A few years later, in 1966, Bentley Engineering Group (a subsidiary of Sears Holdings, Ltd.) received an order valued at $14 million for knitting machinery to equip two new knitting mills.[13]

Italian companies also have been prominent suppliers of textile machinery since World War II. In 1959 Châtillon supplied equipment for a high-tensile-strength cord fiber plant.[14] Further textile mill equipment was supplied under a contract with Sniaviscosa,[15] and in 1967 a contract was awarded the Sant'Andrea company of the Bombrini Parodi Delfino group and the Nuova San Giorgio firm of the IRI Finmeccanica group for machinery to equip a 50,000-spindle mill for the production of mixed woolen and synthetic yarns.[16]

A/B Karlstads Mekaniska Werkstad of Sweden received an order in 1959 for the "design and complete installation and equipment for a viscose rayon factory" (annual capacity of 200,000 tons of prehydraulized sulfate viscose rayon), and machinery was supplied by several Swedish factories.[17]

In 1958 a significant international arrangement to supply three synthetic

[7] *New York Times*, May 20, 1954, 3:6.
[8] *Chemistry and Industry* (London), August 2, 1958.
[9] *East-West Commerce* (London), VI, 12 (December 8, 1959), 6.
[10] *Chemistry and Industry*, December 2, 1961, p. 1968.
[11] *Chemistry and Industry*, May 9, 1959, p. 609.
[12] *Electrical Review* (London), 167 (August 1960), 308.
[13] *Wall Street Journal*, August 19, 1966, 11:6.
[14] *Problems of Economics* (New York), III, 4 (August 1960), 23.
[15] *Ibid.*
[16] Communication from Italian Embassy, Washington D.C.
[17] *East-West Commerce*, VI, 9, (September 28, 1959), 4.

fiber (probably rayon) plants to the U.S.S.R. was headed by Von Kohorn International Corporation of New York. Under this arrangement equipment was supplied by the U.K. firms of Baker Perkins and the A.P.V. Company, while Von Kohorn was "responsible for technical advice connected with the engineering and machinery part of the contract."[18]

Over $30 million worth of machinery was acquired in the United States in 1960 from a consortium of 40 U.S. textile equipment manufacturers. This, the largest single order received from the U.S.S.R. since the end of World War II, provided equipment for a 50,000-spindle mill at Kalinin, to spin, weave, and finish cotton, worsted, and man-made-fiber fabrics. This order was in addition to $6-7 million worth of similar equipment previously shipped by Intertex Corporation, a trading firm representing the 40 U.S. textile machinery manufacturers. Of the total $30 million, $20 million was paid in cash.[19]

Some of the principal equipment—to give an idea of the magnitude of the arrangements—included the following[20]:

Crompton & Knowles	630 type W-3 looms
Saco-Lowell	VersaMatic drawing frames S.J. spinning frames (MagneDraft) Saco-Lowell worsted frames
Whiting Machine Works	20,000 American system worsted spindles
Rodney Hunt	One continuous peroxide bleaching range

The 1962 report of an Indian textile delegation[21] covered nine of the larger textile mills with spinning departments. These were reported as old installations—"some of them 150 years and a few about 30 years old." They clearly represented the two eras of textile mill construction, the first under the Tsars and the second in the late 1920s and early 1930s by British and German companies. This imported equipment was supplemented by domestic duplicates of foreign equipment; neither the Indian nor the U.S. delegation noted indigenous innovation.

Duplication of Western Textile Equipment

In the late 1920s the Soviets started to copy Western textile equipment, and by 1928 the Shunsk mechanical plant at Ivanovo-Voznesensk produced its one thousandth automatic loom of the "Northrup type."[22]

[18] *Chemistry and Industry*, June 21, 1958, p. 763.
[19] *American Machinist* (New York), January 11, 1960, p. 84.
[20] *Textile World* (New York), February 1960, p. 4.
[21] *Textile Industry in the U.S.S.R. and Czechoslovakia* (New Delhi: National Productivity Council, November 1962), Report no. 19.
[22] Amtorg, *Economic Review of the Soviet Union*, III, 9 (April 15, 1928), 161.

In 1958 the U.S. Cotton Delegation visited the Tashkent textile machine construction plant, perhaps the largest manufacturer of roving frames, spinning frames, and twisters in the U.S.S.R. After noting that in the machine shop "there were many U.S.-made lathes and shapers in operation," the delegation reported that the plant expected to go into production of a "new apron-type long draft roving ... an improved Platt design which the staff had modified."[23]

The Indian delegation[24] noted that the blowroom lines in all Russian mills had the following equipment: porcupine opener, Crighton opener, double porcupine opener, and Scutchner with Kirschner beater. Carding machines were of the "ordinary" type with one mill using "Shirley type of cards." The only nonconventional (i.e., non-Western) equipment noted was used in the grinding of flats: "Flats are ground once in three months on Russian-made single flat-grinding machines. Their flat grinder is different in design and manufacture from the types common in our country."

In the drawing process "there was nothing particularly striking" and the mills used the "conventional" process, except that one mill used Saco-Lowell combers with heavy laps. Russian ring frames were "ordinary and conventional models"[25] with conversion to the Blaus-Roth type. In doubling, the Roto-Coner type machine was "generally used," and for multiple and winding a "similar type of English and Japanese double diner is used."[26]

In 1947 a shuttleless loom similar to the shuttleless loom weaving machine produced by Sulzer of Winterthur, Switzerland, was developed by Leonytev of the Moscow Textile Institute.[27] The U.S. delegation also noted winders of the Leesonia type[28] and "imperfect copies" of the Franklin Process package dyeing equipment.[29]

WESTERN DEVELOPMENT OF SOVIET SYNTHETIC FIBER CAPACITY

Soviet production of synthetic fibers is well behind that of the Western world. In 1965, of a total production of 407,300 metric tons of chemical and synthetic fibers, only 77,900 tons was synthetics; the bulk of the Soviet production

[23] U.S. Dept. of Agriculture, *Cotton in the Soviet Union*, Report of a Technical Study Group, Foreign Agricultural Service (Washington: U.S.G.P.O., June 1959), p. 5.
[24] *Ibid.*
[25] *Ibid.*, p. 58.
[26] *Ibid.*, p. 59.
[27] *Encyclopedia of Textiles* (Englewood Cliffs, N.J.: Prentice-Hall, 1960), p. 242.
[28] U.S. Dept. of Agriculture, *op. cit.* n. 23, p. 6. See Russian literature for more detail; for example see A. M. Liberman, *Organizatsiia i planirovanie predpriiatii tekstil'noi promyshlennosti* (Moscow, 1969), p. 167, for manufacture of Barber-Coleman winders.
[29] U.S. Dept. of Agriculture, *op. cit.* n. 23, p. 10.

was viscose fiber, which accounted for just under 75 percent of all chemical and synthetic fiber production in 1965.[30]

Although no breakdown by type of synthetic fiber has been traced in Soviet literature, it is estimated that the Soviets produced the following quantities of synthetic fibers in 1965:

Nylon	65,575 metric tons
Polyester	7,331
Acrylics	2,851
Polyvinyl chloride	1,629
	77,386 metric tons

This is a significant increase from the approximately 13,500 tons produced in 1956 (all Nylon 6), but still far below the U.S. production totals. In 1954, for example, the United States produced over 132,000 tons of synthetic fibers, just under twice the Soviet 1965 production.

Most Western observers comment on the extensive and potentially valuable research on synthetic fibers undertaken in the U.S.S.R. Writing in 1960, I.V. Maistrenko of the Institute for the Study of the U.S.S.R.,[32] described the work of VNIIV (All-Union Artificial Fiber Research Institute) while pointing out Soviet weaknesses in the engineering aspects of synthetic fiber production. E. M. Buras, Jr., in a detailed two-part summary of Soviet synthetic fibers in 1961, concluded that "if its fiber industry lags in growth, the cause will not be any lack of research and development capacity."[33]

In 1960 the Soviets were publishing papers on synthetics at the same rate as U.S. authors; Buras points out that "if we were to list references on synthetic fiber research, about 400 authors in all would have to be cited."[34] This activity was accompanied by cooperation with Czechoslovakia on 81 projects at 112 laboratories in the U.S.S.R. and Czechoslovakia. Further, Buras has outlined areas of research which the U.S. had hardly investigated and where the Soviets were deeply involved—particularly "elementorganic" polymers with possible military applications.[35]

[30] The Soviets have not always distinguished between synthetics and chemical fibers; a distinction has been maintained where possible throughout this section.

[31] These figures were calculated as follows (the Soviets have not published production figures for each synthetic): total for all "chemical" fibers (including synthetics) is given in *Narodnoe khoziaistvo SSSR, v 1968g.: Statisticheskii ezhegodnik* (Moscow, 1969), p. 253; the percentage of each type is given in *50 [Piat'desiat] let sovetskaya khimicheskaya nauka i promyshlennost'* (Moscow, 1967), p. 366.

[32] *Industrial and Engineering Chemistry* (Washington, D.C.), February 1960, pp. 44A-48A.

[33] *Chemical and Engineering News*, July 31, 1961, p. 134.

[34] *Ibid.*, August 7, 1961, p. 83.

[35] *Ibid.*

Finally, a report by two U.S. Army research scientists[36] concluded that by the end of the 1950s the Soviets had made independent advances in synthetic fibers; indeed, they had produced three synthetics with no counterpart in the West, and were cooperating with satellite countries in this research. Much Soviet research was being directed to military applications of fibers, and the authors point out:

> A possible threat from Soviet textile research lies, not in the development of slightly improved counterparts of nylon, Orlon, etc., but in the possibility of a real breakthrough emanating from extensive work in this field of new and unusual fibers.[37]

Three new research achievements reportedly were "Enant," a Nylon 7 represented as a new fiber made from cheap raw materials; "Ftorlon," a process which was said to have better mechanical properties than the Western "Teflon"; and "Vinitron," which was described simply as a "superior" product.[38]

Yet despite this obviously ambitious and viable research program, we find that all Soviet large-scale production facilities for synthetics have derived in greater or lesser degree from the West.[39]

Origins of Nylon 6 (Kapron) and Nylon 66 (Anid) Technology

The synthetic fiber nylon, made from benzene, hydrogen, and oxygen with no vegetable or animal fibers, originated with basic work in the 1920s at Dupont in the United States. Nylon 6 was developed and patented by Paul Schlack in Germany[40] and is known in Germany as "Perlon," while Nylon 66 was selected from among many possible nylons and established on a commercial scale in the United States in 1938; this nylon requires commercial quantities of two intermediates, hexamethylene diamine and adipic acid, the latter—as we shall see later—proving a problem for the Soviets.

Although considerable progress was made in the United States before World War II and in Germany during the war, the Soviet Union had no capacity for producing synthetic fibers (i.e., completely man-made fibers) at the end of World War II. The first Soviet synthetic fiber plant was brought into production

[36] R. C. Laible and L. I. Weiner, "Russian and Satellite Research and Development in the Field of Synthetic Fibers," *Textile Research Journal* (New York), 30, 4 (April 1960).
[37] *Ibid.*, p. 247.
[38] *Ibid.*
[39] This contrast has been noted in Western trade journals. For example, an editorial entitled "The Soviet Puzzle," *Skinners Silk and Rayon Record* (London), 37, 7 (July 1962), asks, "But why is there apparently such a gap between research and commercial development?"
[40] U.S. Patent No. 2,242,321 of May 6, 1941 (assigned to I. G. Farbenindustrie A. G.). The Soviets make a claim for Nylon 6 (Kapron) as a Soviet development in 1944; see *Bol'shaia Sovetskaia Entsiklopediia*, 2d edition (Moscow, 1949), vol. 9, p. 14.

at Klin in 1948[41] for the production of Kapron, i.e., Nylon 6. Large-scale production of Perlon (also Nylon 6) started in Poland at Landsberg (Gorzow) in 1941 with an annual production of 8.7 million pounds of Nylon 6 and one million pounds of Nylon 66.[42] This plant was owned by I. G. Farben, assignee of the Schlack patents, and used intermediates from the Leuna works. According to A. Zauberman,[43] the Landsberg plant was dismantled and shipped to the U.S.S.R. in 1944; it is probable that the first Soviet Kapron (i.e., Perlon or Nylon 6) plant at Klin was the rebuilt Landsberg plant. In fact, the Soviets may have acquired more than the Landsberg plant. For example, one excellent source comments:

> Much of the work on the production and spinning of synthetic polymers was done in Eastern Germany, in works which were either not seen at all or which could be only very superficially examined before they were taken over by the Russian forces. This may explain the scantiness of the available information about the spinning of polyurethane fibres ... vinylidene chloride copolymers ... [and] acrylonitrile polymers.[44]

Two other plants at Kiev and Riga (in former Latvia), both producing Kapron, were brought into production in the 1950s, and in 1956 Soviet production of Nylon 6 was 25 million pounds—which may be compared with U.S. production of 265 million pounds of all synthetic fibers in 1954. In 1960 Nylon 6 was the only synthetic fiber in full-scale production in the Soviet Union.

During the 1950s and 1960s a number of plants were built using the Schlack process of melt spinning and cold drawing the fiber from the condensation polymer of ϵ-caprolactum; these included Chernigov in the Ukraine, Mogilev in Soviet Armenia, the Engel plant in Saratov, Darnitsa in Kiev, and the Kalinin plant.

Kapron production was stressed over other synthetics for two reasons, according to A. L. Borisov:[45] first, there was an improvement in caprolactum production (the raw material for nylon), and second, the Kapron plants required relatively lower capital investment. In the fifties there was criticism in the technical literature concerning the substandard caprolactum supplied by Soviet plants; this quality problem was overcome by the supply of equipment from Germany for two

[41] E. P. Ivanova, *Ekonomika promyshlennosti khimicheskikh volokon* (Moscow, 1968), p. 30. The Soviets include synthetics within the "chemical fiber group"; the statistics in Ivanova are far more detailed for the United States and Europe than for the U.S.S.R., for which data are expressed as percentages computed from an undisclosed base.

[42] *Encyclopedia of Chemical Technology*, 2d edition (New York: John Wiley, 1963), vol. 16, p. 47.

[43] A. Zauberman, *Industrial Progress in Poland, Czechoslovakia, and East Germany, 1937-1962* (New York: Oxford University Press, 1964), p. 267.

[44] A. R. Urquhart, *The German Rayon Industry During the Period 1939-1945* (London, 1952), BIOS Subcommittee Survey Report no. 33, pp. 25-26.

[45] Soviet State Committee on Chemistry, quoted in *Chemical and Engineering News*, July 21, 1961, p. 131.

10,000-ton-per-year caprolactum (from aniline) plants, a caprolactum distillation plant, two caprolactum continuous polymerization plants, and a 10,000-ton adiponitrile-hexamethyl-enediamine plant.[46] This equipment—the core of the caprolactum manufacturing process—was installed at Soviet plants at Kirovakan (for the Kapron plant at Razdan), the Gubakha plant, and the Lisichansk plant in Kiev.

Continuing Soviet technical problems with the production of caprolactum were again eased in 1964 by the purchase of two caprolactum plants from a British-Dutch consortium. Two Japanese firms, Ube Industries, Ltd., and the Nissho Trading Company, were also competing for an order finally awarded by Tekhmashimport to a group including Simon-Carves of the United Kingdom and the Dutch State Mines for a bid of $25 million. Capacity of the caprolactum plants was 50,000 tons each per year.[47]

Therefore it may be seen that the enormous increase in Nylon 6 (Kapron) production in the U.S.S.R. has been dependent on supply from West Germany and the United Kingdom of key equipment and technical assistance for the manufacture of its essential raw material caprolactum.

Little practical success has been achieved in producing other nylons, although much research has been undertaken. Pilot plant production of Anid (Nylon 66) as made by Dupont and British Nylon Spinners was started in 1956 and small-scale production started at Kursk after Krupp installed German nylon spinning equipment. Part of the problem encountered in this production appears to have been a shortage of adipic acid; this lack was only partly offset by blending the available supply of hexamethylene adipamide salt with caprolactum (from the German and British plants) and hexamethylene azelaamide to form a mixed-fiber Anid G-669 and H-669. Another fiber, Enant (or Nylon 7), has been produced in small quantities only.

Other synthetic fibers produced in commercial quantities are Lavsan, Nitron, and Kanekalon.

Krupp Construction of the Stalinogorsk-Kursk Lavsan Complex

Between 1958 and 1961, under a $14 million contract, Krupp of West Germany built a polyester fiber (polyethylene terephthalate) complex of three plants in the Soviet Union.[48] The fiber produced by this complex is known in the U.S.S.R. as Lavsan. Its patents are held by Imperial Chemical Industries, and it is known as Terylene in the United Kingdom and Dacron in the United

[46] *Ibid.*

[47] *New York Times*, September 13, 1964. In 1967 it was reported that the Soviets were seeking six additional caprolactum plants in Germany; *Wall Street Journal*, April 14, 1967, 4:4.

[48] *East-West Commerce*, V. 6 (June 16, 1958), 3; *Chemical and Engineering News*, July 31, 1961, p. 132. It was reported in 1967 that the Soviets were purchasing six polyester plants, with total capacity of 60,000 tons per year, in Czechoslovakia; *Wall Street Journal*, April 14, 1967, 4:4.

States. The first unit built by Krupp was at Novo Kuibyshev to convert petroleum stock into *p*-xylol, which is shipped to a second Krupp-built plant at Stalinogorsk for conversion into dimethyl terephthalate. This stock in turn is shipped to the third Krupp-built plant at Kursk, where the raw material is spun into Lavsan polyester fiber. The project has capacity to produce six million pounds of Lavsan annually.[49]

Polyspinners, Ltd., Construction of the Siberian Lavsan Plant

Imperial Chemical Industries, in a continuing association going back into the 1930s, has made available to the Soviet Union polyethylene manufacturing technology and information on manufacture of polyester fibers and petrochemicals.[50] In May 1964 the company headed a consortium known as Polyspinners, Ltd., which signed a contract worth $140 million—probably the largest British contract with the U.S.S.R. since the Bolshevik Revolution and itself part of a larger agreement. The Polyspinners consortium was required to build a combine in Siberia for the production of a polyester fiber developed from terephthalic acid and ethylene glycol, i.e., Terylene or Dacron. The contract was guaranteed by the British Government under its Export Credit Guarantee Program, and bank credit provided for a 12- to 15-year loan to assist the Soviets in paying for the complex. Utilizing British engineers as supervisors, the combine was built at Irkutsk in Siberia with Russian operating engineers trained at ICI plants in the United Kingdom.[51] The chief construction companies were John Brown & Company, Ltd., of Scotland and Stone Platt of England; numerous other British companies made up the consortium, some of which were the following:[52]

Baker Perkins Chemical Machinery, Ltd.	Loadcell weighing equipment
Gardners (Gloucester)	Large drum blenders
Sigmund Pulsometer Pumps	Pumps
Sharples (Camberley)	Centrifuges
Hydrotherm Engineering, Ltd.	High-temperature heating systems
W. P. Butterfield, Ltd. (Engineering)	Stainless and mild-steel pressure vessels
Lawrence Scott and Electromotors	Electrical machines and control gear
Aiton & Co., Ltd.	Agitators
Gibbons Bros., Ltd.	Shell and tube-heat exchangers
English Electric Co.	Electric motors and switchgear
Dunford & Elliott Process Engineering, Ltd.	Rotary louvre pryers
Petrocarbon Developments	High-purity nitrogen plant

[49] *Chemical and Engineering News*, July 31, 1961.
[50] *Ibid.*
[51] *New York Times*, May 17, 1964.
[52] P. Zentner, *East-West Trade: A Practical Guide to Selling in Eastern Europe* (London: Max Parrish, 1967), p. 78.

Purchase of Japanese Kanekalon and Acrylonitrile Plants

The Soviet-Japanese trade agreement of March 1959 included provision for Soviet purchase of technology and a production plant for Kanekalon, a Japanese-developed synthetic fiber based on acryl and blended with 60 percent polyvinyl acetate and 40 percent acrylonitrile. For a total purchase price of $30 million the Soviets received patent rights, engineering data, and plant equipment to produce 30 tons of Kanekalon and 15 tons of acrylonitrile daily. This amount was apportioned three-quarters to the Kanekalon and one-quarter to the acrylonitrile, the former being supplied by Kanegafuchi Chemical Company and the latter by Toyo Koatsu Industries. Machinery came from several Japanese companies: filament spinning equipment from Kawasaki Aircraft; instrumentation from Yokogawa Electric; and electric motors from Tachikawa and Toshiba. It is notable that the capacity of the plant was large by Japanese standards; payment terms provided for 20 percent down and the balance over five years.[53] The agreement included the necessary training of Russian engineers and technicians in Japan.[54]

Several years later, in 1965, it was reported that the Asahi Chemical Company in Tokyo had sold the Soviets "the world's largest acrylonitrile monomer manufacturing plant," at a cost of $25 million.[55]

The other half of the Soviet acrylic fiber capacity has come from Courtaulds, Ltd., in the United Kingdom. In April 1959 Courtaulds concluded a $28 million contract for the construction of a complete acrylic fiber plant and related supply of process technology and technical assistance. This single plant doubled Soviet 1960 acrylic fiber production.[56]

WESTERN ASSISTANCE TO THE PULP AND PAPER INDUSTRY

In 1930 the Soviet Union had a shortage of paper and wood pulp and both were imported in substantial quantities; pulp and papermaking machinery was not produced in the Soviet Union until after 1932.[57] The large pulp and paper plants built in the Soviet Union before 1930 were with complete American equipment and technical assistance. The Balakhna plant, with a capacity of 88,200 tons of pulp and 145,000 tons of paper including 133,000 tons of newsprint, started operation in 1928; a second section was activated in 1930. All equipment—General Electric control units and Bagley Sewall papermaking

[53] *The Oriental Economist* (Tokyo), October 1960, p. 555.
[54] *Chemical and Engineering News*, July 31, 1961.
[55] *Los Angeles Times*, August 31, 1965.
[56] *Chemical and Engineering News*, July 31, 1961. See also R. W. Moncrieff, *Man-Made Fibres* (New York: Wiley, 1963), p. 695.
[57] *Za Industrializatsiiu* (Moscow), February 21, 1931.

equipment—was imported. The Siaz plant started operating in 1930 with a capacity of 144,000 tons of pulp per year, again with completely imported equipment, part from Norway and part from the United States, including Thorne bleaching towers.[58] The Kondopoga plant started its first section in 1930, and foreign technical assistance and equipment for this plant was so extensive that American foremen supervised the mill as late as October 1933.[59]

Plants built in the Soviet Union after 1933 and before World War II used domestic duplicates of foreign equipment, particularly the Fourdrinier machine; some outside assistance was given during the Lend Lease era, when $367,000 worth of pulp and paper industry machinery was shipped to the Soviet Union.

Table 15-1. ORIGIN OF SOVIET PAPER, BOARD AND PULP CAPACITY AS OF 1958

Origin	Paper (Metric Tons)	Board (Metric Tons)	Pulp (Metric Tons)
Russia (pre-1917)	247,800	8,200	91,000
Soviet Union (1917-58)	509,720	26,500	977,750
Manchuria (reparations)	13,000	—	33,000
Baltic States (occupation)	110,500	—	252,000
Finland (occupation)	119,700	45,000	417,000
South Sakhalin (occupation) (Karafuto)	1,277,000	—	2,492,000
Total (1958)	2,277,720	79,700	4,262,750

Source: Pulp, Paper and Board Bills: Union of Soviet Socialist Republics, (New York: American Paper and Pulp Association, April 1959), p. 6.

Note: Excludes East German reparations and Lend Lease equipment.

Although these mills provided sizable additions to Russian pulp and paper capacity before and during World War II, the extraordinary increment of capacity came after Soviet occupation of Finland, the Baltic States, and Karafuto (South Sakhalin), with lesser increments provided by equipment removals from Manchuria and East Germany. In 1958 Soviet sulfite, sulfate, and mechanical pulp capacity totaled 4,262,750 metric tons, of which 91,000 metric tons was prerevolutionary capacity and 894,750 metric tons built in the Soviet period. The balance, i.e., 75 percent of capacity, was from Finnish, Baltic, and Karafuto mills.

A total of 252,000 metric tons of pulp capacity and 110,500 metric tons of paper capacity was added by mills in Lithuania, Latvia, and Estonia. In Lithuania the Soviets gained the 70,000-ton sulfite pulp mill at Klaipeda; in

[58] Amtorg, *Economic Review of the Soviet Union*, V, 10 (May 1930), 210.
[59] U.S. State Dept. Decimal File, 861.5017/Living Conditions/726.

Latvia the Sloka mill, founded in 1886, provides a capacity of 60,000 tons of sulfite pulp and 50,000 tons of paper. Two smaller pulp mills have contributed another 25,000 tons to Soviet capacity. In Estonia the Soviets have the use of four mills: the Tallin mill, founded in 1890, with an annual capacity for 3000 tons of paper and 77,000 tons of mechanical and sulfite pulp; the Kero mill, another large mill with a capacity for 40,000 tons of sulfate pulp and 16,000 tons of paper; and the Turi and Koil mills, each with a capacity for 8000 tons of paper (the Turi mill also has a 5000-ton sulfite pulp capacity).

Former Finnish mills are the Enso (30,000 tons board and 80,000 tons sulfite pulp capacity), and the Kexholm, on Lake Ladoga, with a capacity of 100,000 tons of bleached and unbleached pulp; the Sovietskii, Vyborg, Lyaskelya, Pitkyaranta, Kharlu, and Souyarvi also are former Finnish mills making Finland's contribution to Soviet pulp and paper capacity 417,000 and 119,700 metric tons, respectively. The Souyarvi mill has a 15,000-ton board capacity, making a total of 45,000 tons (with the Enso board capacity) obtained from Finland.

Over one-half ot the total Japanese production of pulp wood between 1935 and 1945 was from Karafuto, the Japanese half of the Sakhalin peninsula.[60] These wood pulp facilities, mainly chemical pulp processes—sulfite pulp and kraft pulp—were ceded to the Soviet Union at the end of World War II and included nearly all Japanese productive facilities in these types. The significant contribution of these former Japanese facilities to Soviet pulp and paper capacity is indicated in Table 15-2. No less than 1.40 million tons capacity of sulfite pulp, 1.09 million tons of mechanical pulp, and 1.27 million tons of paper capacity were transferred to the Soviet Union.

The Manchurian pulp and paper industry was removed on a selective basis to the Soviet Union. One plant, the Manchurian soya bean stem pulp mill, was removed completely, and according to T. A. Rendricks, a U.S. Army inspection officer, "This plant was more completely stripped than any I have seen to date."[61] The mill produced a high-grade pulp from reeds growing on the banks of the Liao, Yalu, and Sungari rivers as well as a staple fiber from soya bean stalks by a company-developed process. Capacity was 15,000 tons of kraft pulp and 10,000 tons of paper per year, and equipment consisted of shredders, cooking and reagents tanks, separators, mixers, and storage tanks.[62] "Absolutely everything was removed by the Soviets except built-in installations, namely cooking tanks, reagent tanks, drying furnaces, separation tanks, and

[60] Based on R. Seidl, *The Wood Pulp Industry of Japan* (Tokyo: SCAP [Supreme Command Allied Forces in Pacific] General Headquarters, Natural Resources Section, September 1946), Report no. 56.

[61] Edwin W. Pauley, *Report on Japanese Assets in Manchuria to the President of the United States*, (Washington, July 1946).

[62] *Ibid.*

Table 15-2 JAPANESE PULP AND PAPER MILLS ON SAKHALIN (KARAFUTO) TAKEN OVER BY THE SOVIET UNION IN 1945

			CAPACITY IN METRIC TONS				
			PULP			MECHANICAL	
Mill	*Location*	*Built*	*Sulfite*	*Sulfate*	*Mechanical*	*Paper*	*Board*
Korsakov	Otomari	1914	140,000	—	—	—	—
Yuzhno Sakhalinsk	Toyohara	1917	280,000	—	—	25,000 kraft	—
Dolinsk	Ochiai	1917	280,000	—	—	264,000 kraft	—
Kholmsk	Maoka	1919	—	—	—	240,000	—
Tomari	Tomarioru	1915	140,000	—	140,000 (rayon)	20,000	—
Chekhov	Noda	1922	140,000	—	—	59,000	—
Uglegorsk	Esutoru	1925	140,000	—	268,000	388,000	—
Makarov	Shirutoru	1927	280,000	—	204,000	281,000	—
Poronaisk	Shikuka	1935	200,000	—	280,000 (rayon)	—	—
TOTALS			1,600,000	—	892,000	1,277,000	—

Source: Pulp, Paper and Board Mills: Union of Soviet Socialist Republics, American Paper and Pulp Association, April 1959; *Note:* Excludes East German reparations and Lend Lease equipment.

bases for heavy lathes," according to Rendricks. Dismantling began on September 28, 1945, and the last shipment was made on November 15, 1945.[63]

The Nippon-Manshu pulp manufacturing plant at Tunghua, with an annual pulp capacity of 18,000 metric tons, also was completely removed to the Soviet Union,[64] as was the Yaluchiang paper mill at Antung with a capacity of 3000 tons of printing paper per year.[65]

Other plants were selectively removed. The Shinseimei paper plant at Chinchow lost five carloads of paper felts, conveyer belts, and electric motors,[66] while the Kanegafuchi Paper Company lost only 10 percent of capacity[67] and the Chihua Paper Company was not disturbed at all.[68]

Removals from Germany in this industrial sector consisted only of paper plants. The most important removal was the Leipziger Chromo- und Kunstdruckpapierfabrik vorm. Gustav Najork in Leipzig. About 27 plants in Saxony and

[63] *Ibid.*
[64] *Ibid.*, p. 231.
[65] *Ibid.*, p. 231.
[66] *Ibid.*, p. 227.
[67] *Ibid.*, p. 231.
[68] *Ibid.*

another dozen in Thuringia, Brandenburg, and Mecklenburg were also removed to the Soviet Union.

Considerable equipment has been supplied from Finland for the woodworking and paper-manufacturing industries. For example, in the 1956 trade agreement it was agreed that Finland would supply three paperboard-making machines and four papermaking machines, in addition to two plants for the manufacture of sulfate cellulose. This was in addition to a large quantity of pumps and fittings. The Tampella firm, as part of this agreement, received an order from the Soviet Union "for machinery for a semicellulose plant and a cardboard factory with a daily capacity of 200 tons for delivery in 1959. The cellulose plant will use reeds as raw material."[69] In 1962 the Tampella firm built another corrugated cardboard mill in the Soviet Union with a capacity of 300,000 tons per annum.[70] It was also reported:

> A/B Defibrator, Stockholm, has obtained an order from the Soviet Union for Kr32 million (£2,200,000) worth of machinery and equipment for making hardboard. Delivery is to take place by the end of 1958. The company has previously sold fiberboard machinery to the Soviet Union.[71]

In 1958 the West German firm of Himmelheber contracted to install in the U.S.S.R. several plants based on the Behr process of manufacture of fiberboard; these were of 50,100 tons daily capacity.[72]

By combining the capacity originating in Japan, Manchuria, Finland, and the Baltic States we arrive at the conclusion that only between one-quarter and one-third of Soviet pulp, board, and paper capacity in 1960 was actually built by the Soviets, either with or without foreign technical assistance. In 1960 only 22.4 percent of papermaking capacity had been built in the Soviet era in the Soviet Union; another 10.9 percent had been built in Russia before the Revolution; the balance (66.7 percent) came from postwar Soviet acquisition of facilities in the Baltic States, Finland, and Japanese Karafuto. (See Table 15-3.)

In pulp-making capacity, we find that only 22.9 percent was built in the Soviet Union during the Soviet era, and only 2.1 percent of 1960 capacity originated in prerevolutionary Russia; no less than 75 percent of pulp-making capacity came from Soviet acquisitions in Finland, the Baltic States, and Karafuto.

[69] *East-West Commerce*, IV, 12 (December 9, 1957), 4.
[70] *Fortune*, August 1963, p. 80.
[71] *East-West Commerce*, IV, 6 (June 28, 1957), 11.
[72] U.S. Dept. of Agriculture, *Forestry and Forest Industry in the U.S.S.R.*, Report of a Technical Study Group (Washington, March 1961), p. 56. Also see pp. 56-57 for use of Western equipment in the manufacture of fiberboard.
Alexis J. Panshin of Yale University concluded on the basis of his 1958 tour that in the sawmill, plywood, and pulp and paper plants, "all the major pieces of equipment were either of foreign make or obvious copies." Letter to author, February 19, 1968.

Table 15-3 ORIGINS OF SOVIET PAPER, BOARD, AND PAPER CAPACITY IN 1960

	Percentage Built in Soviet era	*Percentage Built in Tsarist era*	*Percentage from occupation*	*Total*
Paper	22.4	10.9	66.7	100.0
Board	33.3	10.2	56.5	100.0
Pulp	22.9	2.1	75.0	100.0

Source: Table 15-1.

In board-making capacity, about one-third had been built in the Soviet Union, primarily with Western technical assistance, and 10.2 percent was inherited by the Soviets from prerevolutionary mills. Over one-half, i.e., 56.5 percent, of board-making capacity came from Soviet acquisitions in Finland and the Baltic States.

Therefore it may be seen that as of 1960 a relatively small portion of Soviet capacity in this industry had been built in the U.S.S.R. during the Soviet era—and even this with extensive foreign technical assistance.

The 1960s saw the beginning of the construction of a gigantic wood-processing combine at Bratsk in Siberia. The capacity of this combine increased by a factor of two Soviet rayon pulp output, and by 300,000 tons (or six times) the amount of paper-board production. The combine has associated sawmills, a furniture plant, a hard-board mill and various wood chemistry plants.[73] The rayon cellulose plant utilizes equipment from the EMW firm of Karlstadt, Sweden; the carton manufacturing equipment was installed by Tampella of Finland.[74] The central instrumentation for the pulp plant was provided by A/B Max Sievert of Stockholm, Sweden; this company supplied installations as built by Leeds and Northrup and the Foxboro Company (Sievert is the manufacturing licensee and agent in Sweden for the Leeds and Northrup Company).[75] The wood pulp plant near Irkutsk has equipment from Rauma Repola Oy of Finland.[76]

Thus it can be seen that the Soviet pulp and paper industry and the textile industry utilize large proportions of imported machinery. No innovation was noted in textile production in the fifties and sixties by expert delegations from the United States and India, and Russian-made equipment then consisted of duplicates of Western equipment—primarily U.S., U.K., and German. This duplication apparently was not altogether successful, as large new installations were made in the 1960s by Italian and American companies.

[73] *Metsalehti* (Helsinki), March 3, 1959.
[74] *Chemical Week*, (New York), September 24, 1966, p. 39.
[75] Letter to author from Leeds and Northrup Company, Philadelphia, August 14, 1967.
[76] *Chemical Week*, September 24, 1966, p. 39.

It seems clear that all developments and equipment in synthetic fiber have originated in the West, despite significant Soviet research efforts in this field. Production of Nylon 6, particularly the production of caprolactum, is dependent on Western equipment and processes from the United Kingdom, Germany, and Japan. Lavsan utilizes German and Czechoslovak machinery; the largest Lavsan unit was built by a British consortium (Polyspinners, Ltd.). Acryl fiber technology and capacity is from Japan and the United Kingdom.

In pulp and paper we find an unusual situation in that as of 1960 two-thirds of the Soviet paper capacity, over one-half of board capacity, and three-quarters of pulp capacity originated in countries occupied by Soviet forces in the forties—the Baltic States, parts of Finland, and particularly Japanese Karafuto. The new Siberian wood processing combines are heavily dependent on Swedish, Finnish, and, indirectly, American technology and equipment. There has been no significant innovation in this group of industries.

CHAPTER SIXTEEN

Western Assistance to the Motor Vehicle and Agricultural Equipment Industries

THE MOTOR VEHICLE INDUSTRY

The Soviet motor vehicle manufacturing industry has a history of production of a very limited range of utilitarian vehicles in a few large plants built with considerable Western technical assistance and equipment. These few plants manufacture most of their own components but export some components to vehicle assembly plants in other areas of the Soviet Union.

There is a high degree of integration between military and civilian models, partly because military and civilian vehicles require a large proportion of similar parts and partly because of the need to maintain unification of military and civilian design to assist model changeover in case of war. This unification of military and civilian automobile design has been described by A. N. Lagovskii:

> The fewer design changes between the old and the new type of product, the easier and more rapidly the enterprise will shift to new production. If, for example, chassis, motors, and other parts of a motor vehicle of a civilian model are used for a military motor vehicle, of course the shift to the mass production of the military motor vehicle will occur considerably faster and more easily than if the design of all the main parts were different.[1]

To achieve unification, precise standards are imposed on Soviet civilian vehicles to enable their conversion in wartime, and as Lagovskii points out, part of current "civilian" production of tractors and motor vehicles may be used directly as military vehicles.[2]

Quite apart from the "unification of design" aspect described by Lagovskii, the Soviets produce both military and civilian vehicles in the same plants, continuing a practice begun in the early 1930s. Accordingly, claims that U.S. technical assistance to the Soviet automobile industry has no military potential, are not founded on substance.[3]

[1] A. N. Lagovskii, *Strategiia i ekonomika*, 2d edition (Moscow, 1961), p. 192.

[2] *Ibid.*, pp. 192-93.

[3] U.S. House of Representatives, Committee on Banking and Currency, *The Fiat-Soviet Auto Plant and Communist Economic Reforms*, 89th Congress, 2d session (Washington, 1967), p. 42. See chapter 27 for military vehicle production. The installation is commonly known as the Fiat-Soviet auto plant, although the Fiat technical component is negligible compared with that of U.S. equipment supplies.

Western assistance to this industry may best be described by examining motor vehicle plants separately in approximate order of size and by outlining the Western contribution to the technical design and production facilities of each.

Table 16-1 lists in descending order of size the major Soviet motor vehicle plants planned or in operation as of 1971, together with approximate output and the main features of Western origin; Table 27-1 (see p. 384) identifies the civilian and military models produced by these plants.

Table 16-1 WESTERN ORIGINS OF AUTOMOBILE AND TRUCK PLANTS IN THE SOVIET UNION AS OF 1971

Plant	*Model Designation*	*Approximate Annual Output*	*Summary of Western technical assistance*
Volgograd (Togliatti)	VAZ	600,000 (1974 projected)	Three-quarters of equipment [a] from United States; Fiat technical assistance in construction and operation
Moscow Small Auto	MZMA	300,000	Original Ford Motor Co. equipment (1930), replaced by German Opel (1945) and Renault (1966)
Gorki	GAZ	220,000	Ford Motor Co. (1930); Renault (1970); Gleason Works (1970)
Kama	(KAZ?)	100,000 [b] (projected)	Design and engineering by Renault (France). Equipment from a consortium of U.S. firms: licenses applied for (1971) by Satra Corp., Swindell-Dressler, Ex-Cell-O Corp., Cross Company, and (unconfirmed) Giffels Associates, Inc.
im. Likhachev	ZIL	100,000	U.S. equipment (mostly prewar)
Urals (Miass)	URAL	55,000	A. J. Brandt, Inc. (1930 plant moved from Moscow in 1941)
Odessa } assembly	OdAZ	21,500	General Motors (1945)
Lvov } plants	LAZ		
Minsk	MAZ	14,400	German technical assistance (1945-46)
Yaroslavl	YaAZ	8,000	Hercules Motor Co. (1930)

Sources: See Sutton II, Chapter 11; *Kratkii avtomobil'nyi spravochnik*, 5th edition (Moscow, 1968); *Automotive Industries* (Philadelphia), January 1, 1958; U.S. House of Representatives, Committee on Banking and Currency, *The Fiat-Soviet Auto Plant and Communist Economic Reforms*, 89th Congress, 2d sess. (Washington, 1967); Leo Heiman, "In the Soviet Arsenal," *Ordnance*, January-February 1968 (Washington: American Ordnance Association, 1968); U.S. Senate, Committee on Foreign Relations, *East-West Trade: A Compilation of Views of Businessmen, Bankers, and Academic Experts*, 88th Congress, 2d sess., November 1964 (Washington, 1964); *Metalworking News*, August 16, 1971.

[a] *Forbes* (October 1, 1966) states three-quarters; the figure may be somewhat less, but is certainly over one-half.

[b] Will be the largest plant in the world (covering 36 sq. mi.), and its output of heavy trucks will be greater than that of all U.S. manufacturers combined. Financing by Chase Manhattan Bank and the Export-Import Bank.

Lend Lease provided a significant contribution to the Russian vehicle stock in World War II and provided the basic designs for postwar domestic production. Vehicles supplied under Lend Lease included 43,728 Jeeps and 3510 Jeep-Amphibians; truck shipments included 25,564 vehicles of three-quarter ton, 218,664 of one and one-half ton, 182,938 of two and one-half ton, 586 of two and one-half ton amphibian, and 814 of five ton. In addition, 2784 special-purpose trucks, 792 Mack ten-ton cargo trucks, 1938 tractor trailers, and 2000 spare engines were sent.[4]

The report of the British delegation visiting the Central Automobile and Engine Research Institute in 1963 suggests that at that time there was a continued reliance on the West, but for design and equipment rather than assembled vehicles. The delegation reported:

> The first installation which we were shown was two single-cylinder engines on which combustion chamber research was carried out; these were old U.S. Universal crankcases, presumably supplied on Lend Lease during the War, and which had obviously not been used for some time. The lack of up-to-date instrumentation was noticeable, the only instrument other than normal thermometers and pressure gauges being an original type Farnborough indicator.[5]

The delegation found no evidence that the extensive staff at the institute, although obviously capable, was doing any large amount of development work. The numerous questions asked of the delegation related to Western experience —for example, on the V-6 versus the in-line six layout—and this, to the delegation, suggested an absence of worthwhile indigenous development work.

German Automotive Plants Removed to the Soviet Union

During the latter part of World War II much of the German automotive industry moved eastward into the area later to be occupied by the Soviet Union, while the second largest auto manufacturer in Germany, Auto-Union A.G., with six prewar plants dating back to 1932, was already located in the Chemnitz and Zwickau areas. Before the war the six Auto-Union plants had produced and assembled the Wanderer automobile, the Audi automobile, Horch army cars and bodies, DKW motorcycles, and automobile motors and various equipment for the automobile industry. It is noteworthy that Auto-Union and Opel, also partly located in the Soviet Zone, were more self-contained than other German vehicle manufacturers and met most of their own requirements for components and accessories. Although Auto-Union was the only German automobile

[4] U.S. Dept. of State, *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945), p. 19.

[5] Confederation of British Industry, "Visit to the Central Research Automobile and Engine Institute, 12th October 1963"; typescript supplied to the writer.

producer to produce automobiles during the war, the firm did make a sizable percentage of tanks and army vehicles (Table 16-2) and in 1944 was the only producer of engines (HL 230) for Tiger and Panther tanks.

Table 16-2 MODELS PRODUCED BY AUTO-UNION A.G. IN 1945 AS PERCENTAGE OF TOTAL GERMAN PRODUCTION

Model	*Maximum monthly production*	*Percentage of total German production of this model*
Full-track truck (R.S.O.)	600	50
1½-ton Steyr truck	750	40
3-ton half-truck	400	50
Steyr motor	1650	45
Steyr gear-box	1300	40
3-ton half-track motor (HL 42)	1500	60
Tank engine (HL 230) for Tiger & Panther	800	50
Army automobile	1000	30
Light motorcycle (RT 125)	600	100
Heavy motorcycle (NZ 250)	1650	100

Source: U.S. Strategic Bombing Survey, *Auto-Union A.G., Chemnitz and Zwickau, Germany*, January 1947 edition, (Washington: Munitions Division, 1947), Report No. 84, p. 5. Date of Survey: June 10-12, 1945.

The Siegmar works near Chemnitz, which manufactured tank engines, was heavily damaged during the later phases of the war. But because all equipment except twenty machine tools, i.e., 4 percent of the total machine-tool stock, was repaired within ten weeks the plant was in full operation at the end of the war. It is also noteworthy that the one-and-one-half-ton Steyr truck, produced at a rate of 750 per month at the Horch plant of Auto-Union, was specially designed for Russian winter conditions in early 1942 as a result of the difficulties experienced with the German standard army truck in the 1941-42 winter campaign.[6]

When the Russians occupied Saxony in 1945, one of their first measures was to completely dismantle the Auto-Union plants and remove them to the Soviet Union.[7] When one considers that in these key plants they had acquired complete facilities to produce tank engines at a rate of 750 per month as well as a truck specially designed for Russian conditions, it is not surprising that

[6] U.S. Strategic Bombing Survey, *Auto-Union A.G., Chemnitz and Zwickau, Germany*, 2d edition (Washington: Munitions Division, 1947), Report no. 84. (Dates of survey: June 10-12, 1945).

[7] G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen, 1951), pp. 101-2; see also *Germany, 1945-1954*, (Cologne: Boas International Publishing Co., [1954?]).

Soviet armored personnel carriers to this day bear a distinct resemblance to German World War II armored personnel vehicles.[8]

Full information is not available on the movement of the Leipzig plant owned by Bussing-National Automobil A.G., a manufacturer of armored cars, or of the firm's dispersal plants in the Saxony area; however, it was reported that the Bussing-National Chemnitz plant was 30 percent removed to the Soviet Union.[9] Three BMW (Bayerische Motorenwerke A.G.) plants were dismantled by the Russians and reportedly were completely shipped to the Soviet Union[10] (see Table 16-3). And the Adam Opel A.G. truck plant at Brandenburg, with a 1944 production of 20,000 three-ton Opel trucks and a capability to produce its own parts (with the exception of sheet metal, rear axle gears, and brake cylinders) was completely removed to the Soviet Union.[11]

In the Soviet sector of Berlin, the Ambi-Budd Presswerk A.G., a subsidiary of the U.S. Budd Company, was the largest single body producer in Germany before World War II. This plant completely escaped bomb damage. Although its equipment was dismantled for transportation (including tools and pressing machines for German passenger automobiles such as the Ford Taunus, the Hanomag 1.3 litre, and the Adler Trumpf-junior), it was not removed to Russia. Instead, "The machines, tools and pressed parts, carefully packed and numbered ... lay for years on the grounds of the works under the guard of a small section of Russian soldiers."[12] Apparently the Soviets had no requirement for equipment to manufacture automobile bodies and no reason to invest in transportation of the 300 specialized machine tools to the Soviet Union. Ultimately, the Ford Company at Cologne negotiated the return of the tools for the Taunus model to the Rhine plant of the Ford Motor Company, and Hanomag succeeded in doing the same for its own equipment.[13]

Other German automotive producers were completely or partly removed to the Soviet Union, including Vomag Betriebs A.G. of Plauen in Saxony, a manufacturer of trucks and diesel engines, and the Auto-Räder plant at Ronneburg in Thuringia, with 550 machine tools for the production of wheels for automobiles and military vehicles. The Bastert Chemnitz plant, a manufacturer of cylinders, was completely removed to the Soviet Union; the Auto-Bark motor plant at Dresden was completely removed; and the truck producer Phanomen-Werke at Zittau was partly removed to the Soviet Union.[14]

[8] *Ordnance* (American Ordnance Association, Washington) January-February 1968, pp. 372-73.

[9] Harmssen, *op. cit.* n.7, pp. 101-2, no. 31.

[10] Harmssen, *op. cit.*, pp. 101-2, nos. 78,79, and 80. However, *Germany, 1945-1954* (*op. cit.* n. 7, p. 216) reports that the BMW plant was later reconstructed sufficiently to build vehicles for the Red Army.

[11] Harmssen, *op. cit.* n. 7, pp. 101-2, no. 105.

[12] *Germany, 1945-1954*, *op. cit.* n. 7, p. 216.

[13] *Ibid.*

[14] Harmssen, *op. cit.* n. 7.

Table 16-3 SUMMARY OF GERMAN AUTOMOBILE PLANTS MOVED TO THE SOVIET UNION IN 1944-50

Name of plant in Germany	*Percentage removed from Germany to the U.S.S.R.*	*Output, 1939-45*
Auto-Union A.G. Chemnitz Plant No. 1	95	Caterpillar trucks (RSO)-5650
Auto-Union A.G. Chemnitz Plant No. 2	100	1½-ton truck – 2000 HL 230 tank engine – 4519
Auto-Union A.G. Siegmar-Schönau plant	100	HL 230 tank engine – 4519
Auto-Union A.G. Audi plant	100	One-half-ton truck – 7787
Auto-Union A.G. Horch plant at Zwickau	100	Steyr motor – 30,000 Steyr gear box – 24,500
Auto-Union A.G. Zschopau plant	100	Army motorcycles
Auto-Union A.G. Scharfenstein plant	100	Parts and electrical equipment
Auto-Union A.G. Burkhardtsdorf branch plant (Fa. Max Pfau & Gustav Frisch)	100	
Bussing-National Automobil A.G. press plant, Chemnitz	30	Armored cars
BMW (Bayerische Motorenwerke A.G.), Dürerhof (Eisenach plant)	100 reported	
BMW Diedorf plant	but possibly	Army vehicles
BMW Treffurt plant	less	
Adam Opel A.G. truck plant, Brandenburg	100	Trucks

Sources: G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen, 1951), pp. 101-2; *Germany, 1945-1954* (Cologne: Boas International Publishing Co. [1954?], pp. 216, 422; U.S. Strategic Bombing Survey, *Aircraft Division Industry Report*, 2d edition (Washington, 1947), Report no. 4.

In Austria the automobile plants at Graz and Steyr were almost completely dismantled and removed.[15] These plants produced three models of the Steyr Type A one and one-half ton truck. These, complete with an eight-cylinder V-type engine, were produced at the rate of 50 to 60 per day. The Ford plant in Budapest, Hungary, was not removed but operated on Soviet account.[16]

Some of these removals can be traced directly to Russian locations through subsequent production. These aspects will now be considered in more detail.

[15] F. Nemschak, *Ten Years of Austrian Economic Development, 1945-1955* (Vienna: Association of Austrian Industrialists, 1955).

[16] U.S. Foreign Economic Administration, *U.S. Technical Industrial Disarmament Committee to Study the Post-Surrender Treatment of the German Automotive Industry* (TIDC Project no. 12, Washington, July 1945), p. 23.

Origins of the Moskvich Passenger Automobile

The Moscow Small Car plant, built by the Ford Motor Company as an assembly plant for parts manufactured in the United States and later at the Ford-built Gorki plant, was brought into production in 1940 but produced only a few model KIM-10 light cars before World War II. In 1947 the plant reopened producing a single model, the Moskvich 401, through 1956. That model was replaced by the Moskvich 402. The 407 came into production in 1958 and in turn was replaced by the 408 in 1964.

The 1947 Moskvich 401 was, in effect, the 1939 German Opel Kadett with a few minor differences.[17] *Product Engineering*[18] concluded that the Moskvich 401 "bears a more than striking appearance to the prewar German Opel Kadett"—the instrument panel "is identical to the 1939 car," the four-cylinder engine has the "same piston displacement, bore, stroke, and compression ratio," and the same single-plate dry clutch, four-speed gear box, Dubonnet system front-wheel suspension, and four-wheel hydraulic brakes (derived from early Chevrolet models).

Differences from the original Opel were a Russian-made carburetor (K-25A), which "closely resembles a Carter down draft unit"; the electrical system, "similar in appearance to the Bosch design"; and a six-volt "Dutch-made battery."[19] The only apparently unique, noncopied feature was a device for facilitating brake adjustment.[20]

In 1963 the Moscow Small Car plant was visited by a delegation from the Confederation of British Industry, which reported an annual production of 80,000 cars produced by 15,000 workers in a plant of 160,000 square meters. Forge and press work was done in-plant, but castings were bought from supplier organizations. The delegation noted: "The layout of the plant and the tooling are not greatly different from Western European plants, but space, ventilation, and lighting are well below U.S. standards."[21]

In October 1966 an agreement was made with the French state-owned automobile manufacturers Renault and Peugeot to place French technical assistance and automobile know-how at the disposal of the Moskvich plant. As a result of this $50 million agreement, the plant increased its output capability

[17] A. F. Andzonov, *Avtomobil' Moskvich* (Moscow, 1950).

[18] New York, November 1953, pp. 184-85.

[19] The domestic Moskvich had a 3-CT-60 battery; *Product Engineering* probably examined an export version. The Soviets typically use foreign batteries, radios, and tires on export versions, and sometimes foreign engines as well (Rover and Perkins diesels).

[20] The *Product Engineering* article has a photograph of the Moskvich; also see *Kratkii avtomobil'nyi spravochnik*, 5th edition (Moscow, 1968), pp. 41-45.

[21] Confederation of British Industry, "Visit to the Moskvitch Car Manufacturing Plant, 10th October 1963"; typescript supplied to the writer.

from 90,000 to 300,000 automobiles annually; and the Renault company retooled the plant to produce modern compact automobiles[22] by installing two new production lines.[23]

The Ford-Gorki Plant

Vehicles produced by the Gorki plant, originally built by the Ford Motor Company and originally a producer of the Ford Model A and 1934 model Ford, continued to manifest their American lineage after World War II, and the plant's original U.S. equipment continues in use to the present day.[24] Production of two trucks and the Pobeda M-20 passenger vehicle started in 1946. The first postwar trucks (GAZ 51 and GAZ 63) were almost exact duplications of U.S. Army World War II vehicles; indeed, the unusual hood design and the hubcap design on the front wheels, for example, were precise replicas. Parts were also made at Gorki for the GAZ 93 and shipped to Odessa to be assembled; GAZ 93 was a dump truck with the same engine and chassis as the GAZ 51.

The Pobeda, produced between 1946 and 1955, had obvious similarities to the U.S. Army world war passenger vehicle, and had an M-20 engine remarkably similar in construction to a Jeep engine. The GAZ 69 and GAZ 69A, produced at Gorki between 1953 and 1956 when production was shifted to Ul'yanovsk, are described by the C.I.A. as "Jeep-like vehicles" and indeed bear a resemblance to the U.S. Army Jeep.[25] The 1956 model change introduced the Volga—described as a replica of the 1954 Mercury;[26] those cars, fitted with automatic transmissions, received a single-stage torque convertor with features like those in early U.S. models.[27]

The Moscow Plant im. Likhachev

The Moscow plant im. Likhachev is the old AMO plant originally built in 1917, rebuilt by A. J. Brandt, Inc., in 1929-30[28] and expanded over the

[22] *Wall Street Journal*, October 17, 1966; and *Minneapolis Tribune*, October 1, 1966. Other interesting information concerning the negotiations and Soviet demands is contained in *Le Monde* (Paris), June 2, 1966, and *L'Express* (Paris), October 1966, pp. 10-16.

[23] *The Times* (London), February 1, 1967.

[24] U.S. Senate, Committee on Foreign Relations, *East-West Trade: A Compilation of Views of Businessmen, Bankers, and Academic Experts*, 88th Congress, 2d session, November 1964, p. 79.

[25] *The Fiat-Soviet Auto Plant ..., op. cit.* n. 3.

[26] *Wall Street Journal*, May 6, 1966.

[27] *Automotive Industries* (Philadelphia), June 1, 1958, p. 61.

[28] Sutton I, pp. 248-49.

intervening years. Over time its name has been changed from AMO to the Stalin plant and then to im. Likhachev. The plant contains key equipment supplied under Lend Lease. For example, the crankshaft lathes currently in use were supplied by a U.S. firm in October 1944.[29] One or two copies of these lines were then duplicated by the Soviets in 1948-49.[30]

In the late 1950s it was reported that "Likhachjov [*sic*] does its own design and redesign and in general follows American principles in design and manufacture"; the same source suggested that the Soviet engineers were quite frank about copying, and that design lagged about three to five years behind the United States. The plant's bicycle production techniques were described as "American with Russian overtones";[31] the plant had developed the "American Tocco process" for brazing[32] and many American machines were in use, particularly in the forging shops.[33]

The Urals plant at Miass (known as Urals ZIS or ZIL) was built in 1944 and largely tooled with the A. J. Brandt equipment evacuated from the Moscow ZIS (now ZIL) plant. The plant started production with the Urals-5 light truck, utilizing an engine with specifications of the 1920 Fordson; this suggests that the original Ford Motor Company equipment supplied in the late 1920s was being used, probably supplemented by Lend Lease equipment.

Smaller plants at Ul'yanovsk and Irkutsk assemble the GAZ 69 from parts made in Moscow, although in 1960 Ul'yanovsk began its own parts production and Irkutsk and Odessa handled assembly of other vehicles—including the GAZ 51 at Irkutsk and trucks with large bodies for farm and commercial use at Odessa. Other assembly plants are Kutaisi (KAZ-150 four-ton truck), the Zhdanov bus works at Pavlovsk (PAZ-651 bus and PAZ-653 ambulance), and the Mytishchi machine works (building trucks on ZIS-150 and GAZ 51 chassis).

The Odessa Truck Assembly Plant

The Odessa truck assembly plant almost certainly originated from two Lend Lease truck assembly plants shipped from the United States to Odessa via Iran in 1945.[34]

Nearly half of the Lend Lease trucks supplied to the Soviet Union were shipped through the Persian corridor route in parts, assembled at two truck

[29] *East-West Trade ...., op. cit.* n. 24. p. 79. Contract No. W-33-008 Ord 586, Requisition R-30048-30048A1.
[30] *Ibid.*
[31] *Product Engineering*, July 14, 1958.
[32] *Ibid.*
[33] *Automotive Industries*, January 1, 1958.
[34] This is inferred from evidence presented in this section; the writer does not have positive identification.

assembly plants in Iran, and forwarded by road as complete vehicles with Russian drivers to the U.S.S.R. About 409,000 trucks were thus sent to the U.S.S.R., equal to seven and a half months of U.S. production at the peak wartime period. The two Truck Assembly Plants (TAPs), at Andimeshk and Khorramshahr, were designed by General Motors and consisted of bolted structural framework on poured concrete floors; they were equipped with cranes, tractors, trailers, and battery chargers. Their output was 50 trucks each per eight-hour shift or about 168,000 vehicles per year from both plants if operated on a three-shift basis—as they would be in the U.S.S.R. Under authorization of November 1944,[35] these two plants were dismantled and shipped to Odessa.[36]

Between 1948 and 1955 the Odessa assembly plant turned out the GAZ 93 dump truck with a GAZ 51 six-cylinder gasoline engine of 70 horsepower, followed by a modified version model GAZ 93S. Since 1960 Odessa has been a major trailer manufacturing plant.[37] The GAZ 93 and 93A have a basic resemblance to the Lend Lease U.S. Army two-and-one-half-ton cargo trucks.

U.S. and Italian Assistance to Volgograd (VAZ)[38]

The Volgograd automobile plant, built between 1968 and 1971, has a capacity of 600,000 automobiles per year, three times more than the Ford-built Gorki plant which was the largest auto plant in the U.S.S.R. until Volgograd came into production.

Although the plant is described in contemporary Western literature as the "Togliatti plant" and the "Fiat-Soviet auto plant," and indeed does produce a version of the Fiat 124 saloon, the core of the technology is American, and three-quarters of the equipment,[39] including the key transfer lines and automatics, came from the United States. What is remarkable is that a plant with such obvious military potential[40] could have been equipped from the United States in the middle of the Vietnamese war, which has been largely supplied by the Soviets. Had there not been strong Congressional objections, it is likely that even the financing would have come from the United States Export-Import Bank.

[35] Memorandum 28, November 1944, AG 400.3295, HQ Amet.

[36] T. H. Vail Motter, *The Persian Corridor and Aid to Russia*, (Washington: Department of the Army, Office of the Chief of Military History, 1952), pp. 281, 432, and 494.

[37] Trailers OdAZ Models 885, 784, 794, 832, 795, 935, 822, and 857 B for cattle and the refrigerated trailer Model 826. See *Kratkii* ..., *op. cit.* n. 20, pp. 307-50.

[38] The best summary of this project, the largest single unit of assistance in the 50 years since the Bolshevik Revolution, is *Fiat-Soviet Auto Plant* ..., *op. cit.* n. 3. This document also reprints many of the more informative journal articles written while the contract was in negotiating stages. The Italian economic daily *24 Ore*, May 5 and May 7, 1966, also has details.

[39] See note to Table 16-1.

[40] See chapter 27.

The construction contract, awarded to Fiat S.p.a., included an engineering fee of $65 million;[41] in 1970 at peak construction, 1000 Italian engineers and technicians were employed on building the Volgograd plant.[42]

The agreement between Fiat and the Soviet Government includes:

> The supply of drawing and engineering data for two automobile models, substantially similar to the Fiat types of current production, but with the modifications required by the particular climatic and road conditions of the country;
> The supply of a complete manufacturing plant project, with the definition of the machine tools, toolings, control apparatus, etc;
> The supply of the necessary know-how, personnel training, plant start-up assistance, and other similar services.[43]

About three-quarters of the production equipment in Volgograd, including all key machine tools and transfer lines, came from the United States. Although the tooling and fixtures were designed by Fiat, over $50 million worth of special equipment came from U.S. suppliers. This included:

a) foundry machines and heat-treating equipment, mainly flask and core molding machines to produce cast iron and aluminum parts and continuous heat-treating furnaces;
b) transfer lines for engine parts, including four lines for pistons, lathes, and grinding machines for engine crankshafts, and boring and honing machines for cylinder linings and shaft housings;
c) transfer lines and machines for other components, including transfer lines for machining of differential carriers and housing, automatic lathes, machine tools for production of gears, transmission sliding sleeves, splined shafts, and hubs;
d) machines for body parts, including body panel presses, sheet straighteners, parts for painting installations, and upholstery processing equipment;
e) materials handling, maintenance, and inspection equipment consisting of overhead twin rail Webb-type conveyers, assembly and storage lines, special tool sharpeners for automatic machines, and inspection devices including surface roughness measuring instruments for paint, fabric, and plastic materials.

Some of the equipment was on current U.S. Export Control and CoCom lists requiring clearance and changing of control regulations.

U.S. equipment was a necessity (despite talk of possible European supply and the fact that the Soviets had made elementary automatic production lines

[41] *Ibid.*, p. 21.
[42] *The Times* (London), February 1, 1967.
[43] Letter from Fiat S.p.a. to writer, May 31, 1967.

as far back as 1940[44]) because U.S. equipment has proved to be far more efficient and productive than European, and Soviet automatic lines have been plagued with problems and deficiencies.[45] Fiat plants in Italy are themselves largely equipped with U.S. equipment—a measure of the necessity of U.S. equipment for the VAZ plant.

Table 16-4 EXPORT OF U.S. MACHINERY FOR THE VOLGOGRAD AUTOMOBILE PLANT

Year and quarter	*Description of industrial machinery*		*Approved licenses (Million)*
1968			
2d quarter	Gear manufacturing and testing	$9.2	$15.6
	Molding and casting line foundry equipment	2.9	
	Crankshaft grinding machinery	2.3	
3d quarter	Automatic piston machinery	5.1	10.8
	Automatic crankshaft grinders	2.3	
	Industrial furnaces	1.3	
4th quarter	Valve grinding line	2.0	6.4
	Metal cutting machinery	1.6	
	Grinding and honing machinery	0.8	
1969			
1st quarter	Not specified	32.8	32.8
Total			$65.6 million

Source: U.S. Dept. of Commerce, *Export Control* (Quarterly Reports), 1968, 1969.

Some of the leading U.S. machine tool firms participated in supplying the equipment enumerated in Table 16-4: TRW, Inc., of Cleveland supplied steering linkages; U.S. Industries, Inc., supplied a "major portion" of the presses; Gleason Works of Rochester, New York, supplied gear cutting and heat-treating equipment; New Britain Machine Company supplied automatic lathes.[46]

Further equipment was supplied by U.S. subsidiary companies in Europe and some came directly from European firms (for example, Hawker-Siddeley Dynamics of the United Kingdom sold six industrial robots.)[47] In all, approximately 75 percent of the production equipment came from the United States

[44] U.S. Senate, *Export of Strategic Materials to the U.S.S.R. and Other Soviet Bloc Countries*, Hearing Before the Subcommittee to Investigate the Administration of the Internal Security Act and Other Internal Security Laws, 87th Congress, 1st session, Part 1, October 23, 1961, "Appraisal of Soviet Mechanization and Automation" in testimony by J. A. Gwyer, p. 84.

[45] *Ibid.*

[46] *Forbes*, October 1, 1966.

[47] *Schenectady Gazette*, August 6, 1969.

and about 25 percent from Italy and other countries in Europe, including U.S. subsidiary companies.[48]

In the late 1960s Soviet planners decided to build what will be the largest truck factory in the world on the Kama River. This plant will have an annual output of 100,000 multi-axle trucks, trailers, and off-the-road vehicles. It was evident from the outset that, given the absence of internal Soviet technology in the automotive industry, the design, engineering work, and key equipment for such a facility would have to come from the West. In late 1971 the plant was under construction with design and engineering work by Renault of France. A license had been issued for equipment to be supplied by a consortium of American firms: Satra Corporation of New York, Swindell-Dressler, Ex-Cell-O Corporation, Cross Company, and according to *Metalworking News* (August 16, 1971) Giffels Associates, Inc., of Detroit.[49]

TRACTORS AND AGRICULTURAL MACHINERY

A report by a technical study group of the U.S. Department of Agriculture summarized the Russian agricultural machinery position in 1959 as follows: "Machinery from the U.S.A. has been used as a pattern for Russian machinery for many years. This is evident from the designs of older machines in particular, and a few of the new machines."[50]

This official statement parallels the findings of this study for the period to 1960, although the writer was unable to find any new designs that could not be traced to some foreign, but not necessarily American, origin. (The study group was interested in U.S. machinery—not European equipment.)

Soviet tractors produced before World War II came from three plants established in the early 1930s with major U.S. technical and equipment assistance.[51] The Stalingrad tractor plant was completely built in the United States, shipped to Stalingrad, and then installed in a building also purchased in the United States. This unit, together with the Kharkov and Chelyabinsk plants, comprised the Soviet tractor industry at that time, and a considerable part of the Soviet tank industry as well. Equipment from Kharkov was evacuated and installed behind the Urals to form the Altai tractor plant which opened in 1943.

[48] There are varying reports on the percentage of U.S. equipment. See *Los Angeles Times*, August 11, 1966, and note to Table 16-1. The figures may be approximately summarized as follows: all key equipment, three-quarters of the production equipment and one-half of all equipment used in the plant and supporting operations.

[49] See p. 192.

[50] U.S. Dept. of Agriculture, Agricultural Research Service, *Farm Mechanization in the Soviet Union*, Report of a Technical Study Group (Washington, November 1959), p. 1.

[51] Sutton II, pp. 185-91.

Three postwar tractor plants were in operation by 1950, and thereafter there was no further construction. The Vladimir opened in 1944, the Lipetsk in 1947, and the Minsk plant and the Kharkov assembly plant in 1950. This was the basic structure of the Soviet tractor industry in 1960. In brief, additions to tractor capacity between 1917 and 1960 can be identified in two phases:

Phase I, 1930-33: Stalingrad (1930), Kharkov (1931), Chelyabinsk (1933); U.S. equipment and design with U.S. models.

Phase II, 1943-50: Altai (1943), Vladimir (1944), Lipetsk (1947), Minsk (1950), and Kharkov tractor assembly plant (1950); U.S. and German equipment, with U.S. (and one German) models.

These plants produced a limited range of tractors with a heavy emphasis on crawler models rather than the rubber-tired tractors more commonly used in the United States. The 1959 USDA technical delegation[52] estimated that 50 percent of the current output was in crawler models as contrasted to only 4 percent in the United States; the military implications of such a mix is obvious. These crawler models, including the heavy industrial tractors S-80 and S-100, are produced in the older plants built in Phase I in the 1930s.

In 1960 the Stalingrad plant produced the DT-54 and the DT-57 crawlers at a rate of about 110 per day.[53] Kharkov produced the DT-54 at a rate of 80 per day[54] in addition to 80 DT-20 wheeled tractors and 20 self-propelled chassis DSSH-14 using the same single-cylinder engine. Chelyabinsk concentrated on the production of S-80 and S-100 industrial models, used not only as tractors but as bulldozers and as mobile base for a wide range of equipment including cranes, excavators, and logging equipment.

The postwar tractor plants concentrated on agricultural tractors. The Altai, with prewar U.S. equipment evacuated in 1943 from Kharkov, produced 40 of the DT-54 crawlers per day; Vladimir produced 60 wheeled models per day, first the DT-24 model and after 1959 the DT-28. Lipetsk produced about 55 of the crawler KDT-35 model per day, and Minsk produced about 100 of the MTZ-5 Belarus and seven Belarus models daily.[55]

In general, the Soviet Union in 1960 produced about one-half—a very high proportion—of its tractors in crawler models and concentrated this production in two or three types, almost all production being C-100 industrial tractors or DT-54 and DT-20 agricultural tractors. The remaining models were produced in limited numbers only.

[52] U.S. Dept. of Agriculture, *op. cit.* n. 50, p. 24.
[53] *Ibid.*
[54] *SAE Journal* (New York), February 1959.
[55] *Ibid.*

The S-80 and S-100 (Caterpillar) Crawler Tractors

In 1951 two Soviet S-80 Stalinets diesel crawler tractors were captured by the United States Army in the Korean War and shipped to the United States, where they were sent to the Caterpillar Tractor Company for technical inspection and investigation. The S-80 was identified as almost identical to Caterpillar designs built in Peoria, Illinois, between February 1942 and March 1943. As 85 percent of machines in this period were sold to the U.S. Government, it is a reasonable supposition that the originals were Lend Lease tractors. The Caterpillar Company investigation concluded the following on the S-80:

> It looked like a Caterpillar tractor. It smelled like a Caterpillar tractor. It sounded like a Caterpillar tractor. It made horsepower like a Caterpillar tractor.[56]

The Caterpillar investigation provided two clearcut conclusions. First, the Soviet copy was well engineered; in fact according to Davies, "We feel this machine is the best engineered of any foreign-made tractors we know anything about."[57] The design had been completely changed over to the metric system—no small task—and the machine had been "completely reengineered" to conform to Soviet shop practice, manufacturing standard and domestically available machines and materials. Although it was concluded that the machine was roughly finished and probably noisy, Caterpillar investigators expressed a healthy respect for Soviet engineering abilities. They commented: "The whole machine bristles with engineering ingenuity."

The second major conclusion was that the Soviet engineers "were clever in not trying to improve the Caterpillar design.... By sticking to Caterpillar's design, they were able to come up with a good performing, reliable machine without the usual development bugs.[58]

Figure 16-1 illustrates some of the technical similarities of the Caterpillar D-7 and the Chelyabinsk S-80.

The metallurgical composition of the S-80 component parts varies from the original—mainly in the substitution of more readily available manganese and chrome for U.S. molybdenum specifications, and in different heat-treatment practices which probably reflect Soviet equipment and process availabilities. However, according to observers the end result is not significantly different—except that the Russian product generally has a rougher finish (except where finish is needed for functional purposes)—and tolerances are held as

[56] Lecture by J. M. Davies, director of research for Caterpillar Tractor Company, to the Society of Automotive Engineers Earthmoving Conference at Peoria, Illinois, April 10, 1952.

[57] *Ibid.*

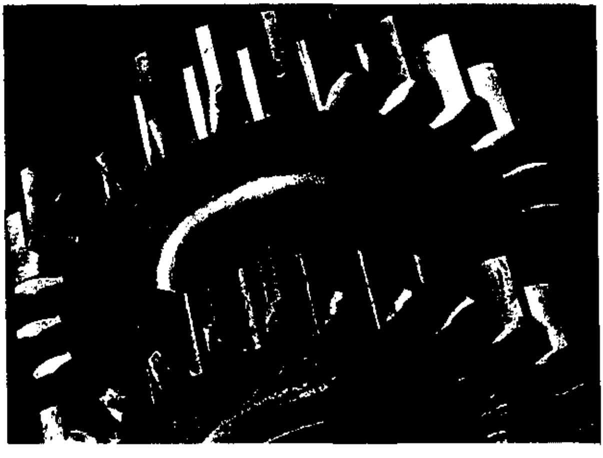
[58] *Ibid.*

Figure 16-1 Comparison of Caterpillar D-7 and Chelyabinsk S-80

(a) TRANSMISSION CASE AND DRAWBAR

This comparison exemplifies differences in manufacturing practices; where Caterpillar used forgings, the Soviets used castings—no doubt reflecting lack of forging machines.

(b) TRANSMISSION GEAR



The Soviet gear has the same number of teeth but due to rough finish has more error in tooth spacing. Russian gear teeth are hand-finished, not machined-finished.

Figure 16-1 (cont.)

(c) TRANSMISSION SHIFT AND FORK

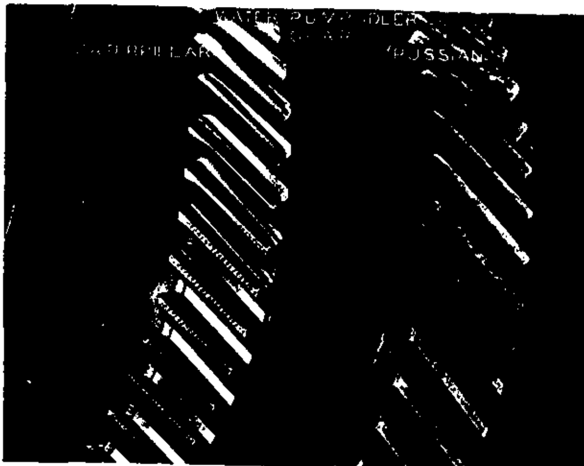
Possibly because the Soviet forging dies were newer, the transmission fork is a better job; Caterpillar does a little more machining.

(d) PISTON

The Russian alloy in the piston has both silicon and copper; Caterpillar has no silicon. The casting methods differ slightly.

Figure 16-1 (cont.)

(e) WATER PUMP IDLER



Again the Soviet finish is rough, and this may affect life of the gear.

(f) SOVIET S-80 TRACTOR

(Photographs 16 a-f courtesy of Caterpillar Co.)

Further comparisons of this nature are contained in *Product Engineering*, (New York), October 1952; and *SAE Journal*, (Society of Automotive Engineers, New York), June 1952; these compare other parts of the tractor, but in general their conclusions support the findings indicated in this text.

close as, or even closer than, on the American counterpart.[59] Comparison of metallurgical specifications of Russian and American tractor parts from the Caterpillar D-7 tractor in Table 16-5 illustrates this point.

Table 16-5 COMPARATIVE METALLURGICAL SPECIFICATIONS IN SOVIET S-80 AND CATERPILLAR D-7 TRACTORS

Part	Material	Hardness	Heat Treatment	Miscellaneous
		Soviet S-80		
Fuel pump plunger	AISI 52100	Rockwell A79-82	Oilp-quenched and tempered	—
Fuel pump barrel	AISI 52100	Rockwell A79-28	Oil-quenched and tempered	—
Track pin bushing	Approx. AISI 1020	Case: Rockwell C64 Core: Rockwell C32	Carburized, quenched, and tempered	Cracks in case
Flywheel clutch plant (center)	Gray iron, high emanganese	Approx. Brinell 230-250	None	Pearlitic cast iron
Final drive gear	AISI 1045	Case: Rockwell C56 Core: Rockwell C20	Induction-hardened one tooth at a time	Prior structure quenched and tempered; Residual tensile strength
Final drive pinion	2.7% Ni 0.85% Cr	Tip of tooth: Rockwell C60-64 Core: Rockwell C22-25	Carburized, quenched and tempered	About 1% C in case
Transmission gear	2.5% Mi 1.04 Cr	Tip of tooth: Rockwell C61-65	Carburized, quenched, and tempered	About 1.25% in case
		Caterpillar D-7		
Fuel pump plunger	AISI 52100	Rockwell A79-82	Oil quenched and tempered	—
Fuel pump barrel	AISI 52100	Rockwell A79-82	Oil quenched and tempered	—
Track pin bushing	AISI 1020	About same	Carburized, quenched, and tempered	Bushings sometimes sometimes crack due to soft core
Flywheel clutch plant (center)	Cast iron (0.6%C.) (0.6%Cu)	Brinell 230-250	None	Pearlitic matrix
Final drive gear	AISI 1045	Case: Rockwell C56 Core: Rockwell C18	Induction-hardened and tempered	High compressive stress in rim
Final drive pinion	0.55%Ni 0.50%Cr 0.20%Mo	Rockwell C59-64	Carburized, quenched,and tempered	
Transmission gear	0.55%Ni 0.50%Cr 0.20%Mo	Rockwell C59-62	Carburized, quenched, and tempered	Depth of carburized case is less

Source: Caterpillar Company

[59] *Product Engineering*, October 1952, pp. 154-59.

The parts for which Russian standards were higher are probably accounted for by the fact that the tractors examined were military tractors made to more exacting specifications; for example, on the track pins the Russian pin has a much better uniformity of hardening that the D-7 pin, and the Russian track link is considerably lighter.[60]

Soviet copies are not, then, precise replicas—they are more accurately described as "metric imitations." Two principles are balanced in the imitation process: (1) to copy the original Western model as precisely as possible, to avoid costs of research and development and by close copying to avoid the pitfalls ironed out in the original debugging of Western development models; and (2) to convert the model to Soviet metric practice and shop practice—not always consistent with the first principle.

Thus, the Caterpillar Company research engineers reported:

> Not a single Russian part is interchangeable with the Caterpillar part from which it was copied. Metric dimensioning is not the only reason, however, because even the internal parts of the Caterpillar fuel pump (made to metric dimensions originally) are not interchangeable with the Russian parts.[61]

In effect, then, the Russian tractor S-80 was a very ingeniously reengineered copy of the Caterpillar tractor D-7. The question logically arises: Why spend so much effort and engineering time on a complete reengineering job? The answer has to lie in some extraordinary defect in the Soviet industrial system; if it pays to reengineer a U.S. tractor to metric dimensions with the numerous problems involved rather than design a new tractor for Russian operating conditions, then something more than cost of research and development is involved.

Wheel-Track Tractors in the Soviet Union

The first mass-produced wheel tractor in the Soviet Union was based on the International Harvester Farmall.[62] It was produced first in Leningrad, and after 1944 at the Vladimir factory, with a 22-hp four-cylinder kerosene engine. In 1953 this wheel tractor model was supplemented by the Belarus, produced at the Minsk tractor plant; this is a 40-belt horsepower diesel-engined wheel tractor similar to the Fordson Major manufactured by Ford Motor Company, Ltd., at Dagenham in England. Finally, in the early 1950s the Soviets produced the DT-20 Row Crop tractor and the ABC-SH-16 self-propelled chassis, both with the same one-cylinder diesel engine and built at the Kharkov tractor works.

[60] *Ibid.*, p. 159.
[61] *Product Engineering*, October 1959, p. 155.
[62] See V. V. Korobov, *Traktory avtomobili i sel'skokhozyaistvennye dvigateli* (Moscow, 1950), p. 10.

The self-propelled chassis and the single-cylinder engine are based on a design originated by the German firm of Heinrich Lanz A.G. of Mannheim, West Germany. Before World War II this firm produced the well-known Lanz single-cylinder two-stroke hot-bulb type engine, which was of great simplicity, able to perform well on low-grade fuels, and therefore suitable for use in relatively underdeveloped countries. In the late 1950s the total daily production of the Lanz engine and associated equipment was approximately 545 per day.[63]

Origins of Other Farm Machinery and Equipment

Soviet agricultural machinery and equipment is dependent almost entirely on foreign prototypes. As late as 1963 a U.S. Department of Agriculture report commented as follows:

> As soon as feasible the U.S.S.R. buys prototypes of new foreign machines and places them at one of ... 29 machine test stations. If the machine or parts of it have desirable characteristics, production is recommended.[64]

In 1958 a U.S. technical study group sent to the Soviet Union to observe soil conservation[65] noted that the Soviet laboratories in the soil science field had instruments and equipment similar to those in American laboratories. Furthermore, methods of application of fertilizer had been copied from American equipment. For example:

> We observed a large number of anhydrous ammonia applicators, for injecting ammonia gas into soils, at the Middle Asian Scientific Research Institute on Mechanization and Electrification of Irrigated Agriculture near Tashkent. These seemed to be copies of ours; in fact, a Schelm Bros. machine made in East Peoria, Ill., was alongside several Soviet machines. Also exhibited at the Institute

[63] *SAE Journal*, February 1959, p. 51.

[64] U.S. Dept. of Agriculture, *Soviet Agriculture Today*, Report of the 1963 Agriculture Exchange Delegation, Foreign Agricultural Economic Report No. 131 (Washington, December 1963), p. 35. There is some confusion on the part of executive departments concerning this copying. For example, the following statement was made to Congress in 1961: "MR. LIPSCOMB. Does the Department of Commerce feel that Russia has developed a great deal of their agricultural equipment from prototypes obtained both legally and illegally from the United States? MR. BEHRMAN. No, sir. I don't think that the evidence we have indicates that the equipment that they themselves produce copies—that they produce copies of equipment which we have supplied." U.S. House of Representatives, Select Committee on Export Control, *Investigation and Study of the Administration, Operation, and Enforcement of the Export Control Act of 1949, and Related Acts(H.R. 403)*, 87th Congress, 1st session, October 25, 26, and 30, and December 5, 6, 7, and 8, 1961; p. 403.

[65] U.S. Dept. of Agriculture, Soil Conservation Service, *Soil and Water Use in the Soviet Union*, Report of a Technical Study Group, (Washington, 1958), p. 23.

for Mechanization and Electrification was a crude version of the two-wheel, tractor-drawn broadcast-type spreader such as is widely used in the United States.[66]

Drainage research equipment also appears to have been developed from U.S. models; the conclusion of the delegation was: "Most of [the machines] appear to be adaptions of American or European types."[67] These observations relate to a back-hoe ditcher, a wheel-type trencher, and a tile laying machine (copied from a similar machine made in the Netherlands by the Barth Company), a pool ditcher, a mole drain device, a ditch cleaner, brush cutters, and a virgin peatland plow.[68]

Other agricultural equipment also appears to have been copied from U.S. equipment; for example, the fertilizer spreader No. BB-35 is a close replica of the New Idea, an American model, and the corn drill model SUK-24 is very similar to U.S. models of such equipment. Examination of a single agricultural machine—the cotton picker—will bring out this process of duplication in greater detail.[69]

The Rust Cotton-Picking Machine

The Rust cotton-picking machine, developed and patented by John Rust, an American agrarian socialist, was the first spindle picker, and in the long run the most successful; in fact, the Rust principle has been preserved essentially in its original form in machines currently made by four U.S. companies. The first Rust patent was filed in 1928. By 1936 ten machines had been built in the United States, and two of them were sold to Amtorg.[70] Whereas Rust in the United States was forced to abandon production by 1942 because of insufficient financing and lack of durability in the machine, the Soviets on the other hand went ahead—they adopted the Rust principle and started to produce cotton pickers utilizing this principle in large quantities.[71]

[66] *Ibid.*, p. 30.

[67] *Ibid.*, p. 36.

[68] *Ibid.*

[69] This duplication may be found even in minor equipment items. For example, compare various seed drills and their feedwheel mechanisms; *Encyclopedia Britannica* 17: "Planting Machinery," (Chicago: William Benton, 1958) p. 1011; and V. N. Barzifkin, *Mekhanizatsiia sel' skokhoziaistvennogo proizvodstva* (Moscow, 1946), p. 103.

[70] J. H. Street, *The New Revolution in the Cotton Economy* (Chapel Hill, N.C., 1957). On p. 128 Street quotes from *Survey Graphic* (July 1936) as follows: "John Rust made a trip there [to the U.S.S.R.] to supervise their introduction in the belief that they [the cotton pickers] would be used 'to lighten man's burden rather than to make a profit at the expense of the workers.'"

[71] *Strana Sovetov za 50 let: Sbornik statisticheskikh materialov* (Moscow, 1967), p. 156. A good source of technical detail concerning the Soviet cotton picker is I. I. Gurevich, *Khlopkouborochnaya mashina KhVS-1, 2M: Rukovodstvo po ekspluatatsii* (Tashkent, 1963). There is a translation: U.S. Dept. of Commerce TT 66-51114/1966.

By 1940 the Soviets had a park of 800 cotton pickers based on the Rust principle, whereas the United States, where Rust had initiated, developed, and built the original machines, had none in commercial production and only a few in use on a custom picking basis. Only in 1942 did International Harvester announce it was ready to go into commercial production of machines based on the principle, producing 12 in 1941 and 1942, 15 in 1943, 25 in 1944, and 75 annually in 1945-47. In 1945 Allis-Chalmers started work using a modified Rust principle, but by 1949 only 49 Allis-Chalmers pickers had been manufactured. By 1953 cotton pickers designed on the Rust principle were produced not only by International Harvester and Allis-Chalmers but also by Ben Pearson, J. I. Case, and Massey-Harris-Ferguson. Deere attempted to develop the Berry spindle picker between 1943 and 1946, but abandoned the effort.

In 1953, then, about 15,000 pickers were available in the United States while the Soviet Union had about 5000 cotton pickers in operation.[72]

In summarizing this discussion of the Soviet automotive sector, it may be said that the Soviet Union was as dependent on Western automobile manufacturing technology in 1970 as it was in 1917. In 1968-70 U.S. companies installed over $65 million worth of equipment in the 600,000-autos-per-year VAZ plant; in 1917 the Baltic and AMO plants, large units for the times, were also equipped with the latest American equipment.[73] Therefore there has been no innovation of indigenous Soviet automobile or truck technology.

The Stalinetz S-80 and S-100, both heavy tractors that provide the chassis for other Soviet equipment, were found to be replicas of the Caterpillar D-7. Other agricultural equipment, including farm implements and cotton pickers, is based on American models, although there are a few examples of British (Fordson Major), German (Lanz tractor engine), and Dutch (Barth tile laying machine) origins.

[72] *Strana Sovetov ...*, *op. cit.* n. 71.
[73] Sutton I, pp. 243-44.

CHAPTER SEVENTEEN

Western Origins of Soviet Prime Movers

This chapter examines the Western origins of some of the common Soviet prime movers—diesel engines for marine and truck use and internal combustion engines, together with steam boilers and steam and gas turbines.

Fortunately, complete and reasonably accurate Soviet data are available on marine prime movers (diesel, steam, and gas turbine engines) used in marine propulsion systems. These data, derived from a detailed descriptive listing of the 5551 ships in the Soviet merchant marine as of July 1967,[1] were subjected to an exhaustive analysis to determine the types and origins of marine engines used in Soviet merchant ships. (See Table 17-1.)

Two characteristics were examined: first, diesel, and steam engines by type and system, i.e., by their technical characteristics; and second, the origin and date of construction of these engines in order to arrive at an understanding of the manner in which the Soviet merchant marine had been acquired, i.e., the rate of addition of different types of engines, changes in foreign supply sources, and the extent to which the Soviets may possibly have divested themselves of foreign assistance.

Table 17-1 lists marine diesels (if more than four units of a single type were identified) in use in the Soviet merchant marine in 1967. The table does not include steam turbines, reciprocating steam engines, diesel-electric engines, or gas turbine engines; steam turbines and gas turbines are discussed later in the chapter. The table does include about 80 percent of the marine propulsion units in use.

The most striking characteristic is the absence of diesel units of Soviet design. Although a few (reference numbers 6, 10, 11, 12, 14, and 35) are listed as of probable foreign origin and three units (reference numbers 9, 26, and 43) are not identified, there is evidence to suggest that these units are of Sulzer or M.A.N. design except for reference number 43, which is probably of Fiat design. Early technical-assistance agreements in the 1920s with the Sulzer and M.A.N. firms resulted in several "Soviet" diesels manufactured

[1] Registr Soyuza SSR. *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966), plus annual supplements.

Table 17-1 TECHNICAL CHARACTERISTICS OF SOVIET MARINE DIESELS IN USE IN 1967*

			Specification of marine diesels in use in 1967			
Reference number	*Engine design*	*Country of origin*	*Number of cylinders*	*Cylinder diameter (mm.)*	*Piston stroke (mm.)*	*Rated bhp*
1	Buckau-Wolf	G.D.R.	8	240	360	300
2	Buckau-Wolf	G.D.R.	6	320	480	400
3	Buckau-Wolf	G.D.R.	8	320	480	550
4	Skoda	Czechoslovakia	8	430		2500
5	Görlitzer	G.D.R.	6	175	240	200
6	M.A.N.(probable)	Germany	6	300	500	600
7	Alco	U.S.A.	6	318	3300	1000
8	Burmeister & Wain	Denmark	5	500	1100	2900
9	Not identified	—	6	180	220	150
10	Sulzer (probable)	Switzerland	6	250	340	300
11	M.A.N. (probable)	Germany	8	300	500	800
12	M.A.N. (probable)	Germany	4	300	500	400
13	M.A.N.	Germany	6	570	800	4000
14	M.A.N. (probable)	Germany	12	150	180	300
15	Sulzer	Switzerland	6	760	1550	9600
16	Burmeister & Wain	Denmark	5	620	1400	600
17	M.A.N.	Germany	7	700	1200	6000
18	Görlitzer	G.D.R.	8	365	550	2000
19	Burmeister & Wain	Denmark	8	740	1600	13000
20	Sulzer	Switzerland	5	720	1250	4500
21	Sulzer	Switzerland	8	480	700	3000
22	Lang	Hungary	8	216	310	200
23	Lang	Hungary	8	315	450	1000
24	Burmeister & Wain	Denmark	9	500	1100	5200
25	M.A.N.	Germany	6	520	900	1900
26	Not identified	-	12	180	200	150
27	Burmeister & Wain	Denmark	7	740	1600	11000
28	M.A.N.	Germany	6	700	1200	5800
29	Sulzer	Switzerland	6	560	1000	2400
30	M.A.N.	Germany	5	520	700	4500
31	Burmeister & Wain	Denmark	8	350	620	2260
32	Burmeister & Wain	Denmark	9	900	1550	19800
33	Sulzer	Switzerland	6	500	900	2000
34	Polar	Sweden	6	340	570	1550
35	M.A.N. (probable)	Germany	6	150	180	150
36	Mash.Kiel A.G.	Germany	8	290	420	640
37	Götaverken	Sweden	7	760	1500	8750
38	Burmeister & Wain	Denmark	6	740	1600	9760
39	Fiat	Italy	8	750	1320	8000
40	M.A.N.	Germany	9	720	1200	8150
41	M.A.N.	Germany	6	600	1050	5600
42	Polar	Sweden	5	345	580	1260
43	Not identified	Italy	6	540	960	2000
44	Sulzer	Switzerland	7	760	1550	9100

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

* Includes all units for which more than four engines of a single type were identified.

in the 1930s and 1940s.[2] No purely Soviet marine diesels have been traced in this period,[3] so the units mentioned are probably either M.A.N. or Sulzer. These companies have manufactured units with similar technical characteristics.

Positive identification of foreign origin for the other units in Table 17-1 has been made, and agreements or sales have been traced from the Western company either to the Soviet Union or to an East European country manufacturing the design under foreign license and then in turn selling the unit to the Soviet Union.

The two most common designs are those of M.A.N. (Maschinenfabrik Augsberg-Nurnberg A.G.) of Augsburg, Germany, and Burmeister & Wain of Copenhagen, Denmark. The latter company has supplied technical assistance and designs for large marine diesels, while M.A.N. units are normally less than 4500 hp. Sulzer in Switzerland, the former Buckau-Wolf at Magdeburg in Germany, Skoda in Czechoslovakia, and Nydqvist & Holm (Polar) in Sweden are other commonly found marine diesel designs.

Table 17-2 indicates the number of each of these marine diesel designs in use in the Soviet merchant marine in relation to geographic origin. One noticeable disclosure is that, of the 4248 marine diesels in use in 1967, an extraordinarily large number (2289 or 54 percent) were manufactured in Czechoslovakia and that 82 were manufactured at the prerevolutionary Russky Disel plant in Leningrad. Another common design is that of Görlitzer in East Germany, comprising 239 marine diesels in two models.

Table 17-2 ORIGINS OF SOVIET MARINE DIESELS, BY NUMBER OF EACH DESIGN, 1967

Reference number in Table 17-1	*Built outside U.S.S.R.*	*Built inside U.S.S.R.*	*Total*
1	1,413	—	1,413
2	519	6	525
3	351	—	351
4	170	82	252
5	202	—	202
6	2	147	149
7	—	142	142
8	76	25	101
9	—	96	96
10	41	47	88
11	—	80	80
12	—	68	68
13	66	—	66
14	—	64	64

[2] See Sutton I, pp. 35, 332.

[3] *Ibid.*

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Table 17-2 (cont.)

Reference number in Table 17-1	*Built outside U.S.S.R.*	*Built inside U.S.S.R.*	*Total*
15	61	—	61
16	51	—	51
17	39	—	39
18	37	—	37
19	36	—	36
20	36	—	36
21	42	—	42
22	35	—	35
23	31	—	31
24	5	24	29
25	24	—	24
26	—	23	23
27	10	12	22
28	21	—	21
29	21	—	21
30	17	—	17
31	18	—	18
32	13	—	13
33	11	—	11
34	11	—	11
35	1	9	10
36	10	—	10
37	10	—	10
38	5	5	10
39	7	—	7
40	6	—	6
41	7	—	7
42	5	—	5
43	4	—	4
44	4	—	4
TOTAL	3418	830	4248

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

Burmeister & Wain of Denmark has been a prominent supplier of diesel marine engines, and under an agreement signed in 1959 the Soviet Union now manufactures Burmeister & Wain diesels at Bryansk in the Ukraine. Thus numerous Burmeister & Wain designs figure into Table 17-2, either as units imported from Denmark (reference numbers 8, 16, 19, 24, 27, 31, 32, and 38) or as units manufactured at the Burmeister & Wain plant in Copenhagen and, under license, at Bryansk in the Soviet Union (for example, reference numbers 8, 24, 27, and 38).

The most prominent feature of Table 17-2, however, is the relatively small number (830, or 19.5 percent) of marine diesels actually manufactured inside the Soviet Union.

Table 17-3 lists the origins of these Soviet marine diesels according to aggregate horsepower. This listing provides a more accurate reflection of the importance of each type of unit for the Soviet merchant marine.

In general terms, four-fifths (79.3 percent) of the aggregate diesel generated horsepower was built outside the Soviet Union. Of a total of 4,633,890 hp, some 3,672,890 hp was built outside the Soviet Union and only 961,000 hp was built inside the Soviet Union, and even that portion required foreign technical assistance.

Table 17-3 ORIGINS OF SOVIET MARINE DIESELS AS OF 1967, BY AGGREGATE HORSEPOWER FOR EACH DESIGN

		Aggregate horsepower built			
No.	*Reference number from Tables 17-1 and 17-2*	*Outside U.S.S.R.*	*Inside U.S.S.R.*	*Total*	*Percentage of this design built outside the U.S.S.R.*
1	4	425,000	205,000	630,000	67.5
2	1	423,900	—	423,900	100.0
3	8	220,400	72,500	292,900	75.2
4	13	264,000	—	264,000	100.0
5	32	257,400	—	257,400	100.0
6	27	110,000	132,000	242,000	45.5
7	17	234,000	—	234,000	100.0
8	2	207,600	2,400	210,000	98.8
9	3	193,050	—	193,050	100.0
10	20	162,000	—	162,000	100.0
11	24	26,000	124,800	150,800	17.2
12	7	—	142,000	142,000	0.0
13	21	126,000	—	126,000	100.0
14	28	121,800	—	121,800	100.0
15	38	49,500	99,000	99,000	50.0
16	6	1,200	88,200	89,400	1.3
17	37	87,500	—	87,500	100.0
18	30	76,500	—	76,500	100.0
19	18	74,000	—	74,000	100.0
20	11	—	64,000	64,000	0.0
21	15	58,560	—	58,560	100.0
22	39	56,000	—	56,000	100.0
23	29	50,400	—	50,400	100.0
24	40	48,900	—	48,900	100.0
25	19	46,800	—	46,800	100.0
26	25	45,600	—	45,600	100.0
27	16	41,400	—	41,400	100.0
28	5	40,400	—	40,400	100.0

Table 17-3 (cont.)

No.	Reference number from Tables 17-1 and 17-2	Aggregate horsepower built: Outside U.S.S.R.	Inside U.S.S.R.	Total	Percentage of this design built outside the U.S.S.R.
29	31	40,080	—	40,080	100.0
30	41	39,200	—	39,200	100.0
31	44	36,400	—	36,400	100.0
32	23	31,000	—	31,000	100.0
33	12	—	27,200	27,200	0.0
34	10	11,400	15,000	26,400	43.2
35	33	22,000	—	22,000	100.0
36	14	—	19,200	19,200	0.0
37	34	17,050	—	17,050	100.0
38	9	—	14,400	14,400	0.0
39	43	8,000	—	8,000	100.0
40	22	7,000	—	7,000	100.0
41	36	6,400	—	6,400	100.0
42	42	6,300	—	6,300	100.0
43	26	—	3,450	3,450	0.0
44	35	150	1,350	1,500	10.0
		3,672,590	961,000	4,633,890	79.3 percent

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

The most important design, Skoda of Czechoslovakia, contributes 630,000 hp to the Soviet merchant fleet. The next design in terms of contribution to aggregate horsepower is that of Buckau-Wolf, contributing 423,900 hp; this is numerically the most common unit. Other prominent designs are Burmeister &Wain (the 2900 hp unit) with 292,900 hp, M.A.N. of Germany with 264,000 hp, and Burmeister & Wain (the 11,000-hp unit), which contributes some 242,000 hp to the total.

The last column in Table 17-3 indicates the percentage of each design built outside the Soviet Union. While it is obvious from the table that a comparatively small amount (20 percent) of aggregate horsepower was built inside the Soviet Union, it may not be so readily obvious that this domestic construction is also concentrated into a few designs. For example, the 1000-hp unit, originally an American Locomotive design sent to the Soviet Union under Lend Lease, contributes 142,000 hp. It is today built only inside the Soviet Union, whereas other types, particularly Burmeister & Wain designs, are both built in the Soviet Union and imported.

Table 17-4 shows quite clearly the fact that units of large horsepower are not built in the Soviet Union. This table lists construction inside and outside the Soviet Union in terms of rated horsepower category. It is notable that the units of 9000-12,000 hp, partly built in the Soviet Union and partly imported, are the Burmeister & Wain design built with technical assistance under terms of the 1959 agreement. Otherwise, units built in the Soviet Union are of much smaller capacity.

Table 17-4 PERCENTAGE OF SOVIET MARINE DIESELS BUILT OUTSIDE THE SOVIET UNION AS OF 1967 (BY RATED HORSEPOWER CATEGORY)

Horsepower rating category	*Built outside U.S.S.R. (in bhp)*	*Built inside U.S.S.R. (in bhp)*	*Total bhp*	*Percentage built outside U.S.S.R.*	*Category as a percentage of total aggregate horsepower*
Less than 1,000	891,000	235,200	1,126,300	79.1	24.3
1-1,999	99,950	142,000	241,950	41.3	5.2
2-2,999	839,880	277,500	1,117,880	75.2	23.9
3-3,999	126,000	—	126,000	100.0	2.7
4-4,999	502,500	—	502,500	100.0	10.8
5-5,999	187,000	124,800	311,800	59.9	6.7
6-6,999	275,400	—	275,400	100.0	5.9
7-7,999	—	—	—	—	—
8-8,999	192,400	—	192,400	100.0	4.1
9-9,999	144,460	49,500	193,500	74.2	4.2
10-10,999	—	—	—	—	—
11-11,999	110,000	132,000	242,000	45.5	5.2
12-12,999	—	—	—	—	—
13-13,999	46,800	—	46,800	100.0	1.0
14-14,999	—	—	—	—	—
15-15,999	—	—	—	—	—
16-16,999	—	—	—	—	—
17-17,999	—	—	—	—	—
18-18,999	—	—	—	—	—
19-19,999	257,400	—	257,400	100.0	5.5
Totals	3,672,890	961,000	4,633,890	79.3	99.5

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

Note: This table includes all marine diesels where more than 20 of a single model were manufactured or imported. It does not include reciprocating steam engines, steam turbines, gas turbines, or diesel-electric drives.

We may conclude concerning marine diesels that the Soviet Union is still heavily dependent on Western technology. The significant increment in size of unit built after 1960 is due mainly to the Burmeister & Wain technical-assistance agreement, although East Germany and Czechoslovakia have also contributed significantly to Soviet construction of marine diesels. The technical lag is extraordinary when compared to the gigantic increment since World War II in the Soviet mercantile fleet.

FOREIGN TECHNICAL ASSISTANCE TO SOVIET MARINE ENGINE CONSTRUCTION

The Soviet marine diesels actually manufactured in the Soviet Union have received a considerable amount of foreign technical assistance. Technical-assistance agreements were made with both M.A.N. and Sulzer in the 1920s,[4] and the Soviet Union has continued since that time to receive M.A.N. and Sulzer technology in addition to new assistance agreements with Burmeister & Wain of Denmark and Skoda of Czechoslovakia in the fifties and sixties.

An agreement was signed in early 1959 in Copenhagen by Niels Munck, managing director of Burmeister & Wain, and Mikoyan, who visited the company on his way back to Moscow from a visit to the United States.[5] The Danish company also has a licensing agreement with the Polish engine builders Stocznia Gdanska, and part of that organization's annual production of 350,000 bhp of B & W designs goes to the Soviet Union.[6]

Under the 1956 Scientific and Technical Cooperation agreement between the U.S.S.R. and Czechoslovakia, the Skoda works sends technical documentation and technical assistance to the U.S.S.R. on the latest marine diesel designs. Skoda is also a major direct supplier of diesel engines to the U.S.S.R.[7]

The available evidence strongly indicates that all Russky Disel (Leningrad) marine engines are made under the technical-assistance agreement with Skoda of Czechoslovakia while all diesels at Bryansk are built under the B & W agreement. Under the COMECON specialization agreements, Czechoslovakia undertakes development and production of large marine diesels while the Soviet Union is not listed for that responsibility—nor indeed for any development or production of marine diesels of any size.[8] Agreements and trade between the two countries confirm this. The 1956 Scientific and Technical Corporation required Czechoslovakia to send technical documentation for the manufacture of the latest designs in diesel engines to the U.S.S.R. Further, Czechoslovakia is not only the fourth largest producer of diesel engines in the world—far larger

[4] *Ibid.*
[5] *East-West Commerce*, VI, 2 (February 1959), 3.
[6] See chapter 6.
[7] See chapter 6 for more information on these indirect transfers.
[8] See Frederic L. Pryor, *The Communist Foreign Trade System* (London: George Allen & Unwin, 1963), Appendix E.

Table 17-5

UTILIZATION OF DIESEL ENGINES IN SOVIET VEHICLES

Diesel engine model	*YaAZ-M204A*	*YaAZ-M204B*	*YaAZ-M206A*	*YaAZ-M206B*	*YaAZ-M206D*
Soviet vehicle model	ZIL-152	MAZ-200B	KrAZ-219	KrAZ-214	ZIL-127
	MAZ-200	MAZ-502	KrAZ-221		YaAZ-210E
	MAZ-200G		KrAZ-222		YaAZ-218 (1957)
	MAZ-205				YaAZ-210 (1951-58)
	MAZ-501				YaAZ-210G (1951-58)

Source: Kratkii avtomobil'nyi spravochnik, 5th edition (Moscow, 1968) p. 409.

Table 17-6

ORIGINS OF TRUCK DIESEL ENGINES IN THE SOVIET UNION UP TO 1960

Basic engine Model number	*Type*	*Weight, kg*	*Number of cylinders*	*Displacement*	*Cylinder diameter, mm*	*Piston Stroke*	*Horsepower*	*rpm*	*Western origin*
YaAZ-M206D	In-line	960	6	6.97	108.0	127.0	180	2,000	GMCModel (U.S.)
YaAZ-M206A	V	890	6	6.97	108.0	127.0	180(215)	2,000	GMC Model (U.S.)
YaAZ-M204A	V	800	4	4.65	108.0	127.0	120	2,000	GMC Model (U.S.)
D-12A	V	1,400	12	38.80	150.0	180.0	300	1,500	Not known

Source: Kratkii avtomobil'nyi spravochnik, 5th edition (Moscow, 1968).

than the U.S.S.R.—but also exports 80 percent of all its diesels, and the U.S.S.R. is the largest buyer.[9]

DIESEL ENGINES FOR TRUCK USE

The range of diesel engines for truck use in the Soviet Union is very limited. Between 1945 and the mid-1960s, when new models YaMZ-236 and YaMZ-238 replaced earlier engines,[10] only four commonly used models were identified.

Three models widely used in trucks and buses were based on General Motors engines: the YaAZ-M206D, a six-cylinder in-line 180-hp engine; the YaAZ-M206A, a V-type version of the same engine; and a four-cylinder V type developing 120 hp mainly for use in the MAZ-200 truck produced from 1947 to 1966 at Minsk. These three basic models, produced at Yaroslavl,[11] have been utilized for at least a dozen Soviet truck and bus models. (See Table 17-5.)

The only other engine that has been produced is the D-12 type used in the MAZ-525, MAZ-530, and BelAZ-540 dump trucks. This engine has a 300-hp rating, compared to the 120-180-hp range of the YaAZ series (see Table 17-6). Its origin is not known, although the Soviets received the Kloeckner-Humboldt-Deutz diesel engine plant in 1946 under U.S. Operation RAP,[12] and Deutz prewar diesels had similar specifications.

The new model truck diesels introduced in the late 1960s (YaMZ-236 and YaMZ-238) bear considerable resemblance to the U.S. Cummins engine. The YaMZ-236 has a layout similar in many respects to the Cummins 90° V6-200, while the YaMZ-238 resembles the Cummins 90° V8-265.[13]

A backwardness in truck diesel engines is reflected in Soviet use of European diesel engines in the few Soviet automobiles assembled in Belgium and sold on the European market. The Volga automobile was offered with an optional Rover U.K. diesel engine in 1965; the Moskvich was offered by the Soviets, also in 1965, with a Perkins U.K. 99 diesel engine.[14] In 1968 Soviet trucks sold in Europe also utilized diesel engines supplied by Perkins.

In 1960-61 the Soviets attempted to purchase in the United States over $40 million worth of specialized equipment for the manufacture of truck engine blocks.[15] This generated a great deal of controversy in Congress, and ultimately

[9] *Czechoslovak Economic Bulletin* (Prague), no. 306 (March 1956), 25.

[10] *Ekspluatsionnye kachestva dvigatelei YaMZ-236 and YaMZ-238* (Moscow, 1968).

[11] See Sutton II for assistance to this plant.

[12] See chapter 2.

[13] No confirmation can be obtained from the company on this point, but compare G. D. Chernyshev, *Dvigateli YaMZ-236, YaMZ-238* (Moscow, 1968), pp. 5, 16, with D.S.D. Williams, *British Diesel Engine Catalogue*, 6th edition (London, 1965), p. 57.

[14] S. d'Angelo, ed., *World Car Catalogue* (New York: Herald Books, 1965), pp. 228, 356.

[15] U.S. House of Representatives, Select Committee on Export Control, *Investigation and Study of the Administration, Operations, and Enforcement of the Export Control Act of 1949, and Related Acts (H.R. 403)*, 87th Congress, 1st session, October, December 1961 pt. I, p. 220.

the sale involved only two transfermatic machines to produce V-8 engine blocks; one unit was valued at $3.4 million and one at $1.9 million, for a total of $5.3 million. The units were required by the Soviets to produce 225-hp truck engines.

DIESEL-ELECTRIC PRIME MOVERS

The most important Soviet diesel-electric prime mover is the 2 D 100 unit utilized in more than 1000 type TE 3 diesel-electric locomotives and more than 50 merchant vessels.[16] The 2 D 100 power plant is a two-stroke, opposed piston model with ten cylinders developing 2000 hp at 850 rpm. Design work started in 1950; the first locomotive with the unit was produced in 1953 and the first ship in 1954.

The opposed piston principle was developed by Fairbanks-Morse in the United States, and the Soviet 2 D 100 is a copy of Fairbanks Morse Model 38D 8-1/8 series, although the cylinder diameter of the Soviet version is 207 mm compared with 206.37 mm in the Fairbanks Morse original.[17]

Since no other diesel-electric unit has been identified in current production, the possibility exists that this unit is used in the Soviet icebreakers of the "Ledokol" series for which no engine data are given in the Soviet Register, and also in numerous Soviet naval units propelled by diesel-electric propulsion units.

INTERNAL COMBUSTION ENGINES

About 95 percent of Soviet internal combustion engine production in 1959 was represented by two engines, an in-line six-cylinder in the GAZ 51 truck series and another in-line six-cylinder in the ZIL 150 series.[18] Most of the remaining production was taken up by heavier truck engines. Table 17-7 summarizes the origins of the major truck and automobile gasoline engines in operation up to 1960.

The original Moskvitch 401, a four-cylinder in-line engine, was a copy of the 1939 German Opel engine. Two subsequent versions, the MZMZ 407 and the MZMA 408, were modified versions of the original Moskvitch 401

[16] For merchant ships see Registr Soyuza SSR, *op. cit.* n. 1; for locomotives see K. A. Shishkin *et al.*, *Teplovoz TE-3* (Moscow, 1969).

[17] Fairbanks Morse, Power Systems Division, *Fairbanks Morse 38D8 1/8 Series Opposed Piston Diesel and Gas Engines* (Beloit, Wis., n.d.), Bulletin 3800D8-S3.

[18] Barney K. Schwalberg, *Manpower Utilization in the Soviet Automobile Industry*, Supplementary Report (Washington: U.S. Department of Commerce, Bureau of the Census, June 1959), p. 16.

Table 17-7 ORIGINS OF AUTOMOBILE AND TRUCK INTERNAL COMBUSTION ENGINES IN THE SOVIET UNION UP TO 1960

Basic engine model number	*Type*	*Weight, kg*	*Number of cylinders*	*Displacement, litres*	*Cylinder diameter, mm*	*Piston stroke*	*Horsepower*	*rpm*	*Western Origin*
401	in-line	112	4	1.07	67.5	75.0	26.0	4,000	Opel
MZMA 407	in-line	123	4	1.36	76.0	75.0	45.0	4,500	modified
MZMA 408	in-line	123	4	1.36	76.0	75.0	50.0	4,750	
GAZ 20	in-line	153	4	2.12	82.0	100.0	52.0	3,600	World War II Ford/Willys
GAZ 69	in-line		4	2.12	82.0	100.0	52.0	3,600	¼-ton truck (Jeep)
GAZ 21A	in-line	146	4	2.445	92.0	92.0	75.0	4,000	Improved GAZ 20
UAZ 451	in-line	145	4	2.445	92.0	92.0	70.0	4,000	(WW II Jeep)
UAZ 450	in-line		4	2.43	88.0	100.0	62.0	3,800	
GAZ 13	V		8	5.52	100.0	88.0	195.0	4,200	Ford Motor Co.
ZIL 111	V	312	8	5.98	100.0	95.0	200.0	4,200	
GAZ 51	in-line	235	6	3.48	82.0	110.0	70.0	2,800	Ford Motor Co. plant
ZIL 158B	in-line	400	6	5.55	101.6	114.3	109.0	2,800	
Ural 353A	in-line	380	6	5.55	101.6	114.3	95.0	2,600	
ZIL 150	in-line	—	6	5.55	101.6	114.3	90.0	—	1934 Fordson engine;
ZIL 164A	in-line	380	6	5.55	101.6	114.3	100.0	2,800	Hercules Motor Co.
ZIL 157K	in-line	380	6	5.55	101.6	114.3	110.0	2,800	equipment
KAZ 606A	in-line	380	6	5.55	101.6	114.3	104.0	2,600	
GAZ 53	V	215	8	4.25	92.0	80.0	115.0	3,200	Ford Motor Co. plant

Source: Kratkii avtomobil'nyi spravochnik, 5th edition (Moscow, 1968).

and the latter was used in the Moskvitch automobile as late as the mid-1960s.

The GAZ 20 is the four-cylinder U.S. Jeep engine and used in both the civilian and military versions of the GAZ 20 and the GAZ 69. Its closest U.S. counterpart is the World War II Ford/Willys one-quarter-ton Jeep engine, and the Soviets presumably based their design on Lend Lease supplies and equipment.

The GAZ 21A and UAZ 451 are improved versions of the original Jeep engine, with somewhat larger displacement (2.445 instead of 2.12 litres) and a higher horsepower rating (70-75 hp instead of 52 hp). The GAZ 51, the GAZ 53 with a V-8 engine of U.S. type, and all other GAZ engines, are built in the Ford-designed and -built Gorki plant,[19] which received a considerable quantity of new U.S. machinery during and after World War II.

The 5.55-litre displacement engine used in the ZIL-158B, the Ural 353A, the more common ZIL 150, the ZIL 164A, the ZIL 157K and the KAZ 606A has the same engine characteristics as the prewar Fordson tractor engine produced at Yaroslavl with equipment installed by the Hercules Engine Company in 1934.[20]

FRENCH ORIGINS OF MARINE GAS TURBINES

Soviet marine gas turbines are based on French turbines imported in 1959. Table 17-8 lists all gas turbine-powered Soviet ships built up to 1967 and the origin of their gas generators and turbines. The typical plant consists of four free-piston gas generators, 340 by 904 mm, manufactured by S.I.G.M.A. at Venissieux,[21] and a gas turbine geared to the shaft manufactured by Société Alsthom of Belfort, France.[22] The hulls were built and the French turbines installed at the Baltic Yards in Leningrad.

WESTERN ORIGINS OF SOVIET STEAM TURBINES

Analysis of the Soviet register of shipping suggests that no steam turbines for merchant marine use were manufactured in the Soviet Union before 1959.[23]

[19] See Sutton I and II.

[20] *Ibid.*

[21] S.I.G.M.A. is Société Industrielle Générale de Mécanique Appliquée, a subsidiary of Organisation Bossard et Michel S.A.

[22] Alsthom is Société Générale de Constructions Electriques et Mécaniques Alsthom, a subsidiary of Française Thomson-Houston-Hotchkiss-Brandt S.A. Cie and affiliated with Thomson Electric Company of New York.

[23] This statement should be modified by the observation that Soviet Navy ships use steam turbines; hence the Soviets probably had a capability for manufacturing marine steam turbines before 1959. The statement here applies only to the merchant marine.

Table 17-8 ORIGINS OF SOVIET MARINE GAS TURBINES AS OF 1967

Soviet register number	*Name of Ship*	*Date Launched*	*Gas Turbine manufacturer*
2126	*Pavlin Vinogradov*	1960	S.I.G.M.A. France (1960)
4465	*Umbales*	1962	S.I.G.M.A. France (1959)
4859	*Johann Mahmastal*	1965	S.I.G.M.A. France (1959)
2197	*Pechorales*	1964	S.I.G.M.A. France (1959)
4345	*Teodor Nette*	1963	S.I.G.M.A. France (1959)

Sources: *Lloyd's Register of Shipping, 1969-70*, (London, 1969); Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965*, (Moscow, 1966).

Note: These five ships constituted the total Soviet fleet of gas turbine-powered ships to 1967

In 1964 the Soviet mercantile fleet had 45 ships powered by steam turbines. The acquisitions of these turbines fall into three distinct periods: stage one, that of foreign purchases only; stage two, that of foreign purchases concurrent with limited domestic production of steam turbines; and stage three, that of domestic manufacture of steam turbines without foreign imports.

Stage one extended from 1953 through 1956. In 1953 the Soviets installed German boilers in a Dutch ship with turbines built in 1919, possibly as a test bed for further work. Then in 1955 six steam turbines for marine use were ordered in France and two more in East Germany. Of the French turbines, one came from Schneider et Cie at Le Creusot (France), one from a subsidiary of this company (Société des Forges at Ateliers du Creusot), and four from Ateliers et Chantiers de Bethune located at Nantes on the western coast of Brittany.The turbines supplied by Schneider et Cie at Le Creusot were undoubtedly of Westinghouse design, inasmuch as Schneider has a licensing agreement with the Westinghouse Electrical Corporation in the United States and both companies jointly own a French development company, Société de Développement Westinghouse-Schneider of Paris.

In 1959 the Soviets produced the first domestic (at least nonmilitary) marine steam turbine, which was installed in a 12,000-ton ship (Soviet Register Number 1602); this was followed by construction of four turbines in 1959, seven in 1960, six in 1961, five in 1962, and eight in 1963. However in 1959, when the first Soviet merchant marine steam turbine was produced, four turbines were purchased abroad and installed in ships later added to the Soviet mercantile fleet. One turbine came from Italy and was installed in the *Giuseppe Garibaldi;* this was a geared turbine manufactured by the Ansaldo shipyards in Genoa, Italy. This company is licensed to manufacture De Laval geared turbines (De Laval is an American corporation). Another De Laval turbine was installed in the *Trud* (Soviet Register Number 4393). This was a geared turbine manufactured by De Lavals Angturbin in Stockholm, Sweden, and also manufactured under license from the De Laval Company in the United States. Two additional steam turbines were purchased in Japan. One, from the shipbuilding company Hitachi, is a Kawasaki turbine with water tube boilers. The second turbine was purchased in 1960, and is a geared unit manufactured by Ishikawajima Harima in Tokyo; this company has a licensing agreement with Foster Wheeler in the United States for manufacturing water tube boilers for marine use.

Thus, between 1958 and 1961 the Soviets purchased four steam turbines abroad and manufactured another five or six steam turbines within the Soviet Union. Undoubtedly the initial Soviet steam turbines were compared with imported turbines concerning operating characteristics.

Up to 1962 we find that the Soviets manufactured an average of five or six steam turbines per year and since that time all units have been manufactured domestically. The Western predecessors of these domestic steam turbines are not known; they may be Metropolitan-Vickers (a subsidiary of Westinghouse) under an old agreement, or General Electric, or possibly even Sulzer.

A similar three-stage development process appears to be under way in marine gas turbines; several gas turbines were purchased in France in 1960 and presumably by the end of the decade of the sixties the Soviets will have started to manufacture, within the Soviet Union, marine gas turbines according to this design.

ORIGINS OF MARINE BOILERS INSTALLED BETWEEN 1945 AND 1960

Between 1945 and 1960 a total of 447 marine boilers of three types (water tube, fire tube, and combined) were installed in Soviet merchant ships. Of this total, only 76 (or 17.0 percent) were manufactured in the Soviet Union. The remainder were imported: 181 (or 40.5 percent of the total) from Finland, 116 (or 25.9 percent) from the East European communist countries of East Germany and Poland, and the rest from non-Finnish sources in the Free World, including 46 (or 10.3 percent) from Sweden.

There are several noteworthy observations concerning these boilers. The large percentage imported, i.e. 83 percent, suggests there was a major Soviet weakness in this area. The 17 percent Soviet-manufactured boilers also are of a standard type; between 1949 and 1954 only one type of marine boiler was manufactured, i.e., of a 174-square-meter heating surface with a working pressure of 15.0 kg/cm^2. Between 1955 and 1960 this standard model was replaced by another of 180-square-meter heating surface with the same working pressure. During this period of 15 years the Soviet Union manufactured only a single standard boiler model at any one time. The flexibility required in practice was attained by imports from Eastern Europe and the Free World;[24] larger sizes of marine boilers with greater working pressures were imported in a variety of models from Finland, Poland, East and West Germany, Sweden, Italy, Denmark, Norway, Belgium, the United Kingdom, and Holland. (See Table 17-9.)

Table 17-9 ORIGINS OF MARINE BOILERS INSTALLED IN THE SOVIET UNION BETWEEN 1945 AND 1960

Size of boiler; m² of heating surface	*Finland*	*U.S.S.R.*	*Poland*	*East Germany*	*Sweden*	*Other Free World countries*	*Total*
718	—	—	—	—	—	2 (Italy)	2
495	—	—	2	—	—	—	2
390	—	—	—	4	—	—	4
386	—	—	—	2	—	—	2
287	—	—	1	—	—	—	1
286	—	—	—	2	—	—	2
260	—	—	—	—	3	—	3
254-6	—	—	69	2	—	1 (Denmark) 2 (Norway) 4 (FRG)	78
245	—	—	4	—	—	3 (U.K.)	7
235-8	—	—	—	—	32	—	32
213-9	—	—	—	—	11	1 (Belgium)	12
204	—	—	8	—	—	—	8
186	—	—	—	16	—	—	16
180	—	35	—	—	—	—	35
174	—	41	—	—	—	—	41
170	4	—	—	4	—	6 (Holland) 4 (FRG)	18
163-5	17	—	—	—	—	2 (FRG)	19
150	1	—	—	—	—	—	1
140	128	—	—	—	—	1 (FRG)	129
136	—	—	—	2	—	—	2
125	—	—	—	—	—	2 (Norway)	2
103	31	—	—	—	—	—	31
	181	76	84	32	46	28	447
Percentage of Total	40.5	17.0	18.8	7.1	10.3	6.2	99.9

Sources: Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966). See chapter 28 for diagram based on these data.

[24] See diagram, p. 407.

The most significant conclusion is that a detailed examination of one important class of prime movers—marine diesels, for which we have complete and accurate data does not produce evidence of useful Soviet innovation. Four-fifths of these units, whether measured in terms of units or aggregate horsepower, were built abroad and those built inside the U.S.S.R. had considerable, if not complete, dependence on foreign designs and for the most part technical assistance in the form of drawings and sample engines.

The evidence produced for truck diesels, internal combustion engines, and gas turbines suggests a similar heavy dependence on foreign technology—no indigenous Soviet work forms the basis for large-scale production of these propulsion systems. In boilers we find long-term manufacture of a single model of 174 to 180 cubic meters for marine use (boilers are of course manufactured in other models for nonmarine uses), with flexibility obtained by boilers from outside the U.S.S.R.

CHAPTER EIGHTEEN

Western Assistance to Soviet Atomic Energy

SOVIET THEORETICAL WORK BEFORE WORLD WAR II

Russian aptitude for theoretical work in mathematics and physics is well exemplified in the fields of high-energy physics and atomic theory. As a result of the work of Petr Kapitsa and other physicists in the decade of the twenties, Soviet research paralleled Western research in the 1930s. A series of institutes was established, of which the Nuclear Physics Laboratory at the Leningrad Technical Institute under Igor Kurchatov was preeminent. Two cyclotrons were established under Kurchatov (at the same time as scientists at the University of California at Berkeley pioneered the cyclotron), but two other cyclotrons were left unfinished until the end of the war.

According to A. Kramish, Soviet scientists had made several major discoveries by 1940 and "the Russians are justified in claiming priority for the discovery of spontaneous fission."[1] Work was undertaken on methods for quantity production of fissionable materials, i.e., uranium-235 and heavy water, and methods later used by the United States in the Manhattan Project were under active discussion and even partly published in the U.S.S.R. before World War II.

The Nazi attack of June 1941 brought this promising theoretical work to a halt, and for some years thereafter Russian activity was limited to monitoring Western progress, particularly the extraordinary progress in the United States. There is no question that Soviet scientists were at least on a par with Western scientists in 1940, and in some areas of theory they could have been slightly ahead.

The wartime monitoring process comprised espionage, not only in the United States and Canada,[2] but also in Germany.[3] It was later asserted in scientific circles in the United States that scientific "secrets" could not be effectively retained, and official U.S. policy, as announced by President Truman in October 1945, was to retain the engineering and industrial techniques but not the scientific

[1] M. J. Ruggles and A. Kramish, *The Soviet Union and the Atom: The Early Years* (Santa Monica: RAND Corp., 1956), Report no. RM-1711. Arnold Kramish has also published *Atomic Energy in the Soviet Union* (Stanford, 1959); this is in great part a reproduction of the material in RAND report no. RM-1711 and companion studies.

data within the United States; hence the preparation of the 1945 Smyth Report, which was of some assistance to Soviet work.[4]

German wartime efforts in the same field, from the scientific viewpoint, were on a level with those of the United States. The Weinberg-Nordheim report[5] concluded that German wartime researchers "were on the right track and their thinking and developments paralleled ours to a surprising extent. According to this report the Germans knew the correct lattice dimensions for a P-9U system as well as the required quantity (four tons) of P-9. Their uranium metal "was about as pure as ours," their theory of the chain reaction "was in no wise inferior to ours, in some respects it was superior," and the only nonengineering "secrets" they might not have had was an understanding of the Xeon-135 poisoning problem and possibly of the properties of plutonium-240.[6] It was primarily lack of heavy water that accounted for inability of the Germans to achieve a chain reaction; however, their total effort was on a much smaller scale than the American effort. The report concludes:

> We must proceed, therefore, on the basis that anyone knowing what is in the German reports can establish a chain reaction provided he has sufficient materials. The Smyth report will give additional very helpful hints. The time when others can establish a chain reaction is therefore no longer a matter of scientific research but mostly a matter of procurement.[7]

Given vigorous Soviet atomic espionage, the high level of prewar Soviet scientific work, the American inability to retain scientific secrets, and the availability of German atomic work, scientists, and equipment to the Soviet Union (both through espionage and as a result of postwar capture of German reports), the Soviets had adequate *theoretical* knowledge of atomic weapons manufacture in 1945.

What was perhaps as important as the access to atomic bomb research,

[2] See U.S. Congress, Joint Committee on Atomic Energy, *Soviet Atomic Espionage*, 82d Congress, 1st session, April 1951; and *The Report of the Royal Commission to Investigate the Facts Relating to and the Circumstances Surrounding the Communication, by Public Officials and Other Persons in Positions of Trust, of Secret and Confidential Information to Agents of a Foreign Power: June 27, 1946* (Ottawa, 1946).

[3] A. Kramish, *The Soviet Union and the Atom: The "Secret" Phase* (Santa Monica: RAND Corp., 1957) Report no. RM-1896, p. 17 fn.

[4] U.S. Senate, *Nuclear Scientist Defects to United States*, Subcommittee to Investigate the Administration of the Internal Security Act and Other Internal Security Laws of the Committee on the Judiciary, 89th Congress, 1st session (Washington, 1964).

[5] U.S. Atomic Energy Commission, *Memorandum on the State of Knowledge in Nuclear Science Reached by the Germans in 1945*, by A. M. Weinberg and L. W. Nordheim (Oak Ridge, Tenn: Technical Information Service, November 8, 1945), German Series no. G-371.

[6] Weinberg and Nordheim pointed out their limited access to German reports, but were able to establish these major propositions.

[7] AEC *Memorandum*, *op. cit.* n. 5, p. 3.

the Soviets had access *on an exclusive basis* to German hydrogen bomb work. David Irving notes a series of experiments on thermonuclear fusion at the German Army explosives research establishment at Kummersdorf; the results of these experiments were captured by Soviet forces and the only document to fall into Western hands, according to Irving, was a "six-page report among the *Alsos* collection ... entitled 'Experiments on the Initiation of Nuclear Reactions by Means of Exploding Substances.' "[8]

Therefore, as the Weinberg-Nordheim report concludes, the important restriction to Soviet atomic development at 1945 was not the scientific method of "making an atomic bomb" but the materials and equipment with which to undertake the program; i.e., it was "mostly a matter of procurement."[9]

CONTRIBUTION OF THE ATOMIC SPIES TO SOVIET WORK

The Soviets made persistent efforts during World War II to penetrate Western work in atomic energy. General L. R. Groves indicates that the major atomic espionage was carried on by Soviet, not German, agents,[10] and such espionage has undoubtedly continued since that time. There is a correlation between the work of the known Soviet agents—Fuchs, Greenglass, May, and Pontecorvo—and subsequent Soviet developments in the atomic energy and weapons field.

Klaus Fuchs, a theoretical physicist, was a member of the inner group in the development of the atomic bomb in World War II; his work in England concerned the gaseous diffusion process used in the Oak Ridge plant. In the United States, Fuchs was intimately associated with both groups (SAM and the Kellex Corporation) working on gaseous diffusion.[11] According to Karl Cohen, former director of the Atomic Energy Commission, Fuchs " ... had intimate and detailed knowledge of all phases of the design of the K-25 plant, including methods of fabricating the barrier, the assembly of the diffuser, and the planned production rate."[12] At Los Alamos, Fuchs took part in making the first atomic bomb and in the weapons work involved.

By contrast, both May and Pontecorvo understood the operating problems

[8] David Irving, *The Virus House* (London: William Kimber, 1967), pp. 193-95; p. 194 has a photograph of p. 1 of the 1944 German Army report on initial work on an H-bomb. The full report is probably at Oak Ridge, Tennessee.

[9] AEC *Memorandum*, *op. cit.* n. 5, p. 3.

[10] Leslie R. Groves, *Now It Can Be Told* (New York: Harper and Row, 1962), p. 141.

[11] U.S. Congress, Joint Committee on Atomic Energy, *Soviet Atomic Espionage*, 82d Congress, 1st session, April 1951 (Washington, 1951).

[12] Letter, Cohen to Joint Committee on Atomic Energy, in *ibid.*, p. 23. Fuchs also was working on uranium hexafluoride and the control problems of gaseous diffusion plants.

of plutonium piles and both worked on the Hanford reactor, which was copied by the Soviet Union in developing the first Soviet reactor.[13]

Nunn May worked in 1942 at the Cavendish Laboratories in Cambridge, England, and in January 1943 went to Canada where he was senior member of the Nuclear Physics Division. Espionage, for which he was sentenced to ten years in prison, consisted of supplying the Soviets with samples of uranium-235 and uranium-233. May admittedly also passed on to the Soviets information that was still classified in 1946.[14]

Prior to his defection to Russia in 1950, physicist Bruno Pontecorvo worked as senior principal scientific officer at the British Harwell Laboratory. The most significant knowledge possessed by Pontecorvo concerned the Hanford reactor and the nuclear aspects of the Canadian NRX heavy-water pile at Chalk River, Ontario—at that time the most advanced reactor of its type in the world.[15]

David Greenglass, the fourth atomic spy, was a machinist assigned to the Los Alamos weapons laboratory, where he worked on high-expolsive lens molds: "Greenglass testified that he conveyed to Russia a diagram of the atomic bomb, along with a detailed explanation and related materials in writing."[16]

In sum, the Soviets gained a great deal of useful information and technical know-how from espionage sources; by themselves these data were of limited use, but combined with other sources they comprised a package with significant potential.

THE GERMAN CONTRIBUTION TO SOVIET ATOMIC ENERGY PROJECTS[17]

The widespread impression that the Soviets did not gain useful materials, equipment, or information from the German atomic research program is erroneous.[18] (See Table 18-1.)

[13] *Ibid.:* May p. 2, Pontecorvo p. 2. See also p. 242 below.
[14] *Ibid.*, p. 2.
[15] *Ibid.*, p. 1.
[16] *Ibid.*, p. 3.
[17] For the status of the German atomic energy projects in 1945 and also for a measure of the technology and facilities removed to the Soviet Union, see the G Series of reports at the Atomic Energy Commission, Oak Ridge, Tennessee. Some 394 reports are listed in Atomic Energy Commission TID-3030, *German Reports on Atomic Energy*. See also BIOS Final Report 675, *Production of Thorium and Uranium in Germany*.
[18] For example, see G. A. Modelski, *Atomic Energy in the Communist Bloc*, (Melbourne, 1959), p. 36. Modelski concludes: "... the Russians may have picked up some useful material and information, as well as some trained men, but the sum total cannot have been very large. German research had not progressed very far during the war and by 1944, far from having a pile working, German scientists merely envisaged the possibility that one might be made to work."

Table 18-1 SUMMARY OF GERMAN ATOMIC ENERGY PROJECTS REMOVED TO THE U.S.S.R. IN 1945

Material or project	*Location and plant*	*Status at 1945*
Uranium metal reduction	DEGUSSA, Frankfurt plant (moved to Berlin in 1944)	Peak annual production 5,000 kg (1942); removed to U.S.S.R.
	DEGUSSA, Berlin-Grünau plant	Peak production of 376 kg (1945); removed to U.S.S.R.
Stocks of uranium metal and oxides at Oranienburg plant Uranium metal refinery	Auer A.G.	Removed to U.S.S.R.
Heavy water	Stocks at Leuna in Silesia	Probably removed to U.S.S.R.
Separation processes	von Ardenne magnetic separator	Removed with von Ardenne to U.S.S.R.
	Groth centrifuge	
Linear accelerator	Berlin	Removed to U.S.S.R.

Source: David Irving, *The Virus House* (London: William Kimber, 1967).

In 1945 the bulk of German uranium ore, the balance of 1200 tons removed by the German Army from Belgium in 1940, was moved to a salt mine near Stassfurt in what was to become the Soviet Zone. A British-American mission attached itself in 1945 to a U.S. infantry division and under "Operation Harborage" seized the mine and the 1100 tons of Belgian ore located nearby. This uranium ore was removed to the American Zone of Germany.[19]

Uranium metal was produced in Germany in World Warr II at two plants operated by DEGUSSA (German Gold and Silver Extraction Corporation). Uranium oxide supplied by Auer A.G. in Berlin was reduced by DEGUSSA at its Frankfurt plant, and by the end of 1940 the company was producing a maximum of one ton of uranium metal per month. In the United States, by way of comparison, almost no uranium metal was available until the end of 1942; when the first chain reaction took place at Chicago, the DEGUSSA plant in Frankfurt had manufactured over seven tons of uranium metal.[20]

Work began in 1942 on a second uranium production plant identical to the DEGUSSA plant but at Grünau, Berlin. In January 1945 the DEGUSSA Frankfurt plant was removed to the Auer location near Berlin, where the uranium metal was being refined. The Soviets occupied Oranienburg and the Auer works, and so obtained several tons of pure uranium oxide and, more importantly, the two DEGUSSA uranium smelting plants and the Auer refining plant. In addition they captured five tons of uranium metal powder, a quantity of uranium

[19] See Irving, *op. cit.* n. 8; also see S. Goodsmit, *ALSOS* (New York: Schuman, 1947).
[20] Irving, *op. cit.* n. 8, pp. 75-76.

cubes, and about 25 tons of unrefined uranium oxide and uranates. This became the uranium stockpile for the early Soviet atomic bomb program.[21]

Unlike the American program, for which the ultrapure graphite necessary for use as a moderator was produced by several firms, the German atomic project was not able to use graphite as a moderator and thus came to be dependent on the use of heavy water. Part of the Norwegian heavy water plant, captured by the Germans and then destroyed by British Commandos, was duplicated by I. G. Farben at Leuna. The Leuna plant was later subjected to heavy bombing, but the surviving drums of heavy water were transported to the I. G. Farben plant at Myrow in Silesia and presumably captured there and removed to the Soviet Union.[22]

By the time the war ended the Germans had seven isotope separation processes under consideration, excluding the gaseous diffusion process used in the United States, and at least two of these had been brought to the equipment stage. Manfred von Ardenne had developed a magnetic isotope separator similar in concept to the magnetic process that was then used at Oak Ridge in the United States and later built at von Ardenne's Berlin laboratories. Also, a prototype centrifuge with an operating speed of 50,000 revolutions per minute was built by Groth; although the early models failed, it seems that this centrifuge process had practical possibilities for isotope separation. In 1945, von Ardenne's laboratory at Berlin, complete with a Van de Graaf machine, a cyclotron, and the prototype electromagnetic isotope separation equipment, was removed with von Ardenne himself to the Soviet Union.

The Germans also built several subcritical piles. The first German pile was at the Kaiser Wilhelm Institute of Biology and Virus Research in Berlin. This was a heavy-water pile, and according to the American intelligence mission which inspected it in July 1945 after much of the equipment had been removed to the Soviet Union, it appeared to have been excellently equipped when compared to the primitive setup that Enrico Fermi used at Columbia University in the United States.

The Kaiser Wilhelm Institute was stripped of all its equipment, including a high-voltage linear accelerator, and moved to the Russian atomic project at Obninchoye.[23]

Another pile, built at Leipzig, was destroyed in a 1942 explosion, and a third pile was located at Haigerloch. In the late summer of 1944 all uranium pile research was removed to Stadtilm in Thuringia in what was to be the Soviet Zone. Later, in 1945, some pile research was moved south.

It is interesting to note, then, that while in 1944 and early 1945 rocket development projects under Werner von Braun moved westward into the future

[21] *Ibid.*, p. 263.
[22] *Ibid.*, pp. 157, 178, 191-92.
[23] *Ibid.*, p. 264.

U.S. and British zones, the movement of atomic energy projects (metal reduction, uranium ore, and pile research) was eastward into the future Soviet Zone, and there most of it remained when the war ended.

Finally, the Soviets rounded up the uranium project scientists and most went, under good contracts, to the Soviet Union. Among these men were von Ardenne, an expert in the separation process and something of an equipment genius, and Nikolaus Riehl, an expert in the processing and refining of uranium metal; both worked for about ten years on the Soviet atomic project.[24]

The German nuclear scientists were settled at Sukhumi and remained there from 1945 until some time after 1955. The sanatoriums along the Black Sea coast were converted into nuclear research institutes where the German groups were installed and projects started. For example, Heinz Barwich was the leader of 18 scientists working on theoretical questions concerning control problems in the diffusion process of isotope separation.[25] Associated in this work was Yuri Krutkov, who was technically known as a "prisoner-engineer" and had been released from a prison camp for this purpose. Another group at Sukhumi was the von Ardenne team working with R. A. Demirkhanov on instrumentation for nuclear energy and later on ion sources and mass spectrography. Although the Sukhumi laboratories are today of secondary importance, they formed the key section for the development of atomic energy in the Soviet Union in the forties and fifties and employed many German engineers. Some of the personnel have since returned to Germany, but others are still in Sukhumi.

Methods for the mass production of uranium-235 were developed at Sukhumi. The Soviets undertook duplication of both the barrier method (already established in the United States) and the centrifuge method of isotope separation. Doctor Zuehlke specialized in the barrier question. The manufacture of metallic barriers was divided into two groups: those working on flat barriers and those working on tube barriers. Max Steenbeck, another German scientist, was one who concentrated for a number of years on the ultracentrifuge method for separating uranium gas.[26]

In summary, at the end of World War II the Soviets obtained from Germany not only scientists and expert technicians (the Germans were then on the threshold of achieving a chain reaction) but facilities for ore processing, reduction, and refining of uranium metal and oxides, two working isotope separation processes and operating equipment, advanced laboratories and equipment, and several

[24] *Ibid.*, p. 263. Irving also lists about a dozen other Germans, key members of the German atomic energy project, who went to the Soviet Union.

[25] See Dr. Barwich testimony to U.S. Senate, *Nuclear Scientist Defects .... op. cit.* n. 4, pp. 10 *et seq.*

[26] See *ibid.*, for usefulness of U.S. reports to German work in the U.S.S.R. Also see U.S. Senate, Committee on the Judiciary, *Scope of Soviet Activity in the United States*, Hearings Before the Subcommittee to Investigate the Administration of the Internal Security Act and other Internal Security Laws, 84th Congress, 2d session, (Washington, 1956), pt. 21.

subcritical piles. In addition they located and removed small stocks of heavy water, uranium metal, and uranium oxides.

The Soviets failed to obtain from the Germans any information on the gaseous diffusion separation process, the use of graphite as a moderator, or knowledge of a chain reaction in practice. Nor did they obtain any operational atomic weapons technology, although they did acquire useful German research work. These technologies could only have come from the United States or from Great Britain (for the gaseous diffusion process).

Probably the most accurate estimate of Soviet capability in atomic development at the end of World War II was made in November 1945 by Major General L. R. Groves, testifying before the Senate Special Committee on Atomic Energy. General Groves was director of the Manhattan Project during World War II, and at that time was more knowledgeable than any other person concerning the industrial and technical features of production of atomic materials and atomic bombs. He made a statement relative to the Soviet Union as follows:

> I testified before the House Committee in response to a direct question on that point, that one nation could catch up and produce a bomb, if they did it in complete secrecy, probably within from 15 to 20 years—more likely the latter. If they did it without secrecy and with a great deal of help from the United States and from England and Switzerland—and I say Switzerland because she is a manufacturer of precision machinery—it would be done in five to seven years, probably seven.[27]

Under questioning from the committee, General Groves elaborated on the assistance that would be needed. This would have to include engineering developments, i.e., the design and manufacture of and the specifications for metallurgical processes. Groves commented on the fact that at the Hanford Engineering Works, the Dupont Company had over 10,000 subcontractors, "each of them supplying a different material . . . they were supplying subassemblies."[28] At least 50 percent of these 10,000 subcontractors required some special "know-how." With all the technical resources of American industry it had taken 18 months to build this kind of equipment, and according to General Groves, in 1945 such resources could have been obtained only in the United States, England, and Switzerland, with possibly some parts in Sweden. Switzerland was isolated by General Groves because it has been a center of high-grade machine tools of special design: "You find a great many [Swiss machine tools] in this country [i.e., the U.S.A.]

[27] U.S. Senate, Special Committee on Atomic Energy, *Hearings* Pursuant to S. Res. 179, Creating a Special Commission and Investigating Problems Related to the Development, Use and Control of Atomic Energy, 79th Congress, 1st session, November and December 1945 (Washington, 1946), pts. 1-3; *idib.*, 2d session, January and February 1946 (Washington, 1946), pts. 4, 5.

[28] *Ibid.*, pts. 1-3, p. 67.

particularly in any plant that has been in operation for a number of years and has accumulated a number of special Swiss machines."[29]

It is quite clear that in 1945 the Soviets with outside help of a detailed nature, would have required five to seven years to reproduce the American achievement, and that such assistance could only come from one of three countries—the United States, England, or Switzerland. General Groves's testimony is entirely consistent with evidence provided in this study concerning Soviet technical backwardness.

INDUSTRIAL ASPECTS OF THE SOVIET ATOMIC PROGRAM

The conclusion of the Weinberg-Nordheim report is supported by Klaus Fuchs's statement that he could do no more than explain to the Soviets the principle upon which a bomb was based: " ... it was up to the Russians to produce their own industrial equipment."[30] Neither could any other of the atomic spies provide more than information on scientific and technical principles. The key question after taking atomic espionage into account, then, is this: Where did the Soviets get the industrial ability to manufacture an atomic bomb? This achievement is infinitely more important than transfer of scientific information; it is also more difficult to assess.

Klaus Fuchs indicated that he had been "astonished" when the Soviets "succeeded in making and detonating a bomb so rapidly," and he added that although scientifically they were sufficiently advanced, he "could not have believed that commercially and industrially they had developed so quickly."[31]

Certainly the overall conclusions of this study and General Groves's expressed views raise similar questions about Soviet industrial ability. In 1945-46 the U.S.S.R. was technologically backward and heavily dependent on the West. Even though priority there is traditionally given to military objectives, the extraordinary effort required—one that strained even American technical resources—was far beyond purely Soviet industrial abilities in the 1940s and 1950s.

It is therefore suggested, in line with the Weinberg-Nordheim report and the comments of Klaus Fuchs, that the essential question to be answered about Soviet atomic weapons development, and about the Soviet atomic energy program in general, is what was the source of the industrial capability to manufacture atomic materials, including atomic weapons. The argument, outlined below, is that the technical capability came by various routes from the West.

The basic raw material for atomic reactors is uranium ore converted into uranium metal—the metal being the raw material for pile operation.

[29] *Ibid.*, p. 69.
[30] Allan Moorehead, *The Traitors*, (London: Hamish Hamilton, 1952), p. 141.
[31] *Ibid.*

In January 1943 the Soviet Purchasing Commission requested eight tons each of uranium oxide and uranyl nitrate salts.[32] A. Kramish indicates that if this was processed into metal it would yield "just about the right amount of material necessary to duplicate the United States experiments at Chicago."[33]

In March 1943 two licenses were granted to the S. W. Shattuck Chemical Company of Denver, Colorado, for shipments to the Soviet Union: one was for 200 pounds of urano-uranic oxide and 220 pounds of uranium nitrate, and one for 500 pounds each of urano-uranic oxide and uranium nitrate. Granting of these licenses was followed in April 1943 by a license for 25 pounds of uranium metal and in November 1943 by a license for 1000 grams of heavy water. These licenses were granted by the Lend Lease administration to the Soviet Purchasing Commission in the United States. General Groves comments:

> There was a great deal of pressure being brought to bear on Lend Lease apparently to give the Russians everything they could think of. There was a great deal of pressure brought to give them this uranium material.[34]

However, it seems unlikely that the Soviets obtained sufficient reactor materials from U.S. sources. Soviet requisition No. R-12045 of February 4, 1943, for uranium oxide was not filled, and so far as the allowed 25 pounds of uranium metal is concerned, General Groves comments:

> We didn't stop [the] shipment for a very good reason. We were anxious to know if anybody in this country knew how to make uranium metal. . . . We were willing that the Russians have 25 pounds . . . it would be worth more than that to us to find out how to make uranium metal.[35]

Later, on March 31, 1944, Lieutenant General L. G. Rudenko wrote to Secretary of War Stimson to the effect that the Soviet Union was "in most urgent need of the following materials for its war industry," i.e., eight tons of uranium nitrate, eight tons of urano-uranic acid, and 25 pounds of uranium metal. Again, these quantities were sufficient to duplicate U.S. work.[36]

The only Soviet receipt of uranium metal from the United States was two pounds of inferior material. However, in June 1948 the Canadian Radium & Uranium Corporation of New York City did ship to the Soviet Union 500 pounds of black uranium oxide and 500 pounds of uranium nitrate—and the

[32] U.S. Congress, *Soviet Atomic Espionage, op. cit.* n. 11, pp. 184-92.
[33] Kramish, RAND Report RM-1896, *op. cit.* n. 3., p. 63.
[34] U.S. House of Representatives, Committee on Un-American Activities, *Hearings Regarding Shipment of Atomic Materials to the Soviet Union*, 81st Congress, 1st and 2d sessions, December 1949-March 1950 (Washington, 1950), p. 940.
[35] *Ibid.*, p. 942.
[36] *Ibid.*, p. 1044.

Atomic Energy Commission did not become aware of this shipment for five years.[37]

Of far greater value than uranium metal or oxides supplied from the United States and Canada was the Soviet capture of the Auer A.G. plant at Oranienburg, just outside Berlin, together with German uranium metal and oxides. The Auer plant produced uranium metal for the German atomic program.[38]

SOVIET URANIUM MINING IN SAXONY: WISMUTH A.G.

German uranium ore was mined in Saxony. As soon as American forces evacuated the Saxony area of East Germany, Soviet geologists prospected the old mines around Oberschlema. Subsequently, a corporation named Wismuth A.G. was formed to reopen the mines and develop the uranium content. The chief German adviser used by the Soviets for this project was a Nazi named Schmidt, a former mine inspector and an expert on the Saxony mines. Released from a Soviet concentration camp for this purpose, Schmidt was provided with an excellent salary and privileges on the understanding that the mines were to come into active production.

By 1951 there were ten producing groups of mines within the Wismuth corporation comprising a total of between 65 and 70 individual uranium mines. (See Figure 18-1.) In addition there were subsidiary organizations for the construction of mining equipment, a warehouse for technical equipment, a uranium processing point at Aue, and auxiliary units for equipment of repair, lumber, assay, and other mining operations. Electrical equipment, compressors, and electric pumps were supplied by former East German companies.[39]

A German mining engineer, Hans Scherbel, has described the working conditions for the 300,000 Germans who worked around the clock in these mines: "The equipment was incredibly primitive. The shaft had no elevator. You had to climb 250 feet down on ladders. The miners had to make this climb twice daily."[40] Concerning construction of a new shaft at the Filzteich pond at Schneeberg to mine a pocket of high-grade ore, Scherbel comments that the operation was conducted "in a manner that can only be described as criminal.

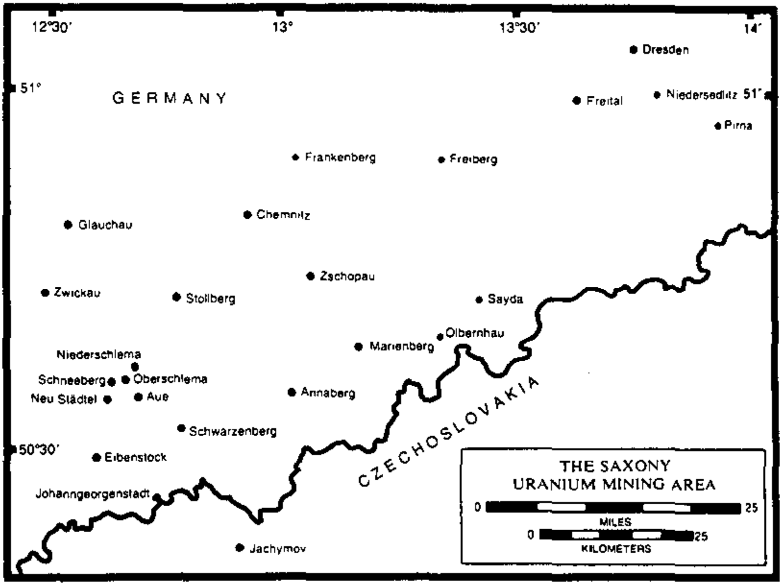
[37] *Ibid.*, p. 969.

[38] Irving, *The Virus House*, p. 250, says the plant was bombed "and completely destroyed." Reference to the U.S. Strategic Bombing Surveys suggests that few of these "completely destroyed" plants were in fact put out of action for long. Reference to the bombing records would determine the state of the plant as occupied by the Soviet forces.

[39] See Nikolai Grishin, "The Saxony Uranium Mining Operation (Vismut)" in Robert Slusser, ed., *Soviet Economic Policy in Postwar Germany* (New York: Research Program on the U.S.S.R., 1953), p. 127. This is an excellent description of the Soviet uranium mining operations in Saxony as of 1950.

[40] "The Secret Mines of Russia's Germany," *Life*, XXIX, 13 (September 25, 1950), 83.

Figure 18-1 THE SOVIET URANIUM MINES IN SAXONY



Source: Robert Slusser, ed., *Soviet Economic Policy in Postwar Germany* (New York: Research Program on the U.S.S.R., 1953), p. 137. Map data are from annex 1, pp. 154-55.

A diagonal shaft had been driven from the surface downward under the pond ... floods periodically swept through the shafts below."[41]

The reopening of the mines was successful, and output increased from 135 tons of ore in 1946 to about 900 tons in 1948; the output stabilized at this figure, and after processing was shipped to the U.S.S.R.

THE FIRST SOVIET REACTOR

The feasibility of a nuclear chain reaction was demonstrated at the University of Chicago in 1942; the Soviets had no need, therefore, to duplicate initial American work. The first Soviet reactor had the same functions as the fourth U.S. reactor at Hanford, i.e., to test materials and produce limited quantities of fissionable material. A. Kramish has pointed up the technical similarities between the first Soviet PSR reactor and the Hanford reactor, concluding that

[41] *Ibid.*

a reactor physicist would deduce that "the Soviet reactor was practically a carbon copy of the American 305 reactor built at Hanford during the first phases of the Manhattan Project."[42] (See Table 18-2.)

Table 18-2 COMPARATIVE CHARACTERISTICS OF THE AMERICAN HANFORD AND SOVIET PSR REACTORS

	Hanford 305	*First Soviet reactor (PSR)*
Start-up date	1944	1947
Power	10 watts	10 watts
Diameter	18-20 feet	19 feet
Lattice Spacing	8½ inches	8 inches
Loading	27 tons of uranium	25-50 tons of uranium*
Rod diameter	1.448 inches	1.2 to 1.6 inches

Source: A. Kramish, *The Soviet Union and the Atom: The "Secret" Phase*, RAND Report RM-1896, p. 64.

*Soviet estimate.

Kramish also points out that the Soviet PSR reactor was completed many years before the declassification of data on the Hanford 305 reactor and observes that "the similarity of construction is interesting. Is it coincidental, or were details on the 305 reactor obtained through espionage?"[43]

The first Soviet power reactor (VAM-1), as distinct from a materials testing reactor, began operation in June 1954, and was promptly claimed as the world's first atomic power station.[44] This was not an altogether accurate statement; the first nuclear reactor to generate electric power was operated in the United States in 1951. The first full-scale power reactor was the Calder Hall unit in England, which began operation in October 1956 with a reactor generating ten times more power than the 5-MWe net capacity of the Soviet 1954 reactor. The first authentic industrial reactor, the Shippingport pressurized water reactor, was built in the United States in 1958.

The original 5-MWe Soviet power reactor VAM-1 was the only Soviet power reactor from 1954 until 1964. In that year two more power reactors came into operation, the AMB-1 graphite water reactor of 100 MWe and the VVPR-1 pressured water dual-purpose reactor of 210 MWe. Therefore, although they had an extensive program employing 31,400 persons, the Soviets in 1965 had only three power reactors in operation generating a total of 315 MWe. By way of comparison, France in 1965 had five power reactors generating 350 MWe and the United Kingdom was far ahead with nine reactors generating

[42] Kramish, RAND Report RM-1896, *op. cit.* n 3, p. 64.
[43] *Ibid.*, p. 65.
[44] For a brief description see G. Ostroumov, *Pervaia v mire* (Moscow, 1956).

1395 MWe. Germany and Italy had no reactors at all in 1960, but Germany by 1965 had one reactor generating 50 MWe and Italy had three generating 607 MWe. This comparative development is of some interest in view of the early Soviet start in generation of electric power by use of atomic energy and the claims made for atomic energy in the early 1950s by Soviet scientists. (See Table 18-3.)

Table 18-3 COMPARATIVE DEVELOPMENT OF ATOMIC POWER REACTORS

	Net installed capacity				
	1960		*1965*		*Manpower employed in*
Country	*Plants*	*MWe*	*Plants*	*MWe*	*nuclear energy at 1965*
Soviet Union	1	5	3	315	31,400
France	3	85	5	350	37,500
Germany	—	—	1	15	9,676
Italy	—	—	3	607	3,500
United Kingdom	3	373	9	1395	38,632

Source: John W. Shartall, *Atomic Handbook* (London: Morgan, 1965), pp. 9, 13-14.

The position was even more distinctive at the end of 1969, when a map in *Pravda*[45] pinpointed only four operating atomic power reactors in the Soviet Union, with none under construction. This total obviously includes the original three brought into production between 1954 and 1964 together with the Siberian dual-purpose reactor brought into production sometime after 1965. This may be compared with developments in the United States, where in June 1969 a total of 13 power reactors were in operation and another 79 were on order or under construction.[46]

It appears that Soviet atomic energy development has been held back by lagging development of instrumentation and computers. The history of atomic reactors and digital computers is intertwined. Development for both began at about the same time during World War II and considerable support was given to computer development by early atomic energy researchers; the AVIDAC at Argonne, the ORACLE at Oak Ridge, and the MANIAC I at Los Alamos were products of this early cooperation.[47] By 1959, "over 300 nuclear reactor codes had been programmed in the United States for digital computers,"[48] including such major problem areas as burn-up, age diffusion equations, and kinetic responses of reactors. Soviet backwardness in computer technology is noted elsewhere.[49]

[45] *Pravda*, November 14, 1969.

[46] *Business Week*, June 14, 1969.

[47] Ward C. Sangren, *Digital Computers and Nuclear Reactor Calculations* (New York: John Wiley & Sons, 1960), p. 3.

[48] *Ibid.*, p. 10.

[49] See p. 318 below.

The 1963 U.S. atomic energy delegation to the Soviet Union had an unparalleled opportunity to see Soviet atomic development at first hand; the delegation report substantiates the evidence of Soviet technical weakness in atomic energy.[50]

For example, the delegation reported: "Equipment in the hot cells, such as viewing devices and manipulators, was not as good as that found in equivalent U.S. installations."[51] The delegation also reported: "An example of Soviet instrumentation was a transistorized television camera in a radiation cell. This was the only piece of completely transistorized equipment that the delegation saw during the trip."[52]

Only one project, the 70-GeV proton synchrotron then under construction at Serpukhov, appeared to strike the delegation as outstanding:[53]

> The delegation formed a generally favorable impression of the project and personnel. The plant layout appeared to be sound, and factory-made equipment looked as if it were of high quality, e.g., canned rotor pumps. Standard field construction, however, was of a poorer caliber. For example, the masonry work was not done as carefully as might be expected. The few examples of stainless-steel welding seen, however, looked competently done.
>
> On the whole, the project seems well conceived and is being executed with adequate competence.[54]

Inasmuch as the Serpukhov operation was singled out for comment, a brief study was undertaken of the origins of the Serpukhov equipment.

CERN ASSISTANCE FOR THE SERPUKHOV PROTON SYNCHROTRON

The European Center for Nuclear Research (CERN) was established in Geneva, Switzerland, in 1954 to provide for nuclear research collaboration among European countries. On July 4, 1967, an agreement was signed in Moscow relating to scientific and technical cooperation between CERN and the Soviet Union for construction and operation of a 70-GeV proton synchrotron at Serpukhov. It was to be capable of the highest energy acceleration in the world. Discussions concerning the possibilities of such collaboration had been initiated

[50] Further evidence for the 1950s is in Medford Evans, *The Secret War for the A-Bomb* (Chicago: Henry Regnery Company, 1953)

[51] *Atomic Energy in the Soviet Union*, Trip Report of the U.S. Atomic Energy Delegation, May 1963 (Oak Ridge, Tenn.: AEC Division of Technical Information, n.d.), p. 25.

[52] *Ibid.*, p. 7.

[53] *Ibid.*, pp. 54-55. Concerning the preinjector for the 70-BeV machine, the delegation observed: "This was perhaps the most interesting and surprising piece of equipment of the tour."

[54] *Ibid.*, p. 65.

by Victor F. Weisskopf while he was director general of CERN in the mid-1960s.[55]

The main features of the technical-assistance agreement were as follows:[56]

1. CERN provides a fast-ejection system for the Serpukhov accelerator which becomes the property of Serpukhov; "CERN will be responsible for the design, construction, testing, and installation of the system (including its magnets, their vacuum tanks, and the associated supplies and controls), and for commissioning the vast ejected proton beam at the accelerator."
2. CERN provides radio-frequency particle separators which will be used at Serpukhov, "and will be responsible for the design, construction, testing, and installation of these items of beam line equipment and for commissioning at the accelerator."

   The Soviets for their part agreed to make available necessary technical information to build the extraction system and the separators, and also to establish at Serpukhov the buildings and supplies of electricity, cooling water, etc., and generally provide services such as workshops and stores. Also the U.S.S.R. has the responsibility to operate the accelerator and provide the beams which are necessary for the program.
3. CERN has the right to propose a succession of electronics experiments to be incorporated in the experimental program and the 70-GeV machine.
4. CERN Institute for High-Energy Physics in Switzerland will collaborate in bubble-chamber physics, and Soviet scientists will join teams working at CERN "in preparation for the start of bubble-chamber physics at Serpukhov."

In October 1966 the French Government agreed to send to Serpukhov a large hydrogen bubble chamber (with a volume of 6000 litres) developed at the Saclay Laboratory in France. Under the agreement, French scientists were to participate in the bubble-chamber experiments with Soviet scientists.[57] This provision is interesting in light of the comment of the U.S. delegation report that "only one specific item of experimental equipment was mentioned, namely, a large hydrogen bubble chamber."[58] The report did not state the origin of the bubble chamber.

Two factors bring Western assistance to Serpukhov into focus: first, the technical complexity and cost of these machines increase with size; and second, because of its technical complexity the Soviets would have been unable to build the Serpukhov unit without CERN assistance. Indeed the Soviets started

[55] *CERN Courier* (Geneva), VII 7 (July 1967), 23. V. F. Weisskopf was among the small group of physicists who in 1939 made the historic and voluntary agreement to restrict publication of information concerning nuclear developments. At present (1969) Weisskopf is chairman of the High-Energy Physics Advisory Panel of the Atomic Energy Commission.

[56] *CERN Courier*, VII, 7 (July 1967), 23.

[57] *Ibid.*, p. 122.

[58] *Atomic Energy in the Soviet Union*, *op. cit.* n. 51, p. 77.

excavation for a 6-GeV machine at Erevan in 1960 and only completed it in 1967, a little before the 70-GeV Serpukhov unit started. At that time the most powerful accelerator in the United States was the 15-GeV proton synchrotron at the Argonne National Laboratories in Chicago; the CERN machine of 24 GeV started in 1959, and then the largest Soviet installation, at Dubna, was rated 10 GeV.

Therefore Western techniques and instrumentation enabled the Soviets to claim the most powerful high-energy accelerator in the world.[59] Although such machines are generally regarded as basic research units, it has been argued by physicists in the high-energy field that accelerators do have a technical spillover effect of some magnitude. For example, R. R. Wilson in the 1968 Richtmyer Lecture acknowledged the assistance given by the accelerator to the nuclear power industry and noted also,

> ... the kind of unexpected but immediately practical developments that accompany any intensive technological activity ... the high-power transmitting tube ... fast pumps ... high-vacuum techniques ... particle counters ... flip-flop circuits.[60]

In a survey of Soviet technology the field of atomic energy poses a paradox of some magnitude.

General Groves's opinion in 1945 was that the Soviet Union would require 15 to 20 years to construct an atomic bomb. This view is supported by such diverse sources as Klaus Fuchs and this study. The Soviet Union in fact required four years to achieve a "nuclear explosion."

Today we find that while the Soviet Union has some first-class scientists—the physicist Lev Artsimovich is one whose name comes to mind—it is obviously weak in converting nuclear science into practical systems. We see the evidence in restricted development of power reactors, Western observations of Soviet project instrumentation, assistance required for the Serpukhov proton synchrotron, and the backwardness in computer technology.

Given this relative technical backwardness both in 1945 and today, the paradox is in the Soviet Union's ability to achieve an advanced nuclear weapons capability. This is not an economic question of how resources were shifted but a question of engineering capability. It is therefore suggested as a working hypothesis that even in nuclear weaponry, in the development of controlled thermonuclear reactions and all fields of nuclear science and technology requiring extensive computer backup and instrumentation, there has been a large—and yet unrecorded—transfer of equipment and technology from the West.[61]

[59] The existence of the Serpukhov machine also gave U.S. scientists a useful means to prod Congress into appropriating $250 million for the 200-GeV unit under construction at Weston, Illinois, in 1970.

[60] *CERN Courier*, VIII, 7 (July 1968), 156-57.

[61] This chapter is restricted by the limited open data available on most aspects of atomic energy. It should be viewed as little more than a preliminary to the study of the transfer of Western assistance to the Soviet nuclear program.

CHAPTER NINETEEN

Western Origins of Soviet Railroad Locomotives

While there is little question that the Soviet railroad system has made gigantic strides since the early 1930s, there was still a high degree of technical dependence on the West at the end of the 1960s.[1]

As of 1960 more than 31,000 steam locomotives were still in use in the Soviet Union. This was considered undesirable (despite the excellent working characteristics of the locomotives), and efforts were directed to the electrification of high-density lines and the use of diesel-electric locomotives on low-density lines. Gas turbines and diesel-hydraulic locomotives were in an experimental stage. The 1960 U.S. Railroad Delegation concluded on the basis of its observations that this motive equipment "showed no radical departure from familiar designs but is rather an adaptation or copy of designs of engines and components found in the United States and Western Europe—without regard for patent considerations."[2]

Special-purpose cars were rarely used, customers being enjoined to conform their requirements to standard box, flat, tank, gondola, or refrigerator cars. Although many of these were two-axle units, they were being replaced by four-axle units. As far as signals and communications are concerned, the 1960 delegation commented: "Observations confirmed that the systems in service in the United States during the years from about 1930 to 1945 have been reproduced and manufactured for use on the Soviet railroads."[3]

A number of wagon and locomotive construction and repair plants were removed from Saxony and Thuringia to the U.S.S.R. in 1945-46. The wagon

[1] See Sutton I and II for data concerning early Western technical transfers.

[2] Association of American Railroads, *Railroads of the U.S.S.R.*, Report on the Visit of the United States Railroad Exchange Delegation to the Soviet Union during June 1960 (Washington, n.d.), p. 9. The wide use of foreign locomotives as late as 1962 may be gauged from an observation by J. N. Westwood, on leaving Sebastopol: "As the train moved out through the suburbs it was easy to fancy that this was not Russia but Czechoslovakia, for it was only after several miles that I saw a Russian-built locomotive. Not only were the passenger trains Skoda-hauled but switching and local freight were in the care of new Czech-built 750-hp diesel switchers (class ChME2)." *Trains* (Milwaukee, Wis.), July 1962, p. 44.

[3] *Railroads* ..., *op. cit.* n. 2, p. 11. See Sutton II, pp. 205-6, for assistance of Union Switch and Signal Company (Subsidiary of Westinghouse Electric) in the 1930s.

construction plants at Stassfurt and near Halle were partly removed to the U.S.S.R.; also in Saxony, the Gotha wagon-building plant was about 60 percent removed and the Ilmenau works was completely removed. In Thuringia the Wurzen plant was partly removed; Waggon- und Maschinenbau A.G. (Wumag) at Görlitz was also partly removed and Waggon- und Maschinenfabrik A.G. at Bautzen was about 50 percent removed to the U.S.S.R.[4] However, the more important present-day Russian locomotive and car construction plants are enlarged Tsarist plants or units built in the 1930s rather than transferred German plants.

AMERICAN ORIGINS OF DIESEL-ELECTRIC LOCOMOTIVES

By 1960 the Soviet locomotive construction industry had produced three basic diesel-electric locomotive models in addition to several prototypes (Table 19-1). The three basic production models were based on U.S. locomotives—on American Locomotive Company (Alco), General Electric, and Fairbanks-Morse designs. During World War II a considerable number of U.S. diesel-electric locomotives were shipped to the U.S.S.R. under the Lend Lease program. These locomotives ultimately became prototypes for postwar Soviet models; they included the Alco (Soviet Type Da) and the standard Baldwin (Soviet Db).[5]

Table 19-1 DIESEL-ELECTRIC LOCOMOTIVES IN THE SOVIET UNION FROM 1944 to 1965

Soviet class	*Weight, tons*	*Dates in use*	*Western origins*
		Foreign construction	
Da	—	1943	Alco
Db	—	1943	Baldwin Locomotive
		Soviet construction based on foreign basic design	
TE-1	124	1947	Alco-Da class
TE-2	85	1950-56	Modified TE-1(Alco-Da)
TE-3 (standard)	126	1956-	Fairbanks-Morse engine

Source: J. N. Westwood, *Russian Locomotive Types*, (Bristol: W. Norman, 1960).

The Soviet TE-1, for which production started in 1947 and continued until 1950, was based on an imported Alco-G.E. diesel-electric road switcher that

[4] G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen, 1951).

[5] U.S. Dept. of State, *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945).

was first delivered to U.S. customers in 1941. Although designed primarily for road service, it was similar in basic design to a yard-switching locomotive. The 1000-hp diesel engine operated at 740 rpm, and was turbocharged by the Buchi system; the electrical equipment for the engine was built entirely by General Electric, and included the main traction generator, auxiliary generator, and four G.E. 731 traction motors with Type P control equipment and Westinghouse air-brake equipment.[6] The Soviet-built version of this Alco model (i.e., the Da type) had three truck bogies (like the Alco unit delivered under Lend Lease) and a D-50 six-cylinder four-stroke diesel engine of 1000 hp. About 300 such TE-1 models were still in service in 1960.[7]

The TE-1 was followed by the TE-2, which first appeared in 1948 with series production from 1951 to 1956. About 1100 were still operating in 1960. The D-50 diesel engine and generators were the same as in the earlier TE-1.

In 1950 design started on a more powerful locomotive—the TE-3 freight (and TE-7 passenger version)—with a prototype appearing in 1953 and series production started in 1956. This locomotive had a 2000-hp ten-cylinder engine (the 2D 100) based on the Fairbanks-Morse opposing piston design. Today the TE-3 and the TE-7 are the standard Soviet freight and passenger diesel electric locomotives.[8]

The TE-3 locomotive unit has been described by an American railroad delegation as containing

> . . . a 2000-hp opposed piston type normally aspirated diesel engine with ten cylinders operating at 850 rpm. This engine appears to be very similar to the Fairbanks-Morse diesel engine used in the United States.[9]

It is normally used as a two-unit consist providing a total of 4000 hp with a passenger service modification (the TE-7).

We may conclude, then, that in the 1960s Soviet diesel-electric locomotives were based on U.S. models of the 1940s; there had been no major improvement in design in Soviet models over their earlier American predecessors.

Soviet hydraulic-electric locomotives are of Austrian and German origin. In 1956 the U.S.S.R. imported some Voith (Austrian) 200-hp switchers, and in 1957 some 400-hp units (Soviet class MG-2) with Voith transmission and Jenbach mechanical units and engine. These were supplemented in 1962 with further imports of German 4000-hp Henschel Werke units with Maybach engine

[6] The Alco-G.E. road switchers are described in *Railway Mechanical Engineer* (Philadelphia), February 1942, pp. 62-66.

[7] *Railroads . . . , op. cit.* n. 2.

[8] For technical details of Soviet diesel-electric locomotives see K.A. Shishkin *et al., Teplovoz TE-3* (Moscow, 1969), which contains numerous construction diagrams and details. For electrical equipment on the 2TE-10L, TEM-2, and TE-3 see *Elektricheskoe oborudovanie teplovozov* (Moscow, 1968).

[9] *Railroads . . . , op. cit.* n. 2, p. 47.

and Maybach-Mekydro transmission. Soviet production began in 1962 at Kaluga with 4000-hp units obviously based on these Austrian and German prototypes. Other experimental hydraulic-electric units, the TGM-10 (1200 hp) and the T-106 (4000 hp) were built at Bryansk and Lugansk, respectively.[10]

The Soviet gas turbine that was in the experimental stage in 1960 used the body of the TE-3 2000-hp diesel-electric,[11] whereas gas turbine locomotives in the United States are specially designed overall as gas turbine locomotives. It would be reasonable to surmise that the Soviet unit was merely a test bed for an engine rather than the prototype of a gas turbine locomotive.

Table 19-2 ORIGINS OF ELECTRIC LOCOMOTIVES IN USE IN THE SOVIET UNION, EARLY 1960's

Class	*Rated output*	*Weight, tons*	*Year first built*	*Builder of mechanical equipment*	*Builder of electrical equipment*
			Foreign Construction		
NO	2490 kw	132	1954	Skoda (Czechoslovakia)	Skoda
chS1	2285	85	1957	Skoda (Czechoslovakia)	Skoda
F(T)	4550	138	1959	Schneider-Alsthom, SFAC (France)	S.W.; Jeumont
FP(TP)	4550	131	1960	Schneider-Alsthom, SFAC (France)	S.W.; Alsthom; Jeumont
K	4730	138	1961	Krupp (Germany)	Siemens-Schukert
chS2	3430	120	1961	Skoda (Czechoslovakia)	Skoda
			Domestic Construction		
VL 22m	2340	132	1947	Tbilisi	Tbilisi
VL 23	3070	138	1952	Novocherkassk	Novocherkassk
VL-8 (N8)	4065	180	1953	Novocherkassk	Novocherkassk
VL-60 (N60)	4065	138	1959	Novocherkassk	Novocherkassk
VL-10 (T8)	5070	184	1961	Tbilisi	Tbilisi
VL-62 (NO-VL 61)	4065	138	1961	Novocherkassk	Novocherkassk
VL-80 (N80)	6050	184	1961	Novocherkassk	Novocherkassk

Source: Adapted from *Worlds Railways*, 1964-65, (London: Odhams Press, 1965), p. 240.

[10] W. M. Keller, "What We Saw in Russia," *Railway Age* (Chicago), July 11, 1966, p. 15. "Q. Are their hydraulic locomotives on the order of the Krauss-Maffei or do they have their own design? Keller: They're similar to the Krauss-Maffei."

[11] *Trains*, July 1960, p. 27.

FOREIGN PROTOTYPES OF ELECTRIC LOCOMOTIVES

From the beginning of the 1930s to the present, Soviet electric-locomotive manufacture and prototype design has been based almost completely on Western models acquired from all countries making advanced designs. According to J. N. Westwood,[12] however, the Soviets have had considerable technical problems with domestic locomotives based on such foreign designs and therefore the railroad sector continues to be heavily dependent on COMECON and Western technical assistance.

The most common electric locomotives in 1960 were the VL-22 and VL-22m of which almost 2400 were in operation. These can be traced directly to the General Electric S class imported in 1932, according to Westwood: "It is possible to trace elements of the present VL-23 design back to the American engines delivered 32 years ago, and in outward appearance type S is almost indistinguishable from the later VL-22m."[13] Also, about 150 types VL-19 and VL-19m, based on a Soviet design of the early 1930s and built after World War II, were still in operation in the early 1960s.

The other standard electric locomotive of the period 1945 to 1960 was the N class, the prototype of which was produced at Novocherkassk in 1953; the locomotive was mass-produced at Novocherkassk after 1955 and at Tbilisi after 1958. About 310 were in operation by 1960.[14] These locomotives, although acceptable to Soviet customers, were backward by Western standards; an AARR report, for example, isolated obsolescent use of tape insulation on the traction motors:

> While a few traction motors of comparable nature may possibly still be in use in America, none with this type of insulation had been built for railroad use for twenty-five years or more.[15]

The wide application of outdated practices in 1960 may be noted from the observation that standardized traction motors—the latest DP type—are used in Classes VL-22, VL-22m, VL-19, and NO electric locomotives, as in all the main locomotive classes. Moreover, import of foreign component parts for electric locomotives (for example, mercury rectifiers from Japan under the

[12] J. N. Westwood, *Soviet Railways Today* (New York: Citadel Press, 1964), pp. 46-59, has an excellent description of electric locomotive development, its origins and current problems. Westwood considers that production of the basic N-60 and N-80 models was premature: "The fundamental problem of railway electrification in the U.S.S.R. is that at a time when more and more line is rapidly being electrified, there are no completely satisfactory locomotives in operation." (p. 58).

[13] *Ibid., p. 46.*

[14] Association of American Railroads, *A Report on Diesel Locomotive Design and Maintenance on Soviet Railways*, (Chicago: AAR Research Center, September 1966), p. 80.

[15] *Ibid.*, p. 74.

1956 trade agreement) supports the argument that the Soviets lag in domestic abilities.

One advantage of import of electric locomotives for line haul use is that imports are of greater technical sophistication and give better performance than domestically produced models. Westwood gives the power-to-weight ratio for several Soviet and foreign locomotives. The Soviet N 60, for example, has a ratio of 28.1 kw of power per ton of weight compared with 32.6 for the imported French T class electric locomotives; similarly, the Soviet VL-23 has a ratio of 22.8 compared to the Czech ChS2 with a ratio of 33.0. Thus Soviet electrics are decidedly heavier for their power output.[16] Imports also provide the basis for further Soviet technical development and, through comparative performances, afford us a measurement of domestic technical lag.

[16] J. N. Westwood, "Russian Railroading Revisited," *Trains*, July 1962, p. 46. See also Novocherkasskii elektrovozostroitel'nyi zavod, *Elektrovoz VL 60 k* (Moscow: Transport, 1969).

CHAPTER TWENTY

Western Origins of Aircraft and Space Technology

AIRCRAFT DESIGN AND ENGINE TECHNOLOGY

During World War II the Soviets produced 115,596 aircraft and Lend Lease delivered to the U.S.S.R. an additional 14,018.[1] The Russian-produced aircraft were mainly obsolete prewar types and most were one-engine wood and canvas models with inferior engines. Domestic production was assisted, however, by a high degree of production specialization. The only Soviet dive bomber, the Stormovik (IL-2), was in production at three plants; each plant produced about the same number of IL-2s but no other aircraft. Fighter production was concentrated on the YAK-3, the YAK-2 and YAK-6 being advanced trainer versions. The YAK was produced in six widely scattered plants producing only YAK aircraft at rates of between 65 and 400 per month.

Two-engined bomber production included the PK-2 (based on the French Potez), at two plants, and the IL-4 at three plants, only one of which (Komsomolsk) produced other aircraft. The LI-2 (or Douglas DC-3) transport was produced only at Tashkent, and the PO-2 (or De Havilland Tiger Moth) was

[1] R. H. Jones, *The Roads to Russia* (Norman: University of Oklahoma Press, 1969). According to U.S. Dept. of State, *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945), Lend Lease deliveries of aircraft to the Soviet Union from June 22, 1941, to September 20, 1945, were as follows:

Fighter planes	*Quantity delivered*	*Bombers*	*Quantity delivered*	*Cargo planes*	*Quantity delivered*
P-40	2,097	A-20 (light)	2,908	C-46	1
P-39	4,746	B-25 (medium)	862	C-47	707
P-47	195	B-24 (heavy)	1 (force-landed in Siberia)	O-52 Observation	19
				Advanced Trainers	82
P-63	2,400			PBN Navy Patrol planes	137
				PBY-64	48

produced only at Kazan. Training aircraft (YAK-6s) were produced at three locations and the UT-2 advanced single-engined trainer at two locations.

Thus Soviet aircraft production was concentrated on a comparatively few simple types, each for a single function only. Most plants concentrated on the production of a single model, although several plants were usually involved with the production of the important types.

Lend Lease was of great assistance in the development of the Soviet aircraft industry. For example, Henry Wallace after his visit to the important Komsomolsk aircraft plant commented as follows:

> The aircraft factory in [Komsomolsk], where Stormovik bombers were being built, owed both its existence and its production to the United States. All the machine tools and all the aluminum came from America.... It looks like the old Boeing plant at Seattle.[2]

However, according to General G. A. Tokaev:[3]

> The aircraft industry was lagging well behind the West owing to constant political interference, political purges, and the general low level of technical efficiency. Consequently, at the end of World War II the Soviets had not produced a single jet engine or guided missile.

Work in 1945 and 1946 involved nothing sensational from the design viewpoint and in effect consisted in mastering the German aircraft industry that was developed from 1941 to 1943. The years immediately after 1946, however, were to show a remarkable expansion in the industry, an expansion achieved by utilizing German and some British technical assistance in an expert manner. Technical assistance from the West entered through two main channels—first from the United Kingdom and particularly through transfer of the Rolls-Royce Nene, Derwent, and Tay engine technologies; and second (and a much larger flow) from Germany via the transfer of the wartime German aircraft industry to the Soviet Union.

The postwar Soviet aviation and space industries have their roots in German World War II aircraft and rocket developments. In 1945 the Germans had a large and relatively undamaged aircraft and rocket manufacturing industry that had been dispersed under threat of continued Allied bombing toward the eastern regions of Germany—that area later occupied by the Soviets (Figure 20-1). Over two-thirds of this productive capacity fell intact into Soviet hands[4] and

[2] Quoted by Werner Keller, *Ost minus West=Null* (Munich: Droemersche Verlagsanstalt, 1960), p. 265.

[3] G. A. Tokaev, *Soviet Imperialism* (New York: Philosophical Library, 1956), p. 56.

[4] The writer has calculated the capacity in terms of 1944-45 output as 68 percent of the assembly capacity, although this figure varies by type of aircraft produced.

Figure 20-1 LOCATION OF THE GERMAN AEROENGINE PLANTS AT THE END OF WORLD WAR II.

Source: U.S. Strategic Bombing Survey, Aircraft Industry Survey, Figure VII-2, based on data from the German Air Ministry.

was largely, but in some cases not immediately, transported to the U.S.S.R. These transfers included development and experimental work, but most important they also included complete production lines for aircraft engines, equipment, and the V-2 missile. Consequently in both aircraft and rocket industries we can trace Soviet developments directly to German wartime research and development work and production methods.

Accurate information concerning this transferred productive capacity and technology comes as a result of an unusual sequence of events which itself is still subject to debate. In 1945 American and British armies swept 200 miles into what is now the Soviet Zone and met the Soviet armies on the Elbe-Mulde river line rather than on the zonal frontiers earlier agreed upon. Very little, if any, machinery was removed by the West before this area was surrendered to the Soviet armies, although dozens of CIOS, BIOS, FIAT, U.S. Army, and U.S. Navy teams had scoured the factories in the occupied areas assessing German technical developments.[5] The intelligence results were published in several hundred detailed technical reports. As some Allied teams were examining German plants only days before the Soviets took over, we have accurate, detailed accounts of the equipment and technical information that came under Soviet authority.

The technical information flowed first to the Central Institute of Aerohydrodynamics (TsAGI) and then to design institutes in Moscow, where it was allocated to various Soviet design teams working closely with deported German engineers and technicians. German technology was converted into experimental work, and after choice of design production was carried out at associated production units. The Mikulin design team at Plant No. 300, for example, worked on the Mikulin turbojet and was associated for production purposes with the Tushino Plant No. 500, Moscow Aircraft Engine Production Plant No. 45 (which produced the Rolls-Royce Nene engine from 1948 to 1956), Kharkov Plant No. 75, and a plant associated with the Gorki automobile plant and known as Plant No. 466. In this way, Soviet-German experimental and design teams were located at specific factories, but the design reproduction and experimental stages normally were kept apart from the production process.

These flows of technology will be examined as follows: (a) the flow of aircraft engine technology and production facilities from Germany and the United Kingdom, (b) airframe manufacturing and design capacity, which came almost entirely from Germany (although B-29 bomber technology came from the United States), and (c) space technology, which, again, came largely from Germany.

[5] Reports were issued later by CIOS (Combined Intelligence Objectives Committee), BIOS (British Intelligence Objectives Committee), and FIAT (Field Information Agency Technical).

The German Aircraft Engine Industry In The Soviet Zone

The capacity of the German aircraft engine industry was more than adequate for the German aircraft program in the first years of the war, and its production schedules were maintained almost until the end in 1945. The basic design, development, and production companies were Junkers, Daimler-Benz, and BMW. These companies licensed production to additional firms, particularly in the case of Junkers and Daimler-Benz; BMW licensed only to Klockner in Hamburg. The largest single unit in the German Air Ministry expansion program was the Ostmark plant in Vienna, Austria, which covered an area of 3,000,000 square feet. This plant, although begun in 1941, did not produce engines until May 1943 and by the end of the war it had produced only 3000 engines in all.[6]

Daimler-Benz operated 10 aircraft engine plants (see Table 20-1). The largest plant was Genshagen near Berlin, which had produced a total of 30,000 aircraft engines by the end of World War II and in December 1944 was operating at a rate of 700 engines per month. In 1945 part of the principal plant at Genshagen was moved to a gypsum mine in Heidelburg to set up what was called the Goldfischwerke.[7] In all, 2500 machine tools were moved to the Goldfisch works. The Soviets acquired the greater part of both the Genshagen main plant in Berlin and the Goldfisch underground plant at Heidelburg; according to G. E. Harmssen, all of the machine tools at Genshagen were removed to the U.S.S.R. and 80 percent of the Goldfisch underground plant was removed to the U.S.S.R. at the end of 1945, under U.S. Operation RAP.[8] Total production of all Daimler-Benz plants in 1944 was 28,669 aircraft engines; since 16,794 of these were produced in plants located in the future Soviet Zone, it is clear that the Soviets gained control of the greater part of aircraft engine production of Types 603, 605, and 610.[9]

Daimler-Benz produced only reciprocating aircraft engines; gas turbines were produced by Junkers and BMW. The BMW 003 gas turbine was actually in production in 1945 and a total of 450 had already been built when the war ended.[10] Production facilities established for the 003 were much greater than

6 U.S. Strategic Bombing Survey, *Aircraft Division Industry Report*, 2d edition (Washington, January 1947), Report no. 4, p. 96.

7 *Ibid.*, p. 28.

8 G. E. Harmssen, *Am Abend der Demontage: Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen 1951), p. 102; and Germany, Office of Military Government, (U.S. Zone), Economics Division, *A Year of Potsdam: The German Economy Since the Surrender* (n.p.: OMGUS, 1946), p. 36.

9 For further information see BIOS Report no. 35: *Report on Visit to Daimler Benz, at Stuttgart-Unterturkheim*.

10 CIOS Report no. XXX-80: *Bavarian Motor Works-A Production Survey*.

the production total indicates, however; the German program envisaged a production of 2500 per month by September 1945 from Harz Mountain area occupied by the Soviets.[11] These plants, built underground at Eisenach and Zuhlsdorf, were removed to the Soviet Union.[12] Moreover the Munich plant of BMW, with a production of 500 engines at the end of 1944, was removed to the Soviet Union under Operation RAP.[13]

Similarly, the Junkers turbojet was of special interest to the Soviets. By March 1945 approximately 6000 of these engines had been built, although the German Air Ministry was beginning to favor production of the BMW 003 for technical reasons. The Junkers 004 was in production at three centers in 1945—at Mäldenstein across the river from Dessau in the Soviet Zone (not examined by either the British or the American intelligence teams), at Kothen about 20 miles southwest of Dessau, and at Nordhausen in the V-1 and V-2 factories. Junkers was also producing the 012 engine with a similar layout to the 004, and an 11-stage axial compressor and a thrust of seven thousand pounds. The 022—a propeller version of the 012—was in the project stage and designed to attain 500 miles per hour.[14]

Table 20-1 REMOVAL OF MAIN GERMAN AIRCRAFT ENGINE PLANTS IN 1945-46

Type of engine	*Location produced*	*Total production 1939 - 1944*	*Total production Dec 1944*	*Disposal of plant in 1945*
Daimler-Benz (603)	Stettin	3582	250	Probably removed to U.S.S.R.
Daimler-Benz (601,603,606)	Berlin, Marienfelde	—	65	Not known
Daimler-Benz (601,605,606,610)	Bussing (Brunswick)	13,805	—	Not removed to U.S.S.R.
Daimler-Benz (601,605)	Henschel (Kassel)	13,119	600	Not removed to U.S.S.R.
Daimler-Benz (605)	Manfred Weiss (Budapest)	1,189	—	Probably removed to U.S.S.R.
Daimler-Benz (605)	Steyr	1,885	65	
Daimler-Benz (603)	Prague	311	76	
Daimler-Benz (603)	Austria (Ostmark)	2,890	77	
Daimler-Benz (601,605,606,610)	Genshagen	30,833	700	100 percent removed to U.S.S.R.

[11] *Ibid.*, p. 62.
[12] Harmssen, *op. cit.* n. 8, no. 78.
[13] *Op. cit.* n. 8, p. 36.
[14] CIOS Report no. XXXI-66; *Notes on Aircraft Gas Turbine Engine Developments at Junkers, Dessau and Associated Factories.*

Table 20-1 (cont.)

Type of engine	*Location produced*	*Total production 1939 - 1944*	*Total production Dec 1944*	*Disposal of plant in 1945*
Daimler-Benz (601,605,606,610)	Goldfisch underground (Heidelburg)			80 percent removed at end of 1946
BMW (801)	Allaco-Munich*	17,529	526	82 percent removed at end 1946
BMW (801)	Klockner (Hamburg)	4,206	150	Not removed to U.S.S.R.
BMW (801)	Spandau (Berlin)	5,695	326	Probably removed
BMW (132)	Eisenach	4,099	—	100 percent removed to U.S.S.R.
BMW (323)	Zuhlsdorf	3,227	plan 2500 month by September '45	100 percent removed to U.S.S.R.
Junkers (004,012)	Mäldestein (Dessau)	—	—	100 percent removed to U.S.S.R.
Junkers (004)	Kothen	—	—	100 percent removed to U.S.S.R.
Junkers (004)	Nordhausen	—	—	100 percent removed to U.S.S.R.
Junkers (003)	Magdeburg	—	—	100 percent removed to U.S.S.R.

Sources: U.S. Strategic Bombing Survey, *Aircraft Division: Industry Report,* Number 84 (January 1947), Table VII-1; *A Year of Potsdam* (n.p.: Office of Military Government for Germany [U.S. Zone], Economics Division, 1947) p. 36; G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen, 1951), p. 102.

Note: BMW Argus and Franck plants excluded.

The Junkers company had extensive engine manufacturing facilities in the Soviet Zone. The Dessau aircraft design and production plant produced the regular Junkers engines and design work on the 012. There was also a Junkers engine plant at Magdeburg, and a great deal of development work on the 003 gas turbine was handled by underground shops there. The Junkers company also operated the rear portion of Tunnel No. 2 at the Nordhausen underground facilities.[15]

[15] CIOS Report no. XXXI-36: C. L. Fay, *Junkers Aircraft and Engines Facilities*, May 1945.

TRANSFER OF GERMAN TECHNICIANS AND TECHNOLOGY TO THE U.S.S.R.

Continuing the pattern established with the absorption of Junkers technology after the Treaty of Rapallo in 1922, the main channel of aircraft engine production facilities for the U.S.S.R. was from East Germany to Aircraft Plant No. 1 at Kuibyshev. This plant was established essentially with Junkers facilities transferred from Germany and using Junkers engineers, designers, foremen, and test pilots. The central function of the plant was to convert the promising German jet technology into the first Soviet jet fighters and bombers.

The aircraft industry was not removed immediately to the Soviet Union, however. Soviet designers like Tupolev and Gurevitch first visited German aircraft factories and examined prototypes and production methods. The Junkers company organized for this purpose an exhibition of German secret aircraft projects and arranged for tours of inspection of the industry.[16] Equipment was then removed under the program of OKBs (Osoboye Konstruktorskoye Byuro); for example, OKB No. 1 was at the Dessau plant of Junkers.

Nor were the German technical personnel immediately removed to the Soviet Union.[17] The bulk of the German engineers and scientists were moved by train to Russia on the night of October 22-23, 1946—in what was probably the largest mass movement of scientific brains in the history of the civilized world.[18] Engineers and scientists were not given contracts or other written agreements; they were divided into small groups of about 15 persons, and about 30 Russian engineers were attached to each German nucleus for study and work. The Russian groups were changed with some rapidity, and each project was handled by stages—the draft stage, the technical project stage, and finally the presentation stage. Whenever a project was almost complete it was canceled by the Soviets and the related drawings, papers, biographies, and technical material were turned over. Duplicate work was undertaken by separate all-Russian groups some distance from the location of the original German pilot groups; in addition German groups were put in competition one with another.[19]

Often the complete working environment of the German specialists was removed to the U.S.S.R., according to Keller:[20]

> Engineers and draftsmen found the same desks lying ready for them which they

[16] *Flying* (New York), 51, 5, (November 1952), 15.

[17] V. L. Sokolov, "Soviet Use of German Science and Technology, 1945-1946" (New York: Research Program on the U.S.S.R., 1955; Mimeographed Series no. 73) argues that the removal program was carried out hastily; this is not completely in accord with other evidence.

[18] *Aviation Week* (New York), 62, 14 (May 9, 1955).

[19] *Ibid.*

[20] W. Keller, *op. cit.* n. 2, p. 336.

> had used in Dessau, Oranienburg, Halle, or Leipzig. They were able to find their old drawings and tracings, technical reports, neatly tied up with labels bearing cyrillic lettering.

Most German designers and engineers in the aeroengine industry were sent to Kuibyshev.[21] They came largely from the Junkers and BMW plants; no less than 800 engineers and technicians came from these two companies alone in 1946.[22] Among the members of the BMW contingent was Kurt Schell, former head of the BMW rocket laboratory, and engineers Winter, Kaul, Schenk, Tietze, Weiner, and Muller.[23] The Junkers group led by Walter Baade was the most important. Not only was Dr. Baade formerly chief engineer of Junkers; he had previously worked for ten years in American aeronautical plants and so was fully familiar with American methods of aircraft construction. With Dr. Baade was a group of engineers including Freundel, Haseloff, Wocke, Elli, Lilo, Rentel, Hoch, Beer, Antoni, Reuss, Heisig, and Hartmann. The Junkers engine team in the Soviet Union was headed by Dr. Scheibe, who designed the Junkers P1 turbine; he was assisted by engine designers Gerlach and Pohl, who at Dessau had been in charge of the engine testing department. Also in this group were Steudel and Boettger and a large number of personnel from the turbojet department, including engineers, foremen, and skilled workers.[24] Another prominent designer, Ernst Heinkel, worked in the Soviet Union at the Kalinin Experimental Station.[25]

The Junkers plant itself was rebuilt at Kuibyshev, "almost exactly" as it had stood in Leipzig.[26]

Development Of The First Soviet Jet Engine

The use of German engineers to develop Soviet jet engines fell into three stages. The first stage included the reproduction of the Junkers 004 and the BMW 003 jet engines removed to the Soviet Union with their production equipment. The 004 became the Soviet RD-10, and the BMW 003 was produced as the Soviet RD-20 on a stop-gap basis until more advanced designs came along.[27] (See Table 20-2).

[21] *Ibid.*
[22] *Aviation Week*, 66, 14 (April 8, 1957), 53.
[23] *Aeronautics*, (London), April 1952, p. 46.
[24] *Ibid.*
[25] *Ibid.*
[26] *Flying*, 51, 5 (November 1952).
[27] *Aviation Week*, April 8, 1957, p. 54.

Table 20-2 ORIGINS AND UTILIZATION OF SOVIET JET ENGINES

Engine	*Thrust, lb*	*Weight, lb*	*Max. rpm*	*Compressor*	*Used on*	*Western origins*
RD-10	2,200	1,650	8,700	Axial	MIG-9 YAK-17	Junkers 004
RD-20	2,250	1,375	10,000	Axial		BMW 003
RD-45F	5,000	1,612	12,500	Centrifugal	MIG-15 IL-28	Rolls-Royce Nene
RD-500	3,600	1,280	14,700	Centrifugal	YAK-23	Rolls-Royce Derwent
VK-1 (Klimov)	6,000	1,930	—	Centrifugal	IL-28	Rolls-Royce Tay
VKIA	7,590	1,960	—	Centrifugal	IL-20 MIG-15 MIG-17	Rolls-Royce Tay
VK-2	5,950	—	—	Centrifugal	MIG-15	Rolls-Royce Tay
VK-2JA	6,850	—	—	Centrifugal	MIG-17	Rolls-Royce Tay
VK-2R	7,500	2,650	—	Centrifugal	—	Rolls-Royce Tay
VK-5	8,690	—	—	Axial	MIG-19 YAK-25	—
AM-2 (Mikulin)	6,000	4,250	—	Axial	—	Junkers 022
AM-3	19,000	5,000	—	Axial	Badger Bison	Brandner
AM-5						
MIK-205	10,000	3,000	—	Axial	—	(Junkers-BMW team)
MIK-205R	13,000	3,900	—	Axial	—	(Junkers-BMW team)
AM-9 M-209	14,850 22,000	5,500	—	Axial	TU-104 Fishpot	(Junkers-BMW team) (Junkers-BMW team)

Sources: Text; *Aero/Space Engineering*, October 1959, pp. 45-50; H. Hooftman, *Russian Aircraft* (Fallbrook, Calif.: Aero Publishers, 1965); W. Keller, *Ost Minus West=Null* (Munich: Droemersche Verlagsanstalt, 1960), pp. 341-42, 348-49; C. L. Fay, *Junkers Aircraft and Engine Facilities*, CIOS No. XXXI - 36, p. 7.

The first project given to the German design groups was a Soviet specification for a 3000-hp jet engine; essentially this was a development of the Junkers 012 turbojet, which was at the design stage in Germany at the end of World War II. By 1947 the Junkers 012 had been developed as a 12-burner assembly, but operating inefficiencies and two blade failures canceled development of this engine in 1948.[28] The next project specification given to the German designers was for a 6000-hp turboprop to attain a speed of 560 miles per hour at sea level. Essentially, this engine was developed from the Junkers 022 turboprop engine, with the same general design and characteristics as the 012 but

[28] *Ibid.*

modified to provide geared turbine drive to contrarotation propellers.[29] By 1949 the Brandner design teams had essentially met the Soviets' specification and immediately set to work on yet another detailed specification—a power plant with 12,000 hp in contrast to the 6000 hp developed by the Junkers 022. The first (unsuccessful) attempt at this specification was to couple two Junkers 002 power plants together.

Finally, the Type K turboprop was developed by the Junkers-BMW Team as a 14-stage compressor and five-stage turbine engine; it was a logical development from the German engines under development in the latter stages of World War II. The Type K engines produced by the mid-1950s power the Soviet four-engine bombers (TU-20 Bear) with four MK-12M turboprop engines of 12,000-hp capacity, and the civilian version, the Rossiya.

The AM series (after Mikulin) developed from the work of a Junkers-BMW team in the U.S.S.R. under engineer Brandner. The most powerful end result of this design, the AM-3, was seen in 1958 by an American engineer whose comment was "The engine is not an outstanding power plant, being of simple design of very large diameter and developing about 15,000 pounds thrust with 8 compression stages."[30] It is currently used in the TU-104 "Camel," which was developed from the TU-16 ("Badger").

Rolls-Royce Nene And Derwent Turbojets

In 1946 the Soviets bought 55 Rolls-Royce centrifugal compressor-type turbojets—25 Nenes and 30 Derwents. These Rolls-Royce engines, simple and well suited to Soviet mass production methods, introduced the Soviets to the use of a centrifugal turbojet; Russian turbojets up to that time were of the axial-flow type based on German designs.

Two versions of the Rolls-Royce engines were produced at Engine Plant No. 45 near Moscow beginning in 1948 and continuing at least until 1956. The plant was toured in 1956 by U.S. Air Force General Nathan Twining, who noted that it contained machine tools from various countries including the United States and Germany, and had 3000 workers engaged in producing the Rolls-Royce Nene.[31]

The American counterpart in 1951 to this Rolls-Royce engine was the Pratt & Whitney J-42 Turbo-wasp, based on the Nene but not then in quantity production.[32] Thus when the Korean war broke out in 1950 the Russians had thousands of improved Nene engines in service powering MIG-15s, whereas the U.S.

[29] CIOS XXXI-36, *op. cit.* n. 15, p. 7.
[30] *Ordnance*, May-June 1958, p. 1084.
[31] *Aviation Week*, July 2, 1956, p. 29.
[32] *Aviation Week*, June 11, 1951, p. 16. See also *The Times* (London) April 28, 1953, p. 9c.

Air Force had only a few hundred F-86A Sabres with comparable engines. The Soviets had also been able to solve certain turbine blade problems that were still puzzling Rolls-Royce and Pratt & Whitney engineers.[33]

By 1951 the Soviets had two versions of the original Rolls-Royce Nene in production quantities. The first version, the RD-45 that powered an early MIG-15, was a direct copy of the original Nene and delivered 5000 pounds of thrust. The second version of the RD-45 delivered 6000 pounds of static thrust at sea level and 6750 pounds of thrust with water injection.

Significant improvements were made by the Russians in the original design:

> Principally the changes involved the combustion chambers, which have 15 percent greater area, and the turbine blades which are longer and of wider chord. Comparison with the earlier Nene dimensions shows the blade is one-half inch longer and one-fourth inch wider in chord. Blade profile is still similar.
>
> Tailpipe area is reported 30 percent greater than that of the original Nene. The scale-up of internal gas passages was accomplished, however, with no increase in the 50-in. overall diameter of the original Nene.
>
> Other refinements [are]: an additional ring of perforations just aft of the primary zone of the combustion chambers for increased dilution of air; insertion of reinforcement rings in the liner perforation in the hot zone of the combustion chambers; increased gage of metal used in hot zone and liner; improved duplex fuel nozzle.
>
> The refined Soviet engine weighs about 2000 lb as compared to 1715 lb for the original Nene. Specific fuel consumption is given as 1.14 lb fuel/lb thrust/hr. The engine analyzed did not incorporate afterburning. It was noted that tailpipe diameter and length were sufficient to utilize a short afterburner which would boost total thrust a calculated 1000 lb additional.[34]

The turbine blades in the Soviet RD-45 engines were made of a stainless steel alloy of the Nimonic 80 type while the burner liner and swirl vanes were made of Nimonic 75. Parts of the Nene sold to Russia in 1948 were fabricated from Nimonic alloys—"Nimonic" being the registered trademark of Henry Wiggin and Company of Birmingham, England. Both Nimonic 75 and Nimonic 80 were developed by Mond Nickel about 1940, and their specifications had been earlier published by the Ministry of Supply in the United Kingdom. There are considerable difficulties in the production of Nimonic alloys, and such difficulties could be surmounted only with the practical know-how accumulated by Wiggin.[35]

Several engines from captured MIG-15s were evaluated by the United States Air Force, and reports were prepared by engineers of Pratt & Whitney Aircraft

[33] *Aviation Week*, March 12, 1956, p. 264.
[34] *The Aeroplane* (London), August 1, 1952, p. 163.
[35] *Ibid*.

Division of United Aircraft Corporation, the Wright Patterson Air Force Base, and Cornell Aeronautical Laboratory.[36]

The RD-45 (Nene) was produced not only in Moscow but also at Magadan from 1951, and at Khabarovsk, at Ufa Plant No. 21, and at Kiev Plant No. 43 from 1951 until sometime after 1958.

Soviet Acquisition Of Four-Engine Aircraft

During World War II the United States was unwilling to send heavy four-engine bombers to the Soviet Union under Lend Lease. Although in April 1944 General John R. Deane recommended U.S. approval of Russian requests for heavy bombers, the War Department refused on the grounds that the Soviets could not train a bombing force prior to the spring of 1945 and that certain special equipment for such bombers was in short supply.[37]

The official Lend Lease report on war aid therefore lists Russian acquisition of only one four-engine bomber (a B-24 that force-landed in Siberia), although the Soviets were in fact able to acquire four others. One of these was acquired in July 1944 when a U.S. bomber ran low on fuel after a raid against Mukden in Manchuria and landed at Vladivostok; two others—B-29s—landed at Vladivostok during the war, both having run short of fuel while on bombing raids over Japan; the fourth, a B-17 Flying Fortress, crash-landed in Siberia in December 1944 and its crew was rescued by Red Army forces. The Soviets retained all four aircraft.[38]

The Soviets then started work on the Tu-4 four-engine bomber and the Tu-70 civilian transport, and in 1946 Amtorg attempted to purchase from the Boeing Aircraft Company a quantity of B-29 tires, wheels, and brake assemblies. The attempt was unsuccessful, but nevertheless when in 1947 the Soviets produced the Tupolev Tu-70 it was immediately identified as a virtual copy of the B-29. The similarity was described in *Boeing Magazine:*[39]

> The famed Boeing 117 airfoil that the Tu-70 is sporting is an exact replica of the Boeing B-29 wing. Along with the wing are the *Superfortress* nacelles: outline, cooling air intake, auxiliary air scoop, cowl flaps and inboard and outboard fairings. The cabin cooling air inlet in the wing leading edge between the body and the inboard nacelle is the same. The trailing edge extension on the flap between the inboard nacelle and the side of the fuselage are also identical, according to the evidence provided by the photographs.

[36] For a summary of these examinations see *Product Engineering* (New York), August 1952, pp. 194-95.

[37] Jones, *op. cit.* n. 1.

[38] *Boeing Magazine* (Seattle), February 1948; *Flying*, 42, 6 (June 1948) 28; *New York Times*, December 24, 1944, 12:3.

[39] *Boeing Magazine*, February 1958.

> The Tupolev Tu-70 uses the Twenty-nine's main landing-gear structure as well as its fairings and doors. The nose gear also appears to be that of the *Superfortress*, with the upper trunnion located closer to the body contour of the Tu-70 than on the Boeing bomber.
>
> The tail surfaces of the Russian transport also come direct from the Boeing engineering department. On comparison it is apparent that the vertical tail and the dorsal outline as well as the leading edge of the rudder are the same on the two planes. The rudder of the Tu-70 appears to end at what would be the top of the tail gunner's doghouse on the *Superfortress*. The shape of the stabilizer and the elevator is the same on the two ships, and the transport also uses the inverted camber of the B-29's tail.
>
> Propellers of the Tupolev Tu-70 appear to be original B-29 props, less cuffs. The hubs are characteristic of the Hamilton-Standard design. Boeing engineers also report that the drift meter installation of the Russian transport looks like that of the *Superfortress*, and the pitot head type and location match.
>
> Tupolev did, however, design a new fuselage for the transport. It sits higher on the wing of the Tu-70 than does the fuselage of the B-29, and the fuselage is larger in diameter and a little longer (119 feet as compared to 99 feet). While the transport has a new fuselage, it retains the bomber nose, including the bombardier's plate-glass window.

An interesting question, not discussed in the late forties, was the manner by which the Soviets were able to advance from their inability to produce four-engine bombers to their ability to produce a workmanlike design requiring an extensive period of research and flight testing. Even if the designs were available, jigs and dies to put the plane into quantity production also were required. The 18-cylinder Wright engines for the B-29 had been extremely difficult to manufacture even in the United States, and had required several years to reach the desired standard of reliability. Further, the Soviets had no apparent experience in the production of four-engine bombers; the wartime Tupolev PE-8 was generally considered not to be a successful design. Moreover we know from Douglas Aircraft files that in 1940 the Soviets had enormous difficulties in putting the much simpler DC-3 twin-engine transport plane into production and repeatedly came back to the Douglas Aircraft Company for aluminum sections, parts, and technical advice.[40] There is an unknown element of some magnitude (also found in other technical areas, such as atomic energy) concerning the ability of the Soviets to produce in the brief span of three years between 1944 and 1947 a usable copy of the complex B-29 U.S. four-engine bomber.[41]

[40] See Sutton II: *Western Technology . . 1930 to 1945*, p. 234.

[41] A possible explanation appears in the German intelligence material. It will be remembered that Vice President Henry A. Wallace on his visit to Komsomolsk Aircraft Factory No. 126 in 1944 commented that the plant looked like the Boeing Plant in Seattle (above, p. 255). The German intelligence report on Komsomolsk Plant No. 126 indicates that in October 1943 the plant was producing the Boeing B-17, and makes the notation that it was receiving materials from the United States.

Another German intelligence report lists no fewer than 371 four-engine aircraft from the

The German Contribution To The Aircraft Manufacturing Industry

The major design units of the German wartime aircraft industry were removed to Podberezhye, about 90 miles north of Moscow,[42] and included most elements from Junkers, Siebel, Heinkel, and Messerschmidt. Professor Walter Baade of Junkers continued development of the Ju-287K (as the EF-125) after moving to Podberezhye and followed this with the T-140 and T-150 bombers—jets capable of carrying an atomic bomb and, according to one report, out-performing the U.S. B-47.[43] There were 11 major Junkers plants in the Soviet Zone and six of these are known to have been completely removed to the U.S.S.R., including the main Otto Mader works two miles east of Dessau (where Professor Baade had been located) in addition to the Aschersleben, Bernburg, Leopoldshall, and Schönebeck plants.[44] We know the condition of some of these plants at the end of World War II. Aschersleben was a fuselage building plant in process of changing over to the production of the He-162; its instrument storeroom was "virtually intact" and was placed under military guard by the U.S. Army until the Soviets were able to take it over.[45] Bernburg was intact. Leopoldshall had been "badly damaged."[46] The condition of the Schönebeck plant is not known.

In 1944, the outstanding German rocket designer Sanger was working the Sanger-Bredt project to develop a long-range rocket aircraft. Former Russian General G. A. Tokaev recalls that in 1947 he was summoned by Stalin to a Moscow conference concerning the project:

United States in stock in the Soviet Union at November 1944. (This contrasted to the five presumed to be in the Soviet Union at that time). This stock allegedly consisted of 119 B-17 Flying Fortresses, 129 Consolidated B-24 Liberators, 81 C-56 Lockheed Lodestar, and 42 C-54 Douglas Skymasters.

The German intelligence reports, if correct, would go far to explain the production capability question outlined above. If indeed the Soviets were producing B-17 bombers during World War II at Komsomolsk, then this would be with U.S. Lend Lease assistance, and such assistance might well have given the Soviets sufficient production background and experience to produce B-29 bombers by 1947. However, if the German data are correct, the official U.S. reports are erroneous.

According to Anthony Kubek (quoting Isaac Don Levine), the Soviets obtained blueprints of the B-36 from the United States; see Kubek's *How the Far East Was Lost*, (Chicago: Regnery, 1963), p. 46.

[42] Keller, *op. cit.* n. 2, p. 336.

[43] Sokolov, *op. cit.* n. 17, p. 31. Methods used to get Baade to the U.S.S.R. are described in *Flying* 51,5 (November 1952), 15. This article also describes the German development of the Type 150 for the U.S.S.R. Also see Irmgard Grottrup, *Rocket Wife* (London: Andre Deutsch, 1959).

[44] Harmssen, *op. cit.* n. 8.

[45] CIOS XXX1-36, *op. cit.* n. 15, p. 7-13.

[46] *Ibid.*

> A thorough examination of the Sanger Project would prove invaluable, partly because it might enable us to produce a super-plane, but far more importantly because of the experience such research would give our scientists in solving related problems and preparing a base for future activities. In other words, by mastering Sanger's theories our experts would be able to begin where he had left off.[47]

A group of Soviets was already working on the concept, as was a group of Germans under Dr. Lange. Stalin then signed a draft decree (reprinted in Tokaev's book) instructing a commission to "direct and coordinate work" in piloted and rocket planes "and the Sanger project"; for this purpose "a commission" was sent to Germany.[48] Despite such high-level efforts, however, Professor Sanger was never captured by the Soviets.

A particular gap in Soviet technology in 1945 was in modern fighter aircraft. Dr. Siegfried Gunther and Professor Benz, both developers of German fighter aircraft, were moved to the U.S.S.R. Gunther had been chief designer for Heinkel and a designer of jet fighters since the late 1930s, while Benz designed the German HE 162-Volksjager jet fighter that achieved over 500 mph in 1944.

Among the Soviet acquisitions in Saxony was the Siebel works at Halle, where the experimental rocket-powered research aircraft DFS 346 (equivalent of the Bell X-1 and X-2 and the Douglas X-3) was in final assembly; this work was continued at Halle on behalf of the Russians until October 1948, when it was moved to the OKB-2 combine at Podberezhye with workers from the Junkers, Heinkel, and Siebel plants.[49] Flight testing of the versions built in the U.S.S.R. was begun in early 1948 using a Lend Lease North American Mitchell B-25 bomber and later a Boeing B-29 Superfortress as mother aircraft. The first test pilots were German, later replaced by Russian pilots.[50]

The MIG-15 used in Korea was powered by various versions of the Rolls-Royce Nene engines (see Table 20-2) and came from the same source as the U.S. F-86 fighters—German World War II aircraft.[51] Armament was the German Rheinmetal-Borsig feed for a MK-108 gun, but in general the MIG-15 had far less equipment than the comparable U.S. plane.

The aircraft manufacturing facilities removed from Germany contained unique equipment. Two German Wotan presses of 15,000 tons were removed and

[47] G. A. Tokaev, *Stalin Means War* (London: Weidenfeld and Nicolson, 1951), p. 100 See also *Flying*, 53, 4 (October 1953), 22, 61.

[48] Tokaev, *op. cit.* n. 47, p. 158.

[49] *Interavia* (Geneva), VIII, 5 (1953), 256-57. This article has much detail, including drawings of the Germano-Russian DFS-346. See *Flying*, 46, 1 (January 1950) for details of Soviet development of Me-163 and similar plants into mass production facilities.

[50] *Interavia*, VIII, 5 (1953).

[51] For details see *Aviation Week*, July 7, 1952, pp. 10-15; for welding techniques see *Aviation Week*, November 2, 1953, pp. 46-47, and for structural details see *The Aeroplane*, August 1, 1952, pp. 160-62. Also see M. Gurevich, "How I Designed the Mig 15," *Aero Digest*, (Washington, D.C.), July 1951, pp. 17-19.

at least four copies were made and others developed from these presses.[52] Aircraft equipment plants included the former Nitsche plant at Leipzig, used in the U.S.S.R. to manufacture curve potentiometers, and the Karl Zeiss plant, used for position finders, wind-tunnel parts, and various precision instruments. It was estimated that in 1954 this segment of German industry supplied between 65 and 75 percent of Soviet radar equipment and precision instruments.[53]

In sum, about two-thirds of the German aircraft industry with its top designers and many technicians and engineers established the postwar Soviet aircraft industry. Attention was focused first on designs for military use and these then were adapted, sometimes rather crudely, for civilian use; in fact some Russian civilian aircraft have complete military subassemblies.[54]

Gradually, by the 1960s, the Soviets attained some design independence, but whether the resulting aircraft were successful or not—at least in economic terms—is doubtful. The MIG-21s sold to India were plagued with maintenance and structural problems.[55] It was reported that a Scandinavian Airlines delegation that examined the Tu-104 concluded that a Western commercial line could not afford to fly them if given away "for free" because of high operating costs.[56] In the mid-1960s we find evidence of a pattern that was also established in other industries–a report of a joint French-Soviet project to build an airliner, the fuselage to be supplied by the French and the engines by the Soviets.[57]

THE SOVIET SPACE PROGRAM

Historically, the Russians have had a great interest in rockets. Pyrotechnic rockets were manufactured in the seventeenth and eighteenth centuries, and Russian literature on rockets dates from that period. Signal rockets were used by the Russian Army as early as 1717. Russian theoretical development stems from the work of K. E. Tsiolkovskii, whose papers, beginning in 1903, investigated atmospheric resistance, rocket motion, and similar problems. This work was continued in the Soviet Union during the twenties and thirties (meanwhile close observation was kept on the work of Robert H. Goddard in the United States and Hermann Oberth in Germany). In 1928 Tsiolkovskii wrote that the value of his contribution had been in theoretical calculations, however, and that nothing had been achieved in practical rocket engineering. Some years later, in 1936, V. F. Glushke designed and made a prototype rocket engine,

52 *American Aviation*, (Washington, D.C.), 19, 1 (June 6, 1955).
53 *Ibid.*
54 *Aviation Week*, April 2, 1956, p. 31.
55 *Aviation Week*, November 4, 1963, pp. 33-34.
56 Hans Heymann, Jr., *The Soviet Role in International Aviation*, RAND Report no. RM-2213 (Santa Monica, December 4, 1957), p. 6.
57 *New York Times*, October 16, 1966.

the ORM-65; this rocket used nitric acid and kerosene as a propellant. The Russians later developed the ZhRD R-3395, an aircraft jato rocket using nitric acid and aniline as a propellant (during the early 1930s Dupont had provided technical assistance and equipment for the construction of large nitric acid plants).[58] And during World War II, Soviet rockets used "Russian cordite," which was 56.5 percent nitrocellulose; the nitrocellulose was manufactured under a technical-assistance agreement made in 1930 with the Hercules Powder Company of the United States. Finally, under Lend Lease, 3000 rocket launchers and large quantities of propellants were shipped from the West to the U.S.S.R.

German Rocket Technology At The End of World War II

The major assistance to Soviet rocket ambitions undoubtedly came from Germany at the end of World War II. This assistance may be summarized as follows:

1. The testing sites at Blizna and Peenemunde were captured intact (except for Peenemunde documents) and removed to the U.S.S.R.
2. Extensive production facilities for the V-1 and V-2 at Nordhausen and Prague were removed to the U.S.S.R.
3. The reliability tests from some 6900 German V-2s were available to the Soviets—a major prize.
4. A total of 6000 German technicians (but not the top theoretical men) were transported to Russia and most were not released until 1957-58.

The German weapons program was in an advanced state of development in 1945. About 32,050 of the V-1 "flying bomb" weapons had been produced in the Volkswagen plant at Fallersleben and at the underground Central Works (Mittelwerke) at Nordhausen.[59] In addition, 6900 V-2 rockets had been produced—6400 at the underground Mittelwerke at Nordhausen and 500 at Peenemunde.[60] Rocket fuel facilities had been developed in the Soviet Zone: liquid oxygen plants at Schmeidebach in Thuringia and at Nordhausen, and a hydrogen peroxide plant at Peenemunde.[61]

The Germans undertook two and one-half years of experimental work and statistical flight and reliability evaluation on the V-2 before the end of the war. There were 264 developmental launchings from Peenemunde alone.[62] In

[58] See Sutton II, pp. 100-101.
[59] U.S. Strategic Bombing Survey, *op. cit.* n. 6, p. 114a.
[60] *Ibid.*, p. 120a.
[61] *Ibid.*, p. 121
[62] D. K. Huzel, *Peenemunde to Canaveral* (Englewood Cliffs, N. J.: Prentice Hall, 1962), pp. 128-29.

February 1945 it was decided to abandon Peenemunde, and the base was left intact; papers and personnel were removed after some deliberation:

> To whom, the Russians or the Americans, would fall this treasure of engineering research and knowledge? It was more than just a question of who would catch us first, because we still had some element of choice. We had, in point of fact, already exercised this choice by moving West away from the Russians.[63]

Thus it was that 400 top Peenemunde people were at Garmisch-Partenkirchen at the end of the war. Of these about 118 later went on to the U.S. rocket program. The data, hidden in the Harz Mountains, were transferred to the Aberdeen Proving Grounds.[64]

Mittelwerke at Nordhausen was visited in June 1945 by U.S. Strategic Bombing Survey teams who reported that the enormous underground plant could manufacture V-ls and V-2s as well as Junkers 87 bombers. Twenty-seven tunnels—a large proportion of the plant—were used to manufacture V-2s. The plant was well equipped with machine tools and with "a very well set up assembly line for the rocket power unit."[65] Its output at the end of the war was about 400 V-2s per month, and its potential output was projected at 900 to 1000 per month. The team commented: "Jigs and fixtures developed for the fabrication of fuselages and tail units were excellently conceived, consisting of copper-lined jigs permitting stilus spot welding of the steel sheets and parts used in this design."[66] The Nordhausen plant was removed completely to the U.S.S.R.

The United States and Britain were less successful in gaining access to German rocket testing sites in Poland. The Sanders Mission reached the Blizna test station only after considerable delays in Moscow,[67] and when they got there they found equipment had been removed "in such a methodical way as to suggest strongly to the mission's leader that the evacuation was made with a view to the equipment being reerected elsewhere."[68]

The Sanders Mission accumulated one and one-half tons of rocket parts and readied them for shipment to the West. The parts included:

> a complete steel burner unit; the framework for a radio compartment; a rear fin significantly providing for a wireless aerial; and numerous radio and servo-mechanical components. Of great importance was the finding of a forward fuel

[63] *Ibid.*, p. 150
[64] *Ibid.*, p. 222.
[65] U.S. Strategic Bombing Survey, *Inspection Visits to Various Targets: Special Report* (Washington, 1947), p. 13.
[66] *Ibid.*
[67] D. Irving, *The Mare's Nest* (London: William Kimber, 1964), p. 278.
[68] *Ibid.*, p. 285.

> tank, whose capacity was estimated at 175 cubic feet, sufficient to contain 3900 kilogrammes of alcohol.[69]

Unfortunately, when the mission reached home it was found that the rocket fragments had been intercepted by the Soviets:

> The rocket specimens which they had crated up in Blizna for shipment to London and the United States were last seen in Moscow; the crates were indeed duly freighted to the Air Ministry in London, but were found to contain several tons of old and highly familiar aircraft parts when they were opened. The rocket specimens themselves had vanished into the maw of the Soviet war machine.[70]

Many German rocket technicians (as distinct from the top theoreticians in German rocketry) went or were taken to the Soviet Union. The most senior was Helmut Groettrup, who had been an aide to the director of electronics at Peenemunde; 200 other former Peenemunde technicians are reported to have been transferred as well.[71] Among those from other sites were Waldemar Wolf, chief of ballistics for Krupp; engineer Peter Lertes; and Hans Hock, an Austrian specialist in computers. Most of these persons went in the October 22-23 haul of 92 trainloads comprising 6000 German specialists and 20,000 members of their families. Askania technicians, specialists in rocket-tracking devices, and electronics people from Lorenz, Siemens, and Telefunken were among the deportees, as were experts from the Walter Raketentriebwerke in Prague.

The Balance Sheet On German Rocket Technology

It is possible to make a reasonably accurate estimate of what the Soviets did—and did not—gain from German World War II rocket work. Their prize was considerable in material terms: the Blizna site in Poland (subject of the abortive Sanders Mission), the Peenemunde facilities (but not the documents),

[69] *Ibid.*

[70] *Ibid.* This is inconsistent with Ambassador W. Averell Harriman's report to the State Department in Washington. Harriman stated that after a "firm but friendly letter to the Deputy Chief of the Red Army General Staff [pointed out] that neglect to consider U.S. Army proposals was giving the impression that the Red Army did not want to cooperate; the Red Army made more favorable and quicker decisions, one of which was that when Anglo-American technical experts were finally allowed to visit German experimental rocket installations in liberated Poland, they were given the most complete collaboration and attention." U.S. State Department Decimal File 711. 61/9-2944: Telegram, September 29/44.

[71] For material on these transfers see A. Lee, *The Soviet Air and Rocket Forces* (New York: Praeger, 1959), pp. 229-40; Albert Parry, *Russia's Rockets and Missiles* (London: Macmillan and Company, 1960), pp. 113-31; and V. L. Sokolov, "Soviet Use of German Science and Technology, 1945-1946" (New York: Research Program on the U.S.S.R., 1955), Mimeographed Series no. 72.

the main production facilities at Nordhausen, all Berlin production facilities, and various rocket manufacturing plants in Germany and Prague went completely to the Soviets. In terms of physical facilities, the West got the documents from Peenemunde and the Nordhausen area together with only a sample selection of rockets from Nordhausen. But as far as personnel was concerned, the best went west. The von Braun group was determined to go west; only Groettrup and several thousand technicians went east.

In sum, the Soviets got production facilities and the technical level of personnel. The West got the theoretical work in the documents and the top-level German scientists and theoretical workers.

With true Bolshevik determination the Soviets concentrated talent and resources into a rocket program; the result was *Sputnik*—which came to fruition in 1957, just at a time when it was essential for strategic reasons for the U.S.S.R. to convince the world of its prowess and technical ability. The nations of the West, too, had integrated their acquired top-notch theoreticians and wealth of documentary material into developmental programs—but with less zeal. They had undertaken the British tests at Cuxhaven and the U.S. work at White Sands, but the real propaganda prize had slipped from their grasp.

It is impossible to say which side received "the most." In the long run, however, because of the indigenous strength of the Western industrial systems it is probable that the West gained less from the German work.

German Origins Of Soviet Rockets And Missiles

It is not surprising in view of these technical acquisitions that the postwar rocket and missile industry in the Soviet Union had strong roots in and orientation toward German developments.

The most important Soviet missile developments have taken place with respect to intermediate- and intercontinental-range missiles. In essential features these have been developed from the German V-2, and up to 1959 the developments were attained with German assistance. (See Tables 20-3 and 20-4.)

Although the original V-2 had only 28,400 pounds of thrust, this was improved to 78,000 pounds in the Soviet T-1. Then by grouping the T-1 and T-14A rockets that had been developed in a German-Soviet effort into two- and three-stage versions, the Soviets formed the T-3, T-3A T-3B, and T-4 missiles. The T-3 three-stage ballistic missile became operational in 1960 and was designed to carry a thermonuclear warhead and to travel 5000 miles.

In addition the Soviets adapted the German Rheinbote and R-4/M air-to-air rockets as well as the antiaircraft Wasserfall rocket.[72] The German air-surface

[72] Aviation Week, January 14, 1952, pp. 37-41.

Table 20-3 SOVIET ROCKETS AND THEIR GERMAN V-2 ORIGINS

Liquid fuel models,	*with thrust in lb*	*Stages*	*Western origin*
V-2	28,400	Single stage	Captured German V-2
R-10,	41,500	Single stage	Improved V-2 } Developed from V-2
T-1,	78,000	Single stage	Improved R-10 } Developed from V-2
T-1A,	99,000	Single stage	Improved T-1 } Developed from V-2
T-2.	78,000 268,000	Two stage	R-10(V-2) plus R-14A (German-Soviet effort)
T-3.	78,000 268,000 440,000	Three stage	R-10(V-2) plus R-14A
T-3A.	78,000 268,000 520,000	Three stage	R-10(V-2) plus R-14-A
T-4.	52,800 180,000	Two stage	V-2 plus two R-10 (German Sanger concept)
Golem-1,	120,000	n.a.	n.a.
Golem-2,	242,000	n.a.	n.a.

Sources: Alfred J. Zaehringer, *Soviet Space Technology,* (New York: Harper & Brothers, 1961), p. 75; U.S. Senate, Committee on Aeronautical and Space Sciences, *Soviet Space Programs, 1962-65; Goals and Purposes, Achievements, Plans, and International Implications,* Staff Report, 89th Congress, 2d session (Washington, December 1966).

Table 20-4 SOVIET MISSILES AND THEIR GERMAN ORIGINS, IN 1960

Soviet missile	*Description*	*German origin*
M-100	air-to-air; early version unguided, later infrared guidance	Developed in U.S.S.R. under Boris von Schlippe
M-1	2-stage surface to air; liquid-fueled	Developed from Walther-KHW-109-509 (or the Rheintochter)
T-44	Boost glide bomber	Sanger-Bredt antipodal bomber
Golem-1	Underwater to surface	German A-12 underwater

Sources: RAND Corp. Report T-33: Volursus, *The Secret Weapons of the Soviet Union* (Santa Monica, February 1964), pp. 3-4; *Missiles and Rockets* (Washington, D.C.), July 20, 1959, pp. 172-6.

rockets HS-293 and FX 1400 also were taken over.[73] By early 1954 some German technicians had been separated from Soviet rocket work, and return of the main group started in 1958. Even today, however, East Germany supplies the U.S.S.R. with rocket fuel, electrical equipment, and guidance and control equipment, although this role probably is not decisive.

Asher Lee sums up the transfer of German rocket and missile technology:

> ... the whole range of Luftwaffe and German Army radio-guided missiles and equipment fell into Russian hands. There were the two Henschel radar-guided bombs, the Hs-293 and the larger FX-1400 ... the U.S.S.R. also acquired samples of German antiaircraft radio-guided missiles like the X-4, the Hs-298 air-to-air projectile with a range of about a mile and a half, the Rheintochter which was fitted with a radar proximity fuze, and the very promising Schmetterling which even in 1945 had an operational ceiling of over 45,000 feet and a planned radius of action of about twenty miles. It could be ground- or air-launched and was one of the most advanced of the German small-calibre radio-guided defensive rockets; of these various projectiles the Henschel-293 bomb and the defensive Schmetterling and Hs-298 (the V-3) are undergoing development at Omsk and Irkutsk ... Soon they may be going into production at factories near Riga, Leningrad, Kiev, Khabarovsk, Voronezh, and elsewhere.

Other plants in the same areas produced improved radar based on the Wurzburg System; the airborne Lichenstein and Naxos systems were reported in large-scale production in the 1950s.

U.S.-Soviet Technical Cooperation In Space

In 1955 as German technicians began returning home, the United States started to make approaches to the Soviet Union on the question of technical cooperation in space;[74] indeed, in the ten-year period between December 1959 and 1969, the United States made 18 individual initiatives. Any acceptance by the Soviets would of course have supplemented their gains from German assistance.

In December 1959 NASA Administrator T. Keith Glennan offered assistance in tracking Soviet manned flights; on March 7, 1962, President Kennedy proposed an exchange of information from tracking and data acquisition stations, and on September 20, 1963, the President proposed joint exploration of the moon, an offer later repeated by President Johnson. There was no Soviet response

[73] Parry, *op. cit.* n 71, p. 119; see Chapter 8, "The German Role in Russian Rockets." See also A. Lee in *Air University Quarterly Review* (Montgomery, Ala.), Spring 1952, p. 14.

[74] U.S. Senate, Committee on Aeronautical and Space Sciences, *NASA Authorization for Fiscal Year 1970*, (Hearings, 91st Congress, 1st session, May 1969 (Washington, 1969), pt. II, p. 635.

to these offers. There followed a series of proposals from NASA itself: on December 8, 1964, the administration proposed an exchange of teams to visit deep-space tracking and data acquisition facilities; on May 3, 1965, NASA suggested joint communications tests via the *Soviet Molniya I*; on August 25, 1965, NASA, at the request of President Johnson, asked the Soviet Academy of Sciences to send a high-level representative to the launching of *Gemini VI*, and on November 16 of the same year NASA inquired once again about joint *Molniya I* communications tests. Four more U.S. offers were made in 1966: in January NASA inquired about cooperation on Venus probes; on March 24 and May 23 Administrator James Webb suggested that the Soviets propose subjects for discussion; and in September Ambassador Arthur Goldberg again raised the question of tracking coverage by the United States for Soviet missiles. None of these suggestions was taken up. The U.S. emphasis on assistance in tracking coverage is interesting because this constitutes a Soviet weak area.

The unwillingness of the Soviets to cooperate is exemplified by their response to the U.S. National Academy of Sciences proposal in March 1967 that the Soviets provide *Luna 13* soil meter experiment data in advance of normal world reporting "in return for comparable data from future flights in the Surveyor series."[75] The Soviet data were indeed forwarded—but only after they had been reported at the International Committee of Space Research (COSPAR) meeting in London.

Further offers were made in March, April, June, October (twice), and December 1967 with no Soviet response.

Similar efforts elsewhere have met with the same negative results. For example, COSPAR, aware of the possibilities of planet contamination, noted that an "extremely costly effort has been made by the United States to ensure that its probes do not contaminate the planets." COSPAR has "repeatedly" made efforts to obtain similar information from the Soviets "so that the adequacy of Soviet techniques can be exposed to the judgment of the world scientific community."[76] Over the entire ten-year period the Soviets have provided only generalized assurances, and while there was general agreement that Soviet rocket stages had impacted the planets, "no assurances of any kind have been forthcoming regarding sterilization or diversion from the planets."[77]

The only agreement for an exchange of information came in June 1962 after President Kennedy's initiatives; there were limited projects then that appear to have achieved mediocre success. An agreement to exchange meteorological information was made but "to date [1969] the Soviet data have not been operationally useful to us."[78] No exchange of data on magnetic field mapping took

[75] *Ibid.*
[76] *Ibid.*
[77] *Ibid.*
[78] *Ibid.*

place between 1962 and 1969, and although arrangements have been made for exchange of ground-based data "these have not been completely successful either."[79] Cooperative communications using the U.S. passive satellite *Echo II* were completed in February 1964: "The Soviets received communications only, declining to transmit. Technical difficulties of this experiment limited the results received." In space biology and medicine, a U.S. team spent two years putting together material, while the Soviet side has failed to respond.

A direct Washington-Moscow bilateral circuit for the exchange of meteorological information went into effect in September 1964. Without interruption since September 1966, the United States has transmitted to Moscow cloud analyses for one-half the world and selected cloud photographs. Although the Soviets launched a total of seven weather satellites between 1964 and 1969 "there have been numerous interruptions in the transmission for data, at one time for a period of four months."[80] Further, because of insufficient coverage by Soviet satellites, the Soviet data have been limited, often of marginal quality and received after the period of maximum usefulness. It is probable in the light of these results that the Soviet space program is far less technically advanced than has been generally believed, and fear of disclosing this backwardness inhibits the Soviets from taking advantage of superior U.S. technology.

We may conclude that although the Soviets produced large quantities of aircraft during World War II these were for the most part elementary wooden models with inferior piston engines.[81] No jet engines or advanced reciprocal engines had been produced by the end of the war, and Russian aircraft plants were heavily dependent on Lend Lease supplies, equipment, and technology.

During 1945-47 about two-thirds of the extensive German wartime aircraft and missile industry was transferred to the Soviet Union, including designers, engineers, plans, models, equipment, and complete production lines. The most important categories were Junkers and BMW jet engines, with production lines and teams of German engineers used in the late 1940s and 1950s to advance this jet engine technology. This was supplemented by the purchase of 55 Rolls-Royce engines in 1947 which became the prototypes for another group of Soviet jet engines. Soviet jets and turboprops in the early sixties were descendants of these German and British engines.

Although some aircraft are direct copies of Western machines (for example, the Tu-4 bomber and the Tu-70 civilian version in many ways duplicate the Boeing B-29), some design independence is recognizable from the mid-1950s

[79] *Ibid.*
[80] *Ibid.*.
[81] Sutton II, Chapter 14.

onward, although this is not of an advanced nature and dependence is still a factor.[82]

Soviet rockets and missiles can be clearly traced to German V-2 technology and transferred production capabilities; this observation applies also to air-to-air and underwater missile weapons.

[82] A popular but reasonably accurate account of Soviet backwardness in space and aviation in 1958 is Lloyd Mallan, *Russia and the Big Red Lie* (New York: Fawcett, 1959). This is based on a 14,000-mile, almost unrestricted trip to interview 38 Soviet scientists. Mallan's conclusions, amply supported by photographs, are generally consistent with the material presented here. Some of the more interesting items: the Remington Rand UNIVAC computer was used to illustrate an article in *Red Star* on Soviet computers (with captions translated into Russian) (p. 16); Soviet computers had such primitive characteristics as cooling by air blowing over the tubes (pp. 17, 20, and 24); calculations for the Lunik trajectory were done by use of a hand calculator made in Germany, not a computer (p. 26); the major equipment at a Soviet tracking station was an aerial camera that could be purchased at a war surplus store in the United States for $80 (p. 30); primitive cross-hair techniques were in use (p. 34); there was a General Electric radio telescope at Byurakan Observatory (p. 44); Mallan saw Soviet copies of the U.S. Navy space suit (p. 56-57) and the nose-cone spring release from the Viking rocket (p. 86); German rocket launchers were used (p. 95); there were copies of the C-123, Convair, B-29 (pp.112-120); numerous B-29 parts were used on the Tu-104, which had no servomechanisms and thus required brute force to fly; there were no radarscopes on the IL-18 (despite its radome nose, presumably false, p. 121); the ZIL-111 had a Cadillac gold V on the radiator, and the Moskvitch proved to be a copy of the West German Ford Taunus (p. 135).

CHAPTER TWENTY-ONE

Western Construction of the Soviet Merchant Marine

SHIPYARD FACILITIES IN THE SOVIET UNION

Soviet shipyard facilities, in 1944 mostly Tsarist yards, were supplemented after World War II by reparations equipment from Germany (see Table 21-1) and import of shipbuilding equipment from the West, particularly from Finland, the United Kingdom, and Germany.

Table 21-1 SHIPYARDS REMOVED FROM GERMANY TO THE U.S.S.R. IN 1945-46

Name of yard	*Location*	*Extent removed to U.S.S.R.*
Deutsche Schiffs-und Maschinenbau A.G. (Deschimag)	Bremen	Complete [a]
Deutsche Schiffs-und Maschinenbau A.G. (Valentin)	Bremen	Complete [a]
Schiffswerft und Maschinenfabrik	Dresden-Laubegast	Part only [b]
Schiffswerft Uebigau	Dresden-Uebigau	Part only [b]
Schiffswerft Rosslau	Saxony-Anhalt	Complete [b]
Neptunwerft Rostock	Rostock	Part only [b]

Sources: [a] Germany, Office of Military Government (U.S. Zone), Economics Division, *A Year of Potsdam* . . . (n.p.: OMGUS, 1947), p. 36; [b] G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik (Bremen: F. Trüjen, 1951),* pp. 101-2.

Shipyards at Bremen in the U.S. Zone of Germany were completely removed to the U.S.S.R. on a priority basis under U.S. Operation RAP.[1] The German submarine yards at Bremen and Stettin, including the torpedo and fire-control manufacturing plants, were also completely dismantled and shipped to the U.S.S.R., together with engine manufacturing plants and some "4000 submarine experts and construction supervisors."[2]

[1] See p. 26.

[2] U.S. Naval Institute, *Proceedings* (Annapolis, Md.), October 1945, p. 1225.

This is of great significance, as the German submarine of 1945 was quite different from the submarine of 1943; the later units were streamlined, with revolutionary engines enabling a tripling of underwater speed.[3] These German facilities became the nucleus of Soviet postwar construction of submarines and naval ships.

In 1954 this German equipment was supplemented by extensive purchases of shipbuilding equipment in the United Kingdom and Belgium. Under the January 1954 Soviet-Belgian trade agreement a total of $100 million in ships, floating cranes, and marine boilers was to be supplied from Belgium during the years 1955-57.[4] Large orders also were placed in the United Kingdom for shipbuilding equipment. For example,

> Soviet orders are being placed for shipbuilding equipment, Messrs Fielding and Platt having recently secured a £2¼ million contract for hydraulic equipment, including joggling presses and large forging and flanging presses.[5]

Moreover, Finnish deliveries to the Soviet Union for the latter half of the decade of the 1950s contained, among other equipment, five floating docks and 25 floating cranes and electric bridge cranes.[6]

These equipment deliveries were in addition to the extensive use of foreign shipyards—and this particularly applies to Finland and Poland—to build up the Soviet merchant marine. Many yards in Western Europe have since about 1951 had a large proportion of their tonnage on Soviet account, and a few yards have produced almost entirely for the Soviet Union. For example, in 1954 in the Netherlands the De Schelde, Kononklijke Mij N.V. yards in Flushing produced 100 percent of their output on Soviet account. In Belgium in 1954 the shipyard Boel et Fils S.A. produced 20 percent of its output on Soviet account. In Finland in the same year the two major yards Wärtsilä-Koncernen A/B (Sandvikens Skeppsdocka) and Wärtsilä-Koncernen A/B (Crichton-Vulcan) produced 50 and 64 percent, respectively, of their output on Soviet account. In the same year in Sweden Oskarshamns Varv A/B at Oskarhamn built 25 percent of its output on Soviet account. And in the same year in the United Kingdom the yards of William Gray and Company, Ltd., at West Hartlepool produced 20 percent of their output on Soviet account.

In addition, foreign government-owned yards have produced ships on Soviet account. For example the Howaltdwerke in Kiel, Germany, is owned by the German Government and has been a major source for Soviet ships.[7]

[3] *Ibid.*

[4] Raymond F. Mikesell and Jack N. Behrman, *Financing Free World Trade with the Sino-Soviet Bloc* (Princeton: Princeton University Press, 1958), Appendix.

[5] *The Motor Ship* (London), XXXIV, 408 (March 1954), 549.

[6] U.N., *Treaty Series*, vol. 240 (1956), p. 202.

[7] Gunnar Adler-Karlsson, *Western Economic Warfare, 1947-1967* (Stockholm: Almquist and Wikesell, 1968), p. 94. *Merchant Ships: World Built* (Southampton: Adlard Coles, annual).

CONSTRUCTION OF THE SOVIET MERCHANT MARINE

The total tonnage in the Soviet merchant fleet at July 1967 was 11,788,625 gross registered tons. Of this total, only 34.4 percent (4,058,427 gross registered tons) was built in the Soviet Union; the balance of 7,730,198 gross registered tons was built outside the Soviet Union.[8]

The largest single supplier of shipping to the Soviet Union has been Poland, a country that was not even a shipbuilder before 1950. During the period 1950-66 Poland supplied 379 ships totaling 1,454,314 gross registered tons, to the Soviet merchant marine. Table 21-2 illustrates the number of Polish ships built on Soviet account in each year during that period and gives their gross tonnage. It may be observed that the average size of these ships increased quite significantly at the beginning of the 1960s, when "hundreds" of technical-assistance agree-

Table 21-2 MERCHANT SHIPS BUILT IN POLAND ON SOVIET ACCOUNT FROM 1950 to 1966

Year	*Number of Ships built*	*Gross registered tonnage*	*Average size built, GRT*
1950	1	1946	1946
1951	—	—	—
1952	21	36,036	1716
1953	28	46,657	1666
1954	24	43,240	1800
1955	31	46,470	1499
1956	35	61,295	1751
1957	30	53,985	1799
1958	29	61,876	2133
1959	19	86,887	4573
1960	19	122,053	6424
1961	12	52,808	4400
1962	21	134,991	6428
1963	31	167,806	5413
1964	24	159,228	6634
1965	23	175,191	7617
1966	31	203,845	6576
Totals	379	1,454,314	

Source: Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

[8] Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966). The reader should also examine *Soviet Merchant Ships 1945-1968* (Havant, England: K. Mason, 1969), for detailed material. It should be noted, however, that that survey includes only about 2500 ships, whereas this section is based on the Soviet Register at July 1, 1967, i.e., it considers a total of 5551 ships.

ments between Polish shipyards and West European manufacturers of shipbuilding equipment came into operation;[9] from an average gross tonnage of about 1600 tons in the early 1950s, the average Soviet ship built in Polish yards in the mid-1960s was between 6500 and 7500 tons.

The largest Free World suppliers of ships to the Soviet fleet have been Japan and West Germany. In 1955-56 West Germany supplied 32 ships with an average tonnage of about 3000 gross registered tons. Thereafter orders dribbled down to one and two ships per year until 1964, when seven ships of 4700 tons each were delivered, and 1965-66, when eight ships of an average of 16,000 tons were delivered from West Germany to the Soviet Union. Japanese orders have been concentrated in the years 1962 to 1966 and comprise numerous 22-23,000-ton tankers.

Among socialist countries, Yugoslavia is a prominent supplier of ships to the Soviet Union; in 1965 Yugoslavia built 11 ships of two types (11,000 tons and 15,000 tons) and in the following year supplied another ten ships (also 11,000 and 15,000 tons). Most of these Yugoslav ships have Burmeister & Wain diesel engines.[10]

Construction in Soviet shipyards has concentrated on standard ships. One such standard ship is the *Leninskii Komsomol*,[11] a dry cargo ship of 12,000 gross registered tons and generally comparable to the U.S. "Mariner" class; i.e., it is a conventional design ship of a type known throughout the world. This type of vessel has also been ordered on Soviet account in Japan, Yugoslavia, Finland, and Poland.

Another standard dry cargo freighter is the 12,500-dwt class built at Nikolaev with engines based on Burmeister & Wain design; this "Poltava" class became well known in 1961 as a missile carrier to Cuba.

SOVIET OIL TANKERS AND WESTERN DIESEL ENGINES

The Soviet merchant marine is heavily dependent not only on Western shipyards but on foreign marine diesel engine technology.[12] A quantitative expression of additions to the Soviet tanker fleet in 1964-65, i.e., those tankers under construction at the very end of the period under consideration, illustrates the point.[13] In those years a total of 541,201 gross registered tons of tankers was added and the construction origin of this segment was as follows:

[9] John D. Harbron, *Communist Ships and Shipping* (London, 1962), p. 196. The Soviets have also made hard currency available to the Poles for purchase of Western equipment for ships built in Poland on Soviet account. *Ibid.*, p. 109.

[10] See A. Sutton, "Soviet Merchant Marine," U.S. Naval Institute, *Proceedings*, January 1970, for Western construction of merchant ships on Soviet account.

[11] Registr Soyuza SSR, *op. cit.* n. 8, no. 1602.

[12] See chapter 17.

[13] This is the segment of the fleet contained in Supplement No. 1 to the Soviet Register. Registr Soyuza SSR, *op. cit.* n. 8.

Hulls built in U.S.S.R.		236,358 gross tons	(or 43.6 percent)
Hulls built in Eastern Europe:			
Yugoslavia	167,803		
Poland	13,218	184,881 gross tons	(or 34.1 percent)
Bulgaria	3,860		
Hulls built in Free World:			
Finland	13,439		
Japan	75,390	119,962 gross tons	(or 22.2 percent)
Italy	31,133		
			99.9 percent

In general these vessels had main engines manufactured in the country of hull construction; therefore the geographic distribution of engine construction is about the same in percentage terms. However, almost all the Soviet-built propulsion units (229,530 tons) were steam turbines. If we consider only that portion of tanker fleet additions equipped with diesel propulsion units, the distribution is as follows:

Main diesel units built in U.S.S.R.	1.7 percent	(5,372 gross tons)
Main diesel units built in Eastern Europe	59.8 percent	(186,337 gross tons)
Main diesel units built in Free World	38.4 percent	(119,962 gross tons)
	99.9 percent	(311, 617 gross tons)

If we make a further analysis and examine diesel engines by country of *design* (not construction) origin (most East European manufacturers have technical-assistance agreements with Western diesel engine manufacturers; all Yugoslav diesels in this segment, for example, have Burmeister & Wain main diesels), then the percentages are:

Main diesels designed in U.S.S.R.	1.7 percent	(5,372 gross tons)
Main diesels designed in Eastern Europe	1.7 percent	(5,318 gross tons)
Main diesels designed in Free World	96.5 percent	(300,981 gross tons)
	99.9 percent	(311,671 gross tons)

The most numerous class of Soviet tankers in a fleet of 300 such vessels[14] is the "Kostroma" class of 8229 gross registered tons. Between 1953 and 1961 about 58 were built in this class, which is a close copy of the U.S. wartime T-2 tanker;[15] about 17 of these have Skoda engines imported from Czechoslovakia and the remainder have a similar engine which is manufactured at Russky Diesel in Leningrad. According to J. D. Harbron,[16] the "Kostroma"

[14] *Ibid.*, at July 1967. See Statistical Note to this chapter for detailed data on 242 (out of 300) tankers built after World War II.

[15] Harbron, *op. cit.* n. 9, p. 151.

[16] *Ibid.*, p. 154.

class in the early sixties was fully occupied in supplying oil to Cuba and in Soviet naval supply work.

The remaining tankers can be divided for analysis into three groups—large tankers in excess of 13,000 tons, medium tankers of about 3300 gross registered tons, and small tankers of less than 1772 tons. Analysis of these three classes is contained in the Statistical Note to this chapter (see pp. 295-302) and includes a breakdown by foreign and Soviet domestic production.

About two-thirds of large tankers in the Soviet tanker fleet as of July 1967 had been built outside the Soviet Union; of a total of 129 such tankers, only 25 had been built in the Soviet Union and all these were powered by steam turbine rather than diesel engines. Soviet construction falls into two classes: one class, of 21,255 gross registered tons, includes seven vessels built between 1959 and 1963, and the other class, of 32,484 gross registered tons, includes the remaining 18 tankers built between 1963 and 1966. All other Soviet tankers over 13,000 tons were built abroad. Italy built six of 20,000 and 31,000 gross registered tons; Holland built two of 16,349 gross registered tons; Poland built seven of a standard class of 13,363 gross registered tons; Yugoslavia built 15 of a standard tonnage (15,255 tons); Japan built 20 tankers of between 22,000 and 25,000 tons; and the remaining two tankers were a Polish-built standard vessel with East German engines and a Yugoslav-built tanker of 17,861 tons with a Swedish engine. This comprised the total Soviet tanker fleet in excess of 13,000 tons—and 67.5 percent in tonnage terms had been built abroad.

There were 76 tankers in a medium category (3300 and 3820 gross registered tons). Of these only 15 were completely built in the Soviet Union; however, the class does contain one unusual characteristic—a group of 22 tankers with Soviet diesel engines but built in Bulgaria. The largest group was built in Finland—28 of 3300 tons with hulls from Finnish shipyards and Danish engines. The remaining vessels in this group constituted a few built in Finland with Finnish engines, three built in Finland with Swedish engines, and two tankers built completely in Japan.

The last group of tankers comprised 89 vessels, all of less than 1772 gross registered tons, 70.8 percent built outside the Soviet Union. The largest group built inside the Soviet Union comprised 20 small tankers of between 756 and 802 gross registered tons, for use in the Caspian Sea. Another group of nine tankers of 1775 gross registered tons had hulls built in the Soviet Union but Czechoslovak Skoda engines. The largest group of small tankers built outside the Soviet Union comprised 33 tankers of between 260 and 305 gross registered tons, with both hulls and engines built in East Germany. A group of thirteen tankers of 1117 tons was built in Finland on Soviet account in 1954-55 and powered with Swedish engines.

Therefore it may be seen that as of July 1967 about two-thirds of Soviet tankers had been built outside the Soviet Union, and the foreign-built segment included almost all tankers in excess of 13,000 tons. Even two-thirds of the smaller tankers, including those for use in the Caspian Sea and for coastal use, were built abroad rather than in the Soviet Union. Further, a number of the tankers built in the Soviet Union had engines manufactured abroad, imported into the U.S.S.R., and then installed in hulls built in Soviet yards.

MODERNIZATION AND EXPANSION OF THE SOVIET FISHING FLEET

Between 1945 and the late 1960s the Soviet fishing fleet was modernized and greatly expanded; between 1945 and 1961 about 3500 modern large and medium trawlers and refrigerator ships were added to the fleet.[17] The program started in the early fifties when orders were placed for prototype fishing vessels in the Netherlands, Sweden, Finland, Denmark, Japan, and, more significantly, in the United Kingdom and Germany.

The Soviets' first step in 1954 was a $20 million order for 20 modern fishing trawlers, placed with the United Kingdom firm of Brooke-Marine, Ltd., of Lowestoft.[18] In this connection, a U.S. Congressional report[19] notes:

> From the specifications they received, the British engineers learned that the Russians were still designing their trawlers pretty much as they were designed 20 years earlier. They seemed to have no knowledge of what went into the making of a modern fishing trawler....[20]

The series of 20 Brooke-Marine trawlers embodied the latest in world technology, and "after they were turned over to Russia, the new trawlers were distributed as prototypes among the shipyards of the U.S.S.R., Poland, and East Germany, and large-scale production of large, efficient, oceangoing fishing vessels was launched in earnest in the Soviet bloc."[21]

The first vessel in the class—the side-set trawler *Pioner*—was launched and delivered in 1956. Its equipment was of the most advanced type: Donkin & Co., Ltd., of Newcastle-on-Tyne supplied a partially balanced streamlined rudder actuated by means of electrohydraulic steering gear; an electrically driven windlass, installed by Clarke-Chapman & Co., Ltd., was capable of lifting two improved Hall stockless bower anchors from 260 feet at a rate of 30 feet

[17] U.S. Senate, Committee on Commerce, *The Postwar Expansion of Russia's Fishing Industry*, Report by the Fisheries Research Institute, 88th Congress, 2d Session, January 1964 (Seattle: University of Washington, 1964), p. 6.

[18] *Commercial Fisheries Review* (Washington, D.C.), 16, 5 (May 1, 1954), 68.

[19] U.S. Senate, *op. cit.* n. 17, p. 7.

[20] *Ibid.*

[21] *Ibid.* For details of equipment on Soviet trawlers see Yu. Kostyunin, *Rybolovnye traly* (Moscow, 1968).

per minute; the ventilating-heating system was by R.B. Stirling & Co., Ltd.; and the insulation, of "very high standard throughout," was by Darlington Co., Ltd.

The most up-to-date navigation aids were installed by Brooke-Marine, Ltd.—a Redifon radio apparatus, Pye sound reproduction system, Bendix echosounding gear, a Revometer, Browne standard and steering compasses, and an eight-way batteryless telephone communication system by Telephone Manufacturing Co., Ltd. The refrigeration plant was built by L. Sterne & Co., Ltd., of Glasgow with automatic controls by Malone Instrument Co., Ltd., and the fish meal plant by Farrar Boilerworks, Ltd. The main engine was a four-stroke, eight-cylinder diesel-type KSSDM by Mirrlees, Bickerton & Day, Ltd., developing 950 shp at 255 rpm. The whole ship was specially strengthened for ice work.[22]

In all, 20 ships were built to this specification by Brooke-Marine, Ltd., for the Soviet Union. (See Table 21-3.)

In 1954 the Scottish shipbuilder John Lewis & Sons, Ltd., of Aberdeen designed an advanced fishing vessel, the *Fairtry*, which was hailed in the trade

Table 21-3 TRAWLERS SUPPLIED BY BROOKE-MARINE, LTD TO THE U.S.S.R. IN 1956-59

Soviet register	*No.*	*Name*	*Gross registered tons*	*Date supplied*
2855	PT-200	*Pioner*	684	1955
2856	PT-201	*Akula*	684	1956
2857	PT-202	*Muksun*	685	1956
2858	PT-203	*Karas*	684	1956
2859	PT-205	*Sokol*	684	1956
2860	PT 207	*Sever*	684	1957
2861	PT-208	*Vostok*	685	1957
2862	PT-209	*Ug*	685	1957
2863	PT-210	*Zapad*	685	1957
2864	PT-211	*Tunets*	685	1957
2865	PT-212	*Rion*	685	1957
2866	PT-213	*Stavrida*	685	1957
2867	PT-214	*Shongui*	685	1957
2868	PT-215	*Kotlas*	685	1957
2869	PT-216	*Okun*	685	1957
33	—	*Adler*	685	1958
2158	—	*Pelamide*	685	1958

Source: Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

[22] Data from *The Shipbuilder and Marine Engine-Builder* (London), February 1956, p. 1179.

literature as one of the most interesting ships to have been built in recent years[23] and subsequently became the basis of the Soviet "Pushkin" class. The *Fairtry* resulted from experimental work that had been going on since 1947. It was the largest trawler built to that time and the first specially designed and constructed for stern trawling and for complete processing of the catch on board. The *Fairtry* had a gross registered tonnage of 2605 with a main propulsion unit built by Lewis Doxford—a four-cylinder oil engine capable of developing 1900 bhp.[24]

This advanced design was used by the Russians for their main postwar class of trawlers. The Soviets placed an order in the Howaldtwerke shipyards in Kiel, West Germany, for 24 trawlers based on the *Fairtry* design, and these trawlers of 2500 gross tons were built on Soviet account between 1955 and 1958.[25] The 24 German-built prototypes became the basis for the Soviet "Pushkin" class of stern trawlers, first launched in the spring of 1955, and the other 23 German-built units followed in the next several years.

After being tested in operation the "Pushkin" class became the prototype for a Soviet-built version—the "Maiakovskii" class; the "Maiakovskii" vessels of 3170 gross registered tons were of the same overall dimensions as the "Pushkin" class. Two years later work began in Poland on a modified version of the same trawler, the "Leskov" class of 2890 gross registered tons and of similar dimensions to the "Pushkins" and the *Fairtry*.

There is also an East German version of the *Fairtry* known as the "Tropik" class, of 2400 gross registered tons; the first craft in this series, launched in East Germany in July 1962, was specially built for operation by the Soviets in tropic areas.

Table 21-4 ORIGINS OF SOVIET STERN TRAWLERS AS OF 1965

Soviet trawler class	*Design based on*	*Original prototype order*	*Number of copies*
"Pushkin" 2,470 GRT	U.K. *'Fairtry'*; prototype built in W. Germany	24	—
"Maiakovskii" 3,170 GRT	U.K.*'Fairtry'*	—	60
"Leskov" 2,890 GRT	Polish modification of U.K. *'Fairtry'*	20	—
"Tropik" 2,600 GRT	East German version of U.K.*'Fairtry'*	—	65 (to 1965)

Sources: Commercial Fisheries Review (Washington), May 1, 1954; and author's calculations based on Soviet sources.

[23] *The Shipbuilder and Marine Engine-Builder*, September 1954, p. 541.
[24] *Ibid.*, pp. 541-44.
[25] *Commercial Fisheries Review*, 16, 5 (May 1, 1954), 69.

Therefore the numerous Soviet stern trawlers are based on a single British vessel, the most advanced of its type when first produced in 1954. (See Table 21-4.)

FISH FACTORY SHIPS, MOTHER SHIPS, AND REFRIGERATED FISH TRANSPORTS

In 1959 an order for 11 "Severod Vinsk" class mother ships was placed with the Polish Government shipyards in Gdansk. The ships were delivered between 1959 and 1962 with a gross registered tonnage of 11,500; their function is to serve as supply and base ships for Soviet trawler fleets.

The "Zakharov" class, based on the "Severod Vinsk" design, performs the functions of processing fish as well as the service functions of a mother ship; it is also equipped to manufacture fish meal and oil from wastes obtained during the canning operations. It was built at the Admiralty yards at Leningrad between 1960 and 1963. The "Zakharov" class ships have a daily canning capacity of 1600 cases, and one version receives fish from an accompanying fleet of medium fishing trawlers (SRTs) or from 12 motor boats carried on board (the motor boats are of a special Japanese Kawasaki design for catching king crabs with angle nets).

There are also about a dozen classes of refrigerator transport vessels, some of which have equipment for quick-freezing fish.

Table 21-5 ORIGINS OF REFRIGERATOR FISH CARRIERS AND PRODUCTION REGRIGERATOR TRANSPORTS

Class	*Built*	*GRT*
"Bratsk"	*East Germany*	*2,500*
"Tavriia"	*Soviet Union*	*3230*
"Pervomaisk"	*Denmark*	*3300*
"Sevastopol"	*Soviet Union*	*5525*
"Skryplev"	*Denmark*	*4700*

Sources: Commercial Fisheries Review (Washington, D.C.), Nov. 1964 supplement, pp. 11-12; Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

These refrigerated transport vessels have been built partly in the Soviet Union and partly abroad on Soviet account. (See Table 21-5.) The "Bratsk" class of refrigerated vessels, built in East Germany with a gross registered tonnage of about 2500 to carry a crew of 91 with a 40-day cruising capacity, was built after 1960 for the Soviet merchant fleet. The vessels have equipment installed in the East German yards of Stralsund Volkswerft, comprising freezing and refrigeration plant with two freezer machines, four air-blast freezing tunnels, packing departments, refrigerating machines, and refrigerating holds. Capacity is about 1800 cubic meters, permitting storage of about 800 tons of frozen fish.

Another class, built completely in the Soviet Union, is the "Tavriia" class (3230 gross registered tons), which performs the same function as the "Bratsk" class. Another is the "Pervomaisk" class built in Denmark on Soviet account and with Danish engines; these vessels are of about the same tonnage as the "Tavriia" class and about the same overall length, and there is in general a distinct similarity between this Danish class and the "Tavriia" class.

The largest class of refrigerator vessels is the Soviet-built "Sevastopol" of 5525 gross registered tons and about 430 feet in overall length, with a capacity to handle 100 metric tons of fish per day with equipment consisting of eight air-blast freezing tunnels each 39 feet long and related storage of five holds of 5400 cubic meters each; total capacity is 2700 metric tons of fish.

Finally, there is the "Skryplev" class, designated as refrigerator transports but actually factory ships with a capability of freezing fish and preparing fish meal and oil. These ships of 4700 gross registered tons and overall length of about 300 feet were built in Denmark in the early 1950s.

SOVIET OCEANOGRAPHIC AND RESEARCH VESSELS

In 1967 there were approximately 71 research and oceanographic vessels in the Soviet fleet. The origin of about one-half of these vessels has been traced. None of those traced originated in the Soviet Union.[27]

Several research ships have been built in East Germany on Soviet account. For example, the *Okeanograf* was built in East Germany in 1956 and has Buckau-Wolf diesel engines; the *Poliarnik,* built in East Germany in 1952, also has Buckau-Wolf engines; the *Akademik S Vavilov*, built in East Germany in 1949, has a 350-hp Buckau-Wolf diesel engine; the *Zemchug* of 422 tons, built in East Germany in 1950, also has a Buckau-Wolf 300-hp engine; similarly, the *Topseda* of 239 tons, built in East Germany in 1950, has a Buckau-Wolf 300-hp engine.

Some research vessels have been built in Finland. For example the *Professor Rudovits* of 626 tons was built in Finland in 1950, and has Finnish engines. The *Zaria*, built in Finland in 1952, has an East German 300-hp engine.

Holland built a large 12,000-ton research vessel, the *Ob*, in 1953 with a 7000-hp diesel-electric engine made by Schelde-Zulzer.

China built several research vessels for the Soviet Union in the mid-1950s and fitted them with East German Buckau-Wolf engines. For example, the *Pervenets* (442 gross registered tons) was built in 1956 in China. Some prewar

[26] *Commercial Fisheries Review*, 26, 11A (November 1964), Supplement.

[27] A list of these vessels is in U.N., Food and Agricultural Organization, *Research Craft Conference* (Seattle, 1968), pt. 2.

vessels also appear to have been converted for oceanographic use; for example the *Vitiaz* (5710 gross registered tons), built in Germany in 1939 with a Krupp reversible two-cycle engine of 3600-hp, was converted sometime in the 1950s for oceanographic use.

Finally, in 1966 Poland agreed to build ten advanced oceanographic research vessels for the Soviet Union. These are ice-strengthened to the highest classification in the Soviet Registry, 282 feet long, 45-foot beam and 15-foot draft with a displacement of 3735 metric tons, and propelled by two Sulzer diesels each of 2400 hp with variable-pitch propellers.[28]

Perhaps the most notable feature of Soviet oceanographic vessels is their navigation and echosounding equipment. This appears to have originated in large part in the West, although we have data for only about 20 of the approximately 70 ships in the Soviet oceanographic research fleet. For example the *Vitiaz*, the converted 1939 German 5700-ton vessel, has the following equipment:

Navigation:	2 gyrocompasses (Course 3 and Course 4)
	3 magnetic compasses (2 track, 1 main)
	1 Gauss-25 hydraulic log
	1 electromechanical log
	2 radiolocators (Don and Neptun)
	1 Kelvin-Hughes navigation log
	2 radio direction finders (Millard)
	2 long-distance meteorological stations
Echosounders:	2 Kelvin-Hughes (10,000-meter)
	2 Kelvin-Hughes (4500-meter range)
	1 Kingfisher fishlocator

The *Ob*, built in Holland in 1953, similarly has Western equipment:

Navigation:	4 gyrocompasses
	2 magnetic compasses
	1 Gauss-25 log
	2 Zarnitsa and Neptun radar
Echosounders:	2 Kelvin-Hughes (MS 26)
	2 Nippon Electric L-5, 2000-meter range

Vessels built in East Germany on Soviet account also have been fitted with Western equipment. For example, the *Zemchug* has Nippon Electric echosounders; the *Akademik Vavilov* has echosounders made by Kelvin-Hughes and Nippon Electric; the *Poliarnik* has Nippon Electric echosounders; the *Sevastopol* has echosounders made by Hughes (type MS 26) and Nippon Electric.

So far as navigation equipment is concerned, we find similar use of Western equipment. For example, the *Okeanograf* built in East Germany in 1956 has a Thomson-type manual mechanical sounding instrument; the *Akademik Vavilov*,

[28] *Undersea Technology* (Washington, D.C.), May 1967, p. 67.

built in East Germany, has a Nippon Electric navigation sounder; the *Professor Rudovits* has a Lyth magnetic compass.

Therefore we may conclude that Soviet oceanographic research vessels are heavily dependent on Western sources, particularly for their instrumentation, even though this instrumentation has been indirectly acquired through East European socialist countries.

So far as underwater sea laboratories are concerned the Soviets are somewhat backward. An article in the U.S. Naval Institute *Proceedings* on the Russian sea lab[29] reviews the Russian *Sadeo-2* and concludes:

> Quite noticeable under various Soviet programs revealed to the West, is that living or working depths have been no more than 100 feet.... One can only speculate on the apparent Soviet backwardness in this field.

By contrast, the United States had vessels operating to a depth of 36,000 feet at that time (1969).

WESTERN ORIGINS OF SOVIET ICEBREAKERS

Before World War II the Soviet Union had only two or three icebreakers (built in Europe between World War I and the mid-1920s). Three modern icebreakers were transferred to the Soviet Union in the early 1940s under Lend Lease. Secretary of the Navy James Forrestal attempted to have these icebreakers returned in 1946, and in a memorandum to the State Department requesting institution of recovery proceedings Secretary Forrestal commented:

> Of particular importance are the three CRs or icebreakers identified as:

U.S. Name	U.S.S.R Name
Northwind	*Severny Veter*
Southwind	*Admiral Makarof*
Westwind	*Severny Polus*

> These are high-powered icebreakers of the most modern design, sister ships (except in armament) of the two now in commission in the U.S. Coast Guard and of two others under construction and completing for the Navy. The importance of an adequate number of high-capacity icebreakers in supporting any operations in the frigid zones cannot be overemphasized. Three-sevenths of the total war production of this type are held by the U.S.S.R.[30]

The Soviet Register of 1966 lists icebreakers with characteristics similar

[29] U.S. Naval Institute, *Proceedings*, July 1969, pp. 113-15.
[30] U.S. State Dept. Decimal File 861.24/5-646.

to these Lend Lease vessels. Soviet Register No. 38, for example, is the *Admiral Makarov* (U.S. *Southwind*); however, this icebreaker is listed as built in the Soviet Union in 1941 with an engine built in the Soviet Union in 1939.[31]

In the early 1950s the Soviets contracted with the Wärtsilä Kon. Sandvikens shipyards in Finland for a series of 3000- and 9000-ton icebreakers with diesel-electric engines manufactured by Wärtsilä Kon. Crichton-Vulcan at Abo in Finland. These icebreakers are listed in Table 21-6.

Table 21-6 ICEBREAKERS BUILT IN FINLAND ON SOVIET ACCOUNT FROM 1955 TO 1959

Name	*Year built*	*Gross registered tons*
Kapitan Belusov	1955	3710
Kapitan Voronin	1955	3419
Kapitan Melekhov	1956	3377
Murtaya	1958	2720
Moskva	1959	9165

Sources: Lloyd's Register of Shipping, 1965; *Registr Soyuza SSR, Registrovaya kniga sudov soyuza SSR 1964-1965* (Moscow, 1966); A. C. Hardy, *Merchant Ships: World Built* (Southampton: Adlard Coles, 1960).

Then in 1960 the Soviets produced the *Lenin*, an atomic icebreaker that was followed by a series of ten icebreakers adopted from earlier Finnish designs. The *Lenin* was launched in December 1957 as the world's first atomic icebreaker. Its reactors were reported as three and one-half times larger than the first Soviet reactor, which generated 5000 kw in June 1954. The main turbines were manufactured at the Kirov plant in Leningrad, the electric motors at the Electrosila plant, also in Leningrad; and the main generators were manufactured at KHEMZ in Kharkov, a plant originally designed and built by the General Electric Company. All together, some 500 Soviet plants contributed to the construction of the *Lenin*.[32]

In 1958 an equally large icebreaker, the *Moskva*, was supplied by Finland to the Soviet Union; this icebreaker has Siemens-Schuckert propulsion machinery and the same company made most of the electrical equipment.[33] When it was launched in January 1959 at Helsinki, the *Moskva* was the largest icebreaker built in Finland for the Soviets, with eight Sulzer engines generating 22,000 hp.

Between 1961 and 1967, the Soviets launched a series of ten standard icebreakers named *Ledokol-1* to *Ledokol-10*.[34] This series has diesel-electric motors

[31] *Jane's Fighting Ships*, 1969-1970, lists the "Wind" class as returned to the United States in 1951.

[32] U.S. Naval Institute, *Proceedings*, November 1959, p. 142.

[33] American Society of Naval Engineers, *Journal* (Washington, D.C.), May 1959, p. 337.

[34] These are listed in the Soviet Register under different names; for example *Ledokol-1* is the *Vasily Pronchishchev*.

and is remarkably similar in dimensions to the series of icebreakers built for the Soviet Union in Finland in the 1950s.

Table 21-7 COMPARISON OF SOVIET "LEDOKOL" CLASS AND EARLIER ICEBREAKERS SUPPLIED FROM FINLAND

Characteristic	*Soviet "Ledokol" class*	*Finnish "Karhu" class*
Overall length, feet	222.1	224.0
Breadth, feet	59.25	55.7
Depth, feet	27.23	28.10
Draught, feet	19.1	19.0
Propulsion	Diesel-electric	Diesel-electric (7500 shp)
Displacement, tons	—	3,370

Source: Lloyd's Register of Shipping, 1965; Registr Soyuza SSR, *Registrovaya kniga sudov soyuza SSR 1964-1965* (Moscow, 1966); A. C. Hardy, *Merchant Ships, World Built* (Southampton: Adlard Coles, 1960).

It is a reasonable assumption that the Soviet series of standard icebreakers is based on the earlier Finnish designs. (See Table 21-7.)

Thus in icebreakers, a class of ship where the Soviets have requirements considerably greater than any country except perhaps Canada, apart from the single atomic icebreaker *Lenin* there is a dependence on designs originating in Finnish shipyards or on icebreakers built in Finland and the United States.

Construction of the Soviet merchant fleet constitutes a sector for which precise and accurate information is available—more so than for any other sector. The problem has been to distill the information into a succinct and meaningful pattern.

In broad terms, up to July 1967 65.6 percent of the Soviet merchant fleet was built completely (hulls plus engines) outside the Soviet Union. In terms of propulsion units, the most common engine is the marine diesel—and of these, just under 80 percent were built outside the U.S.S.R., but even those built in Soviet plants were derived from foreign designs, particularly Burmeister & Wain of Denmark and Skoda of Czechoslovakia.

Marine tonnage built inside the U.S.S.R. is of standard types, often based on Western prototypes, as in the cases of icebreakers, the "Kostroma" class tanker, and the "Pioner" class fishing trawler. In other cases, e.g., in oceanographic vessels, equipment is largely of Western origin and construction. Apart from the *Lenin* atomic icebreaker there is no vessel in the Soviet merchant marine that represents indigenous Soviet innovation.

Table 21-8A ORIGINS OF MAIN ENGINES IN SOVIET MERCHANT SHIPS ADDED TO FLEET BEFORE 1930

	1929	*1928*	*1927*	*1926*	*1925*	*1924*	*1923*	*1922*	*1921*	*1920*	*PRE-1920*	*Total*
Germany	1	3	4	—	4	3	4	2	6	4	6	37
United States	—	—	—	—	—	—	—	—	1	1	25	27
Holland	—	—	—	1	—	—	1	1	3	—	7	13
Denmark	—	—	—	1	—	—	—	—	—	—	—	1
U.S.S.R.	1	4	1	—	—	—	—	—	—	—	3	9
Finland	—	—	—	—	—	—	—	—	—	—	2	2
United Kingdom	1	—	—	1	—	—	1	—	—	2	17	22
Sweden	1	—	1	1	—	—	—	—	—	—	1	4
Japan	—	—	—	—	—	—	—	—	—	—	5	5
France	—	—	1	—	—	—	—	—	—	—	—	1
Others	—	—	—	—	—	—	—	—	—	1	5	7
Totals	4	7	7	4	4	3	6	3	11	8	71	128

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

Table 21-8B

ORIGINS OF MAIN ENGINES IN SOVIET MERCHANT SHIPS ADDED TO FLEET BETWEEN 1930 AND 1940

	1930	*1931*	*1932*	*1933*	*1934*	*1935*	*1936*	*1937*	*1938*	*1939*	*1940*	Total
United Kingdom	—	—	1	—	1	—	3	—	1	1	—	7
Germany	7	4	2	—	—	3	2	4	3	17	2	44
Norway	—	—	—	—	—	—	—	—	1	—	—	1
U.S.S.R.	3	4	6	5	1	3	1	3	2	1	—	29
Denmark	—	1	1	1	—	—	2	2	—	—	—	7
Holland	—	1	—	—	—	—	—	—	—	—	—	1
Finland	—	—	—	1	—	1	—	—	2	—	—	4
Japan	—	—	—	—	—	—	1	1	—	—	—	2
Sweden	—	—	—	—	—	—	—	—	—	—	—	1
United States	—	—	—	—	—	—	—	—		1	—	1
TOTALS	10	10	10	7	2	7	10	10	9	20	2	97

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

Table 21-8C ORIGINS OF MAIN ENGINES IN SOVIET MERCHANT SHIPS ADDED TO FLEET BETWEEN 1941 AND 1945

	1941	*1942*	*1943*	*1944*	*1945*	*Total*
United States	1	13	48	14	2	78
Germany	5	3	14	7	—	29
Norway	2	3	2	—	—	7
Sweden	—	—	1	—	—	1
United Kingdom	—	1	—	—	1	2
Finland	1	—	—	1	6	8
Hungary	—	1	—	—	—	1
Denmark	—	—	—	1	—	1
Holland	—	—	—	1	—	1
Others	—	—	—	1	—	1
Totals	9	21	65	25	9	129

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

Table 21-8D CONSTRUCTION OF THE SOVIET TANKER FLEET FROM 1951 TO 1967

	Hull and engine built in U.S.S.R.	*Hull and/or engine built outside U.S.S.R.*	*Total added to tanker fleet*	*Percentage built outside U.S.S.R.*
1951	8,229	1,113	9,342	11.9
1952	8,229	14,618	22,847	65.0
1953	24,687	16,570	41,257	40.1
1954	77,798	4,468	82,266	5.4
1955	65,077	20,721	85,798	24.1
1956	60,337	46,820	107,157	43.7
1957	59,532	54,109	113,641	47.6
1958	18,556	35,502	54,058	65.7
1959	90,066	24,663	114,729	21.5
1960	93,707	105,827	199,534	53.0
1961	31,074	56,397	87,471	64.5
1962	42,510	178,879	221,389	80.8
1963	87,693	179,055	266,748	67.1
1964	164,205	328,265	492,470	66.6
1965	132,872	242,201	375,073	64.6
1966	234,235	145,857	380,092	38.4
1967	—	41,833	41,833	100.0
Totals	1,198,807	1,496,898	2,695,705	55.6 percent average

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965 (Moscow, 1966).*

Table 21-8E FOREIGN CONSTRUCTION OF MARINE DIESEL ENGINES FOR THE SOVIET TANKER FLEET, 1951-JULY 1967

	Total installed in Soviet tankers	*Foreign*	*Percentage foreign-built*
1951	2	1	50
1952	7	6	86
1953	16	13	81
1954	14	4	28
1955	17	8	47
1956	25	14	56
1957	33	19	58
1958	17	9	53
1959	16	4	25
1960	15	3	20
1961	11	6	54
1962	21	18	86
1963	16	11	68
1964	22	19	86
1965	21	18	86
1966	22	12	55
1967	7	4	57
Totals	281	169	60

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

Table 21-8F DESIGN ORIGINS OF MARINE DIESELS USED IN THE SOVIET TANKER FLEET, 1951-JULY 1967

Manufactured in U.S.S.R.			*Year*																
Model	*Specification*	*Total*	*1951*	*1952*	*1953*	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*	*1967*
Russki Diesel	8 x 300/500	53	—	—	—	1	2	6	9	8	4	6	4	3	4	3	1	1	1
	8 x 430/610	47	1	1	3	9	7	4	5	0	8	6	1	—	—	—	—	2	—
	6 x 250/340	5	—	—	—	—	—	—	—	—	—	—	—	—	1	—	2	2	—
Bryansk	5 x 500/1100	8	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	5	2
Total Manufactured in U.S.S.R.		113	1	1	3	10	9	11	14	8	12	12	5	3	5	3	3	10	3
Manufactured outside U.S.S.R.																			
Model	*Specification*																		
Polar (Nydqvist & Holm)	6 x 300/500	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Polar	6 x 345/580	2	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	8 x 500/700	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Skoda	8 x 430/610	25	—	—	1	—	3	5	6	3	—	—	—	—	—	3	2	2	—
Burmeister & Wain	5 x 500/1100	33	—	—	—	—	—	—	—	3	4	2	4	8	4	5	2	—	1
	6 x 740/1600	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	8 x 740/1600	15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	7	—
	(Yugoslav license)																		
Deutz (?) E. Gem.	6 x 240/360	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
	8 x 240/360	35	—	—	8	—	3	8	13	3	—	—	—	—	—	—	—	—	—
Sulzer (Span. lic)	5 x 480/700	4	—	—	—	—	—	—	8	—	—	—	1	3	—	—	—	—	—
Sulzer (Jap. lic)	9 x 900/1550	18	—	—	—	—	—	—	—	—	—	—	—	5	4	7	2	—	—
	6 x 480/700	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—
	6 x 760/1550	8	—	—	—	—	—	—	—	—	—	—	—	2	2	—	1	1	2
Atlas	6 x 340/570	12	—	3	3	4	2	—	—	—	—	—	—	—	—	—	—	—	—
Fiat (Italy)	9 x 900/1600	6	—	—	—	—	8	—	—	—	—	—	—	—	—	1	8	1	—
Stork (Holland)	8 x 750/1600	2	—	8	—	—	—			—	—	—	1	1	—	—	—	—	—
	6 x 360/480	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Total manufactured outside U.S.S.R.		169	1	6	13	4	8	14	19	9	4	3	6	18	11	19	18	12	4
Total marine diesels in tanker fleet at July 1967		281	2	7	16	14	17	25	33	17	16	15	11	21	16	22	21	22	7

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

Table 21-8G CONSTRUCTION OF SMALL TANKERS (1772 GRT AND LESS), 1951-67

	1951	*1952*	*1953*	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*	*1967*
U.S.S.R. hull and Czechoslavakia engines 1,772 tons	—	—	—	—	—	—	—	—	—	—	—	—	—	3	2	4	—
U.S.S.R. 756-802 tons	—	—	—	—	—	—	6	—	4	5	—	—	1	—	2	2	—
Finland 1,081 tons	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sweden 1,145 tons	1	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Finland hull Sweden engine 1,117 tons	—	3	3	4	3	—	—	—	—	—	—	—	—	—	—	—	—
G.D.R. hull and engines 260-305 tons	—	—	8	—	3	7	12	3	2	—	—	—	—	—	—	—	—
Bulgaria hull G.D.R. engine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	1
Poland hull Spain engine 1,333 tons	—	—	—	—	—	—	—	—	—	—	—	1	3	—	—	—	—
Total	1	5	13	4	6	7	18	3	6	5	1	3	1	3	4	8	1
Foreign-built	1	5	13	4	6	7	12	3	—	5	1	3	0	0	0	2	1
Percentage	100	100	100	100	100	100	66	100	—	100	100	100	0	0	0	25	100

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

Table 21-8H

CONSTRUCTION OF MEDIUM CLASS TANKERS
(3300-3820 GRT), 1954-67

GRT		1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	TOTAL
3737	Soviet-built 8 x 300/500	1	2	3	1	—	—	—	—	—	—	—	—	—	—	7
3821	Soviet-built 8 x 300/500	—	—	—	3	4	1	—	—	—	—	—	—	—	—	8
	Bulgarian hull USSR engine 8 x 300/500	—	—	—	—	—	3	3	2	3	4	4	1	1	1	22
	Soviet hull Danish engine	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
3300	Finnish hull Danish engine	—	—	—	—	3	3	2	3	6	4	4	3	—	—	28
3360	Finnish hull Finnish engine	—	—	—	—	—	—	—	—	—	—	1	1	—	1	3
3259	Finnish hull Swedish engine	—	—	—	—	—	—	—	—	1	—	—	1	—	—	3
3470-90	Japanese hull Japanese engine	—	—	—	—	—	—	—	—	—	—	—	2	—	—	2
3120	Swedish hull Danish engine	—	—	—	—	—	—	—	1	1	—	—	—	—	—	2
	Total	1	2	4	4	7	8	5	6	11	8	9	8	1	2	76
	Foreign-built hulls & engines	—	—	1	—	3	3	2	4	8	4	5	7	—	1	38(50%)

Source: Calculated from Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

Table 21-8I CONSTRUCTION OF LARGE TANKERS (13,000 TONS AND OVER), 1959-67

	1959	*1960*	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*	*1967*	
U.S.S.R. hulls, steam turbines 21,255 GRT	1	2	1	2	1	—	—	—	—	
U.S.S.R. hulls, steam turbines 32484	—	—	—	—	2	5	4	7	—	
Italy (hull & engine) 20,659 GRT	—	1	—	—	—	—	—	—	—	
31,295 GRT	—	—	—	—	1	3	1	—	—	
Holland (hull & engine) 16,349 GRT	—	1	—	—	—	—	—	—	—	
Poland (hull & engine) 13,363	—	—	—	2	2	—	—	1	2	
Yugoslavia 15,255	—	—	—	—	—	—	8	7	—	
Japan (hull & engine) 22-5,000	—	2	—	5	4	7	2	—	—	
Poland hull; GDR engine 13,218	—	—	—	—	—	—	1	—	—	
Yugoslavia hull; Sweden engine 17,861 GRT	—	—	1	—	—	—	—	—	—	
Total	1	6	3	9	10	15	16	15	2	77
Foreign-built	0	4	2	7	7	10	12	8	2	52
Percentage	0	66	66	77	70	66	80	53	100	67.5

Source: Calculated from Registr Soyuza SSR, *Registrovaya Kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

CHAPTER TWENTY-TWO

Western Assistance to the Machine Tool Industry

The Soviet Union is a major volume producer of machine tools. In 1964 the industry's production was about three-quarters, by value, of U.S. production of machine tools, slightly greater than the production of West Germany and equivalent to the combined machine tool output of Great Britain, Japan, and France.[1]

Historically, the increase of machine tool output has been significant. In 1928 the Soviet Union produced only 2000 metal cutting tools, and this output increased to 38,400 in 1945, 156,000 in 1960, and about 200,000 in 1967.[2] However, output does not tell the whole story; this flood of machine tools is by and large of simple construction with numerous quality defects. One observer has described the Soviet machine tool industry as follows:

> . . . the bulk of current models turned out by the Soviet industry approach in make-up, speeds, rate of feed, etc., the U.S. models made during the late 1930s and during World War II. Since then the United States has made considerable advance in machine tool technology.[3]

Problems in machine tool quality are described in several sources. J. A. Gwyer in particular has listed excerpts from Soviet literature on problems of quality and reliability in the industry.[4] Lack of high-quality raw materials, reliability services, accurate instrumentation, trained Soviet technicians, and similar factors have led to major problems in quality control.

Another commentator, P. H. Ponta, a member of the U.S. Machine Tool Delegation to the Soviet Union in 1965, reported that although in general Russian

[1] Data in *American Machinist* (New York), January 18, 1965, p. 133.

[2] *Strana Sovetov za 50 let: Sbornik statisticheskikh materialov* (Moscow, 1967), p. 83.

[3] J. A. Gwyer, "Soviet Machine Tools," *Ordnance*, (Washington, D.C.), November-December 1958, p. 419.

[4] J. A. Gwyer, "Soviet Quality and Reliability Programs at the Crossroads," *R.S.Q.C. Conference Transactions 1968*, March 26, 1968. Also see Appendixes I, II, and III to U.S. Senate, Committee on the Judiciary, *Export of Strategic Materials to the U.S.S.R. and Other Soviet Bloc Countries*, Hearing Before the Subcommittee to Investigate the Administration of the Internal Security Act and Other Internal Security Laws, 87th Congress, 1st session, Part I, October 23, 1961 (Washington, 1961).

:chnical ability was "impressive," he found poor quality of workmanship, ery bad material handling, and an extreme neglect of cleanliness and order. Ie suggested that the answer to the question of how the large output of Soviet achine tools can be absorbed lay in the fact that Soviet tools had a shorter verage life than those made elsewhere, and this information, coupled with /hat is known about the scarcity of spare parts, implies earlier replacement an would be normal in the West. An article in *Stanki i instrument* (Moscow) 1965 also points out considerable problems involved in manufacturing machine ools and suggests ways in which these problems can be overcome.[5]

Soviet imports today are not quantitatively as significant as domestic produc-ion, although they have been in the past.[6] Lend Lease was a major supplier, roviding over $465 million worth of machine tools in addition to about the ame amount of related engines, industrial equipment, electrical equipment, nd machinery not normally included under the category of machine tools.[7] The major machine tool-related categories sent to the U.S.S.R. under Lend ease included:

Machine tools, rolling mills, drawing machines	$404,697,000
Welding machinery, testing and measuring machinery, metal working machinery	15,199,000
Cemented carbide cutting tools, metal cutting tools	45,042,000

In 1965 the U.S.S.R. imported 6503 machine tools. Of these, 2249 came rom Czechoslovakia, where the largest heavy machine tool manufacturer is he former Skoda company (which has a technical-assistance agreement with Simmons Machine Tool, an old, established machine tool manufacturer of New York.[8] However, the relatively small quantity belies the value of these more ecent imports. The average unit value of Soviet imports of machine tools is wice that of exports.[9] By importing prototypes of advanced machines from he West the Soviets can, with little effort, keep abreast of world developments n this field. Thus, although the Soviets may lag by a few years at any one ime, the effect over the long run is to keep Soviet machine tools more or ess on an equivalent basis to current world technology.

[5] *American Machinist*, July 19, 1965.

[6] "It is a fact that some 300,000 of the very finest high-output machine tools were purchased abroad from 1929 to 1940, tools manufactured by the best companies all over the world." G. Anisimov, "The Motive Forces of Technological Progress in the U.S.S.R. at Its Present Stage of Development," *Problems of Economics*, (New York), III, 1 (May 1960), 18.

[7] U.S. Dept. of State, *Report on War Aid Furnished by the United States to the U.S.S.R.* (Washington: Office of Foreign Liquidation, 1945).

[8] See p. 84 below.

[9] *Vneshniaia torgovlia SSSR za 1965 god* (Moscow, 1966).

SOVIET ACQUISITIONS IN GERMANY

The prize machine-building plant removed by the Soviets from Germany was in the British Zone—the Dusseldorf plant of Schiess-Defries. It was the most important German manufacturer of heavy machine tools; the firm was noted for "crankshaft turning equipment, tool and cutter grinders, horizontal borers, gear cutters, gun boring equipment, universal milling machines, plane milling machines, heavy lathes, slotting machines, forging machines, equipment for railway shops, and special machine tools of the largest size."[10]

Two important tool manufacturers in the U.S. Zone were also removed to the U.S.S.R.—Hahn & Tessky and the Esslingen firm of Bohner & Koehle, manufacturers of aircraft presses.[11]

Toward the end of World War II, the greater part of German industry was moved eastward to avoid its being bombed. Accordingly, when the war ended there was a concentration of machine tool and equipment manufacturers in the provinces of Saxony, Thuringia, Mecklenburg, and Brandenburg, all later to be occupied by the Soviet forces. The greater number of the 636 machine tool companies in the area had equipment removed to the Soviet Union.[12] Unlike other industrial sectors, removals seem to have been complete: probably over three-quarters of the companies were 100 percent stripped of their equipment and the remainder were 80 or 90 percent stripped.

Fortunately (for the purposes of this study), a number of the larger machine tool manufacturing units, particularly those in Leipzig, were visited by CIOS (Combined Intelligence Objectives Subcommittee) teams just before the Soviet occupation; consequently, we have an accurate record of their condition and equipment capability at the time of the Soviet occupation.

One of the largest machine tool plants on the continent, Pittler Werkzeugmaschinenfabrik A.G. in Leipzig, was completely removed to the Soviet Union. This plant was earlier visited by both CIOS and U.S. Strategic Bombing Survey teams. The manufacturing program as of May 1945 consisted primarily in the production of turret lathes and automatic lathes, and the CIOS team reported

[10] U.S. Foreign Economic Administration, *U.S. Technical Industrial Disarmament Committee on the German Machine Tool Industry* (T.I.D.C. Project no. 11; Washington, 1945), p. 43. One observer suggested an interesting reason for the removal of this important plant from the British Zone to the Soviet Union: "This company *was* Germany's greatest producer of large type machine tools such as planers, lathes, and boring mills. They were [i.e., the company's plant was] completely dismantled, including machine tools and buildings, by the Russians. I learned from an authoritative source that this action was induced and approved by the British representative then in charge, who was the principal competitor of the Scheiss Company." F. H. Higgins Collection, Item 1, Memorandum to Director, Industry Division, p. 5 (Hoover Institution Special Collections, Stanford University).

[11] Germany, Office of Military Government (U.S.Zone), Economics Division, *A Year of Potsdam: The German Economy Since the Surrender* (n.p.: OMGUS, 1946).

[12] G. E. Harmssen, *Am Abend der Demontage; Sechs Jahre Reparationspolitik* (Bremen: F. Trüjen, 1951), pp. 95-102.

that the Pittler plant was "very modern" and "only slightly damaged by bombing"; the treating department was reported to be excellent and the stockrooms well filled with finished parts. The manufacturing methods appeared to be efficient, and the smaller turret lathes built in large quantities were assembled on a conveyer system.[13] Unfortunately the survey teams gave no estimate as to productive capacity, but they did indicate that, with materials on hand, 800 machines could be completed within a six-month period, which suggests a minimum capacity of 1600 machines per year.

Another company visited by a CIOS team was Kirschner A.G.–later completely removed to the Soviet Union. Kirschner was "one of the largest manufacturers of woodworking machinery on the continent."[14] The company produced a comprehensive range of woodworking equipment, including horizontal log-band mills and high-speed vertical saw frames for saw mills, as well as equipment for wood pattern shops such as band saws and a special coal-cutting machine.

Another machine tool plant removed completely to the Soviet Union was that of Werkzeugmaschinenfabrik Arno Krebs of Leipzig. This company manufactured plane and universal knee and milling machines in the following ranges: working surface of table from 8-1/2 by 26 inches up to 12 by 47-1/4 inches, longitudinal travel from 13 to 36 inches, cross travel from 4-3/4 to 13-1/2 inches, vertical travel from 11-1/2 to 19-1/2 inches. In addition, two types of hand-lever milling machines were manufactured.

The Köllmann-Werkzeugfabrik GmbH of Leipzig was 75 percent removed to the Soviet Union. This was not strictly a machine tool plant, but specialized in the manufacture of all types and sizes of gears up to 36 inches in diameter. It was a modern plant in excellent condition, with a machine shop containing 25 Gleason bevel gear generators, 27 gear grinders, and batteries of gear shapers, hobbing machines, and milling and grinding machines, together with a large number of other machines for manufacturing gears. There was also an excellent heat-treatment department with electric furnaces. The CIOS team commented: "The excellence of this particular plant has to be seen to be appreciated."[15]

The Köllmann-Werke A.G., Zahnräder- und Getriebebau of Leipzig was 75 percent removed to the Soviet Union. This company was a manufacturer of gears, with a modern plant built in 1935. In commenting on it the CIOS team reported: "The plant is in excellent condition, has a large number of Maag gear grinders, as well as other first-class equipment to manufacture precision-type aircraft gears."[16]

[13] See CIOS Report no. XXVIII-10; Andress. *et al.*, *Machine Tool Targets*, Leipzig, pp.5-6, for lists of standard turret lathes, high-speed turret lathes, single-spindle automatic screw machines, and single-spindle and multispindle automatic machines manufactured by Pittler in 1945.

[14] *Ibid.*

[15] *Ibid.*

[16] *Ibid.*, p. 13.

Other companies moved included August Meiselbach, which was 95 percent removed to the Soviet Union; Meiselbach was a manufacturer of stocks and dies for use in public utilities.

Kleim und Ungerer of Leipzig, which manufactured sheet feeders for the printing trade, had 83 percent of its equipment removed to the Soviet Union. The plant contained a single-spindle automatic feeder, a drilling machine, and a stock of small turned parts. During the war it produced test machines for Junkers aeromotors and various parts in subassemblies for elevating antiaircraft guns.

A woodworking machine tool company completely removed to the U.S.S.R. was Deutsche Holzbearbeitungsmaschinenfabrik Jacob & Eichorn, a small firm manufacturing woodworking machines such as circular saws, band saws, planing machines, and jointing machines.

Conrad Modrach of Gera, a manufacturer of commercial shears, croppers, presses, and bending machines, was completely removed to the U.S.S.R., as was G. Weissken, also of Gera, a manufacturer of tool and cutter grinders and small lathes.

An overall indicator of the magnitude of plant removals in the machine tool industry is contained in Table 22-1, which lists eight plants removed to the U.S.S.R. (and approximate extent of removals) together with their ranking by the Foreign Economic Administration in 1944. Only those classified as of outstanding importance are included.

Table 22-1 GERMAN MACHINE TOOL MANUFACTURERS OF "OUTSTANDING IMPORTANCE"* REMOVED TO THE SOVIET UNION IN 1945-46

Percentage removed	*Name of manufacturer*	*Location*	*Main product*
100	Hille-Werke A.G.	Dresden (Soviet Zone)	Relieving lathes, multispindle drilling machines, thread millers, jog borers, diamond and fine borers, honing machines, drilling machines, radial drills.
50	Magdeburger Werkzeugmaschinenfabrik A.G.	Magdeburg (Soviet Zone)	Auto multicut lathes, turret lathes, gun-boring equipment, machinery for aircraft and propeller construction (Junkers plant)
100	Werkzeugmaschinenfabrik Hermann Pfauter	Chemnitz (Soviet Zone)	Tool and cutter grinders, gear cutters, gear hobbers, thread hobbers, long-cut milling machines, thread milling machines
Not known	Billeter & Kluntz	Aschersleben (Soviet Zone)	Surface grinders, ball and face grinders, planers, openside planers

Table 22-1 (cont.)

Percentage removed	*Name of manufacturer*	*Location*	*Main product*
Not known	Franz Braun A.G.	Zerbst (Anhalt) (Soviet Zone)	Lathes, frontal lathes, planing machines, drill presses, thermoplastic molding presses
100	Pittler Werkzeug-maschinenfabrik A.G.	Leipzig (Soviet Zone)	Single-spindle bar autos, multispindle bar autos, multispindle auto machines, turret lathes, die heads, hydraulic pumps, automatic screw machines
100	E. Reinecker A.G.	Chemnitz (Soviet Zone)	Relieving lathes, crankshaft, grinding machines, universal grinders, internal grinders, spline grinders, gear grinders, thread grinders, tool and cutter grinders, surface grinders, ball and face grinders, gear cutters, thread millers, tooth rounding machines, jog borers, plant milling machines, tap and twist drill making, small tools, measuring instrument horizontal milling machines
100	Schiess-Defries	Düsseldorf (British Zone)	See text

Source: U. S. Foreign Economic Administration, *U. S. Technical Industrial Disarmament Committee on the German Machine Tool Industry,* Study of Interagency Committee on the Treatment of the German Machine Tool Industry from the Standpoint of International Security (Washington, 1945), TIDC Project no. 11.

* These are firms identified by the FEA as "of outstanding importance either by volume of output or by monopoly of production of a significant item."

IMPORTS AND EXPORTS OF MACHINE TOOLS FROM 1946 TO 1966

An examination of imports and exports of metal-cutting tools (specifically forges, presses, and the subgroup of mechanical and hydraulic presses) is suggestive of limited Soviet machine tool capabilities.

Firstly, imports of the major category of metal-cutting tools (Soviet foreign trade classification Group 100) have significantly increased in absolute terms since 1946. The year 1946 reflects heavy "pipeline" Lend Lease imports and is therefore abnormal; imports valued at less than 20 million rubles a year in the late 1940s, when the Soviets were absorbing Lend Lease and German reparations machine tools, are replaced by annual imports of 70–80 million rubles in the early 1960s. In specialized fields such as forges and presses we find proportionately greater import.

On the other hand, exports over the long run show a fairly consistent trend and average less than half of Soviet imports. In forges and presses we find that exports are minute (between one-sixth and one-eighth of imports), with none at all in the category of hydraulic presses. These figures reflect the overall composition of Soviet machine tool exports (simple lathes and shapers to underdeveloped countries—Cuba, India, China, Mongolia, and the newer African nations) and imports (sophisticated equipment for prototype use and specialized production machinery from advanced countries—U.K., West Germany, Japan, and U.S.A.). (See Table 22-2.) The exception to this rule is trade with East Germany and Czechoslovakia, which comprises large imports and exports.

Table 22-2 SOVIET IMPORTS AND EXPORTS OF MACHINE TOOLS FROM 1946 TO 1966 (in million rubles)

Year	*Metal cutting tools Stanki metallorezhushchie (Group 100)*		*Forge and press equipment Kuznechno-pressovoe oborudovanie (Groups 101-103)*		*Mechanical and hydraulic presses (Subgroups 10103-10123)*	
	Imports	*Exports*	*Imports*	*Exports*	*Imports*	*Exports*
1946	40.3	0.4	4.9	0	2.3	—
1947	16.3	1.3	3.9	—	1.8	—
1948	5.8	3.1	2.4	0.3	1.5	—
1949	5.5	10.1	1.6	0.6	0.5	—
1950	13.7	19.2	2.0	0.8	0.8	—
1951	12.8	17.5	4.6	2.0	2.8	—
1952	13.5	22.7	4.3	2.9	2.7	—
1953	27.3	27.9	13.6	3.9	5.4	—
1954	25.4	13.8	14.8	2.3	7.4	—
1955	21.9	6.5	21.0	1.5	13.7	—
1956	25.8	7.8	24.3	1.1	17.0	—
1957	28.9	7.0	25.9	1.6	16.7	—
1958	38.9	13.9	31.4	2.3	21.3	—
1959	41.5	16.7	32.4	2.6	21.5	—
1960	56.7	12.9	34.4	4.7	19.2	—
1961	62.5	17.2	37.5	5.0	22.1	—
1962	73.1	25.1	42.1	5.7	24.3	—
1963	78.5	25.7	43.0	5.3	24.1	—
1964	86.7	27.6	49.0	3.3	20.6	—
1965	83.1	39.5	36.2	4.7	18.3	—
1966	76.2	57.2	32.2	7.4	13.7	—

Source: Vneshniaia torgovlia SSSR: Statisticheskii sbornik, 1918-1966 (Moscow, 1967), pp. 76-79 (exports), 98-101 (imports).

DUPLICATION OF WESTERN MACHINE TOOLS

Prewar practice continued after the war—much of Soviet machine tool design was derived from Western origins. In 1953 it was reported by an Austrian engineer who had returned from the U.S.S.R. after working in the Sverdlovsk machine tool plant (where he had access to the plant records) that in 1953 the Soviet Union was still operating "a good deal" with Lend Lease tools.[17] It was noted that the latest model U.S. and European machine tools were acquired despite export control laws, and these were sent to "copying offices" and there stripped, analyzed, and tested, and "exact duplicates [were] made."[18] About 30 to 35 such copying offices existed in 1953 at various machine tool plants, each specializing in a particular type of foreign machine tool. For example, all foreign lathe models went to Plant No. 115 at Novosibirsk, all foreign shaper models went to Plant No. 64 at Gorki, and all foreign hydraulic press models went to Plant No. 101 at Kurgan. In February 1953, Plant 101 was working on a 150-ton hydraulic press originally made by Merklinger in Germany.[19]

Thus in 1957 it was reported that the Leningrad large jig borer had been copied from the Hydroptic SIP (optical coordinate jig borer) and an American trade journal commented: "The machine ... so closely resembles its West European counterpart that even the Sverdlov plant manager calls it the Leningrad SIP."[20] The Sverdlov Plant im. Lenini also specialized in Keller-type copying machines.[21]

Consideration of the foreign origin factor in machine tool production brings the Soviet achievement of gigantic runs of machine tools into focus. This point can be illustrated by a consecutive reading of statements by three independent observers concerning one Soviet machine tool plant—Ordzhonikidze in Moscow. Each statement is by itself an accurate but incomplete description of the plant; taken together, however, the statements point to a significant deduction.

The first description of the plant is by a highly qualified U.S. observer utilizing Soviet literature:

> Machine-Tool Manufacturing Plant im. S. Ordzhonikidze (Stankostroitel'nyy zavod im. Ordzhonikidze)—hence referred to as the Moscow Plant im. S. Ordzhonikidze. The plant, one of the largest in the U.S.S.R., specialized in the production of: automatic transfer lines, unit machine tools, radial drills, boring machines, assortment of automatic and semiautomatic lathes. The equipment installed in this plant is not modern by any means. As of 1 January 1956, 23.7 percent of metal-cutting machine tools was less than ten years old, 71.3 percent ten to twenty years old, and 8.1 percent more than twenty years old. Only 1.5 percent of all installed metal-cutting machine tools were represented by automatic and semiautomatic machines. Presses constituted 1.1 percent of all machine tools. During the 1951-55 period, the plant built 18 automatic transfer machines, in 1957 seven machines, and planned for 1958 an output of 16 machines.[22]

[17] *Iron Age* (Middletown, N.Y.), December 17, 1953.
[18] *Ibid.*
[19] *Ibid.*
[20] *American Machinist*, February 25, 1957, p. 179.
[21] *Ibid.*, p. 181.
[22] J. Gwyer, private communication to author.

The second description is recorded by an American visitor to the plant:

> Ordzhonikidze specializes in making boring equipment. Most of the manufacturing equipment in the plant was foreign-made and has not been modernized, although in some areas the operations looked quite good. Here we saw many American machine tools such as Gardner grinders, different types of Cincinnati machines, King vertical lathes, Gray planers, and many other familiar types. Some were of fairly new vintage. Although many machines in this plant appeared to be old they were still in very good condition, all were running.[23]

The third report, also by an on-the-spot observer, confirms the predominance of foreign equipment:

> In the plant itself, most of the items are imported—some are prewar and others wartime acquisitions. Very few of the machines we saw in this plant seemed to be postwar. Among those noted were two Butler planers and a whole battery of medium-sized Billeter & Klonz machines. There was a Kendall & Gent miller; a small Cincinnati (British-built); a Beliot-Gray planer-miller (this one one of the few postwar machines); a fairly elderly large Giddings & Lewis floorplate horizontal boring machine; Milwaukee millers; a Girards radial and a Wotan grinder.[24]

There is some reference to Russian-built machines: "In the turret lathe section we noticed quite a few copies of Warner & Swazey machines, but we did not see any Russian-built copying lathes."[25]

The first statement establishes the age of the equipment; the second and third statements identify its Western origins and make it clear that in this plant at least, production, including production of automatic transfer machines, is based on equipment imported from the West. *In other words, the machines that build the machines originated in the West.*

By their own admission, the Soviets imported 300,000 top-flight foreign machine tools between 1930 and 1940.[26] Add to this the large quantities received under the Nazi-Soviet pact, Lend Lease, German reparations removals from the occupied countries, and continuing imports since World War II, and it becomes apparent that the military and industrial machine-building industries of the Soviet Union could well be relying heavily on imported equipment. This supposition is supported by the nature of many of the machine tools imported—larger specialized automatic mass-production units.

[23] Nevin L. Bean, "Address Before the Detroit Chapter of the National Society of Professional Engineers," Detroit, February 22, 1956 (Dearborn: Ford Motor Co., News Dept.) pp. 8-9.

[24] *American Machinist*, November 19, 1956.

[25] *Ibid*. The Russian-built machines included also a horizontal boring machine and large- and medium-size planers.

[26] See p. 304 n. 6 above.

The substitution of numerically controlled machine tools for hand-controlled machine tools was indisputably the most important metal-machining innovation in the period 1945 to 1960. In the United States numerically controlled tools became commercially available in the early 1950s, and by the end of the decade there were probably several thousand in commercial use. Apart from substantially improving quality of product and operating control, numerically controlled tools allow substantial savings in both capital and labor.

Their introduction into the Soviet Union has been very slow, however: only two prototypes had been produced there by 1960, and at that time it was projected that only several hundred would be in use by 1965.[27] It is then more than possible that the numerically controlled units displayed at various exhibitions abroad are "one-off" items built for the purpose. For example, J. O. Ellison examined one exhibit model, a Model 1062 shaft-turning lathe that was automated and tracer-controlled, and published his conclusion in the trade journal *American Machinist.*[28] He described this model as a hybrid variation of a family of lathes based on the 1K62. It was the hybrid nature of the model that led Ellison to the conclusion that it was a compromise and therefore not "very salable in the United States"; Ellison added that "the most lasting impression I have of the demonstration aside from the technical points is that the Russians were very good showmen."[29]

BALL BEARING MANUFACTURE CAPABILITY

Ball bearings, of course, constitute a vital part of almost all machines and of numerous other products, including military weapons systems.

It was previously indicated that ball bearing plants in the U.S.S.R. had been equipped from the United States. One U.S. firm, the Bryant Chucking Grinder Company of Springfield, Virginia, was a prominent supplier in the 1930s and 1940s, while Italian and Swedish firms also have contributed a large proportion of the Soviet ball bearing production capacity.[30] Soviet dependence on the West for ball bearing technology came to a peak in the years 1959-61. The Soviets required a capability for mass production, rather than laboratory or batch production, of miniature ball bearings—80 percent of whose end uses are in weapons systems. The only company in the world that could supply the required machine—the Centalign B—on a commercial basis was the Bryant Chucking Grinder Company. The Soviet Union had no mass-production capabil-

[27] U.S. Congress, Joint Economic Committee, *Dimensions of Soviet Economic Power,* Hearings, 87th Congress, 2d session, December 10 and 11, 1962, p. 137.
[28] November 20, 1959, pp. 98-100: "Russia Exhibits Automated Lathe."
[29] *Ibid.*, p. 98.
[30] See Sutton, I: *Western Technology ... 1917 to 1945.*

ity whatever, and its miniature ball bearings were either imported or made in small lots on Italian and other imported equipment.

In 1960 there were 66 Centalign machines in the United States. Twenty-five of these machines were operated by the Miniature Precision Bearing Company, Inc., the largest manufacturer of precision ball bearings; 85 percent of Miniature Precision's output went to military applications. In 1960 the U.S.S.R. entered an order with Bryant Chucking for 45 similar machines. Bryant did not immediately accept the order but consulted the Department of Commerce; the department indicated willingness to grant a license and Bryant therefore accepted the order. The Commerce Department's argument for granting a license turned on the following points: (a) the process achieved by the Centalign is only a single process among several required for ball bearing production; (b) the machine can be bought elsewhere; and (c) the Russians can make ball bearings.[31] The Department of Defense, however, entered a strong objection to the export of the machines on the following grounds:

> In the specific case of the granting of the export license for high-frequency grinders manufactured by Bryant Chucking Grinder, after receiving the request for DOD's opinion from the Department of Commerce, it was determined that all of the machines of this type currently available in the United States were being utilized for the production of bearings utilized in strategic components for military end items. It was also determined from information that was available to us that the Soviets did not produce a machine of this type or one that would be comparable in enabling the production of miniature ball bearings of the tolerances and precision required. A further consideration was whether machines of comparable capacity and size can be made available from Western Europe. In this connection, our investigation revealed that none was in production that would meet the specifications that had been established by the Russians for these machines. In the light of these considerations it was our opinion that the license should not be granted.[32]

The Inter-Departmental Advisory Committee on Export Control, which includes members from the Commerce and State departments as well as the CIA, overruled the Department of Defense opinion and "a decision was made to approve the granting of the license."[33] The Department of Defense made further protest and demanded proof as to the capability of either the U.S.S.R. or Western Europe to produce such machines. No such proof was forthcoming.

The following summarizes the various objections of the Department of Defense, as then outlined by the official concerned:

[31] This section is based on U.S. Senate, Committee on the Judiciary, *Export of Ball Bearing Machines to Russia*, Hearings, 87th Congress, 1st session (Washington, 1961). There are three parts to these Hearings; they provide a fascinating story of one Soviet attempt to acquire strategic equipment. See also the Soviet "machine tools Case of 1945"; a microfilm of documents on this case has been deposited at the Hoover Institution.

[32] U.S. Senate, *op. cit.* n. 31, pp. 267-68.

[33] *Ibid.*

In resumé, the following actions were known to me regarding the transaction of this export license:

(a) I expressed dissatisfaction and suggested that the Department of Defense not concur in the initial request of the Department of Commerce.

(b) The official member of the Department of Defense in this connection concurred and, at a series of meetings of the Advisory Committee on Export Control, spoke against the proposal that an export license be granted.

(c) The Deputy Assistant Secretary of Defense, Supply and Logistics, after reviewing some of the circumstances, requested that I do whatever was possible to stop the shipment of these machines.

(d) A letter was transmitted from the Office of the Secretary of Defense to the Secretary of Commerce, approximately November 1, 1960, saying it [*sic*] spoke to the Department of Defense and requesting a further review.

(e) At two meetings where the matter was reviewed, the Department of Defense maintained nonconcurrence in the shipment of the equipment.

As of this writing I am still convinced that it would be a tragic mistake to ship this equipment.[34]

The reference to a "tragic mistake" refers of course to the known fact that miniature ball bearings are an essential prerequisite for missile production. Granting the license would give the U.S.S.R. a miniature ball bearing production capability equal to two-thirds that of the United States.

The relevance of the case for our study is twofold. First, it illustrates clearly a manner by which the Soviets have acquired a substantial productive capability, even for difficult technologies, very quickly. Second, as the case was uncovered only by accident (an official of the Miniature Precision Ball Bearing Company brought the matter to the attention of Congress), it implies that much "technical leakage" in the sensitive areas of atomic energy and weapons systems may well have gone undetected.

COMPUTING, MEASURING, AND PRECISION INSTRUMENTS

The Soviet Union has always had considerable technical difficulties producing computing, measuring, and precision instruments. Initial production of elementary adding machines in the early thirties was poor in quality and suffered from numerous deficiencies; in particular, early models had parts of nontempered steel and gear teeth were wearing out after just two weeks of operation.[35] The most common Soviet calculating machines today are direct copies of Western models; for example, the "Felix," the subject of the above complaints and the first machine produced in the U.S.S.R., was still in production in 1969

[34] *Ibid.*

[35] *Za industrializatsiiu* (Moscow), August 7, 1930.

and is by far the most common Soviet machine. It is a copy of the Brunsviga 1892 model, apparently without even the modifications introduced into Western models in 1927.[36] The full keyboard calculator of the 1930s—the KSM—is a copy of the Monroe. Punched-card machinery is Hollerith, although at one time a technical-assistance agreement was made with Powers. Campbell suggests, with justification, that the postwar Riazan machine works is the German Astrawerke which was transferred to the U.S.S.R. Other German plants, including the Archimedes and the cash register plant at Glasshütte, were also moved to the U.S.S.R.[37]

In the 1960s, a continuing widespread use of the abacus in the Soviet Union made the Soviets worry about their image abroad—it hardly seemed consistent with the age of cosmonauts and atomic icebreakers. It was this concern that led to an agreement in 1966 with Olivetti of Italy to establish two office equipment plants in the U.S.S.R. under a $60 million contract, one for the production of typewriters and one for the production of calculators and other office machinery.[38]

Several of the most important precision instrument manufacturers in Germany were moved to Russia at the end of World War II. The Zeiss works at Jena, manufacturers of optical and scientific instruments including micrometers, optical comparators, angle measuring equipment, and gear testers, was moved completely to Minino, near Moscow. There with three top German experts, Dr. Eitzenberger, Dr. Buschbeck, and Dr. Faulstich, the new plant developed detector and remote-control equipment, including radio-controlled recording gear and rocket guidance equipment.[39] The Askaniawerke A.G. at Berlin-Friedeman, a very important manufacturer of scientific equipment including optical measuring components such as lenses and prisms, was also moved to Russia. The Siemens & Halske plant at Siemens Stadt in Berlin (with its electron microscopes) was removed, and its top staff members were given work in Russia. The three A.E.G. electron microscopes at the K.W. Institut in Berlin also were removed to Russia.[40]

In the 1960s technical acquisition in the precision instruments field continued

[36] See, for example, S. R. Ivanchenko, *Schetnye mashiny i ikh ekspluatatsiia* (Moscow, 1968), pp. 42, 68, for data concerning the Felix as produced in the 1960s. Compare to *Encyclopedia Britannica* (1958 edition), vol. IV, p. 552 and the Western Brunsviga. For further details see R. W. Campbell, "Mechanization of Cost Accounting in the Soviet Union," *American Slavic and East European Review* (Menasha, Wis.), February 1958. Campbell ascribes the early Soviet arithmometers to the 1874 Russian Odner machine produced in St. Petersburg during World War I; however the design of the Odner is different from the Felix, although based on the same principles.

[37] *Wall Street Journal*, December 16, 1966, 7:3. For data on the Soviet-Olivettis see K. A. Borob'ev, *Konstruktsiia, tekhnicheskoe obsluzhivanie i remont bukhgalterskoi mashiny "Askota" klassa 170* (Moscow, 1969).

[38] Werner Keller, *Ost minus West=Null* (Munich: Droemersche Verlagsanstalt, 1960), pp. 283, 357, 365.

[39] BIOS Final Report no. 485; R. G. Allen, *German Filtration Industry*, pp. 18-18a, 22.

[40] *New York Times*, September 13, 1964.

with foreign purchases. It was reported in 1964 that "recent Soviet purchases cover a vast range from office equipment to camera shutters."[41] The firm of Rank-Xerox sold $3.7 million worth of its equipment, and the Japanese company Copal Koki signed a contract to supply producing facilities and know-how for a "sophisticated electric eye camera shutter."[42] Thus there has been a steady flow of instruments and precision equipment into the Soviet Union through the means of trade. The exception to Soviet inability in the field appears to be the various Soviet medical stapling instruments licensed by the United States Surgical Company and patented in the United States.[43]

In the period 1929 to 1940 the Soviets purchased 300,000 foreign machine tools, while its own output was concentrated in simple drilling machines and bench lathes of a standard type based on Western prototypes. These were supplemented by almost $400 million worth of Lend Lease machine tools.

Twelve very large machine tool plants were removed from Germany at the end of World War II—including the important Schiess-Defries and Billeter & Kluntz (Aschersleben) plants. These acquisitions have been supplemented by continuing and substantial imports from the West, greater in both quantity and unit value than Soviet exports of machine tools to underdeveloped areas.

"Copying offices," each specializing in a particular type of machine tool, have widely duplicated Western imports. Apart from "one-off" items for exhibition and to impress foreign visitors, Soviet machine tools are duplicates of foreign models, with occasional slight variations to adapt them to special Soviet conditions. In numerically controlled machine tools—certainly the most important innovation in the period under discussion—only a few prototypes were produced in the U.S.S.R. by the early 1960s, compared to several thousand in use in the United States.

The "U.S. ball bearing case of 1961," which brought to light a Soviet attempt to import the equivalent of two-thirds the U.S. capacity for producing miniature ball bearings (mainly used in missiles), suggests not only that there is a major lag on the part of the Soviet machine tool industry but that the Soviets are in a position to acquire even the latest and most significant of Western innovations in this field.

In the allied fields of computing, measuring, and precision instruments a like phenomenon was observed: a general backwardness and dependence on

[41] *Ibid.*
[42] *Ibid.*
[43] For example, U.S. Patent 3,078,465 of February 26, 1963. Sales from this license appear to have been insignificant; in the six-month period ending September 30, 1963, the United States Surgical Company paid only $495.00 in license fees. Direct sales to the Instrument Specialties Company were a little better, but not much—five sales totaling $2,892.62 in six months. See Supplemental Registration Statement (Pursuant to Section 2 of the Foreign Agents Registration Act of 1938) as filed in Department of Justice, Washington, D.C.

the West for modern technology acquired by purchases from such firms as General Electric–Olivetti (Italy), Rank–Xerox (U.K.), and Japanese firms.

Thus it is concluded that Soviet innovation in the field of machine tools and allied industries is almost non-existent (only hybrid machine tools have been isolated as Soviet innovations). Technological advance is gained by importing prototypes for copying, or where problems have been encountered in domestic copying, batches of specialized production machines are imported (as evidenced, for example, in the attempted acquisition of Centalign-B and tape-controlled machines).

CHAPTER TWENTY-THREE

Western Origins of Electronics and Electrical Engineering Technology

SOVIET COMPUTER TECHNOLOGY IN THE 1960s

The first generation of computers, developed from U.S. work in World War II, was based on the vacuum tube, and by present-day standards is slow (with only 2500 operations per second), of very limited capacity, and relatively bulky with about 2000 components per cubic foot. The second-generation computer, based on the transistor rather than the bulky vacuum tube, entered the U.S. market during the 1950s. With this development, speed was increased by a factor of ten, to 25,000 operations per second, and the transistor developed by Bell Telephone in 1948 brought component density up to 5000 components per cubic foot. By 1960 about 5000 second-generation computers were in use in the United States and had completely replaced the first-generation computer. Indeed even some early second-generation units had been removed from service by 1959.

The third generation of computers, based on microcircuits, was introduced commercially in 1961 and again increased both speed and capacity by a factor of ten. The third-generation IBM 360 system has 30,000 components per cubic foot, can handle 375,000 operations per second, and reduces the cost per 100,000 computations from $1.38 in first-generation machines to about 3.5 cents.[1]

Such, then, is the nature of the computer revolution in the Western world. The computer in Soviet technology, on the other hand, was still a relatively insignificant factor in the late sixties, behind not only the United States but Western Europe and Japan. Even first-rate scientific institutions have lacked advanced machines. For example, the main atomic energy research institute in the U.S.S.R., directed by famed physicist Igor Kurchatov, used the first-generation computer at the Academy of Science for calculations on uranium

[1] *Fortune*, September 1966, p. 120. An excellent study of the Western origins of Soviet computers appeared after this manuscript was completed: Richard W. Judy, "The Case of Computer Technology" in Stanislaw Wasowski, ed., *East-West Trade and the Technology Gap* (New York: Praeger, 1970). Judy's study is longer and more detailed than the section included here. There is a substantial unity between his conclusions and those of the author; for example, Judy states, "Computer technology in the Soviet Union is virtually entirely imported from the West"; and "literally all significant technological innovations [in the field] have occurred in the West."

burnup—at a time when the comparable Argonne Laboratories in the United States had two second-generation computers.[2]

There are several reasons why the Soviets were late in starting computer production and why their computer technology has lagged behind that of the West. These factors have been discussed in some detail by Richard W. Judy.[3] By 1957 the party journal *Kommunist* pointed out that "a number of firms are engaged in the production of electronic digital computers in the U.S.A., England, the Federal Republic of Germany, and France," and went on to suggest that a socialist economy could utilize electronic computers with even greater effect than capitalist economies. It was suggested that current deficiencies in planning, caused by the large number of manual calculations required, could be overcome by the use of electronic computers capable of operating with an enormous input and handling this input at a high rate of speed. In particular, *Kommunist* urged, the use of computers should be extended from the scientific field into the planning and management of industry.[4]

But if the Soviet dispute over the use of cybernetics in general was resolved, Soviet progress in the field of computer technology remained notably weak. At the end of the 1950s the United States had about 5000 computers in use while the Soviet Union had an estimated 120—about the same number as West Germany. Judging from the general characteristics of these Soviet computers as reported by well-qualified observers, the technology was well behind that of the West and barely out of the first-generation stage even as late as the 1960s.

The only Soviet computer in line production in 1960 was the URAL-I. It was followed by the URAL-II and URAL-4 modifications of the original model. With a prototype appearing in 1953 and series production beginning in 1955, the URAL-I had an average speed of 100 operations per second, compared to 2500 operations per second on U.S. World War II machines and 15,000 for large U.S. machines in the middle to late 1950s. Occupying 40 square meters of floor space, URAL-I contained 800 tubes and 3000 germanium diodes[5]; the storage units included a magnetic drum of 1024 cells and a magnetic tape of up to 40,000 cells, considerably less than U.S. machines. URAL-II and URAL-4 incorporated slightly improved characteristics.[6]

In the late fifties the Soviets also had about 30 to 40 BESM-type computers that were used primarily for research and development, including work on rockets and missiles.[7] The original version of the BESM had 7000 tubes; the later

[2] G. A. Modelski, *Atomic Energy in the Communist Bloc* (Melbourne, 1959), p. 97. In 1964 the Soviet Academy of Sciences received an Elliott Automation (General Electric subsidiary) Model 503 computer.

[3] See Judy, *op. cit.* n. 1, pp. 66-71.

[4] *Kommunist* (Yerevan), no. 7, 1957, pp. 124-27.

[5] Willis H. Ware and Wade B. Holland, *Soviet Cybernetics Technology. I: Soviet Cybernetics, 1959-1962*. (Santa Monica: RAND Corp., June 1963), Report no. RM-3675-PR, p. 91.

[6] *Ibid.*, p. 92.

[7] *Electronics* (New York), December 10, 1957.

version had 3000 tubes and germanium diodes. This computer had some features common to U.S. computers.[8]

Table 23-1 COMPARATIVE DATA ON SOVIET AND WESTERN COMPUTERS UP TO 1968

Name	*Operational date*	*Average speed operations per second*	*Storage capacity*
STRELA	1953	2000	None
BESM I	1953	7000-8000	1023 words
SETUN	1959	4000	81 words
URAL-I	1953	100	None
URAL-II	1960	5000	8192 words
BESM-6	1967	1 million	—
General Electric -Elliott, 503	Installed by G.E. in Moscow Academy of Sciences in 1964	—	2 million characters
English Electric System 4 (RCA technology)	Installed in U.S.S.R. in 1967	23.8 μsec	7.25 million characters
International Computers, Ltd. (U.K.) Model 1905E	Installed in U.S.S.R. in 1968	1.8 μsec	8 million characters

Sources: Soviet machines: Willis H. Ware and Wade B. Holland, *Soviet Cybernetics Technology: Soviet Cybernetics, 1959-1962* (Santa Monica: RAND Corp., June 1963), RM-3675-PR; Western machines: *Office Automation* (New York, 1962).

One observer has rated the BESM as follows: "One of the most impressive achievements of Soviet technology.... It cannot, however, properly be considered as a machine competitive with the IBM-701 or the IBM-704."[9]

The URAL series was manufactured at the Penza computing machine plant,[10] which in 1959 was in series production of URAL-I and preparing to change over to URAL-II. Production methods then were reported to be the same as those in the United States.[11] On the other hand, Soviet computers were far less efficient; the STRELA, for instance, was reported to have only a ten-minute mean free time between errors, while U.S. machines in the fifties normally operated eight hours without error.[12]

A Soviet business data electronic tabulator, the TAT-102, designed primarily for mechanical accounting, statistical calculations, and planning, was developed in the late 1950s and is quite similar to the IBM 604 electronic data-processing

[8] Ware and Holland, *op. cit.* n. 5, pp. 85-91.

[9] Nevin L. Bean, "Address before the Detroit Chapter of the National Society of Professional Engineers," Detroit, February 22, 1956 (Dearborn: Ford Motor Co., News Dept.), p. 11.

[10] Ware and Holland, *op. cit.* n. 5, p. 83.

[11] *Ibid.*, p. 84.

[12] *Control Engineering* (New York), V, 11 (November 1958), 77.

machine. A machinability computer, the VPRR, designed to determine operating conditions for metal cutting tools, also was developed; it closely resembles the Carboloy machine developed by General Electric Company in 1955.[13]

Software has been copied from U.S. equipment. For example Willis H. Ware comments:

> We were shown about 40 card punches. About half of these were 90-column machines and the other half 80-column machines; all were generally similar to United States designs.... We also saw a 500-card per minute sorter which closely resembled a corresponding American product. It has electromechanical sensing of the holes and a set of switches for suppressing specific row selections as in American sorters.[14]

Backwardness in computer technology[15] has led (as in other fields) to imports from the Western world. Imports of computers from the United States were, until very recently, heavily restricted by export control; in 1965 only $5,000 worth of electronic computers and parts were shipped from the United States to the Soviet Union, and only $2,000 worth in 1966. In 1967 such exports totaled $1,079,000, and this higher rate of export of electronic computers has been maintained since that time.[16]

Business relations between International Business Machines Corporation (IBM) and the Soviet Union go back into the 1930s. In August 1936 IBM was advised that in the future all its business would be handled directly with Uchetimport (Bureau for the Import of Calculating Machines and Typewriters) rather than through Amtorg, the Soviet representative agency in the United States. According to E. F. Schwerdt, the Moscow representative of IBM,[17] this rather unusual business arrangement was due to Soviet dissatisfaction with IBM leasing arrangements and to a desire to purchase rather than lease IBM equipment. To avoid losing the business IBM proposed an arrangement under which the Soviets would establish a separate corporation whose sole business would be the import of IBM machines for rent to Soviet organizations at the uniform rental fee (in other words, Uchetimport in effect became an IBM agency); 30 percent of the royalties were payable to IBM with a guaranteed minimum annual payment. IBM was willing to maintain a technical servicing staff in the U.S.S.R. to be paid by the Soviets.[18] The precise amount and nature of IBM computer sales to the Soviet Union since World War II is not known, but it is known that after World War II IBM sales to the Communist world

[13] *Control Engineering*, V. 5 (May 1958).
[14] Ware and Holland, *op. cit.* n. 5, p. 85.
[15] The BESM-6 machine was installed at Dubna in 1967 but is not in general use.
[16] U.S. Dept. of Commerce, *Export Control* (Washington, D.C., issued quarterly). These figures calculated from data contained in various issues for the years 1966-68.
[17] U.S. State Dept. Decimal File, 861.602/279.
[18] *Ibid.*

came "almost entirely from [IBM's] Western European plants," partly because the U.S. equipment operates on 60 cycles whereas Russian and European equipment operates on 50 cycles.[19]

The earliest Western computer sale that can be traced is a Model 802 National-Elliott sold by Elliott Automation, Ltd., of the United Kingdom in 1959.[20] (Elliott Automation is a subsidiary of General Electric.) By the end of the sixties Soviet purchases of computers had been stepped up in a manner reminiscent of the massive purchase of chemical plants in the early sixties. In the last days of 1969 it was estimated that Western computer sales to all of communist Europe, including the U.S.S.R., were running at $40 million annually and these were in great part from subsidiaries of American companies.[21] In 18 months during 1964-65 Elliott Automation delivered five Model 503 computers to the U.S.S.R., one for installation in the Moscow Academy of Sciences;[22] the Elliott 503 ranged in price from $179,000 to over $1 million, depending on size, and has a 131,000-word core capacity. By the end of 1969 General Electric–Elliott automation sales to communist countries were four times greater than in 1968 and this market accounted for no less than one-third of General Electric–Elliott's computer exports.[23] Another General Electric machine, this time a Model 400 made in France by Compagnie des Machines Bull, also was sold to the U.S.S.R.; and Olivetti–General Electric at Milan, Italy, was also a major supplier of G.E. computers to the U.S.S.R. In 1967 the Olivetti firm delivered $2.4 million worth of data-processing equipment systems to the U.S.S.R. in addition to the Model 400 and the Model 115 machines already sold.[24] The Model 115 is a G.E. information processing system, but has a wide range of applications. It can be used as a free-standing tabulating unit or as a peripheral subsystem to other G.E. units.

In sum, General Electric has sold through its European subsidiaries from 1959 to 1970 a range of its medium-capacity business and scientific computers, including the fastest of the 400 series, which can be used either individually or as a group.

Perhaps of greater significance are English Electric sales, which include third-generation microcircuit computers utilizing Radio Corporation of America technology. In 1967 English Electric sold to the U.S.S.R. its System Four machine with microcircuits. This machine incorporates RCA patents[25] and is similar to the RCA Spectra 70 series.

[19] *Wall Street Journal*, May 10, 1966. Thomas J. Watson, chairman of IBM, was in Moscow in October 1970 with four IBM engineers to discuss the nature of continued IBM assistance to the U.S.S.R.
[20] *Electrical Review*, (London), no. 165, p. 566.
[21] *Business Week*, December 27, 1969, p. 59.
[22] *Wall Street Journal*, June 18, 1965.
[23] *Business Week*, December 27, 1969, p. 59.
[24] *Wall Street Journal*, February 7, 1967, 14:3.
[25] *The Times* (London), January 24, 1967.

The largest single supplier of computers to the U.S.S.R. has been International Computers and Tabulation, Ltd., of the United Kingdom, a firm whose technology is largely independent of U.S. patents. In November 1969, for example, five of the firm's 1900 series computers (valued at $12 million) were sold to the U.S.S.R.[26] These are large high-speed units with integrated circuits, and without question they are considerably in advance of anything the Soviets are able to manufacture in the computer field. These machines are certainly capable of utilization in solving military and space problems.

AUTOMATION AND CONTROL ENGINEERING

Given the Soviet backwardness in computer technology, it is pertinent to examine briefly the nature and extent of Soviet achievement in the important fields of automation and control engineering.

The Russian application of the word automation is much wider than in the West; in the U.S.S.R. it can include such elementary control systems as automatic level controls and water pumping stations. In the Western definition, automation designates only advanced mechanization (mainly cyclical operations), automatic control, regulation, and direction work, including self-optimizing operations and the concomitant utilization of computers.

The Moscow Congress of the International Federation of Automatic Control held in June and July 1960, provided an excellent opportunity for examination of the state of automation in the Soviet Union at that time. It was the first such congress, and it brought together 1111 delegates from 29 countries, with the U.S.S.R. being represented by 397 persons, the U.S.A. by 137, the United Kingdom by 78, and a large number in attendance from European socialist countries. In a period of four and one-half days some 275 papers were read.

The general impression gained by British and American delegates to the conference was that the papers presented and the visits made did not support the general understanding of Soviet achievements in space research and nuclear engineering. For example, Professor H. H. Rosenbrock commented as follows:

> It was difficult at first to set this in perspective. The known Russian achievements in theory and in the guidance of rockets did not at first accord with the elementary state of automation in some of the factories that were seen and with the shortage and out-of-date design of tools such as analog and digital computers.[27]

[26] *Business Week*, December 27, 1969. The 1900 series has numerous models and the company has not announced the model numbers of the machines shipped; models vary greatly in speed and capacity.

[27] H.H. Rosenbrock, "A Report of Symposium on Automatic Control," Institution of Mechanical Engineers, (London), 1960.

Similarly, a British delegate, D. C. Rennie, made the following comment:

> The consensus ... from the British delegation was that we saw nothing to support the tremendous achievements of the U.S.S.R. in space research and nuclear engineering. It would appear that the U.S.S.R. has poured much of its resources into these fields.
>
> We did not see anything that would justify the opinion that the U.S.S.R. is ahead of the West. In endeavoring to gauge the potential of any organization, it is usual to examine carefully the base of the pyramid supporting the spearhead. In fact, the "base" appeared to be missing. For example, the computers we saw were far behind those in the West. The instrument engineering in the factories was inferior to comparable Western equipment. The equipment and components being developed in the Institute of Automation at Kiev, one of the largest and most important in the U.S.S.R., were far behind the latest techniques in Britain and the U.S.A. It must be stressed that these opinions are based only on what we saw. It is conceivable that much of their later developments were carefully withheld. The writer is of the opinion that this was unlikely. Conversation with individual Russian engineers gave a strong impression that they were being open.[28]

One of the key institutes in the field of automation is, as Rennie indicated, the Institute of Automation in Kiev, which employs some 2000 persons working in 40 laboratories in addition to experimental workshops and pilot plants. It was of this facility that Dr. H. H. Rosenbrock commented: "This, incidentally, was the first time in Russia that I saw a transistor; all the other equipment, amplifiers and so on, was valve equipment."[29]

The papers presented at the conference confirm the rather skeptical outlook brought back by Western delegates concerning the level of Soviet achievements in automatic control systems. One conference paper, by General Electric engineer E. W. Miller on the "Application of Automatic Control Systems in the Iron and Steel Industry," aroused considerable interest and the author was cross-examined by the Russian engineers present for more than an hour. A British delegate commented that from the discussion it was obvious that the Americans were far ahead of the Russians in this field.[30]

The paper that followed Miller's, one on a similar topic by a Russian engineer (V. I. Feigin on "Automation of a Reversing Mill"), also suggests a much lower level of technology in the U.S.S.R. For example, the system Miller described controlled 12 parameters whereas the Soviet system controlled three parameters. Although the Russian paper took an hour to present, a delegate

[28] Private, unpublished report by D. C. Rennie, London, Eng.: "Report on Moscow Congress of the International Federation of Automatic Control," June 27-July 7, 1960, p. 1. Typescript supplied by author.

[29] Rosenbrock, *op. cit.* n. 27, p. 55. The 1963 U.S. Atomic Energy Delegation observed only one piece of transistorized equipment during the whole visit.

[30] Rennie, *op. cit.* n. 28, p. 12.

commented that at the end there were no questions or comments from the floor. The next Russian paper, also on a similar topic, was canceled.

The following day, on June 28, 1960, a paper by D. A. Patient of Baird and Tatlock (on "Techniques for the Automation of Sampling and Chemical Analysis") induced considerable Russian cross-questioning. However, the subsequent paper by M. Brozgol, a Soviet engineer (on "The Automation of Electric Drives"), was described by the British delegate as being in "the widest terms." The same observer reported that Western delegates "found it extremely difficult to pin the Russians down to giving precise information in one or another particular field," and that "the author of [the 'Electric Drives'] paper stated in response to a direct question that if he had been reporting today, he 'would have mentioned things which had been developed more recently.' " When pressed for further information he was not prepared to give it.[31]

Attempts by Western conference delegates to visit particular plants were not successful. H. H. Rosenbrock commented:

> No visits were arranged during the conference to chemical plants or process plants in general. I tried hard while I was over there to visit a chemical plant; but obviously I was not persuasive.[32]

Another delegate, W. D. Elliott, commented: "Although I tried for five days I was not able to get to see a computer institute."[33]

It may be justifiably concluded, then, that Soviet automation and control engineering is not in an advanced state. This conclusion is entirely consistent with earlier conclusions concerning the elementary nature of Soviet computers in the 1960s and the necessity to purchase IBM, General Electric, and RCA technology to fill a sizable technological gap. Given the fundamental place of these technologies in weapons systems, this conclusion raises serious questions concerning the origins of Soviet military computers and control mechanisms. This question is discussed in chapter 27; at this point the hypothesis is put forward that Soviet military capabilities also are from the West.

THE NATURE OF GERMAN TRANSFERS IN THE ELECTRICAL INDUSTRY

The technical nature of the transfers from the German electrical industry at the end of World War II provide a plausible explanation for current Soviet backwardness in control instrumentation and computers. The Germans did not

[31] *Ibid.*, p. 14.
[32] Rosenbrock, *op. cit.* n. 27, p. 55.
[33] *Ibid.*, p. 57.

work on computer technology—facilities for the production of industrial control instrumentation were not in evidence among the numerous plants and equipment shipped to the U.S.S.R. from Germany.

In prewar Germany the electrical equipment manufacturing industry was heavily concentrated in the Berlin area. Although there was a slight movement away from Berlin as a dispersal measure under the threat of Allied bombing, eastern Germany was by the end of World War II the most important location for the electrical industry. This is confirmed by several sources. In a report from Dr. Fritz Luschen to Albert Speer in March 1945, in the last days of World War II, it was reported that since 1943 the industry had been dispersed to a great extent to Silesia and other eastern areas, and the Soviet advance had led to "severe inroads on manufacturing space and development workshops."[34] It was pointed out by Dr. Luschen that although in February 1945 the reduction in floor space was only 7.8 percent, "this trifling percentage is no index of the significance of the loss, since the most important and specialized manufacturing development facilities of the entire electrical industry had been installed in the East."

Furthermore, large stocks of electrical equipment had been lost, including, for example, 100 repeater stations and radar equipment. The Luschen report goes on to indicate that Berlin therefore had increased in importance and at the end of the war included about 50 percent of the German electrical industry. This reasoning was shared by the U.S. Strategic Bombing Survey team:[35]

> A study of the electrical equipment industry in Germany would have been concentrated in the Berlin area had the region been available for investigation. This is inevitable since there is no other area in Germany which is comparable in size and importance within the province of electrical equipment. The Russian occupation forces in the area did not permit American personnel to enter their zone of occupation at the time the survey was made.

This concentration in Berlin and eastern Germany enabled the Soviets to acquire probably 80 percent of the 1944-45 German electrical industry. As we have already seen, this came about, paradoxically, because of the Allied advance to the Elbe. The Soviets occupied the whole of Berlin and removed the electrical plants from all Berlin zones;[36] then when the frontiers were adjusted on July 1, 1945, the Soviets occupied and proceeded to dismantle the electrical industry of Saxony, Thuringia, and Brandenburg, which had been evacuated by U.S. forces.

[34] U.S. Strategic Bombing Survey, *German Electrical Equipment Industry Report*, 2d edition (Washington, Equipment Division, 1947), Report no. 48.

[35] *Ibid.*, p. 8.

[36] *Ibid.*, p. 9: "Investigation of plants in the Berlin area at the present time [July 1945] would not yield satisfactory results, as key electrical equipment plants have been removed from Berlin by the Russians."

What did the Soviets acquire in East Germany? About 65 percent of the facilities removed were for the production of power and lighting equipment (about one-quarter), telephone, telegraph, and communications equipment facilities (just under one-third), and equipment for the manufacture of cable and wire (about one-tenth).[37] The remainder consisted of plants to manufacture radio tubes, radios,[38] household electrical goods and batteries, and military electronics facilities for such items as secret teleprinters and antiaircraft equipment.

A large number of wartime military electronic developments were made at the Reichspost Forschungsinstitut (whose director went to the U.S.S.R.), and these developments presumably were absorbed into Soviet capability, including television, infrared devices, radar, electrical coatings, acoustical fuses, and similar equipment.[39]

Thus although 80 percent of the German electrical and military electronics industries was removed, the Soviets did not gain computer or control instrumentation technologies developed after World War II.

WESTERN ASSISTANCE TO INSTRUMENTATION SYSTEMS

The computer is the heart of modern control instrumentation. There is no available evidence that direct Western assistance was provided for the early Soviet computers, STRELA, BESM, and URAL, although the components, tubes, diodes, and later transistor technologies came from Germany (the reparations removals) and from postwar purchases of electrical equipment. There is, however, a great deal of Western design influence, and some equipment is copied from American models.[40]

At the 1955 Russian exhibit of nuclear instrumentation in Paris it was noted that Russian instrumentation was second to the U.S. "qualitatively and quantitatively" and overall "several years behind the U.S. on techniques." The items exhibited were largely copies; only one photomultiplier was exhibited and the "RCA people say [it] is a copy of [an] early RCA multiplier" (complete

[37] *Ibid*. For figures on distribution of production from 1943, see *ibid*., p. 14.

[38] See p. 334 below. Removal of at least one radio equipment plant was somewhat delayed: "Of a certain radio-valve plant the Russians seized 50 percent of all the machines and transferred them to Russia. Then they ordered the management to build new machinery in order to keep up production. When the new machines were built and run in, they were seized and taken to Russia. This happened once again and when the plant had reached full production again, it was transferred to Russia, lock, stock, and barrel, including management, engineers, foremen, key workers, and the families of the male and female workers." *Aeronautics* (London), July 1951, pp. 35-36.

[39] U.S. Strategic Bombing Survey, *op. cit.* n. 34, contains a summary of the German wartime military electronics developments; see pp. 67-72.

[40] See p. 319.

with the RCA pinched neck). The pocket dosimeters "seemed similar to Argonne design."[41]

At about the same time a review by a "top German scientist" based on interviews of German electronics engineers returning from the U.S.S.R. concluded that the engineers were returned because the Soviets had nothing more to learn from them; the Soviets were said to "always have working models of the latest U.S. equipment,"[42] and were at that time testing the latest U.S. Tacan navigation system. The Loran system was later copied as the Luga system.[43] Another observer, Dr. W. H. Brandt of Westinghouse, noted that Soviet coil winding techniques were parallel to those of the U.S. in World War II,[44] and that the Soviets apparently were having problems manufacturing transistors. The American trade journal *Control Engineering* reported a few years later (in 1958) a visit by a delegation in industrial instrument design:

> We saw many examples of dial-type laboratory precision resistance decades, Wheatstone bridges, Kelvin bridges, and precision potentiometers, as well as portable bridges and potentiometers. Designs were strongly reminiscent of American designs. A few of the dial-type instruments used switching contact designs normally associated with German precision apparatus.[45]

However, N. Cohn of Leeds & Northrup commented: "Not all units were copies, and the Russians were proud of design advances—from their point of view—of their own." He then added:"We saw an assembly for measuring 10 to 100 percent relative humidity using wet and dry bulb resistance thermometers and a self-balancing computing circuit, originally developed in this country in the 1920s."[46]

An exhibit of Russian electronic test equipment in New York in 1959 provided another opportunity for preliminary observations on this sector of the electronics industry.[47] Unfortunately no opportunity was given visitors to observe the instruments in operation; consequently it was not possible to compare specifications with performance. In microwave test equipment, the design appeared adequate but the specifications were "so much poorer than ours."[48] It was observed that many instruments were copies, but one unique item was shown—a compact calibrating signal generator packaged into a compact unit. David Packard noted that a couple of instruments were "without question" copies of instruments originally developed by Hewlett Packard Company.[49]

[41] *Nucleonics* (New York), September 1955, pp. 12-13.
[42] *Aviation Week*, (New York), April 16, 1956, p. 75.
[43] Institute for the Study of the U.S.S.R. *Bulletin* (Munich), V (December 1956), 13.
[44] *Aviation Week*, April 9, 1956, p. 68.
[45] *Control Engineering*, November 1958, pp. 65-80.
[46] *Ibid.*, p. 74.
[47] *Electronic Design* (New York), August 17, 1960, pp. 50-70.
[48] *Ibid.*
[49] *Ibid.*

This backwardness in electronics was still apparent in 1960. The American trade journal *Electronics* illustrated Soviet space components and their U.S. counterparts, and noted the bulky and obsolescent nature of Soviet components—without printed circuits and using conventional military-type cables and plugs for space work.[50] The journal cited an example of an ionization detector and amplifier used in the 1961 U.S. moon shot in one package six inches long and the comparable Soviet instruments in *Sputnik III*—two packages about two feet long.[51]

Where the Soviets are operating modern systems, the origins can be traced to the West. For example, in 1966 an instrument-landing system valued at $280,000 was installed at the Sheremetyevo Airport in Moscow—the international airport—by Standard Cables & Telephone, Ltd., a subsidiary of International Telephone and Telegraph Corporation (ITT) of New York.[52]

In 1967 Le Matériel Téléphonique S.A. of Paris, France, another subsidiary of ITT, was awarded a contract to equip an all-purpose telephone information center in Moscow. The contract was for the manufacture and supply of telephone switching apparatus to give callers information on weather, time, and cultural events. Although the system was large—employing 500 operators and using advanced microfilm techniques—it seems unusual that this kind of system would still be bought in the West.[53]

SOVIET RADIO AND TELEVISION RECEIVERS

In late 1953 the U.S. Air Force Technical Intelligence Center made an "intensive scrutiny" of two Soviet television sets, the Muscovite and the Leningrad, and concluded that Soviet circuitry and design trailed that of U.S. practice by about ten years. The Muscovite T-1 small 7-inch screen television introduced in 1948 as the first Soviet television set was a "direct copy of a 1939 German receiver." It was capable of picking up only the single Moscow channel, and its performance was described as "mediocre." The follow-on unit was the Leningrad T-2 built in East Germany to Soviet specifications for sale in the

[50] *Electronics*, November 25, 1960, p. 43.

[51] *Ibid.*

[52] *Wall Street Journal*, May 10, 1966. Thus the pilot on the first Soviet flight to the United States was able to claim: "Captain Boris Yegorov said that the efficiency of traffic flow around Moscow was a good deal better than it was around New York, which has been suffering exasperating traffic delays. 'In Moscow, everything is on time,' said the captain after his own flight had to circle New York for an hour and 35 minutes and had come within 10 minutes of having to turn back to Montreal." *San Jose Mercury* (San Jose, Calif.) August 28, 1968.

[53] *Wall Street Journal*, July 31, 1967, 7:2. However, Soviet telephone equipment appears to be of the 1920s era; for example see chart compiled by L. T. Barnakova, entitled *Oborudovanie gorodskikh telefonnykh stantsii* (Moscow, 1966).

U.S.S.R.; this set, with an 8-inch screen, could pick up only the Leningrad station with a performance rated as "fair."[54]

The first color television project is claimed by the Soviet engineer I. Adamian for 1925.[55] In March 1965, however, the Soviets made an agreement with France to utilize the French color television system SEKAM in the Soviet Union.[56] This system, with circuits covered by Radio Corporation of America patents,[57] is used in the Soviet color television receivers Rubin-401, Raduga-4, and Raduga-5.[58]

IMPORT OF POWER STATION EQUIPMENT

Although Soviet literature stresses the ban that was placed on imported equipment for electrical generation in 1934,[59] there has in fact been considerable import of complete power stations and equipment for power generation, particularly during and just after World War II. Robert Huhn Jones estimates that the $167 million worth of electrical-plant shipments under Lend Lease were roughly equal to the capacity of the Hoover Dam or the combined generating capacity of the states of New Jersey, Connecticut, and New York.[60] Up to 1944 these deliveries constituted 20 percent of the increment in Russian wartime power capacity and were in addition to substantial shipments from the United Kingdom and Canada—sufficient to produce 1,457,274 kw of power.[61] The program provided complete stations (this accounted for the high construction cost of $144 per kw):

> ...[Western firms are] shipping the Russians equipment down to and including wiring for the plant's lighting system, leaving out only such items as light bulbs, freight or passenger elevators, metal stairways, and the like. Powerwise we send the Russians everything a complete station requires.[62]

Between 1942 and 1946 the United Kingdom shipped eight complete power

[54] *Product Engineering*, (New York), 1953, pp. 200-1.
[55] *Nauka i zhizn'* (Moscow), no. 6, 1965, p. 7.
[56] *Ibid.*
[57] *Wall Street Journal*, March 23, 1965, 3:2.
[58] A. Bartosiak, *Sistema tsvetnogo televideniia SEKAM* (Moscow, 1968). Dependence on foreign transistors is implicit in such publications as V. F. Leont'ev, *Zarubezhnye transistory shirokogo primeneniia* (Moscow, 1969) and G. G. Sitnikov, *Tranzistornye televizory SShA i Yaponii* (Moscow, 1968).
[59] P.S. Neporozhnii, *Electrification and Power Construction in the U.S.S.R.* (Jerusalem: Israel Program for Scientific Translations, 1966), p. 76.
[60] Robert Huhn Jones, *The Roads to Russia* (Norman: University of Oklahoma Press, 1969), p. 225.
[61] *Ibid.* A few of the units shipped were old and inefficient, such as, for example, the Consolidated Edison plant from Long Beach, California, shipped in 1943. See also Sutton II, pp. 167-68.
[62] *Electrical World* (Manchester, Eng.), August 19, 1944, p. 102.

stations to the U.S.S.R. (four of 10,000-kw, two of 12,000-kw, and two of 25,000-kw capacity[63]), as well as a mixed power-district heating plant.[64] In 1954 two large contracts were concluded, one with R. A. Lister & Company, Ltd., for 90 diesel generating stations of 410 kw each, at a cost in excess of $4 million, and the other and still larger contract with the Brush Group of companies for diesel generating sets, turbines, and transformers valued in excess of $12 million.[65] Motors and alternators were supplied by Crompton Parkinson later in the same year,[66] and in 1958 a 1000-kw gas turbine (Mark TA) was supplied by Ruston and Hornsby for mobile generator use.[67] In addition, large quantities of control instrumentation have been supplied by British firms —for example, an order for 100 starters from Brookhirst Switchgear, Ltd., in 1946[68] and large quantities of power cable and wire from Crompton Parkinson and Aberdare Cables, Ltd.[69]

Other countries have supplied similar equipment. For example, in 1947 the Swedish subsidiary of General Electric supplied a complete power station for delivery in 1949-52 at a cost of $2 million.[70] In addition there was movement of electrical power generating equipment from Germany to the U.S.S.R. under reparations, e.g., the Gensdorf plant,[71] and the removal of the generators from Siemens-Halske works in Berlin to the Elektrosila plant in Leningrad.[72]

THE INCREASE IN ELECTRICAL GENERATING CAPACITY

The only Western delegation to have visited the Soviet Union and returned to give glowing reports of Soviet technical achievements—and also to predict that the Soviet Union would surpass the United States within a foreseeable time period–was the 1960 U.S. Senate power industry delegation.[73] This delegation report was significantly different from that of two other U.S. electrical industry delegations[74] and to some extent from that of the Canadian Electric Power Industry Delegation.[75]

63 *Electrical Review* (London), vol. 140 (1947), 442.
64 *Ibid.*, vol. 135 (1944), pp. 764-70.
65 *Ibid.*, vol. 154, (1954), p. 480.
66 *Ibid.*, vol. 155 (1954), p. 290.
67 *Ibid.*, vol. 163 (1958), p. 22.
68 *Ibid.*, vol. 139 (1946), p. 941.
69 *Ibid.*, vol. 155 (1954), pp. 290, 330.
70 *Ibid.*, vol. 140 (1947), p. 986.
71 See p. 29.
72 Keller, *Ost minus West=Null* (Munich, 1960), p. 283.
73 U.S. Senate, Committees on Interior and Insular Affairs and Public Works, *Relative Water and Power Resource Development in the U.S.S.R. and the U.S.A.*, Report and Staff Studies, 86th Congress, 2d session, May 1960.
74 A Report on U.S.S.R. Electric Developments, 1958-1959 (New York: Edison Electric Institute, 1960).
75 *Report of Visit to U.S.S.R. by Delegation from Canadian Electric Utilities, May 14 to June 2, 1960* (Toronto: September 9, 1960).

The Senate delegation report suggested that the Soviet Union was catching up with the United States in the production of electric power; that in 1961 it was constructing large hydroelectric dams faster than the United States; and that it had not only caught up with the Western world in hydroelectric engineering but "... in fact they are actually preeminent in certain specific aspects of such development."[76] The Senate committee that heard the report therefore recommended a massive U.S. Federal program and a study of planning "on a national basis."[77] On the other hand, the Edison Electric Institute report noted in distinct contrast:

> The economic problems facing the Soviet Union ... are vast and complex. Even assuming the [electrification] goal is reached, however, it is worth remembering that in 1965 the United States should have a total capability of 245 million kilowatts, and the present 123-million-kilowatt gap between Russian and American electric power capability will have increased by some 10 million kilowatts.[78]

The Canadian delegation noted "good" power equipment, impressive plans and organization, and "outstanding" transmission and hydraulic generation, but "their achievements in thermal generation and atomic power generation were not particularly impressive."[79]

Electrification of Russia has of course been a prime goal of the Soviets.[80] However, progress has not been as substantial as planned and certainly not as substantial in absolute terms as in the United States. The United States in 1950 had a total generating capacity of 82.8 million kw, including 18.7 million kw, or about one-quarter of capacity, generated from hydropower sources. In 1958 this total had increased to 160.7 million kw (30.1 million kw in hydropower), and in 1967 to 269.0 million kw (48.0 million kw by hydropower). In comparison, the Soviet total in 1950, after installation of the Lend Lease power station and heavy equipment imports of the 1940s, was 19.6 million kw (of which 3.2 million was from hydropower sources); this increased to 53.4 million kw in 1958 (10.9 million kw from hydropower) and 131.7 million kw in 1967 (24.8 million from hydropower).

The total generating capacity in the United States increased by 77.9 million kw between 1950 and 1958, compared with an increment of 33.8 million in the U.S.S.R. in the same period. During the next decade, 1958 to 1967, the United States increased its total generating capacity by 108.3 million kw and the U.S.S.R. by 78.3 million kw.[81] (See Table 23-2.)

[76] U.S. Senate, *op. cit.* n. 73, p. 1.
[77] *Ibid.*, p. 7.
[78] *A Report on U.S.S.R. Electric Power Developments, op. cit.* n. 74, p. 19.
[79] *Report of Visit to U.S.S.R. ..., op. cit.* n. 74. Further information on methods of construction may be obtained from "Excerpts from a Contractor's Notebook," kindly supplied by Dan Mardian of Phoenix, Arizona, and deposited in the Hoover Institution Library.
[80] See Sutton I, pp. 201-6.
[81] See Table 23-2.

Table 23-2 COMPARATIVE INCREMENTS IN ELECTRICAL POWER CAPACITY IN THE UNITED STATES AND THE U.S.S.R., 1950-67

Capacity	*Year*	*United States (million kw) Increments*		*U.S.S.R. (million kw) Increments*		*Gap U.S./U.S.S.R.*
Total electric	1950	82.8	—	19.6	—	63.2
power generation	1958	160.7	77.9	53.4	33.8	107.3
capacity	1967	269.0	108.3	131.7	78.3	137.3
Hydroelectric	1950	18.7	—	3.2	—	15.5
power generation	1958	30.1	11.4	10.9	7.2	19.2
capacity	1967	48.0	17.9	24.8	13.9	23.2

Sources: U.S. Bureau of the Census, *Statistical Abstract of the United States*, 1969 (Washington, 1969), p. 511; *Narodnoe khoziaistvo SSR* 1967 (Moscow, 1968).

The gap between U.S. and U.S.S.R. generating capacity therefore increased between 1958 and 1967. The difference was 107.3 million kw in 1958, and this difference had increased to 137.3 million kw in 1967. The gap in hydroelectric power, where the Soviets have placed particular emphasis, increased from 19.2 million kw in 1958 to 23.2 million kw in 1967. Increasing the relative gap in generating capacity is not an effective way of "catching up" with the United States.

There are other indications that the position of the Soviets is worsening. At the end of the sixties the United States had more than 70 atomic generating stations on order while the Soviets, with only three or four such stations built and none reported under construction,[82] appeared to be having difficulties with their construction. There is no indication that in the generation of electricity by the use of steam (thermal) plants the Soviets have generated any above-normal efficiency operations. Claims are made concerning the size of turbogenerators and that, for example, in 1960 several 200,000-kw units had been installed. The first U.S. 200,000-kw unit was installed in 1929.[83] The reported fuel consumption in 1958 was 0.97 pound per kw-hr compared with 0.90 pound in the United States, and the Eddystone unit under construction in the United States in 1960 was planned for fuel consumption of 0.60 pound per hour.[84]

The Soviet emphasis has been on the production of standardized facilities using reinforced and prefabricated concrete units in the buildings. In this connection it should be noted that a great deal of General Electric and Metropolitan-Vickers technical assistance was provided for thermal units in the 1930-40 period, and in 1944 a U.S. consulting firm—Ebasco Services, Ltd., under instructions from Lend Lease—prepared a set of drawings and specifications for standardized designs using the metric system. These designs made "extensive" use of rein-

[82] See *Pravda*, November 1969.
[83] *A Report on U.S.S.R. Electric Power Developments*, *op. cit.* n. 74, p. 8.
[84] *Ibid.*

forced concrete adapted to Russian conditions.[85] In addition, a number of power stations were equipped from the United States, Canada, and Britain at the end of and just after World War II.[86]

Lags in Soviet computer technology are clearly apparent throughout the period under discussion and have been compensated for by imports from IBM, General Electric-Elliott, English Electric, and International Computers, Ltd. This computer lag has in turn resulted in a major weakness in automation and control engineering, even in fields such as iron and steel where the Soviets have undertaken extensive research work.

These lags fit the pattern of transfers from the German electrical equipment industry at the end of World War II. The factories transferred then were largely for the manufacture of power and communications equipment, not computers and control equipment. In the field of communications equipment, for example for aircraft landing systems and color television, the Soviets utilized Western technology in the late 1960s.

As the gap between U.S. and Soviet electrical generating capacity is increasing—the gloomy forecasts of a Senate subcommittee notwithstanding—it is considered that the Soviets are well behind the United States. In atomic generating stations the Soviets were considerably behind in the late sixties, with only three or four stations built compared with 70 built or under construction in the United States.

[85] L. Elliott, "Steam Plant Designed for Russia under Lend-Lease," *Electrical World*, December 23, 1944, pp. 69-71.

[86] For detailed information on current standard thermal stations, see P. S. Neporozhnii, *Spravochnik stroitelia teplov ykh elektrostantsii* (Moscow, 1969).

CHAPTER TWENTY FOUR

Western Assistance to Consumer Goods Industries

Consumer goods, the neglected sector under Soviet planning, contains a great diversity of products and technologies too numerous to discuss in detail in a single volume. To illustrate the problems of the sector, however, this chapter provides an in-depth examination of a single food industry, sugar beet production and refining, followed by a more or less cursory description of Western assistance to other consumer goods industries.

Sugar production was chosen as a case study because in the Soviet Union beet sugar refining is an old, established industry, larger in its productive capacity than in any other country, and consequently an industry in which the Soviets have had both the opportunity and the incentive to develop an indigenous technology. There was prerevolutionary Russian innovation and development in the industry; indeed, the Russians claim, probably with justification, that the first beet sugar plants were established in Russia. Indigenous innovative activity was continued in the industry after the October Revolution, and in 1928 two refining processes were planned. Innovative activity thereafter appears to have virtually ceased—it is unlikely that the Soviets would conceal any development in this sector—and we find that by the late 1950s the two 1928 refining inventions were still under development and the industry itself was based on foreign technology, either imported or duplicated. These developments may profitably be considered in more detail.

The first beet sugar mill in Russia, and the first in the world, according to P. M. Silin, was founded in Tula Province in 1802.[1] In the same year

[1] P. M. Silin, *Tekhnologiya sveklosakharnogo i rafinadnogo proizvodstva* (Moscow, 1958); translated as *Technology of Beet-Sugar Production and Refining* (Jerusalem: Israel Program for Scientific Translations, 1964), OTS 63-11073, p. 4. All references are to the translated version, which is more readily available in the United States. The first beet sugar mill in the United States was built in 1838 at Northampton, Mass.; it failed. The first successful U.S. beet sugar factory was not established until 1870 at Alvarado, California; see R. A. McGinnis, ed., *Beet-Sugar Technology* (New York: Reinhold Publishing Corp., 1951). The accuracy of the claim to Russian priority in sugar extraction from beets depends on how completely the story is told. It is true (as indicated in Silin) that a beet sugar extraction plant was constructed in the early 1800s in Russia. However, this was done with the aid of government subsidies as part of a Russian Government program to introduce foreign farming skills into Russia. Tsar Alexander I sent recruiting officers to Germany, and there is little question

Ya. S. Esipov developed the lime method of juice purification, a method later adopted throughout the world, and there followed in 1834 Davydov's development of the diffusion method of sugar extraction from beets. In 1852, Ivan Fomenko introduced at the Balakleya sugar mill the method of boiling massecuite for sugar crystallization, and two years later engineer M. A. Tolpygin developed the method of purifying sugar in a centrifuge by using steam and thus began what became widely known abroad as "Russian sugar washing." As Silin commented in 1958: "This advanced Russian method is now used in all sugar mills of the U.S.S.R. and was adopted by the American beet sugar industry."[2]

In 1890 Shcheniovskii and Pointkovskii created a new design for a continuous separator. In 1907 Ovsyannikov developed continuous crystallization of sugar, and in 1910 he was the first to apply continuous saturation. This work suggests, then, a respectable history of technological development in the field. However, Silin, who lists these Russian inventions and innovations, fails to list any major innovation after 1917. It is unlikely that the opportunity would have been missed had such innovation existed, as glorifications of Soviet technology are found throughout Silin. Silin's sole specific claim for more recent Soviet achievement is contained in the following sentence: "No other country can compete with the U.S.S.R. as to the volume of published scientific and technical material on sugar production."[3]

The following section examines Soviet beet sugar processes stage by stage, with particular reference to the origin of processes in use in Soviet sugar beet plants at about 1960.

COMPARATIVE TECHNOLOGY IN BEET SUGAR PLANTS

The flow diagram of a U.S. beet sugar refining plant is not unlike that of a typical Soviet plant (Figure 24-1).[4] To bring out the comparison the major stages of the refining process are examined in detail. These are:

1) beet washing equipment,
2) the cell method of diffusion,
3) predefecation,
4) thickeners,
5) filter presses,
6) evaporators,
7) centrifugals, and
8) crystallizers.

that German experiments in the extraction of sugar from beets came to their attention. See W. Keller, *Ost minus West=Null*, (Munich: Droemersche Verlagsanstalt, 1960), pp. 160-61; McGinnis, pp. 1-2; and Silin, pp. 4-5.

[2] Silin, *op. cit.* n. 1, p. 4.

[3] *Ibid.*, p. 9.

[4] See, for example, McGinnis, *op. cit.* n. 1, p. 134.

Comparison of Soviet and Western sugar beet washing units suggests that Soviet designers not only adopted Western designs but attached a name of their own to a design that differs little, if at all, from the Western progenitor. The Dobrovolskii beet washing unit with a Baranov stone catcher is identical to the Dyer beet washer and sand trap.[5] Priority of invention in this case is clearly with Western inventors and Soviet units show few variations from pre-1940 U.S. units. (See Figures 24-2 and 24-3.)

Silin's description of the Dobrovolskii unit applies equally to the operation of the Dyer unit:

> The Dobrovolskii washing unit consists of three compartments, the first of which is the most important. The beets move along a perforated false bottom placed above the floor of the washer. Dirt passing through the screen accumulates on the solid bottom from where it is periodically removed through drain hatches (a). The arms are arranged spirally, closer to each other in the first half of compartment I than in the second. The increased number of arms increases agitation, intensifies rubbing of roots against one another and hence improves washing. Since water level is high and the arms are fully submerged, the water surface over the arms remains calm. This very important feature permits the straw to float up to the surface and to be removed through an overflow drain together with the dirty water (left side of section CD). [See Figure 24-3.] Thus the washer acts as an additional trash catcher. . . . Compartments II and III act as stone catchers. They are fitted out with revolving paddles mounted on a shaft placed above the shaft of compartment I. The paddles rake up the beets from compartment II and send them over the partition into compartment III.[6]

Beet lifting wheels (which follow the washing units) used in the Soviet Union are almost exact replicas of the Stearns-Roger beet feeders; the only difference is in the shape of the flumes.[7]

Diffusion is the initial process by which sugar in impure form is extracted from sugar beets. Soviet cell-type diffusers are clearly of Western design, although there is a claim to indigenous research work in rotary diffusers. Priority of invention for rotary diffusers is claimed for the Soviet engineer Mandryko (1928) who, together with engineer Karapuzov, carried out extensive investigations in the 1930s "of all types" of rotary diffusers at the im. Karl Leibknecht plant.[8] Another Soviet claim is that a rotary diffuser "appearing like a prototype of the present BMA tower diffuser," was tested as early as 1928 by Professor Sokolov.[9] Silin adds that "at present" (i.e., 1960) an improved model of a Sokolov diffuser is being tested and further developed. Another vertical diffuser,

[5] *Ibid.*, p. 132.

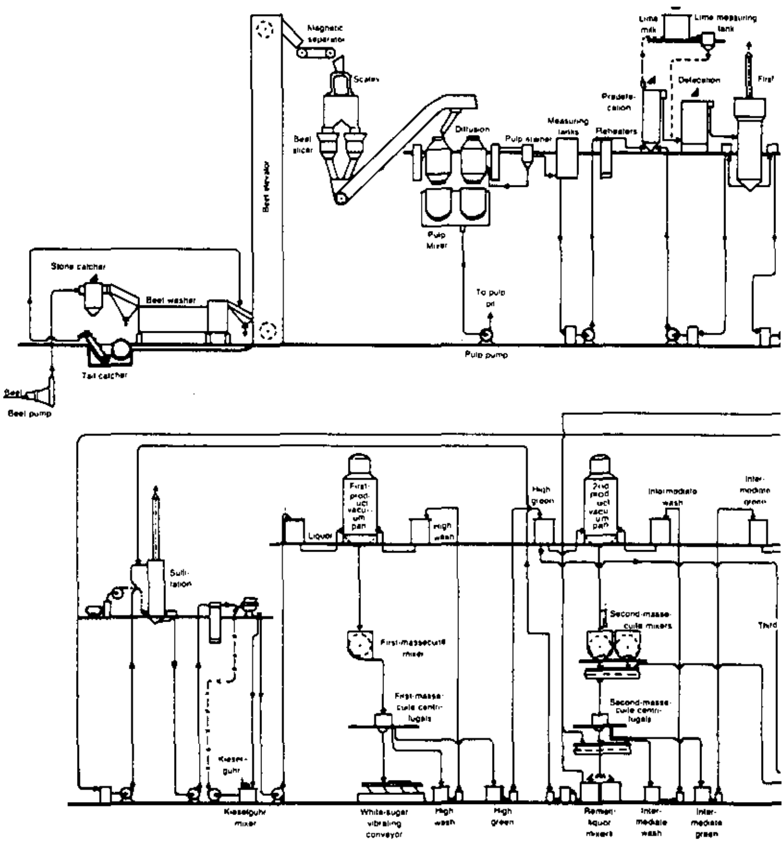
[6] Silin, *op. cit.* n. 1, p. 100.

[7] Compare Silin, *op. cit.* n. 1, p. 96, with McGinnis, *op. cit.* n. 1, p. 129.

[8] Silin, *op. cit.* n. 1, p. 174, quoting A. S. Epishin, *Sakharnaya promyshlennost'*, no. 8 (1953), 14.

[9] Silin, *op. cit.*, n. 1, p. 174.

Figure 24-1 FLOW SHEET OF TYPICAL SOVIET BEET SUGAR PLANT



Source: P.M. Silin, *Technology of Beet-Sugar Production and Refining* (Jerusalem: Israel Program for Scientific Translations, 1964), appendix 1.

Figure 24-1 (cont.)

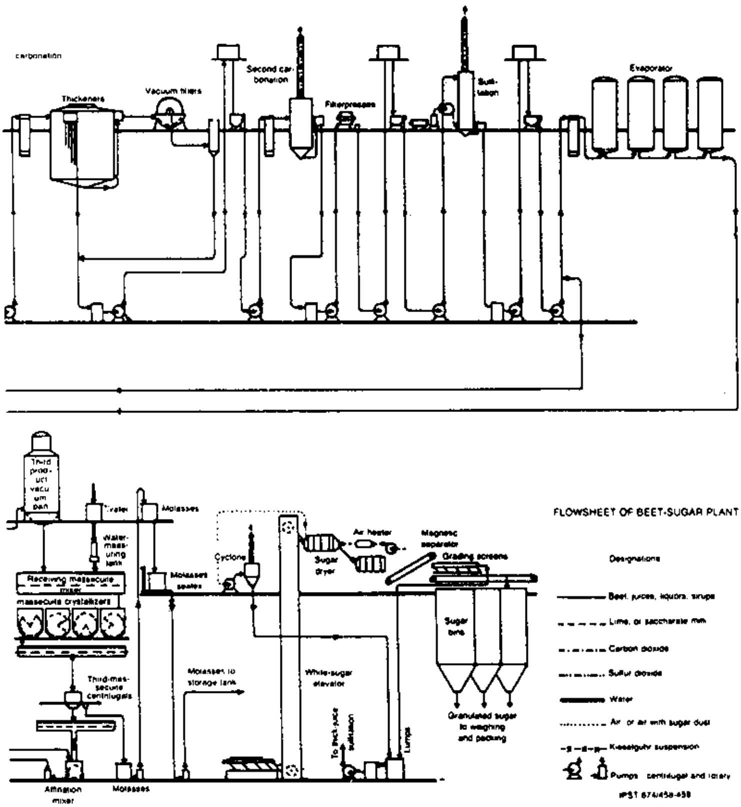
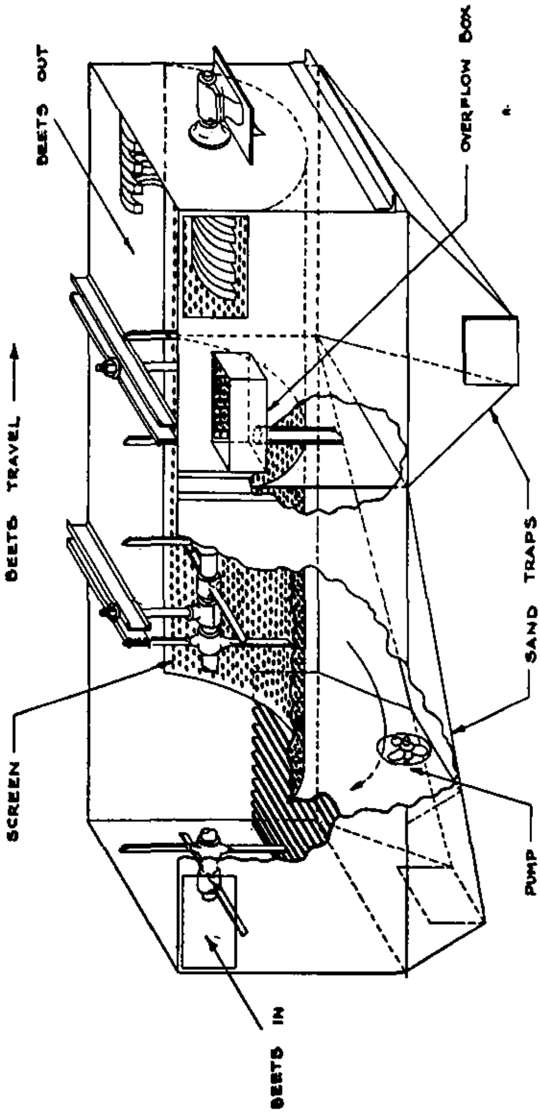


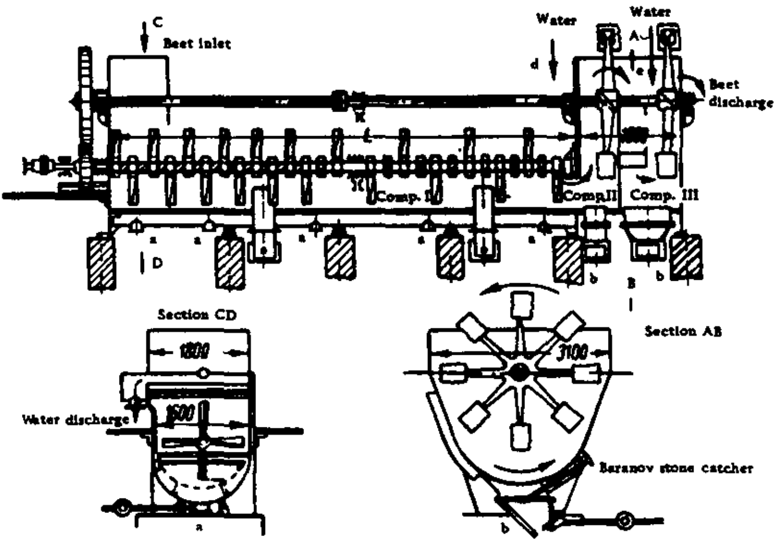
Figure 24-2

THE DYER BEET WASHER



Source: R.A. McGinnis, ed., *Beet-Sugar Technology* (New York: Reinhold, 1951), p.132.

Figure 24-3 THE DOBROVOLSKII BEET WASHER UNIT



Source: Silin, p. 100.

developed by engineer Kundzhulyan, "was in operation at the Zherdevka sugar factory for a number of years."[10]

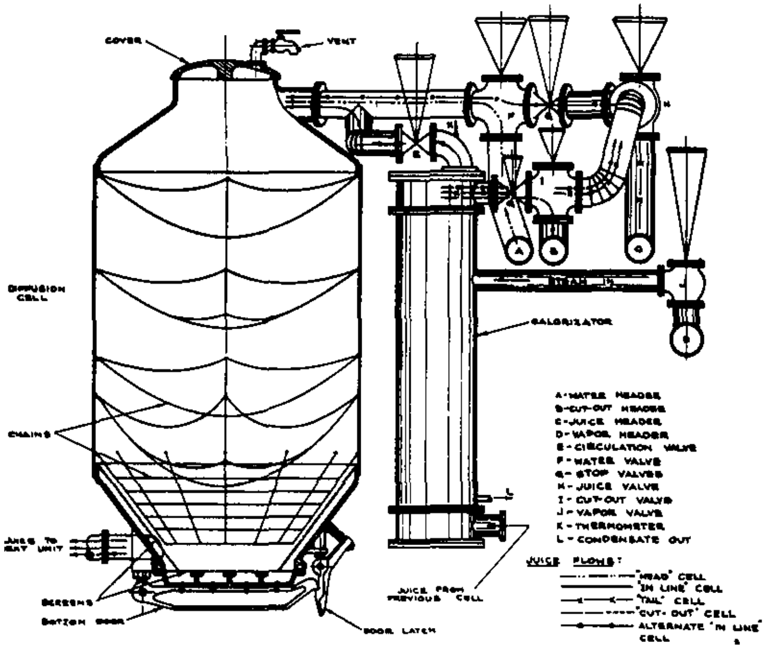
There is no reason why these Soviet claims should not be accepted as accurate. It is probable that diffuser designs were developed and tested in Soviet factories from 1928 onward, but *what is striking is that no Soviet designs are in production or use today; neither is such a claim made.*[11] In fact the Sokolov model "tested as early as 1928" was still being tested in the 1960s.

The most common diffusion operation used in Soviet beet sugar factories is a duplicate of the Roberts cell. These cells are normally used in 12-cell batteries installed in two rows of six cells each. Figure 24-4 shows the cross-sectional elevation of a Robert cell, and Figure 24-5 shows the similar construction of a Soviet diffusion cell.

In the last two decades, world practice has been to utilize rotary continuous diffusers rather than cell-type diffusers and it was recently proposed to install approximately 200 continuous diffusers in the Soviet Union. The most common

[10] *Ibid.*, p. 175.
[11] *Ibid.*, p. 174.

Figure 24-4 CROSS SECTIONAL ELEVATION OF A ROBERTS CELL



Source: McGinnis, p. 155.

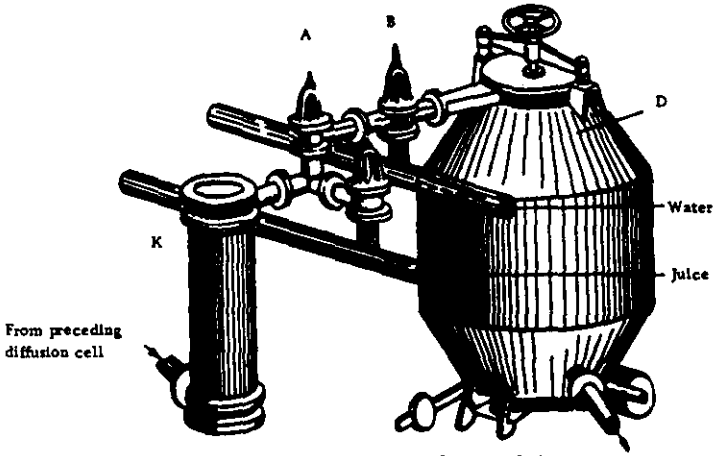
type, the RT (Rotary Tirlemont), is in use in about 80 plants in the world, including ten in the Soviet Union. This process, developed by the Belgians, was first installed in the Tirlemont plant in Belgium.

Although the Soviets claim priority of invention for the rotary diffuser and also for the BMA diffuser (manufactured by Braunschweig Maschinenbau Anstalt), they appear to use rotary continuous diffusers only on an experimental basis (apart from the ten Belgium-type continuous diffusers already mentioned). It therefore appears that although work was done in the late 1920s and the 1930s on continuous diffusers, the Soviet sugar industry is today completely dependent on foreign models for this method of beet sugar extraction.

Equipment for the predefecation and first carbonation process in the Soviet Union is carried out in a vertical tank developed by the Central Scientific and Research Institute for the Sugar Industry (TsINS).[12] This is apparently of Soviet design and is widely used in Soviet sugar factories; however, Silin points

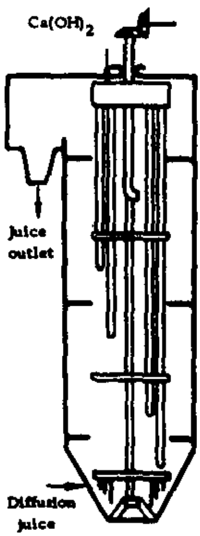
[12] *Ibid.*, p. 195.

Figure 24-5 SOVIET DIFFUSION CELL



Source: Silin, p. 120.

Figure 24-6 Ts INS PREDEFECATION TANK



Source: Silin, p. 195.

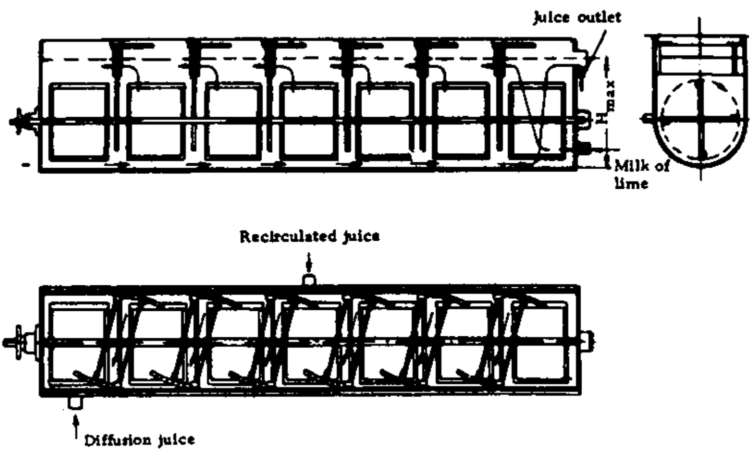
out that foreign-made equipment, and particularly the Brieghel-Müller predefecator, is easier to control and gives a more consistent alkalinity gradient. For example, he comments:

> In other predefecators, the milk of lime enters at a number of given points, creating each time a momentary excess of lime. These points tend to become centers of harmful overliming. The Brieghel-Müller apparatus is free of this defect.

It is notable (Figures 24-6 and 24-7) that the TsINS predefecation tank has the defect described and therefore by Silin's criterion would be inferior to the foreign Brieghel-Müller defecator.

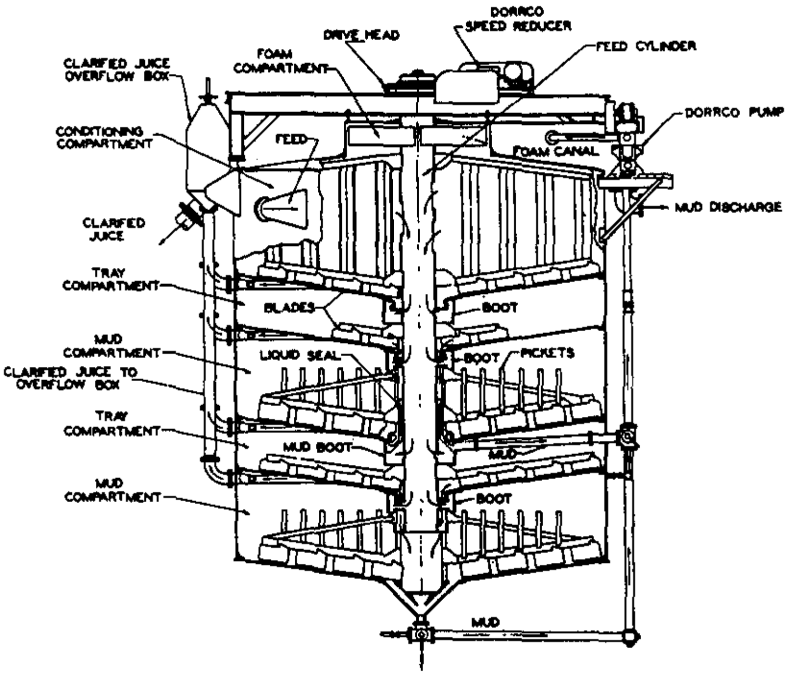
As for the mud-thickening stage, Silin states that of the many types of mud thickeners available in the world, the Dorr-type multicompartment type is particularly widely used in the Soviet Union. It consists of a large cylindrical tank with a slightly conical bottom, filled with first combination juice. Four horizontal trays within the tank divide it into five compartments revolving on a central hollow shaft which carries arms acting as scrapers. Figure 24-8 illustrates the Dorr multifeed thickener while Figure 24-9 illustrates the multicompartment thickener made by the Rostov machine-building plant. Note that the Rostov thickener is an almost exact copy of the Dorr thickener unit. The only Soviet innovation claimed for this stage of refining is one by engineer Shugunov; this innovation apparently improved and speeded up the operation of the thickener by discharging the concentrated muds separately from each compartment and

Figure 24-7 BRIEGHEL-MÜLLER PREDEFECATOR



Source: Silin, p. 245.

Figure 24-8 DORR MULTIFEED THICKENER



Source: McGinnis, p. 248.

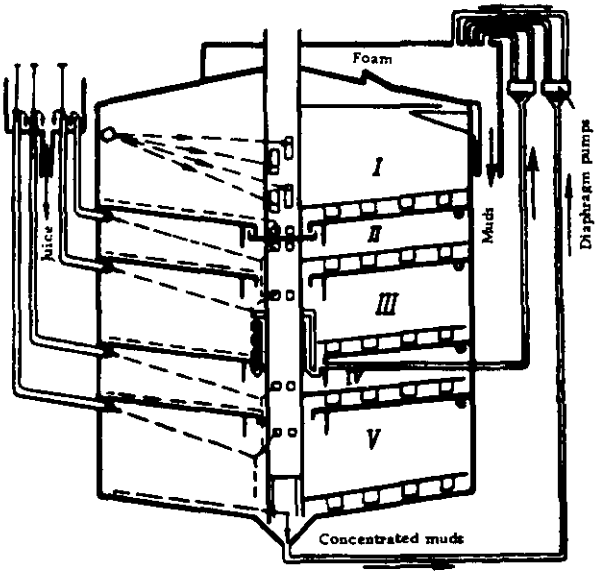
by feeding each compartment with a suspension of exactly the same concentration.[13] The Dorr multifeed thickener has an arrangement similar to that claimed by Shugunov.

Filtration is required to separate the sediment from the liquid. This is done by using a filter press, and the common filter press in the Soviet Union is the Abraham type.[14] The Soviet filter press is of the standard type; i.e., the sides of the frames and the plates are fitted with lugs that support them on two guide bars. The carbonated juice with the precipitate is then pumped into the frames through ports connected with the extension holes. It is claimed that Soviet engineers, notably Gritsenko of the Kagarlyk sugar plant, have improved the operation of the Abraham filter press.

The next stage on the flow sheet is that of evaporation. The standard evaporator used in the Soviet Union is the single-pass TsINS evaporator, which

[13] *Ibid.*, p. 219.
[14] *Ibid.*, p. 211.

Figure 24-9 ROSTOV MACHINE-BUILDING PLANT MULTICOMPARTMENT THICKENER



Source: Silin, p. 218.

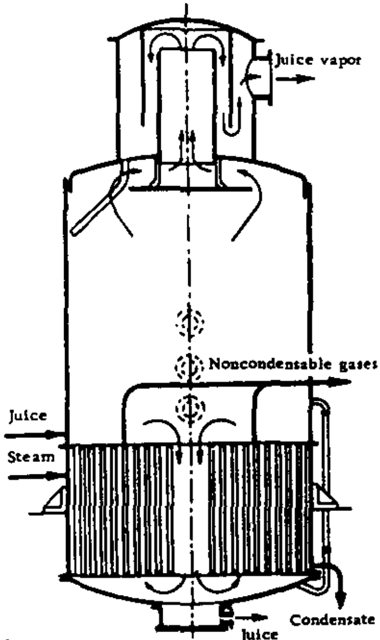
is described by Silin as "similar to the Roberts evaporator, but [having] longer tubes."[15] Figures 24-10 and 24-11 show that the two units are of very similar construction; i.e., each is a closed cylindrical steel boiler with a steam chest at the bottom part of the boiler. In both units, vertical heating tubes are rolled into the holes of the perforated tube sheets and steam is introduced into the space between the tube sheets and so heats the vertical boiling tubes. The juice vapor rises to the top and is conducted outside the evaporator in both cases. It is quite clear that the Soviet single-pass evaporator is based on the Robert evaporator.

The production of white sugar consists in separating the sugar crystals from the mother liquor by centrifugal force. The most common type of centrifugal separator is the Weston type, which is also used in the Soviet Union.[16]

The final process in beet sugar refinement is that of crystallization, which is achieved by spinning of the second massecuite; the object of this process

[15] *Ibid.*, p. 274.
[16] *Ibid.*, p. 312-13.

Figure 24-10 **ROBERTS-TYPE EVAPORATOR**



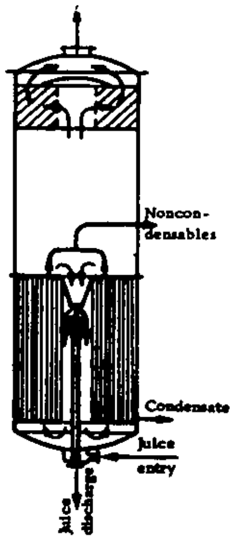
Source: Silin, p. 273.

is to obtain the highest possible yield of sugar in the form of crystals. For crystallization, the second massecuite is mixed in a mixer crystallizer while its temperature is gradually lowered. The standard Western crystallizer is shown in Figure 24-12, and the Soviet mixer crystallizer is shown in Figure 24-13. The principle in both pieces of equipment is the same.

Thus it may be seen from comparison of individual pieces of equipment within sugar manufacturing plants in the Soviet Union with similar pieces of equipment in the West that, first, there is very little if any Soviet innovation; and second, by and large Soviet equipment more or less exactly replicates Western equipment. It is also obvious that much thought, preparation, and investigation have gone into examination of Western processes to choose the most suitable process and equipment for Soviet conditions.

Consistent with these findings concerning Soviet innovation in the beet sugar refining industry are the known major infusions of Western technical assistance and equipment for the industry. In the 1920s German firms reequipped and

Figure 24-11 SOVIET CONSTRUCTION EVAPORATOR

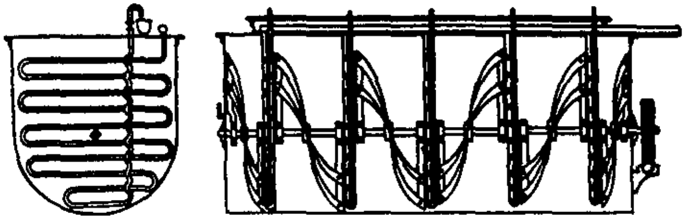


Source: Silin, p. 273.

Figure 24-12 CRYSTALLIZER BY SUGAR AND CHEMICAL MACHINERY, INC.

Source: McGinnis, p. 358.

Figure 24-13 SOVIET CRYSTALLIZER



Source: Silin, p. 319.

brought back into operation the numerous Tsarist-era sugar plants.[17] This aid was supplemented in the early 1930s by technical assistance from the United States.[18] At the end of World War II a number of sugar plants were removed from Germany to the U.S.S.R., including 14 complete plants (for example, Zuckerfabrik Bach at Stöbnitz, Zuckerfabrik GmbH at Zörbig in Saxony-Anhalt, and the Vereinigte Zuckerfabriken GmbH at Malchin, Mecklenburg).[19]

In the postwar years sugar plants were built in Czechoslovakia on Soviet account—for example, two were shipped to the U.S.S.R. in 1955.[20] In the late 1950s and the 1960s extensive purchases were made in the United Kingdom and in Germany. What is more, an order for $4.2 million worth of sugar beet equipment was placed in 1959 with Booker Brothers, Ltd., McConnell & Company, and Vickers-Armstrongs (Engineers), Ltd.[21] This was followed in 1960 by an order to Vickers & Booker, Ltd., for two complete sugar plants to be located in Moscow and the Ukraine valued at $22.4 million and each capable of handling 5000 tons of sugar beet per day.[22] In 1961 Eimco (Great Britain), Ltd., supplied eight rotary vacuum filters, four five-compartment tray thickeners, and two filtration plants for $392,000.[23] Then in 1968 Vickers & Booker, Ltd., supplied a total of $23.8 million worth of beet sugar processing equipment to equip two complete plants—one of which was to be built by Vickers & Booker.

[17] See Sutton I, p. 235; and *Die Chemische Fabrik* (Weinheim, Ger.), 1, 42 (October 17, 1928), 615.

[18] Amtorg, *Economic Review of the Soviet Union* (New York), IV, 23 (December 1, 1929), 428.

[19] G. E. Harmssen, Am Abend der Demontage; Sechs Jahre Reparationspolitik (Bremen: F. Trüjen, 1951).

[20] *Czechoslovak Economic Bulletin* (Prague), no. 293 (February 1, 1955).

[21] *East-West Commerce* (London), VI, 5 (June 4, 1959), 14.

[22] *Chemistry and Industry* (London), February 6, 1960, pp. 154-55. It is presumed that Vickers & Booker, Ltd., is a joint company formed by Booker Brothers and Vickers-Armstrongs (Engineers), Ltd.

[23] *Chemistry and Industry*, July 15, 1961, p. 1087.

WESTERN ASSISTANCE FOR FOOD-PACKING PLANTS

There has been consistent and substantial Western technical assistance for Soviet food-packing and canning operations since the 1920s. For example, in the 1930s at the Kamchatka salmon canneries it was reported,

> All the machinery "down to the nuts and bolts" was American and most of it had been made in Seattle. Makers included the Smith Cannery Machine Co. [and] the Troyer-Fox Co. (Continental Can subsidiary or affiliate), and the lighting installations had been made by Fairbanks-Morse.[25]

In the Kamchatka canneries at that time there were also about 14 Americans working in various positions to train Russians and supervise operations.[26] The American consulting engineer for the Kamchatka salmon canning industry was Alvin L. Erickson, who lived in Vladivostok for about three years in the early thirties, supervising the 15 central canneries that had been established since 1930. These were equipped with the "finest machinery and accessories": according to Erickson most were superior to the average West Coast or Alaskan cannery, " ... while some of them are in installation equal to any in the world."[27] Two of the canneries had been equipped with the latest vacuum-type machinery, each with four lines and a maximum capacity of 9000 cases per day. The industry also acquired 20 modern trawlers which were in charge of an English superintendent, and some German engineers were employed in installing new equipment.[28]

An even more comprehensive food processing contract was that received by the Chicago Kitchen Company, which supplied six architects for six months to design the Soviet community kitchens. This group prepared the detailed plans for 11 model community kitchens which were then duplicated by the Soviets.[29]

In the 1950s and 1960s the purchases of complete plants continued. It was reported in 1957, for example, that

> Mather & Platt, Ltd., Manchester, holds two contracts for the U.S.S.R. including canning lines for fresh peas and also canning lines to handle both fresh peas and runner beans. All these lines are complete, i.e., they start with viners, into

[24] *Wall Street Journal*, March 30, 1967, 20:6.

[25] U.S. State Dept. Decimal File 861.5017/Living Conditions/709, Report no. 689. See also /589 and 861.7186/1, Tokyo, August 31, 1933. The State Department in Washington made the notation, "The memorandum is not of great interest."

[26] U.S. State Dept. Decimal File 861.5017/Living Conditions/709.

[27] U.S. State Dept. Decimal File 861.5017/Living Conditions/701.

[28] *Ibid.*

[29] U.S. State Dept. Decimal File 861.5017/Living Conditions/371. This group had the rare privilege of working in OGPU installations.

which the complete peas plant is fed, and finish with packaging machinery which labels the cans, packs the required number into a case, and then seals the flaps of the case.[30]

A year later Yugoslavia concluded contracts with the U.S.S.R. to provide seven processing plants to manufacture tomato puree, the contract being valued at $440,000.[31] This continued an earlier contract for 12 complete tomato puree processing plants and was subsequently followed by a contract for yet another nine plants valued at $770,000.[32] It would not be unreasonable to suppose that Yugoslavia and Italy have provided the greater part of the Soviet tomato puree manufacturing capacity.

In 1967 the Italian firm of Carle & Montanari of Milan supplied equipment for a plant to be erected at Kuibyshev for the manufacture of 80 to 100 tons per day of chocolate and powdered cocoa, packed and ready for sale. The contract was valued at $10 million.[33] In the same year another Italian firm, S.p.a. Tecmo (Tecnica Moderna) signed a contract valued at $6.4 million to build and equip a plant at Stupino to produce cardboard packaging; the plant's capacity was to be 60,000 tons per year of containers for use in automatic food packing lines.[34]

However foreign assistance apparently is not always utilized industry-wide after it is attained. For example, the 1963 U.S. dairy delegation visited milk and dairy products processing plants, and one observer noted:

> Based on about 27 years of milk plant experience in this country [i.e., the United States], I must say that [the Soviets'] processing equipment, in terms of bottle washers, holding tanks, clarifiers, pasteurizers, final bottling, and capping equipment, are many years behind that which we are permitted to use in this country.[35]

Considering that ten years earlier, in 1954, the Soviet Union purchased from U.D. Engineering Co., Ltd. (a United Kingdom firm and a subsidiary of the dairy chain United Dairies, Ltd.) milk bottling and processing equipment to a total of $3 million, the conditions encountered in 1963 by the U.S. dairy delegation are somewhat surprising.[36]

[30] *East-West Commerce*, IV, 4 (April 3, 1957), 11.
[31] *East-West Commerce*, V, 1, (January 3, 1958), 13.
[32] *Ibid.*
[33] Communication from Embassy of Italy, Washington, D.C.
[34] *Wall Street Journal*, November 14, 1967, 12:4.
[35] Unpublished report by George D. Scott, vice president of Ex-Cell-O Corp.: "Dairy Exchange Delegation to Russia, July 7, 1963-August 2, 1963"; typescript supplied by Dairy Society International, Washington, D.C. The delegation interpreter had the following parting words for Mr. Scott at the Moscow airport: "Mr. Scott, now that you have personally visited several of our great cities in the Soviet Union, and have learned the *truth*, I hope when you return to America, you will try to incite your people to a revolution against the tyranny of your capitalistic system." Report, p. 13.
[36] *The Times* (London), March 24, 1954, p. 4d. For further information see, V. P. Prityko and V. G. Lungren, *Mashiny i apparaty molochnoi promyshlennosti* (Moscow, 1968).

THE WEARING APPAREL INDUSTRY IN 1960

In the early 1960s the clothing industry of the Soviet Union, according to well-qualified U.S. observers, was very backward. In fact it might be concluded from reports of these observers that in terms of organization, methods, and equipment the industry had not advanced very much from Tsarist times.

In mid-1963 the United States sent a garment industry exchange group to the Soviet Union, and the report made by one member of that delegation, Alexander Lerner, President of Phoenix Clothes, Inc., of New York, is a perceptive account through the eyes of an expert observer.[37] After the delegation had visited several clothing factories, Lerner's general conclusion was:

> The production equipment, in my estimation, is very antiquated . . . they are very backward in their supervision and pressing equipment. In their handling of production, they are as far back as 30 to 50 years. . . . [38]

The report then elaborates and supports this summary statement on a plant-by-plant basis. The delegation toured the Central Scientific Research Institute of the Sewing Industries and viewed films of new equipment in operation in the various factories. These films, however, did not show machines at work, and Lerner comments:

> After all this information was given to us, I was very anxious to see some of these machines in operation. We saw some of them at the different factories, but they did not accomplish in action what [I anticipated from what] I saw in the films. Many of the machines [shown in the films] I did not see at all.[39]

Similarly, the Indian Textile Delegation noted that although a great deal of development work was apparently under way in the research institutes they did not see models or systems actually in operation.[40]

The first factory visited by the American group was No. 16 in Moscow, founded before the Revolution. One of the Institute machines viewed was for pressing cuffs and collars by a hot-iron method using a spray of water and no steam—a method described in the report as "very obsolete." At this factory the sewing machinery as a whole was 20 to 40 years old, with perhaps 10 percent of it less than five years old. The second factory visited was No. 2 in Moscow, manufacturing men's suits and slacks. About 80 percent of the machinery here was 30 to 40 years old and the balance, less than five years

[37] Acknowledgement is due Mr. Alexander Lerner for his courtesy in making a copy of his report available. The complete report has been deposited in the Hoover Institution Archives.

[38] Lerner report, p. 1.

[39] *Ibid.*, p. 3.

[40] *Textile Industry in U.S.S.R. and Czechoslovakia.* Report of Indian Productivity Team (New Delhi: National Productivity Council, November 1962), Report no. 19, pp. 42-43.

old, of Russian, German, and Hungarian manufacture. There was no steam pressing because "they had no way of making steam." The plant operated on a straight-line system:

> We visited their cutting rooms and [were] astounded to see their manner of cutting. They were using two-, three-, and four-suit markers.... Also, even though this wasn't heavy fabrics, they were only laying it up 14 double spread and less. They had a tremendous amount of cutters and spreaders for this operation. There were three spreaders to each table.

Lerner then mentions the low quality of Soviet clothes:

> I see now why the clothing is being delivered so badly [in] quality of workmanship. It is simply atrocious. Where they could use automation, they are using the most obsolete methods. I have been in the clothing business for over 35 years and I have never seen such pressing and finishing of garments.[41]

The next plant visited—the Kishinev—was more modern, an improvement over the Moscow plants with only 65 percent "antiquated" equipment and 35 percent less than five years old. The methods were better; while two-, three-, and four-suit markers were still in use, the cutting heights were greater—30 high, and slacks 50 layers high—and there were two, not three, spreaders per table. The Smitrnov-Lastochkin plant in Kiev had antiquated machinery—about 80 percent old and 20 percent more recent machines. The Ukraine factory, also in Kiev, had similar equipment and methods. Finally, the Volodarsky clothing factory in Leningrad was visited, and the systems, machines, and methods there were found to be similar to those of the plants previously toured.

On its return to Moscow for a promised look at the equipment making machines for clothing plants, the delegation was informed that the plant was closed. A visit to a Moscow woolen mill was substituted. This plant was over 100 years old but its machinery was installed after 1917; up to the mid-1950s it had used all American equipment; some of its more recent machines had been built in Tashkent. The delegation reported: "The looms are 10 years old and all German-made. They have ordered 50 percent of their new looms from Sweden."[42]

On the basis of this report by skilled observers it may be concluded that not only was the Soviet wearing apparel industry backward in 1961; it was heavily dependent for its current production on imported equipment.

The manufacture of boots and shoes is a consumer sector for which the Soviets apparently have been unable even to reproduce Western manufacturing equipment. In 1928 the Lenin shoe factory was equipped with foreign machines[43]

[41] *Ibid.*, p. 7.
[42] *Ibid.*, p. 18.
[43] Amtorg, *Economic Review of the Soviet Union* III, 6 (March 15, 1928), 104.

that had been supplied in addition to the concession arrangements previously described.[44] In the early 1930s foreigners apparently acted as supervisors of such plants. For example, in 1932 Max Korr, an American, was under a 300-rubles-per-month contract as superintendent of a shoe factory in Grozny making boots for the Red Army.[45]

More recently, in 1968, 20 complete shoe production lines for plants in Leningrad, Moscow, and Kiev were purchased for $5.6 million from British United Shoe Machinery Company of London (a subsidiary of United Shoe Machinery Corporation of the United States). This order included 2100 machines to produce shoes by the cemented-sole process, and the equipment was installed by British engineers.[46]

In addition, large orders for shoes have been placed abroad. In January 1967 the Lotus Company of the United Kingdom received an order for $2.8 million worth of men's and women's shoes;[47] a few weeks later the Cooperative Wholesale Society reported the largest single order it had ever received from the U.S.S.R.—80,000 pairs of women's shoes, which was 50 percent more than the previous year's order.[48] The British Shoe Corporation also announced a $490,000 order for 100,000 pairs of women's shoes.[49] Simultaneously, Japanese firms sold to the U.S.S.R. 1.2 million square feet of "Clarino"—a Japanese-developed "breathing synthetic material."[50]

[44] See Sutton I, p. 231.
[45] U.S. State Dept. Decimal File 861.5017/Living Conditions/505.
[46] *Wall Street Journal*, March 12, 1968, 27:5.
[47] *The Times* (London), January 8, 1967.
[48] *The Times* (London), January 20, 1967.
[49] *Ibid.*
[50] *The Times* (London), January 11, 1967.

PART III

Implications and Conclusions of the Study

CHAPTER TWENTY-FIVE

Innovation in the Soviet Union

The purpose of this chapter is to summarize verifiable Soviet innovation and to determine the degree of indigenous innovation that has taken place in the Soviet Union relative to the import of foreign innovation. Hopefully this summary will throw some light on the organic capability of the Soviet society to innovate. We may first usefully sum up the innovations found to be truly of Soviet origin.

The first volume of this series isolated several unsuccessful attempts by the Soviets to develop their own technologies. Tractor production in the mid-1920s provides an excellent example.[1] Although these attempts failed, there is no question that considerable effort and resources were placed behind such innovative experiments.

In the period covered by the second volume,[2] the years 1930 to 1945, rather surprisingly we do not find continuation of early efforts; rather we see an abandonment of domestic innovation, but not of basic research effort, and the substitution of wholehearted adoption of foreign techniques. This policy led to the widespread practice of copying and duplication, so that by 1945 Soviet industry was a more or less haphazard copy of Western, predominantly American, technology. The major exceptions to this rule were to be found in Ramzin's "once-through" boiler (which, however, had been abandoned by 1945), the turbodrill, and several machine gun and weapons designs. The weapons designs originated with copies of Western guns, but by 1945 the Soviet stress on the military sector had provided some indigenous Soviet military capability—although Soviet technology was still woefully backward in areas such as fire control and radar. The U.S.S.R. was able to concentrate effort in this field by virtue of free import of Western advances in the general industrial sectors, thus releasing scarce design and engineering talent resources for military work.

In the period covered by this volume (1945-65) we find several groups of indigenous innovations, although obviously the hypothesis that there has been an absence of self-generated innovation is generally supported.

Two questions now arise: what is the nature of these groups of indigenous

[1] See Sutton I, pp. 133-35.
[2] Sutton II.

Soviet innovation? Why have they appeared in only a few fields, and not generally throughout the industrial structure?

SOVIET INVENTION IN THE WORLD MARKET

Table 25-1 contains a list (from an official Soviet source) of *all* Soviet foreign licensing agreements in force at January 1967.

Table 25-1 COMPLETE LISTING OF SOVIET PATENT AND LICENSE AGREEMENTS IN FORCE OUTSIDE THE U.S.S.R. AS OF JANUARY 1967

Country	*Number of Agreements*	*Description of Soviet Invention Transferred*
United States	17	16 agreements for suture instruments
		1 agreement for procedures for producing liquid cores and mold mixtures
Canada	1	Prosthesis of the forearm with bioelectrical control
United Kingdom	3	Computing device for calculating the number of sheets in a stack of paper (sheet counting machine)
		Prosthesis of the forearm with bioelectrical control
		Machine for wire cell bundling at iron and steel plants
Denmark	1	Liquid core and mold mixtures; procedure for producing cores and molds thereof
Italy	5	Universal system of industrial pneumoautomatic elements
		Optimalizing pneumatic controller
		Liquid core and mold mixtures; procedure for producing cores and molds thereof
		Electrodes for arc welding and building up of gray and high-strength cast iron
		Mill for cold rolling of tubes
Norway	1	Liquid core and mold mixtures; procedure for producing cores and molds thereof
France	18	Continuous steel casting plant
		Electro-pulse machine tool for processing to size of conducting materials, model 4733
		Device for automatic control of electrode rod gap
		Device for automatic selection and adjustment of optimal electrode rod gap, model 3P
		Rotary unipolar pulse generators
		High-frequency unipolar pulse generator
		Carbon-graphite material for measuring electrodes, grade
		Machine tool for processing shaped articles made of graphite-containing materials, measuring electrodes predominantly, model MA-459

Table 25-1 (cont.)

Country	Number of Agreements	Description of Soviet Invention Transferred
		Method for electroslag welding and metal buildup and the device for carrying out the above method (apparatus A-372 and A-501)
		Liquid core and mold mixtures; procedures for producing cores and molds thereof
		Method of producing the drug Luteneurin
		Universal system of industrial pneumoautomatic elements
		Optimalizing pneumatic controller
		Evaporative cooling plant for open hearth and heating furnaces
		Powder-cored wires
		Laminated material for resistors and high-precision potentiometer
		Electroslag remelting of metals and alloys in water-cooled mold and equipment for its realization
		Method of continuous neutralization of grease and oil in soap-alkaline medium
Federal Republic of Germany	5	Electrodes for arc welding and surfacing of gray and high-strength iron
		Powder wires agreements for 3 turbodrills
Switzerland	1	Method of dimecarbine production
Sweden	3	Method for electroslag welding and metal build-up and the device for carrying out the above method (apparatus A-372 and A-501)
		Liquid core and mold mixtures; procedure for producing cores and molds thereof
		Method for production of hydrogen peroxide with concentration up to 45 percent by weight
Japan	6	Continuous steel casting plant
		Method for preparation of fine-granulated components for the manufacture of the artificial building material silicalcite
		Electrodes for cold welding and buildup welding of gray iron
		Electroslag remelting of metals and alloys in water-cooled mold and equipment for its realization
		Digger shield for tunneling in weak ground, 3.6-meter diameter
		Mechanized composite mining units (Tula for complete mechanization of coal mining operations)

Source: Letter from Litsenzintorg (Licensintorg), Moscow, February 18, 1967.

In brief, this listing presents the sum total of Soviet invention that had the proven potential of competing in the world technical marketplace as of January 1967. It is not a list of adopted invention, i.e., innovation, but only of that Soviet invention which had possibilities of commercial adoption in the face of competing world technical developments. It is therefore an accurate comparative guide to the originality of Soviet invention, particularly as Party injunctions have been to sell Soviet technology abroad wherever possible. Table 25-2 summarizes the information contained in Table 25-1 on a country-by-country basis and indicates the degree of duplication of licensing agreements and the narrowness of the technical areas covered.

Table 25-2 SUMMARY OF SOVIET FOREIGN LICENSING AGREEMENTS AS OF 1967

		Technologies			
Country	*Number of agreements*	*Suture instruments and apparatus*	*Liquid cores and molds*	*Welding techniques*	*Other*
United Kingdom	3	—	1	—	2
Denmark	1	—	1	—	0
Italy	5	—	1	1	3
Canada	2	1	—	—	1
Norway	1	—	1	—	0
U.S.A.	17	16	1	—	0
France	18	0	2	4	12
F.R.G.	5	—	—	1	4
Switzerland	1	—	—	—	1
Sweden	3	—	1	1	1
Japan	6	—	—	2	4
	62	17	8	9	28

Source: Derived from Table 25-1.

The country having the largest number of agreements was France, with 18. The United States was second with 17, and of these 17, 16 were with U.S. Surgical, Inc., for suture instruments and one was for a core and mold mixture process with Heppenstal.[3]

As we have pointed out, these 62 licensing agreements constitute Soviet inventions that had potential on the world market at 1967. They do not constitute innovations, as the existence of a licensing agreement does not necessarily imply a technology's application in practice. Apart from the small number of such licensing agreements, analysis discloses some rather remarkable features. Of the 62 total, 17 were for medical suture instruments (there are duplicates, as

[3] Examination of Soviet technico-economic literature suggests there was a remarkable lack of substantive innovation—or even invention—in the late 1960s. See, for example, the numerous reports in the monthly *Biulleten' tekhnikoekonomicheskoi informatsii* (Moscow), and various appeals in *Pravda* for a higher technical level of invention and innovation. Pure scientific discovery was somewhat more satisfactory but hardly reflected the proportion of Soviet resources it absorbed.

the same machine may be licensed to more than one country) and another nine licenses were in the field of welding metals. Thus more than one-third of the agreements related to the extremely narrow and specialized aims of joining together either human tissue or metals. The next largest category is licensing in seven countries of a process for producing liquid core and mold mixtures.

In sum, a close look at these 62 licensing agreements reveals a remarkable paucity of Soviet invention to compete with the hundreds of thousands of processes licensed on the world market.

INDIGENOUS INNOVATION IN WEAPONS TECHNOLOGY

Soviet innovation presents a paradox: an extraordinary lack of effective indigenous innovation in industrial sectors is offset—so far as can be determined within the limits of open information—by effective innovation in the weapons sectors, although some weapons development is akin to "scaling-up" innovation (see pp. 362-64).

As far back as the 1930s some indigenous innovation was achieved in such weapons as machine guns and tanks.[4] Such development has become much more noticeable in recent years. A recent weapons innovation in which Russian engineers appear to have conquered a problem unsolved in the U.S. Navy is that of ship-borne radar. Although the U.S. Navy has done a great deal of work in radar control of ship-launched or shore-launched missiles, it remained for the Soviet Styx missile, in the fall of 1967, to sink the Israeli destroyer *Elath* at a distance of more than 12 miles with three shots, thus demonstrating dramatically the effectiveness of a radar-guided surface-launched anti-ship missile. The U.S. Navy had abandoned research because ship-borne radar in such a missile must lock onto a target ship and deliver guidance commands; these commands tend to be swamped by "sea clutter," i.e., spurious signals reflected from the water when radar operates at a flat angle. Obviously, Russian technicians were able to overcome the problem.[5]

We may deduce from this and similar examples that weapons innovation can be successfully achieved by a centralized bureaucracy. This is because weapons innovation is predicated upon well-defined objectives. Military planners, unlike economic planners, can estimate fairly accurately what the next technological stage will be for a given weapon and can define a technical objective for that weapon in clear terms. Work toward such a preordained objective can proceed along well-established lines. Moreover, military technology developed toward a specific objective can be pretested to determine whether it fulfills its objective.

[4] See Sutton II, pp. 240-45.
[5] *Business Week*, November 29, 1969, p. 32.

By contrast, economic innovation has no such clearcut technical objectives, and it does not lend itself to such pretesting. Effective innovation in industrial sectors results from the positive interaction of a myriad of complex forces; it can be realistically tested only in a market situation wherein the market itself determines its success or failure. Soviet central planning cannot anticipate key variables because it lacks the information network of a free market. Moreover the system provides little incentive to explore the unknown: central planning necessarily places its emphasis on known technology, not on revolutionary technology. Therefore innovation in the nonmilitary sectors is likely to be imported from market economies.

Thus the Soviets can achieve adequate weapons innovation—given the existence of a reasonably effective back-up industrial structure—while failing miserably in the economic area of industrial innovation.

Western creation of a viable Soviet industrial structure is therefore also a Western guarantee of a viable Soviet weapons system. This Western economic support ensures that weapons systems may be developed and brought into production because the output of the industrial sector is the input of the military sector, which, unlike the industrial sector, has a proved capacity for self-generated innovation.

SCALING-UP INNOVATION

Review and analysis of Soviet technical achievements outside those offered for export and weapons systems leads to the conclusion that many such other achievements are better described as technical progress attained by means of scaling up Western technologies. This conclusion may be best explained by considering in broad outline the categories in which the Soviets have made indigenous achievements and the relationships between these superficially dissimilar technologies.

Soviet indigenous technical progress is concentrated in three industrial sectors: iron- and steelmaking (but not steel rolling), electricity generation and high-voltage transmission, and rocket technology. It may be noteworthy that each of these three technologies was at one time or another pushed by dominant party personalities: Stalin, as his name implies, favored the iron and steel industry; Lenin of course was the force for the electrification of Russia; and Khrushchev was a force behind the development of rocket and space technology.

Soviet work on blast furnaces has been toward the development of larger volume furnaces and the application of new techniques to the classic process. In open-hearth steelmaking the lines of technical progress are somewhat more complex. In the words of one commentator: "Many things have contributed to the good results obtained by the Soviets on their open hearths, but I feel that the hot-metal spout and the basic roof setup are unique, and probably very important."[6]

Soviet advances in electricity generation have impressed many observers. In 1960 a subcommittee of the U.S. Senate noted that the Soviet power program produced the largest hydroelectric stations in the world—yielding the greatest amounts of electricity from the largest generators connected by the longest transmission lines operating at the highest voltage.[7] It was also noted that while in 1960 the heaviest U.S. transmission lines were 345 kv, the Russians then operated 400-kv lines. These were being stepped up to 500 kv and plans called for use of alternating-current transmission up to 1000 kv and direct-current transmission at 800 kv. The subcommittee concluded:

> It is to the Russians' credit that, building on the experience in technology acquired, they have now caught up with the rest of the world in the general field of hydroelectric development. In fact they are actually pre-eminent in certain specific aspects of such development.[8]

In point of fact, this Senate assessment was somewhat overstated. It was based on only a few observations, in themselves accurate but not sufficiently extensive to warrant the broad conclusions reached.

In rocket technology the Soviets first absorbed the German technology and then, after about 1960, went ahead on their own with more powerful rockets, in effect a scaling up of the original German rockets.

There is a common denominator in each of these seemingly unrelated industrial sectors where the Soviets have made indigenous advance. In each case the Soviets started with a basic Western technology—indeed a classic technology—that was well established and had a strong technical literature. The blast furnace dates from the eighteenth century, and the open-hearth furnace from the nineteenth century. In electricity generation the Soviets adopted the Kaplan and Francis runner systems, and of course long-distance electricity transmission was started in the 1920s. In rockets the Russians have a strong historical interest, but in practical technology they started with the relatively advanced German technology of World War II, and above all they had the reliability trial data from 5700 German tests.

Therefore the essence of each case in which the Soviets have made indigenous advance is that they first acquired and mastered a known and classic technology. In each case the considerable power of the Communist Party chose the industrial

[6] K. C. McCutcheon, "Open Hearth Shops of the U.S.S.R." *Journal of Metals* (New York), November 1958, p. 725.

[7] U.S. Senate, Committees on Insular Affairs and Public Works, *Relative Water and Power Resource Development in the U.S.S.R. and the U.S.A.*, Report and Staff Studies, 86th Congress, 2d session (Washington, 1960), p. 2.

[8] *Ibid.*, p. 1.

sector for allocation of resources, and indigenous technical progress in each case has been in effect a logical scaling up of an original classic Western technology.[9]

In each case the process technology has a precise technical framework and is capable of expansion in size. For example, in blast furnaces Soviet designers concentrated on increase in cubic volume or on specific developments, such as high top pressure, to increase output from a given volume. The same applies to open-hearth steel furnaces, which at a very early date the Soviets expanded in size to 500 square meters. In electrical generators we find the Soviet effort concentrated on an increase in generation capacity, and in transmission lines we find effort concentrated on increase in voltage transmitted.

Not all Soviet scaling-up efforts are so logically conceived as those cited above. Sometimes they are neither technically nor economically practical; sometimes size for its own sake seems to be the desired goal. For example, Moscow has the tallest television tower in the world. With a full height of 1722 feet this structure comprises a prestressed concrete base 1260 feet high topped by a 462-foot antenna. Conic in profile, it is 196 feet in diameter at the base tapering to 26.5 feet at the top. Construction, which took ten years, was interrupted by a debate as to whether high winds would induce oscillations that would create a safety hazard. The tower is designed to withstand winds of 141 mph, although winds of that velocity occur only about once in 50 years in Moscow. In such a wind the tower will oscillate 32.8 to 36 feet, while it is designed for oscillations up to 42.6 feet.[10] What is the end result of this project? The tower increases television range in Moscow from 30 to 50 miles; hence the incremental benefit is an increase of 20 miles in range, a benefit that hardly seems to justify the costs and risks of the effort. On the other hand, Moscow *does* have the tallest TV tower in the world.

In a similar vein, at a 1960 chemical exhibition in Europe the Soviets introduced "what must have been the largest model of a chemical plant ever to appear at a European exhibition."[11] There was nothing novel about the plant itself; the model represented a well-established process for making synthetic rubber. But it was the largest model, and that constituted its novelty.

In each of the cases cited as representative of productive indigenous advance, there was an expansion in quantitative terms of a known classic technology. Consequently much Soviet advance actually falls within the category of technical progress acquired by the application of engineering and experimental resources to a given known technology. It is not innovation in the sense that innovation establishes new and formerly unknown technological horizons.

[9] "Scaling-up" innovation based on Western processes may be found in other sectors, e.g., in sulfuric acid production (1000-ton-per-day contact systems) and coke-oven batteries.

[10] *Engineering News-Record* (New York), December 1, 1966, p. 33.

[11] *British Chemical Engineering* (London), December 1960, p. 868.

AN OVERVIEW OF TECHNOLOGICAL ORIGINS

We may conclude with empirical justification that Soviet indigenous industrial innovation is limited to two types: (a) scaling up, and (b) the miscellaneous category exemplified by the suture, welding, and minor industrial applications licensed for world marketing in 1967 (see Table 25-1).

Obviously, so far as the Soviet economy is concerned, the more important of these types is scaling-up innovation, whereby the Soviets take a classic Western process and proceed by dint of investment, research, and development work to increase the size or capacity of the productive unit. The results of such technical scaling up may or may not meet the test of the Western marketplace; there is no recorded case of its export to the West. Only the second category has led to attempts to export to the West. The returns from these exports are infinitesimal compared with the resources and talent available within the Soviet Union.

It now remains to bring together the overall picture from 1917 to 1965. Table 25-3 identifies origins for technology in 14 major Soviet industrial sectors in each of the periods examined in the three volumes of this study. Where Soviet innovation is the main process in use, it is noted in capitalized italics. Table 25-3 then, is a final summary of the conclusions from the empirical examination of technology in the U.S.S.R. over the course of 50 years.

Of necessity it is a broad examination. There are indeed many thousands of industrial processes; Table 25-3 includes only the most important and, for purposes of further illustration, a select number of lesser importance. There is no question, for example, that drilling technology is fundamental to oil production or that pig iron production is fundamental to iron and steel production; however, of necessity, numerous less important processes for each industry are omitted.

Table 25-3 AN OVERVIEW OF TECHNOLOGICAL ORIGINS OF MAIN SOVIET INDUSTRIAL PROCESSES FROM 1917 TO 1965

No.	*Industrial Process*	*1917-1930*	*1930-1945*	*1945-1965*
	MINING			
1.	Underground equipment	German	U.S./ German	U.S./U.K./ German
2.	Excavation equipment	German U.S./U.K.	U.S.	U.S./U.K./ German
3.	Crushers	U.S.	U.S.	U.S.
4.	Ore beneficiation	—	U.S./ Swedish	U.S./German/ French
5.	Sintering	—	U.S.	U.S.
	OIL INDUSTRY			
6	Drilling	U.S.	*SOVIET*	*SOVIET*

Table 25-3 (cont.)

No.	*Industrial Process*	*1917-1930*	*1930-1945*	*1945-1965*
7	Pumping	U.S.	U.S.	U.S.
8.	Pipelines: pipe	U.S./ German	U.S.	German/ Japanese
9.	Piplines: compressors	U.S./U.K.	U.S.	U.S./Swiss
10.	Refining and cracking	U.S./ German/U.K.	U.S.	U.S./French/ German/ Czechoslovak
	FERROUS METALLURGY			
11.	Pig iron	Classic blast furnace	Scaling-up	*SOVIET*/U.S./ German
12.	Steelmaking	Classic open hearth	Scaling-up	Austrian/ *SOVIET*
13.	Steel rolling: blooming	U.S./ German	U.S./ German	U.S./ German
14.	Steel rolling: wide sheets	U.S.	U.S.	U.S.
15.	Steel rolling: tubes	U.S./ German	U.S./	U.S.
16.	Continuous casting	U.S./ German	U.S./ German	German/ *SOVIET*
	NONFERROUS METALLURGY			
17.	Nickel smelting and refining	—	Canadian	Canadian/Norwegian
18.	Aluminum smelting and refining	German/ U.S.	U.S./*SOVIET*	*SOVIET*/U.S./ Czechoslovak
19.	Copper smelting and refining	U.S.	U.S.	U.S.
	CHEMICAL INDUSTRIES			
20.	Basic acids	U.S./German/ Italian	U.S. German	U.K.
21.	Basic alkalis	Tsarist/ U.S.	U.S./German/ U.K./Tsarist/ Swedish	U.S./German
22.	Fertilizers	Swedish/U.S./ German	Swedish	U.S./Belgian/ Dutch/Italian/ U.K./Japanese
23.	Synthetic fiber intermediates	French	French German	U.K./German/ U.S.
24.	Agricultural pesticides	—	—	U.K.
25.	Synthetic rubber	Tsarist	*SOVIET*	German/ U.S./U.K.
26.	Rubber tires	U.S./ German	U.S./U.K.	U.S./U.K. Italian
27.	Glass	U.S./ German	Belgian/ U.S.	U.K.

Table 25-3 (cont.)

No.	*Industrial Process*	*1917-1930*	*1930-1945*	*1945-1965*
28.	Cement mills	Danish/ German	Danish/ German	Danish/French German
29.	Coke byproducts	Tsarist	U.S./German	Scaling-up
30.	Pharmaceuticals	German	German/U.S.	U.S./Austrian
	MACHINE BUILDING			
31.	General technical assistance	German/U.K.	U.S./German	(None)
32.	Machine tools	German/U.S.	U.S./German/ U.K.	U.S./German
33.	Ball bearings	Swedish/Italian/ German	Italian/U.S.	U.S./Italian
34.	Instrumentation	U.S./German	U.S./German	U.S./German
	ELECTRICAL EQUIPMENT			
35.	General technical assistance	U.S./German/ U.K./German	U.S./U.K./	(None)
36.	Heavy electrical equipment	U.S./U.K./ German	U.S./U.K.	U.S./scaling-up
37.	Low tension equipment	U.S./Swedish/ French	U.S./German	German
38.	Instruments	German/U.S.	U.S./German	U.S./German
	COMMUNICATIONS			
39.	telephone	Swedish/French/ U.S.	Not investigated	French
40.	telegraph	Danish/U.K.	Danish	Not investigated
41.	radio	U.S.	U.S.	Not investigated
42.	television	—	U.S.(black and white)	French (color)/ German
43.	Computers	—	—	U.S./U.K.
	PRIME MOVERS			
44.	Steam boilers	Latvian/ German	*SOVIET*/U.S.	U.S./U.K./ German
45.	Internal combustion	U.S.	U.S.	U.S./German
46.	Diesel engines	German	German/U.K.	German/Danish/ U.S./Swiss
47.	Gas turbines	—	—	French
	AGRICULTURAL EQUIPMENT			
48.	Tractors	U.S./German	U.S.	U.S./U.K./ German
49.	Cotton pickers	—	U.S.	U.S.
50.	Seeding equipment	Tsarist	U.S.	U.S./German

Table 25-3 (cont.)

No.	*Industrial Process*	*1917-1930*	*1930-1945*	*1945-1965*
	TRANSPORTATION INDUSTRIES			
51.	Automobile and trucks	Tsarist/U.S./Italian	U.S.	U.S./German/Italian/French
52.	Railroad locomotives:			
53.	steam	Tsarist/German/U.K.	Tsarist/U.S./U.K.	*SOVIET*/U.S./German
54.	diesel-electric	U.S./German	German	U.S.
55.	electric	German/U.S.	U.S./German	French/U.S.
56.	hydraulic	—	—	Austrian/German
	SHIPBUILDING			
57.	Hull construction	German	75 percent foreign-built	66 percent foreign-built
	Engine design:			
58.	diesel	German	German	Danish/German/Swiss
59.	steam turbine	U.K./U.S.	U.K.	Not known
60.	gas turbine	—	—	French
61.	Trawlers	—	U.K./French/German	U.K./German
62.	Oceanographic equipment	—	U.S./German	U.S./Japanese
	AIRCRAFT			
63.	Aircraft	German	U.S./Italian	*SOVIET*(?)
	Aircraft engines:			
64.	internal combustion	U.S./German	U.S./French	—
65.	turboprop	—	—	
66.	pure jet	—	—	U.K./German
67.	Helicopters	—	*SOVIET*/Italian	*SOVIET*(?)
68.	Landing and communication equipment	Not investigated	U.S.	U.K./U.S.
	MILITARY INDUSTRIES			
69.	Explosives	German	U.S.	
70.	Poison gas	German	U.S.	
71.	Tanks	French/U.K./Italian	U.S./U.K./*SOVIET*	Data
72.	Machine guns	Tsarist/U.K.	*SOVIET*/Finnish	classified
73.	Submarines	German	German/U.K.	
74.	Destroyers	—	Italian/French	
	CONSUMER INDUSTRIES			
75.	Clothing industries	Tsarist/U.S./German	U.K./German	U.K./German/U.S.
76.	Boots and shoes	Austrian/Danish	Not known	U.K.

Sources: Column 1 — Sutton I: *Western Technology ... 1917 to 1930;* Column 2 — Sutton II: *Western Technology . . . 1930 to 1945*; Column 3 — Sutton III: *Western Technology . . . 1945 to 1965*.

Notes: (1) Multi-country listings indicate several technical origins, listed in order of relative importance. (2) In a few cases, as for example in the origin of steam locomotives in the 1930 to 1965 period, there has been Soviet adaptation of basic foreign or Tsarist-era designs; these entries are noted *SOVIET* first and foreign sources second.

The first column in Table 25-3 relates to the period 1917 to 1930. There was no Soviet innovation in this period, although there were, as described in the first volume, several attempts in tractors and synthetic rubber to establish Soviet products.[12] It should be noted that in this period the oil drilling industry was converted almost completely to the American rotary drilling technique.

The second column in Table 25-3 relates to the period 1930 to 1945. In this period Soviet innovation was identified in five of the 75 major industrial processes listed. Although the turbodrill used in oil-well drilling reportedly has German origins, the Soviets undoubtedly have worked on it extensively and the drill introduced in the 1930s may aptly be called a Soviet development; it replaced the rotary technique introduced in the 1930s and by the 1950s was handling the greater part of Soviet drilling. However, overheating and other technical problems led the Soviets to consider a return to rotary drilling in the 1960s. Smelting of alumina from nepheline is a process conducted only in the U.S.S.R. The original flow diagram and equipment for this process were designed by an American company,[13] but there undoubtedly has been some Soviet work. Synthetic rubber, butadiene SK-B, is a result of prerevolutionary Russian research effort, and production was developed under the Soviets. The Ramzin "once-through" boiler appears to be a Soviet innovation, as is the development of some machine guns.

There is no clearcut example in the 1930-45 period of a technology started and brought to productive fruition under Soviet guidance; each of the five examples cited above (except possibly the Ramzin boiler) had its origins outside the Soviet era. On the other hand, the conversion from pilot plant (or equivalent) to series production was achieved in the Soviet economy.

The last period (1945 to 1965) is of particular interest in that we find that several of the five "Soviet" processes adopted between 1930 and 1945 were partly supplanted by Western processes. SK-B was supplemented by Western synthetic rubbers produced with Western equipment. The Ramzin "once-through" boiler was limited to small sizes and Western models were introduced in larger sizes. In turbodrills we find the onset of technical problems and reconsider-

[12] See Sutton I, pp. 133 ff.; Sutton II, pp. 122 ff.

[13] See Sutton II, pp. 57-58.

ation of a Western method—rotary drilling. Only in machine guns and alumina from nepheline do we find continuation of a Soviet process started in the second and continued into the third period. In both of these cases we find some earlier Western influence: American flow diagrams and assistance in the early thirties for alumina from nepheline and the use of Western patents in machine guns.

In sum, it is possible to trace only a single industrial process (the turbodrill) which started, came to development fruition, and went through pilot-plant stages and then to series production without replacement by a later Western process, under the Soviet regime. But the turbodrill cannot stand the test of the Western marketplace (it was tested with this possibility in mind by Dresser Industries of Texas, and rejected). Synthetic rubber work was started under the Tsars and is today about 50 percent supplanted by non-Soviet developed synthetics.

Table 25-3 shows the origins of 75 major technologies in three time periods, or a total of 225 time slots with each slot describing the origins of a technology at one of the three time periods. This matrix is summarized in Table 25-4.

In the period 1917 to 1930 no major applied technologies originated in the U.S.S.R. In the period 1930 to 1945 only two such processes originated in the U.S.S.R., but in another five areas the Soviets developed and applied some major technology and we find both Soviet and Western processes used. In the period 1945 to 1965 three processes were of Soviet origin and again five technical areas used both Soviet and Western processes.

With these data expressed as a percentage of the total 75 time slots included in Table 25-3, we find that in the period 1917 to 1930 the percentage of Soviet technology was zero, that in 1930 to 1945 ten percent of the technologies examined had all or some Soviet components, and that in the period 1945 to 1965 eleven percent of all those major technologies examined had all or some Soviet components. It should be emphasized that this is the most favorable interpretation possible of the empirical findings. It could be argued, with accuracy, that Soviet processes in the 1930 to 1945 period were later replaced by Western origin processes, and that where both Soviet and foreign technologies are used the Soviet process is either relatively inefficient (the turbodrill) or used to a relatively small extent (steam boilers).

Table 25-4 SUMMARY STATEMENT OF THE ORIGINS OF SOVIET TECHNOLOGY FROM 1917 TO 1965

	Number of Major Technologies examined: 75 (in three time-slots)					
	1	*2*	*3*	*4*	*5*	*6*
Period	*Determined as all Soviet origin*	*Percentage of total examined*	*Determined as of both Soviet and Western origins*	*Percentage of total examined*	*Total (column 1 and 3)*	*Percentage of total*
1917 to 1930	0	0	0	0	0	0
1930 to 1945	2	3	5	7	7	10
1945 to 1965	3	4	5	7	8	11

Source: Table 25-3.

CHAPTER TWENTY-SIX

The Level of Technology in the Soviet Union

Given the conclusions of the previous chapter concerning lack of self-generated indigenous innovation in the Soviet economy, it must logically follow that the general level of technology in the Soviet Union at any one time is consistently behind that of the more advanced Western economies. That observation has been made by numerous observers and indeed appears to be valid. This chapter examines the proposition in more detail with respect to selected major technologies.

A prime source of observations concerning technical lags is to be found in the reports of industrial delegations sent to the U.S.S.R. under the technical exchange programs of the last decade.[1] During that period the only delegation to report on Soviet technology in glowing terms was one unskilled in technology—a U.S. Senate subcommittee, which reported on Soviet hydroelectric power developments—and this report was in distinct contrast to the impressions recorded by U.S. and Canadian electric power industry delegations.

In 1960 the Soviet Union in all sectors (apart from the area of rockets and guided missiles and other armaments for which resources had been concentrated) was well behind, even decades behind, both Europe and the United States. On the other hand, the delegations seem to agree that in general the Russian grasp of theory is excellent. The problem is not one of deficient individual ability but rather of the system's inability to convert theory into practical industrial operations; i.e., there is an engineering weakness, not a scientific one.[2]

In some industrial sectors which have seen no great change in technology in this century, Soviet imports of foreign technology essentially reflect a domestic mechanical engineering inability rather than a lack of innovation *per se*. For example, in the manufacture of internal combustion and diesel engines the basic technology has remained the same; improvements have been in the methods of manufacturing engines and the efficiency of the finished product. Table 26-1

[1] A collection of these reports has been assembled and deposited in the Hoover Institution Library.

[2] There are many other factors that contribute to this inability, of course, including misallocation of capital and a bureaucratic inertia. But the proximal technological factor appears to be an engineering weakness.

lists imports of engine manufacturing technology by the Soviet Union from the West from 1917 to 1970; these imports have been supplemented by even more numerous purchases of industrial machines and equipment. In sum, Table 26-1 analyzes the Soviet engine manufacturing capability. Imports do not reflect any great changes in levels of Western technology, but the acquisition of additional capacity does reflect improved manufacturing methods and more efficient engines and therefore suggests a weakness in Russian industrial engineering.

This industrial weakness is effectively hidden from both Soviet and Western eyes by the protective GOST identification. In the case of marine diesels, where we can match GOST identification to Western models (Table 26-2), we find that there probably are no Soviet-designed marine diesels, or at least no GOST numbers appear for marine diesels that do not have a foreign origin. Therefore if any Soviet marine diesels exist they have not been recorded in recent Soviet technical literature.

Table 26-1 TRANSFER OF ENGINE MANUFACTURING TECHNOLOGY (INTERNAL COMBUSTION AND DIESEL) TO THE U.S.S.R. FROM 1925 TO 1970

Date	*Agreement*	*Origin of Technology*	*Western technology transferred*
1926	Sulzer	Switzerland	Diesel manufacture
1926	M.A.N. diesel engines	Germany	Licensing of diesel engines
1929	Fiat S.p.A.	Italy	Truck engine manufacture
1930	Hercules Motor Co.	U.S.A.	Truck engine manufacture
1930	A. J. Brandt Co.	U.S.A.	Truck engine manufacture
1930	Ford Motor Co.	U.S.A.	Truck and automobile engine manufacture
1936	Budd Company	U.S.A.	Automobile engine
1944	General Motors Corp.	U.S.A.	Truck engine assembly
1944	Caterpillar Tractor Co.[a]	U.S.A.	Tractor diesels, KD17-40
1946	Kloeckner-Humboldt-Deutz	Germany	Diesel truck engines
1946	B.M.W.	Germany	Diesel engines
1946	Daimler-Benz	Germany	Diesel engines
1946	Steyr-Daimler-Pusch	Austria	Truck plant
1956	Skoda	Czechoslovakia	Engine manufacture
1959	Burmeister & Wain	Denmark	Marine diesels
1961	Transfermatic	U.S.A.	V-8 truck engine manufacture (U.S.)
1961	Perkins	U.K.	Small diesels
1968	Fiat S.p.A.	U.S.A.[b]	Engine manufacture
1968	Renault/Peugeot	France	Engine manufacture
1970	Renault/U.S. consortium	France/U.S.A.	3- to 11-ton tractors, truck trailers, off-the-road vehicles

Sources: Sutton I: *Western Technology . . . 1917 to 1930*; Sutton II: *Western Technology . . . 1930 to 1945*; *Washington Post*, March 14, 1970; *Business Week*, April 18, 197 and June 19 1971; *Metalworking News* (New York), August 16, 1971; [a] Not by agreement with U.S. firm; [b] U.S. technology supplied indirectly.

Table 26-2 WESTERN MARINE DIESELS AND SOVIET *GOST* DESIGNATIONS

Soviet GOST identification	*Western firm or model*
6 ChSP 10.5/12.7	Cummins JMC 600
18 DN 13/2 x 18.4	Napier-Pielstik
6 ChN 15/19	Mercedes-Benz MB-846A
12 ChVN 17.5/20.5	Mercedes-Benz MB-820
20 ChVN 18.5/25	Mercedes-Benz MB-518
16 D V21.6/25/4	GMC 567 C
16 D VH 22.2/26/6	GMC 498
8 ChR 24/36	8 DV 136 Buckau-Wolf
18 Ch NV 20/45	VV 45-M.A.N.
6 Ch R 32/48	R 6 DV 148 Buckau-Wolf
6 D R 34/47	M 46 M-Polar-Atlas
12 Ch VRN 40/46	PC-SEMT Pielstik
8 ChN 38.1/45.7	KSDM 8 Mirrlees
6 ChRN 45/66	K6V 45/66 M.A.N.
6 DR 52/90	6 GZ 52/90 M.A.N.
6 DKR 55/100	D 55 Cegielski
DKRN 62/115	62 VTBF 115 B & W
DKRN 70/120	KZ 70/120S M.A.N.
DKRN 75/132	C 750S Fiat
DKRN 76/150	760/1500 VGSU Götaverken
DKRN 76/150	RSAD 76 Sulzer
DKRN 84/180	84 VTBF 180 B & W
DKRN 84/160	KZ 84/160 C M.A.N.
DKRN 85/170	850/1700 VGAU Götaverken
DKRN 90/155	RD 90 Sulzer
DKRN 90/160	C 900S Fiat

Source: V. A. Vansheidt, *Sudovye dvigateli vnutrennego sgoraniia* (Leningrad, 1962), pp. 538, 540.

In some processes we can determine the borderlines of the "engineering gap" quite clearly. For example, the Soviet Union purchased enormous synthetic fiber capacity in the West between 1956 and the late 1960s; indeed, almost all of its synthetic fiber capacity has been built by British, German, Dutch, Japanese, and Italian firms. However, the Soviets also pressed forward their own research in synthetic fibers, and a report published by the U.S. Army Quartermaster Research and Engineering Command disclosed that by 1960 the Soviets had developed at least 18 synthetic fibers, including three with no counterpart in the West. These three are Enant (a Nylon 7), Ftorlon (a fluorine with a copolymer), and Vinitron (a combination of nitrocellulose with chlorinated polyvinal chloride). Consequently, given the ability to purchase synthetic fiber capacity in the West, Soviet synthetic fiber research has been directed toward military uses—lightweight textile clothing highly resistant to chemicals and photodegradation, parachutes, ballistic applications, and so on. Thus the Russian

Nylon 7 (Enant), not produced in the Western world, has useful stress-strain properties and ultraviolet resistance. The Ftorlon, a fluorine-containing fiber, is reported to have good resistance to chemicals and a much higher strength than Teflon, the only such polymer available in the United States in fiber form. Vinitron is a new fiber that will not shrink in water and has good dye characteristics. This and similar Soviet work, including development of heat-resistant fibers from organosilica fibers,[3] suggests that in textiles at least there is no lack of ability up to the pilot-plant stage. Like observations can be made for other industries.

The weakness starts with the conversion from pilot-plant production to full-scale production. Therefore, in discussing levels of technology it is important to note that an industrial and engineering journal may report new Soviet technical developments and even pilot-plant or small-batch production; the important factor to determine is whether the process has been utilized on a continuous basis for large-scale production (not just series production) over a period of time (years, not months). It is in this area that we find substantive evidence of Soviet weakness and inability.

DIFFUSION OF TECHNOLOGY WITHIN A SECTOR

Given a reliance on foreign innovation, the extent and speed of domestic technological diffusion becomes of paramount importance. It was indicated earlier[4] that in the twenties, when a trust consisted only of one or two Tsarist-era plants, diffusion was not a major problem. A technical-assistance agreement was made with either the trust or a large and more technically advanced plant; foreign technique was then diffused among the relatively few plants, as often as not by foreign engineers. A single capable consulting engineer in a single plant might, depending on the process, provide considerable information and know-how in a matter of months; rarely did Soviet plants require more than a year to acquire a specific technology.

With the increase in the number of plants, however, a problem of diffusion has arisen. Information on foreign techniques is rapidly acquired and distributed; but foreign machinery and equipment cannot be purchased for all plants. A solution has been found in standardization and duplication,[5] but still there are institutional barriers to rapid diffusion.

These barriers may be exemplified in two areas of technology—numerically controlled machine tools and large presses. Numerically controlled machine tools are typical of the complex computer-based technologies for which the

[3] *The Hosiery Trade Journal* (Leicester, Eng.), February 1962, pp. 134-38.
[4] See Sutton I, p. 331.
[5] See Sutton II, pp. 291-99.

Soviets have not been able to achieve rapid diffusion. The advantages of acquiring the technologies are clear; the Soviet problem is one of inadequate inputs, i.e., computers and precision machinery:[6]

Innovation and Economic effects	*Extent of Diffusion in U.S.S.R.*	*In U.S.A.*
Substitution of numerically controlled for manually controlled machine tools in production of custom (unit)-built machines, machines produced in small batches, and in large-scale production requiring frequent changeovers of tooling and setups. Economic effects: a) Reduction of labor skill requirements b) Capital saving by 20 to 25 percent c) High flexibility in production d) Possibility of centralized planning and control of processes e) Substantially improved quality of products f) Possibility of producing products prohibitively expensive to produce by other methods.	Surprisingly slow progress. Though at least two prototype models, one point-to-point positioning and the other continuous-path, had been produced by 1959, the plan for 1960 called for only 180 units and that for 1959-65 for only several hundred. The relative meagerness of press discussions about actual experience in use suggests that use is still concentrated in the armaments sector.	NC machine tools represent the most important technological innovation in U.S. metalworking sector of the last decade. The industry started experimenting with the idea in late 1940s. The first NC machines became commercially available around 1954. At the time of the Chicago machine tool show in 1960, more than 60 firms were in the business. Since then the number of firms in the business of NC machine tools has grown steadily and most of the functional types of machine tools have been adapted to the system. As yet there are no statistics available on the number of the machines in use. Estimates vary from 1500 to as many as 3000 in the early 1960s.

In metal stamping we find two divergent rates of diffusion for technology relating to the same basic process; one technology has made substantial progress and the other has made very little. It is to be noted that Soviet large presses have evolved from German very heavy presses removed to the U.S.S.R. at the end of World War II. This technology amply supplies Soviet needs; hence it has been well diffused. On the other hand, automatic coil feed for sheet presses, although it is a development that goes back to the early 1920s, is largely a postwar innovation; here we find a Soviet deficiency based on inability to import units in sufficient numbers or to establish the technology within the U.S.S.R. This is a problem that could be overcome given sufficient direction of resources into developing Soviet versions of Western presses and feed equipment:[7]

[6] U.S. Congress, Joint Economic Committee, *Dimensions of Soviet Economic Power*, Hearings, 87th Congress, 2d session, December 10 and 11, 1962 (Washington, 1962), p. 137.

[7] *Ibid.*

Innovation and Economic effect	*Extent of Diffusion in U.S.S.R.*	*In U.S.A.*
Application of extra-heavy presses for stamping large sections of aircraft bodies and heavy machinery parts instead of riveting small stampings. Economic effects: a) Dramatic reduction of production cycle b) Marked metal savings c) Substantial improvements in quality of products d) Large labor savings	Substantial progress achieved in recent 2 or 3 years	For all practical purposes, the 35,000- and 50,000-ton presses manufactured by 1957 are considered more than adequate even today
Substitution of automatic coil and strip feed presses for sheet presses in mass-production industries. Economic effects: a) Marked metal savings b) Large labor savings in stamping c) Cost savings in steel mills because steel rolls are cheaper to manufacture than steel sheets	Thus far very little if any progress made because of deficient supply of presses	In U.S.A., automatic strip-feeding presses have been used for more than 40 years. In recent years phenomenal progress has been made in adapting the presses to wider strips, thicker gauges, and greater speeds. At this time automotive and household appliance industries are using presses with automatic feeds of steel coils up to 90 inches wide and ¼ inch thick

In casting operations, to take another example, the rate and extent of diffusion of technology have varied. In the substitution of mechanical sandslingers for hand sandpacking, common in the United States, diffusion in the U.S.S.R. is limited to establishments able to manufacture their own equipment. In the substitution of machine core making and molding for hand operations, there has been substantially greater productivity of machines in the United States, contrasted to "slow progress" in the Soviet Union; in 1957 the Soviet Union had only about 20,000 molding machines, most of which were "primitive pre-World War II type." In the application of carbon dioxide techniques and related processes there has been rapid diffusion in both the United States and the Soviet Union. In the introduction of resin-bonded shell molding and core making there was rapid introduction in the United States, which slowed down in 1960 owing to introduction of a competing hot-box method; in the Soviet Union there was "slow progress" owing to lack of equipment, thermoreactive resins, and fine-grained sand. In two innovations there was rapid progress in both the United States and the U.S.S.R.—pressure die-casting and semipermanent and permanent mold casting in ferrous and nonferrous industries.

In only one casting process has there been more rapid diffusion in the U.S.S.R. than in the United States—in investment casting, largely by the "lost-wax" method. The restriction in the United States is due to the high cost of small operations and low levels of mechanization possible. The U.S.S.R. probably produced three times more by this method in 1958 than did the United States.

On balance the U.S.S.R. has a slow rate of diffusion brought about by equipment deficiencies and lack of necessary input materials. This completely contradicts the claim that central planning, in contrast to a "chaotic" market system, can foresee and plan for new material requirements. The history of innovative diffusion in the Soviet Union suggests that the market system is infinitely better able to provide new inputs to answer demands for innovative diffusion.

COMPARATIVE LEVELS OF TECHNOLOGY

The evidence presented in this study suggests that, as a result of the need to import foreign technology plus slow rates of technological diffusion, the general level of technology in the Soviet Union should be below that of the United States and the Western world. Certainly Soviet technological levels cannot be above or even generally on a par with those of the Free World in areas where the Soviets rely on foreign innovation. Although there are technologies specially designed by Western firms for the U.S.S.R., and even some examples of new Western processes introduced first in the Soviet Union by Western companies, these do not constitute a general rule—they are exceptions. The rule is that new technology is introduced first in the Western country and then after a time lag is made available to the U.S.S.R.

One OECD study[8] contains a table listing Soviet statements concerning relative technological levels of the U.S.S.R. and the West between 1959 and 1963. These statements form a useful starting point for consideration of comparative levels of technology.

The first of the groups where leadership is claimed is "high-speed aviation, space rockets, long-range rockets, atomic energy." This claim is not generally consistent with the data in this study. By the end of the sixties the Soviets had fallen behind the United States in rocket technology, although the United States started its major program only in 1957 rather than 1945. In atomic energy there is no question that the Soviets lag.[9] They have maintained general equality in high-speed aviation, but their aircraft are technically inferior in many respects (e.g., control systems) and have relatively high operating costs.

Leadership is claimed in steam turbines for the electrical industry, when parity would be a more accurate claim.

The leadership claim in the "extraction of oil" definitely is not supportable: the Soviet Union is today importing oil technology from Europe and the United

[8] E. Zaleski *et al.*, *Science Policy in the U.S.S.R.* (Paris, Organization for Economic Cooperation and Development, 1969), pp. 496-99.

[9] See p. 239.

States. Leadership is claimed in terms of "output per unit volume" of blast furnaces and open-hearth furnaces; this is acceptable,[10] and is a result of "scaling-up" innovation. Claims for priority in rolling mill technology are not acceptable, but a claim for electro-slag resmelting is acceptable on the basis of equality with the United States.[11]

A claimed priority in production of liquid paraffin is limited to pilot-plant production. The claim of leadership in automatic and semiautomatic welding machinery design is not supportable (in 1970)—although there has been some

Table 26-3 COMPARATIVE STATEMENTS ON SOVIET TECHNOLOGICAL LAGS AS OF 1970

Technology	*OECD Report*[a]	*Western industrial delegation*[b]	*Sutton*[c]
Coal mining—underground operations	—	Ten years behind[d]	Ten-year lag
Atomic energy	"Equal or in the lead"	"Competent," "lack of experimental equipment"[e]	10-to 15-year lag as of 1970
Blast furnaces	"Equal or in the lead" (1959)	No lag[f]	No lag
Steel rolling	"Equal or in the lead" (1959)	20- to 30-year lag	30-year lag
Ore beneficiation	"U.S.S.R. lagging" (1960)	"Patterned after early American models"[f]	20-year lag
Oil well drilling	"U.S.S.R. equal or in the lead" (1959)	—	Depth limitations
Pipeline compressors	—	"Far behind"[g]	20-year lag
Large-diameter pipe	—	"Far behind"[g]	20-year lag
Chemical engineering (all phases)	"U.S.S.R. lagging (1959)	—	Minimum 30-year lag

Sources: E. Zaleski *et al., Science Policy in the U.S.S.R.* (Paris: Organization for Economic Cooperation and Development, 1969); [b] See text pp. 372 and 373; [c] See text pp. 369-70; [d] Private letter from Vasiliiy Strishkov, former Russian coal mining engineer, now with U.S. Bureau of Mines, Washington, D.C.; [e] *Atomic Energy in the Soviet Union*, Trip Report of the U.S. Atomic Energy Delegation, May 1963 (Oak Ridge, Tenn.: AEC Division of Technical Information Extension, n.d.); [f] *Steel in the Soviet Union*, Report of the American Steel and Iron Ore Delegation's Visit to the Soviet Union, May and June 1958 (New York: American Iron and Steel Institute, 1959); [g] "USSR Natural Gas Industry," Report of the 1961 U.S. Delegation to the Soviet Natural Gas Industry (n.p.: American Gas Association, n.d.).

[10] See p. 123.

[11] See p. 131.

Soviet development in the field.[12] Claims of engineering priority in four types of textile machinery are not acceptable.

In brief, the Soviets' claims of technological leadership were not generally consistent with the technical data presented in this study or with the reports made by Western industrial delegations and by individual Western observers. Table 26-3 compares the assessment made by different observers for a number of major technologies. The last column is a general assessment, based on the information available, of Soviet lags.

There is little question that behind continuing efforts to establish a paper priority for Soviet technology, particularly before politically aware audiences, is an acute knowledge that the substance of the claims is fragile. Only a superficial examination of Soviet claims is needed to reject many as absurd or inadequate; almost any technology can be asserted as superior to all others if care is taken to choose carefully the parameters of comparison.

In general, the level of Soviet technology is substantially behind that of the West except in those areas (blast furnaces, open-hearth furnaces, coke ovens, electrical generators, turbines) where scaling-up innovation based on classic Western processes has been successful.

[12] See p. 131.

CHAPTER TWENTY-SEVEN

National Security and Technical Transfers

The major conclusions presented by this study are that Western technology has been, and continues to be, the most important factor in Soviet economic development. The technical transfers that have fostered this development have continued over a period of 50 years. These observations will now be related to the declared hostility of the U.S.S.R. to the West since 1917, a hostility such that the United States alone apparently requires annual defense expenditures in excess of $80 billion (1969) to counter the threat.

That the Soviets have openly and consistently advocated the overthrow of Western democratic systems from 1917 to the present time is a fundamental starting point for the development of our national security policies. Rationality suggests, therefore, that either our policy regarding technical transfers to the Soviet Union is in error or our inflated annual defense expenditure is unnecessary. Either there is no valid rationale for much of our trade with the Soviets, i.e., for the main vehicle of technical transfers, or there is no valid rationale for defense against the Soviets. The two policies are incompatible.

The factors to be considered in highlighting this policy conflict are, first, the direct supply of military goods from the West to the U.S.S.R.; second, the supply of technology and equipment for Soviet production of military goods; third, the strategic implications of the technical transfers as seen by both the Soviets and the West; and fourth, the failure of Western export control and the reasons for that failure. Finally, analysis of these factors should conclude with a brief discussion of the relationship between technical transfers and national security in the light of this empirical study.

We are faced initially with the problem that the term "strategic" has a limited definition in the West. All technology, goods, and trade are strategic in the full sense of the word. Western definitions have been restricted, with obvious consequences. It is proposed to outline first some of the direct military transfers (i.e., those which would be militarily "strategic" by any definition) and then some indirect transfers applicable to military ends (but not strategic in the Western definition), and then to examine the spectrum of transfers in light of a more accurate definition of the term "strategic."

DIRECT SUPPLY OF MILITARY GOODS TO THE U.S.S.R.

Earlier chapters have described direct supply of weapons and other military supplies to the U.S.S.R. Before 1930 this was primarily a German transfer. The Red Army and Air Force were trained by German officers, using German equipment, and arsenals and plants for the production of weapons were established with German technical assistance and finance.[1]

In the 1930s Soviet sources of supply widened to include Great Britain and the United States for the early predecessors of Soviet tanks. The United States, for example, supplied the early tractor plants which doubled as tank-producing plants,[2] in addition to cartridge lines,[3] a nitrocellulose plant,[4] and military electronics.[5]

Lend Lease of course was a significant provider of weapons to the U.S.S.R.,[6] and numerous items supplied under Lend Lease became prototypes for later standard Soviet military equipment. For example, the BTR-40 Soviet armored personnel carrier of the 1950s is an almost exact copy of the U.S. M3 A1 scout car.[7] Although the skills of German scientists were used after the war to develop military electronics, including missile guidance systems, much technology in this field as well came from the United States. The Soviet search radar, for example, was based on U.S. Navy type SJ radar sets powered by magnetron tubes and received under Lend Lease.[8] Gun-laying radar was based on the British Mark II, and RUS I and RUS II radar units of the 1950s were based on Lend Lease supplies.

More recently, capture of the U.S.S. *Pueblo* provided the Soviets with electronic equipment 15 years ahead of anything they possessed at the end of the 1960s,[9] and persistent espionage in the United States has provided a steady flow of new military technologies.[10] In the famous 1962 Cuban missile crisis the ships used by the Soviets were fitted with extra-large hatches to carry missiles and were powered by engines manufactured by Burmeister & Wain in Copenhagen, Denmark.[11]

Finally, in 1970 the South African Air Force reported a Russian submarine taking on fuel from the Soviet tanker *Elgava*,[12] a vessel built in Sweden in

1 See Sutton I: *Western Technology ... 1917 to 1930.*
2 See Sutton II: *Western Technology ... 1930 to 1945.*
3 *Ibid.*, pp. 237-38.
4 *Ibid.*, pp. 246-47.
5 *Ibid.*, p. 160-63.
6 See pp. 3-11.
7 *Ordnance*, (Washington, D.C.), January-February 1969, p. 396.
8 J. M. Carroll, *Secrets of Electronic Espionage* (New York: Dutton, 1966), pp. 143-44.
9 *Los Angeles Times*, February 8, 1968.
10 For example, missile accelerometers: in Great Britain, the Lonsdale case revealed that the Soviets had been provided with the Decca Tracking System.
11 *The Washington Post*, February 27, 1970, p. A14.
12 *The Star* (Johannesburg), weekly air edition, February 20, 1971, p.1.

1961 and equipped with Danish engines. The South Africans also reported the Russian ship *Bakoeriani* in the Indian Ocean en route to East Africa with a naval patrol boat as deck cargo. The engines of the *Bakoeriani* are Burmeister & Wain models built at the Bryansk plant in the Soviet Union under the 1959 technical-assistance agreement between the Soviets and the Danish company.[13]

Thus by one means or another—and the greater part of the information on this topic is understandably classified—the Soviets have received a flow of Western technologies for direct military use from 1917 down to the present day.

TECHNOLOGY AND EQUIPMENT FOR THE PRODUCTION OF MILITARY GOODS

It is generally known that an automobile or tractor plant may be used to produce tanks and armored cars, military trucks, and other military vehicles. Indeed, one of the major conclusions reached by a U.S. interagency committee formed to study the war-making potential of U.S. and German automotive industries was that the motor vehicle industry has enormous military potential: "The Committee recognized without dissent that [Germany's] motor vehicle industry was an important factor in her waging of war during the period just ended."[14] On the basis of its findings, the committee recommended that the manufacture of complete automobiles in Germany be prohibited, that the manufacture of certain parts and subassemblies be "specifically prohibited," and that Germany "should not be permitted to retain in her possession any types of vehicles of particular military application, such as track-laying vehicles, multi-axle vehicles, etc."

The committee further listed more than 300 "war products manufactured by the automotive industry" based on a survey of the U.S. automobile industry.[15] Therefore after reviewing the U.S. and German automobile industries the U.S. Government was fully apprised of the industries' clear military potential. For reasons unknown, these conclusions apparently have been ignored with respect to the Soviet automobile industry, although by virtue of its Western origins (if for no other reason) the Soviet automobile industry is essentially no different from the U.S. or the German industry. It has the same capabilities and potentials.[16]

[13] *Ibid.*, p. 5.

[14] U.S. Foreign Economic Administration, *U.S. Technical Industrial Disarmament Committee to Study the Post-Surrender Treatment of the German Automotive Industry* (Washington, 1945), T.I.D.C. Project no. 12.

[15] *Ibid.*

[16] Shortly before this book went to press, the conclusions of the postwar interagency committee were brought to the attention of the Department of Commerce with specific reference to issue of export licenses for the Kama truck plant under construction in the U.S.S.R. in 1971 (see p. 203). The answer of the department was as follows: "The contribution an established

ıble 27-1 CIVILIAN AND MILITARY MODELS PRODUCED IN SOVIET AUTOMOBILE PLANTS, 1945-70

Plants	*Civilian models*	*Military Models*
oscow :IL)	ZIL 110, ZIL 111 passenger autos ZIL 127, ZIL 155 buses ZIL 150, four-ton truck ZIL 585, three-ton dump truck	ZIL 150 armored truck ZIL 151 armored truck ZIL 157 2.5-ton truck
ral Aiass)	Ural-ZIS-150, four-ton truck Ural-ZIS-5,	Ural-375T (6x6 wheeled) Ural-375 (tracked) Ural-375/BM-24, rocket launcher
oscow Small ar works AZMA)	Moskvich passenger auto	Moskva 402, 4-wheel drive cross-country Moskvich
orki ;AZ)	Pobeda and Volga M-21 passenger cars GAZ-69, medical vehicle GAZ-69 parts for assembly at Irkutsk, Odessa and Ulyanovsk	M-72 (4-wheel drive cross-country Pobeda) GAZ-46, Soviet jeep GAZ-47, amphibian personnel carrier GAZ-56, 1½-ton military truck GAZ-62, 1-ton truck (4-wheel drive) GAZ-69A, scout car GAZ-69, command car GAZ-69, Shmel rocket carrier
aroslavl YaAZ)	YaAZ-210, 12-ton truck YaAz-210E, 12-ton truck YaAz-210A, 12-ton truck YaAZ-210G and D tractor	Not known to be making military vehicles at this time
Ainsk MAZ)	MAZ-205, 5-ton truck MAZ-525, 25-ton dump truck MAZ-200, 7-ton truck MAZ-200B tractor	MAZ-57, ammunition carrier MAZ-63, gun tow MAZ-100, utility vehicle

Sources: Institute for Study of the U.S.S.R., *Bulletin* (Munich), III, 1 (January 1956); ∟eo Heimann, "In the Soviet Arsenal," *Ordnance* (Washington, D.C.), January-February 968; *Kratkii avtomobil'nyi spravochnik*, 5th edition (Moscow, 1968).

automotive industry can make to the military potential of a country is recognized by the Department. This factor, along with other considerations, enters into the decision whether or not to issue any licenses authorizing exports of equipment to a plant such as Kama." Letter to writer from Rauer H. Meyer, director of the Office of Export Control, Department of Commerce, November 12, 1971.

The logical deduction from this official statement is that the findings of the interagency committee are known to and are accepted by the administration in Washington. Inasmuch as licenses for the Kama plant nevertheless have been issued (according to the same letter), we are forced to the conclusion that the administration is knowingly allowing the export to the Soviet Union of U.S. equipment with military potential. At the time of this writing, licenses for the Kama project had been issued to Satra Corporation, Cross Company, Ex-Cell-O Corporation, Swindell-Dressler, and (not confirmed) Giffel Associates, Inc., of Detroit.

The interagency committee's conclusions at the end of World War II concerning the military potential of the automobile industry are supported by data on the postwar output of the Soviet automobile manufacturing industry. Table 27-1 lists Soviet automobile manufacturing plants and their production of military vehicles in the 1960s. The Western construction of these plants has been discussed elsewhere in the study.

The vehicles produced at Gorki—to take one example from Table 27-1—are basically Ford Motor Company technology. The plant was erected by Ford in the early 1930s,[17] and additional foreign equipment has been installed since that time.[18] Among the numerous civilian and military models produced today by this Ford plant is the GAZ-69, in its civilian version a medical aid vehicle but in its military versions a one-ton military truck, a scout vehicle, a command car, and a rocket launcher. Examination of the construction details of the GAZ-69 vehicle confirm that it is a facsimile of American technology; the *Katalog detalei avtomobilei GAZ-69, GAZ-69A, YAZ-450, YAZ-450A, i YAZ-450D*[19] includes diagrams of the various parts of the GAZ-69, and these can be usefully compared to parts shown in American catalogs—particularly those of the Ford Motor Company. Comparison of the oil pump (p. 30), oil filter (p. 36), fuel pump (p. 46), carburetor (p. 48), mufflers (p. 57), and radiator (p. 66) will make the point. Variations are mainly in body construction. For example, pages 192-93 provide details of a door construction utilizing wood and a design more common in World War II German vehicles than in present-day American vehicles.

Thus individual parts and overall design of present-day Soviet military vehicles, including those used for weapons systems (e.g., the GAZ-69 Shmel rocket carrier) may be traced in the main to American automobile technology sent to the Soviet Union as normal trade for peaceful purposes.

The more recent U.S.–Volgograd (VAZ) technical-assistance contract of the late sixties for construction of the VAZ plant[20] affords an excellent illustration of the military capabilities of allegedly civilian units. The implications are clear despite the fact that only very limited data have been released. It is known that the engine to be produced by the U.S. equipment belongs to "the small and medium European size class (engine displacement, respectively, 73 and

[17] See Sutton I, pp. 246-49.

[18] As recently as spring of 1971 it was reported that the Gleason Company had been granted a license for supply of bevel gear production equipment for the Gorki plant. *Rochester Times-Union*, June 3, 1971.

[19] Moscow: Mashinostroenie, 1968.

[20] Although this agreement is commonly called the "Fiat deal", the Togliatti plant at Volgograd uses mainly (about three-fourths) American equipment; Volgograd is the Soviet name (i.e., presumably, VAZ), and the facility is more accurately called the "VAZ" or "U.S.-VAZ" plant.

85 cubic inches)."[21] This is approximately the 1500-cubic-centimeter class of engine.

Does such an engine have any military usefulness? This is an important question, since this single plant will have a capacity of 600,000 vehicles per year, or more than twice the 1968 Soviet production of automobiles.[22] In other words, by 1975 over one-half of the total Soviet automobile output will come from this single plant; three-quarters of the plant's equipment, and all of its key equipment, comes from the United States.

The military possibilities for such a small engine include use as the main engine on a special-purpose small military vehicle (like the American Jeep), or as a propulsive unit for a specially designed vehicle for carrying either personnel or weapons. The Soviet strategy is currently toward supply of wars of "national liberation." Small vehicles of the types mentioned constitute excellent means of transportation to replace the bicycle used in Vietnam.

Soviet interest in such small vehicles goes back to World War II. The GAZ-46 is the Soviet version of the U.S. Jeep, and we know that such a vehicle figures into Soviet strategic thinking. For example, General G. I. Prokovskii has commented on one advantage of the Jeep as a weapons carrier: "Even relatively powerful recoilless artillery systems can, at the present time [the late fifties], be mounted on light automobiles, without reducing the number of men who can be accommodated."[23]

It may be argued that a U.S. Jeep engine is more powerful than the engine to be built in the U.S.–VAZ plant; it is estimated that the U.S.–VAZ unit is about two-thirds as powerful as the Jeep engine. But it should be borne in mind that requirements may be quite different from those of the United States. In World War II, for example, the Soviets received about 6500 U.S. Airocobras and promptly discarded armor plate, machine guns, and instrumentation, thereby reducing the weight by 3000 pounds and significantly increasing the performance they desired.[24] If the Soviets can strip 20 percent of the weight from an airplane, could not the same ingenuity be applied to a land vehicle? Certainly the U.S.-VAZ engine offers opportunities to resourceful Russian military engineers.

However, Russian engineers have no particular need to be ingenious. A proven vehicle of excellent capabilities utilizing a 1500-cubic centimeter engine already exists—and the Soviets have all the performance and manufacturing data. During World War II the Germans developed the N.S.U. three-quarter

[21] U.S. House of Representatives Committee on Banking and Currency, *The Fiat-Soviet Auto Plant and Communist Economic Reforms*, 89th Congress, 2d session (Washington, 1967).

[22] *Ibid.*

[23] Major General G. I. Pokrovskii, *Science and Technology in Contemporary War* (New York: Praeger, 1959), p. 122. Accompanying Figure 14 in Pokrovskii's book is a photograph of a U.S. Jeep with mounted artillery weapons and inscription "U.S. 106-mm recoilless weapon mounted on Willys Jeep."

[24] *Aviation Week* (New York), July 7, 1952.

track vehicle which weighed 3100 pounds laden, including three men. The ground pressure was only 4.5 psi, and with a turning circle of 13 feet it was capable of 50 mph. The Germans found this tracked vehicle "invaluable in wooded country impassable to a vehicle of normal size."[25] The propulsion unit was a 1500-cc four-cylinder Opel engine developing 36 bp; this same engine later powered the Moskvitch 401 and the Moskvitch 402 (Moskva) military cross-country four-wheel drive version of the 401, produced at the MZMA in Moscow. In brief, there already exists a tested and usable military vehicle capable of transporting men or adaptable for weapons use and powered by a 1500-cc engine. Therefore the numerous statements by U.S. officials to the effect that the Volgograd plant would have no military capabilities would appear to be erroneous.[26]

In 1961 a dispute arose in U. S. Government circles over the "Transfermatic case"—a proposal to ship to the U.S.S.R. two U.S. transfer lines (with a total value of $5.3 million) for the production of automobile engines. In a statement dated February 23, 1961, representatives from the Department of Defense went on record against shipment of the transfer lines on the grounds that "the technology contained in these Transfermatic machines produced in the United States is the most advanced in the world," and

> So far as this department knows the U.S.S.R. has not installed this type of machinery. The receipt of this equipment by the U.S.S.R. will contribute to the Soviet military and economic warfare potential.[27]

However, this position was overturned by a new secretary of defense, Robert McNamara, in November 1961. McNamara explained his decision in response to an inquiry from a Congressional investigating committee:

> I concluded that the Defense Department should not oppose export licenses for the transfermatic machines in question....My decision was based solely on the merits of the case as I saw them, from the point of view of alternative sources and availability of comparable machinery, and was in no part dictated by political or other policy considerations.
>
> My decision in this case was based on my own knowledge of this type of machinery and of its alternative sources of supply....

[25] "Its dimensions and small turning circle make it possible to operate the vehicle in places, such as mountain tracks and forests, impossible for ordinary transport." *Automobile Engineer* (London), October-December 1945, p. 481.

[26] For example, Eugene V. Rostow, under secretary of state for political affairs, is quoted to the effect that the U.S. equipment for the plant "would not contribute in any way to Soviet military capability." U.S. House of Representatives, *op. cit.* n. 21, p. 42.

[27] U.S. House of Representatives, Select Committee on Export Control, *Investigation and Study of the Administration, Operation, and Enforcement of the Export Control Act of 1949, and Related Acts, (H.R. 403)*, Hearings, 87th Congress, 1st session, pt. 1, October 1961, p. 217.

> As you know, the transfermatic machines were not be be used for the manufacture of military vehicles, but rather for the production of medium-priced or high-priced passenger cars.
>
> Your letter asks whether I consulted with other knowledgeable persons before making my April decision on transfermatic machines. The answer is that I reviewed this case thoroughly myself. I did not consult formally with other automotive experts as I had had the benefit of recent and direct experience with the equipment concerned in private industry.[28]

These Transfermatic machines were in fact for the production of 225-hp truck engines;[29] they were considerably more powerful than the units supplied for the plant at Volgograd and certainly adaptable to military end use.

The final case to be cited in the automotive sector is unfolding as this book goes to press. In 1970, with a still relatively limited car-truck production capacity—and all of that derived from Western sources—the Soviets decided they were faced with an immediate requirement for a plant capable of producing 100,000 three-axle 8- to 11-ton trucks a year, the largest such plant in the world.

The initial Soviet approach was made to the Ford Motor Company, probably the only organization in the world capable of building such a unit with its own technical resources. There is no question that Ford was interested. A company delegation under the leadership of Henry Ford II went to the Soviet Union,[30] and at one point it appeared likely that Ford would build the plant for the Soviets on a nonparticipating basis. In May 1970, however, Secretary of Defense Melvin Laird questioned construction by an American company on the grounds that the trucks to be produced would have military end uses. Henry Ford commented at the time that Secretary Laird's contention was "not only highly misleading but appears to be a gratuitous attack upon my common sense and patriotism."[31] However no one advanced the argument that the proposed plant could not produce military trucks, and the participation of Ford Motor Company faded away.

In subsequent months the Soviets tried elsewhere. The Satra Corporation in New York, which has secured financing for the Soviets in other sectors, attempted to put together a consortium of U.S. bankers and manufacturers of

[28] *Ibid.*, December 1961, p. 474.

[29] *Ibid.*, October 1961, p. 217. William P. Bundy states the 225-hp figure but not the end use. In 1961 no Soviet passenger car had an engine anywhere close to 225 hp. For a similar and better documented example, see the final summary of the "ball bearing machines case" also of 1961: U.S. Senate, Committee on the Judiciary, *Export of Ball Bearing Machines to the U.S.S.R.*, Hearings, 87th Congress, 1st session (Washington, 1961). This is an extraordinary case—the committee called it "of life and death importance to America and the free world" (p. 1)—of an attempt to provide the Soviets with a capability for producing miniature ball bearings, almost all of which are used in missiles.

[30] *Business Week*, April 18, 1970.

[31] *U.S. News and World Report*, May 18, 1970.

truck and truck equipment.[32] In August 1970 spokesmen for Daimler-Benz in Germany, the largest truck builder in Europe, declared that the firm expected to conclude a contract to build a factory in the U.S.S.R. to produce 150,000 trucks a year in the 10- to 20-ton range.[33] In September 1970 it was the French Government-owned Renault firm which announced a contract for construction of the plant, which would be known as the "Kama" plant because of its location on the Kama River, and which would produce 150,000 diesel trucks annually. The French Government had assured financing of $127 million for seven years at 5.95 percent—an extremely attractive package.[34]

Mack Trucks, Inc., entered into some preliminary discussions in 1971 concerning the supply of technical assistance for the plant;[35] and in August 1971 the Department of Commerce granted an export license to the Swindell-Dressler Company of Pittsburgh for $162 million worth of equipment for the Kama foundry.[36] Another license, valued at $37 million, reportedly was granted at the same time to Giffels Associates, Inc., of Detroit,[37] although this report was still unconfirmed in late 1971.

The planned capacity of the Kama plant is greater than that of all U.S. heavy truck manufacturers combined. Three basic models are to be produced: a 260-hp tractor for a 20-ton semi-trailer; a 210-hp tractor for a 16-ton semi-trailer; and a 160-hp dump truck with a seven-ton capacity. All such civilian units have clear military utility. Moreover, always in the past the Soviets have used Western-built plants for military production as soon as the Western engineers have left for home—from the Ford-built Gorki plant onward. Given this consideration, it will be a trusting Western government indeed that accepts a Soviet commitment that this plant will not be used for military purposes.[38]

Chemical industries also are essential to modern warfare, and some of these

[32] *Business Week*, August 29, 1970.

[33] *Ibid.*

[34] The provision of such favorable financing by a French government under President Georges Pompidou raises intriguing questions. The reader is referred to Henry Coston, *M. Pompidou, qui êtes-vous?* (Lectures Françaises no. 147/148, July-August 1969), and *Entre Rothschild et Moscou* (Lectures Françaises no. 146, June 1969), both published in Paris. Coston's arguments can only be described as extraordinary and should be read with some skepticism. Still, they have empirical support and the writer has not (as yet) been able to detect error in this factual support. There may be alternative interpretations, but Coston's charges will have to be answered at some point.

[35] *Business Week*, June 19, 1971, pp. 84-90.

[36] *Metalworking News* (New York), August 16, 1971.

[37] *Ibid.*

[38] For illustration of this point, see U.S. Senate, Committee on the Judiciary, *Soviet Political Agreements and Results*, 88th Congress, 2d session (3d revision; Washington, 1964), vol. 1, p. viii: "The staff studied nearly a thousand treaties and agreements ..., both bilateral and multilateral, which the Soviets have entered into not only with the United States, but with countries all over the world. The staff found that in the 38 short years since the Soviet Union came into existence, its Government had broken its word to virtually every country to which it ever gave a signed promise."

industries contribute directly to any war effort. For example, fertilizer plants can be converted to the manufacture of explosives. Illustrative of the fundamental assistance given in this sector for the development of military industries was the 1930s agreement by the Hercules Powder Company, Inc., to "communicate the secrets of production" of cotton linter, "prepare a complete design of a nitrocellulose plant for the production of 5000 tons yearly," provide drawings (by which the plant could be duplicated), send engineers, supervise installation of equipment and startup, train Russian engineers in manufacture of nitrocellulose and allow a "detailed study of nitrocellulose production" in Hercules' U.S. plants.[39]

This agreement was the basis of the Soviet explosives industry. Yet it was described by the company in a letter to the State Department as "apparently with the view of developing the production of nitrocellulose for peacetime arts."[40] Inasmuch as this letter was sent after informal discussion with Robert F. Kelley of the State Department, it has to be assumed that the department granted approval for Hercules to go ahead on the basis of full information. It is beyond the bounds of common sense to assume that either the State Department or Hercules was convinced that the application of this assistance would be limited to "peacetime arts."

Even in 1963 several congressmen objected strongly to the export of potash mining machinery to the U.S.S.R. on the grounds that potash could be used for explosives. However, the Department of Commerce took the position that potash "is used almost exclusively in the manufacture of potassium fertilizers."[41] Incendiary bombs require sulfuric acid; a process for the concentration of sulfuric acid was sent to the U.S.S.R. in the 1960s. One process for the manufacture of tear gas (used by North Vietnamese forces in South Vietnam) requires carbon tetrachloride and benzene; both products were shipped from the United States to the U.S.S.R. in the late 1960s.[42] Herbicides have the same chemicals as riot-control gases, and herbicides are among the volume imports by the U.S.S.R. from the U.S.A. Both the Japanese anthrax bomb plant at Harbin and the German Tabun plant were removed to the U.S.S.R. at the end of World War II.[43] Since that time the West has given indirect assistance to the Soviet chemical and biological warfare plants. For example, biological warfare requires refrigeration, and technical assistance has been provided for refrigeration; gelatin or synthetic polymers are needed to encapsulate biological warfare particles, and gelatin encapsulating apparatus has been shipped from the United States.

Textiles, of course, are war materials. This was clearly recognized during World War II, and the military end uses for textiles have expanded since that

[39] See Sutton II, p. 246.

[40] Letter from Hercules Powder Company, Inc., to State Department, July 2, 1930.

[41] U.S. Congress, House of Representatives, *Congressional Record*, 88th Congress, 1st session, 1963; vol. 109, pt. II.

[42] U.S. Dept. of Commerce, *Export Control* (Washington, D.C.), 1st quarter 1969 and 2d quarter 1967.

[43] Seymour M. Hersh, *Chemical and Biological Warfare* (Indianapolis: Bobbs-Merrill, 1968).

time. In 1943 the Pepperell Manufacturing Company, a major U.S. textile producer, described its wartime activities: the firm manufactured parachute cloth, airplane fabrics, and life rafts from nylon, uniforms from twill, and jungle hammocks from percale sheeting. Canton flannel was manufactured for shipment to the U.S.S.R. for use in leg and foot wrappings, oil filters, and gun patches. Pepperell even described sheets as "war supplies" and commented that cotton spindles are "weapons."[44]

Soviet uses of textiles are of course similar to our own, and indeed Yuri Krotkov comments that in the early 1960s women's nylon stockings disappeared suddenly from Moscow shops. Why? "Because Gosplan had used up all its reserves of nylon in supplying the defense plants."[45]

What is remarkable is the change in interpretation that has taken place over the last 20 years. In the 1940s automobile plants and textile plants manufactured "war supplies"; by the 1960s these plants could manufacture only "peace supplies." The problem really boils down to one of the Soviets' *intent*. Do they intend to use the technology to military ends? Some of the foregoing examples introduce an element of doubt. But if Soviet intent is in fact peaceful, then has the item no strategic implication? And might there not be circumstances under which peaceful intent could change?

One area in which we can precisely identify Soviet uses of Western-built products is that of shipping, since each vessel is unique and identifiable.

In the 1930s Western-built ships were used to transport political prisoners to Siberia. According to A. Dallin, the following ships were operated for that purpose by the NKVD: *Djurma* (built in Holland), *Minsk* (Germany), *Kiev* (Germany), *Igarka* (United Kingdom), *Komsomol* (United Kingdom), *Svirstroi* (United States), *Volkhovstroi* (United States), *Shatourstroi* (United States).[46] According to V. A. Kravchenko, the *Dalstroi* (Holland) also was used by the NKVD to transport political prisoners to concentration camps.[47] These vessels were all apparently intended for merchant duty when they were received.

Lest the reader argue that such movement was an internal matter and hence not relevant to military strategy, it should be stated that Western-built ships also have been used for overtly military purposes against the builders of the vessels. For instance, it is known that the Soviets have used about 100 vessels on the supply run from the Black Sea and Vladivostok to carry weapons, munitions, supplies, fertilizers, and so on to Haiphong (and earlier to the Cambodian port of Sihanoukville) to supply North Vietnamese actions in South Vietnam and Cambodia. The names of 96 of these vessels were obtained,[48] and Table

[44] Pepperell Manufacturing Company, *People of Peace at War* (Boston, 1943), p. 33.
[45] Yu. Krotkov, *The Angry Exile* (London: Heinemann, 1967), p. 92.
[46] A. D. J. Dallin and B. I. Nicolaevsky, *Forced Labor in Soviet Russia* (London: Hollis & Carter, 1947), pp. 128-29, 137.
[47] V. A. Kravchenko, *I Chose Justice* (New York: Scribners, 1950), pp. 290, 300.
[48] U.S. Senate, Committee on Banking and Currency, *Export Expansion and Regulation*, Hearings Before the Subcommittee on International Finance of the Committee on Banking and Currency, 91st Congress, 1st session (Washington, 1969).

27-2 lists the origins of their main engines. Of the 96 vessels, identification of main engines was possible in all but 12. Of the 75 diesel engines it was

Table 27-2 WESTERN ORIGINS OF MAIN ENGINES IN SOVIET SHIPS (96) USED ON THE HAIPHONG SUPPLY RUN

	Engines manufactured	
	in U.S.S.R.	*not in U.S.S.R.*
DIESEL ENGINES:		
Manufactured in the U.S.S.R. to Soviet design	0	
Manufactured in U.S.S.R. under license and to foreign design:		
Skoda (at Russky Diesel)	5	
Burmeister & Wain (at Bryansk)	8	
Manufactured outside U.S.S.R. to foreign design:		
Skoda		5
M.A.N.		11
Fiat		2
Burmeister & Wain (in Copenhagen and elsewhere under license)		8
Sulzer (Switzerland)		13
Lang (Budapest)		4
Görlitz (G.D.R.)		10
Lend Lease (United States)[a]		7
Non-Lend Lease (United States)[a]		1
Krupp (Germany)		1
Total diesel engine	13	62
STEAM TURBINES AND RECIPROCATING STEAM ENGINES		
Manufactured in U.S.S.R. to Soviet design	0	
Manufactured in U.S.S.R. to foreign design	1 (possible)[b]	
Manufactured outside the U.S.S.R.		
Canada[a]		1
U.S.A.[a]		3
United Kingdom[a]		1
Sulzer (Switzerland)		2
ZUT (Switzerland)		1
Total steam turbines	1	8

Grand total:	diesel engines	75
	steam turbines	9
		84
	not identified	12
		96

Source: U.S. Naval Institute, *Proceedings*, January 1970.

[a] Manufacture unknown.

[b] Possibly Sulzer steam turbine.

determined that 62 had been built outside the U.S.S.R. and 13 inside the U.S.S.R. The 13 domestic diesels were of either Skoda or Burmeister & Wain design, and only one steam turbine is listed as of possible Soviet manufacture and design.

The Burmeister & Wain technical-assistance agreement with the Bryansk plant has produced engines for numerous ships used by the Soviets for military purposes. Table 27-3 lists some Haiphong run vessels with Burmeister & Wain engines built at Bryansk.

Table 27-3 HAIPHONG RUN SHIPS WITH ENGINES MADE UNDER THE BURMEISTER & WAIN TECHNICAL-ASSISTANCE AGREEMENT OF 1959

Soviet Register no.		*Name*	*Tonnage*	*Type*	Engine *model no. (Burmeister & Wain)*
4776	1965	*Belgorod Dnestrovskiy*	11,011	—	B&W 774-VT2BF-160
5450	1967	*Berezovka*	10,996	Cargo	B&W 674-VT2BF-160
569	1964	*Bryanskiy Rabochiy*	11,089	Cargo	B&W 774-VT2BF-160
5492	1967	*Partizanskaya Slava*	10,881	Cargo	B&W 674-VT2BF-160
2127	1964	*Pavlovsk*	11,089	Cargo	B&W 774-VT2BF-160
2172	1963	*Perekop*	11,089	Cargo	B&W 774-VT2BF-160
2232	1963	*Polotsk**	9,500	Cargo	B&W 674-VT2BF-160
2268	1964	*Pridneprovsk*	11,089	Tanker	B&W 774-VT2BF-160

Sources: U.S. Naval Institute, *Proceedings*, January 1970.

**Lloyd's Register of Shipping*, 1970 (London) indicates built at Bryansk; Soviet Register indicates built in Denmark.

Quite apart from main engines, complete ships have been built in the West and utilized for military purposes. Table 27-4 gives a selected list of such ships known to have supplied material to North Vietnam, together with their Western origins.

Table 27-4 SHIPS KNOWN TO HAVE TRANSPORTED MATERIAL TO NORTH VIETNAM

			Place of construction	
Reg No.	*Year of* Construction	*Name of ship*	*Hull*	*Engines*
M26121	1960	*Kura*(4084 tons)	West Germany	West Germany
M11647	1936	*Arktika*(2900 tons)	United Kingdom	United Kingdom
M17082	1962	*Sinegorsk* (3330 tons)	Finland	Sweden
M3017	1961	*Ingur*(4084 tons)	West Germany	West Germany

The *Ristna*, which was reported off Ghana in 1966 with arms for internal revolts,[49] is powered by M.A.N. six-cylinder engines (570-mm bore and 800-mm stroke) built in Hamburg.[50] During the Cuban missile crisis of 1962 Soviet ballistic missiles were carried to Cuba in the "Poltava" class of dry-cargo carrier. These have an exceptionally long No. 4 hatch (13.5 meters) enabling transport of intermediate-range missiles. The class consists of a number of vessels with common construction characteristics; thus details of one vessel, the *Poltava*, will make the point clear. The *Poltava* (Soviet registration number M-22600) is an 11,000-ton dry-cargo ship with engines constructed by Burmeister & Wain of Copenhagen, Denmark. The engines are two-cycle supercharged, six-cylinder diesel marine type, with a cylinder diameter of 740 mm and a piston stroke of 1600 mm; some vessels of the "Poltava" class have engines made in the Soviet Union but based on the Burmeister & Wain engine. The *Polotsk*, for example, has a Danish engine, but the *Perekop* has a Soviet-built B&W engine of the same type.[51]

In brief, there is a direct, identifiable military utilization by the Soviets of technologies, equipment, and products supplied by Western governments under the assumption that these items were for peaceful use.

What is more, there is evidence that there has been a considerable "leakage" of Western equipment under export control.[52] This, of course, is a different proposition from export of peaceful goods where reliance is placed on Soviet intent not to use these goods for military purposes. Where products are defined as "strategic" and still find their way in quantity to the U.S.S.R., there is a problem of ineffective administration.

THE FAILURE OF WESTERN EXPORT CONTROLS

The United States in the Export Control Act of 1949 and the Battle Act of 1951, and other Western nations under equivalent legislation, have attempted to restrict exports of "strategic" goods to the Soviet Union. In the United States the export of purely military goods is administered by the State Department while the export of "strategic" goods is vested in the Department of Commerce, although the State Department has a major influence in this area also. The Department of Defense may register objection to export of a specific item, but has been overruled on sufficient occasions with regard to strategic goods

[49] *Current Digest of the Soviet Press*, XIX (March 19, 1967), 35.

[50] Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-1965* (Moscow, 1966).

[51] *Ibid.*

[52] See chapter 7, "The Arms Runners," in J. B. Hutton, *The Traitor Trade* (New York: Obolensky, 1963). Hutton is a former Soviet agent who was employed in smuggling strategic goods. Since the book has an epilogue by W. Averell Harriman it is presumably authentic.

that its influence may be considered as greatly subordinate to that of the Stat and Commerce departments.

The provision of fast, large ships for Soviet supply of the North Vietnames will indicate the type of problem arising where export control has failed. Tw segments of the Soviet merchant marine were examined to determine the relation ship between Western origins and maximum speed of Soviet ships. It was antici pated that because of the NATO limitations on the speed of merchant ship supplied to the U.S.S.R. (reflected in export-control laws) the average spee of NATO-supplied ships would be considerably less than ships either supplie by East European countries to the U.S.S.R. or built within the U.S.S.R. itself The results of the analysis are as follows:

SEGMENT 1: AVERAGE SPEED OF SOVIET SHIPS USED ON THE HAIPHONG SUPPLY RUN
(42 ships)

Merchant ships with engines manufactured in Free World	14.62 knots
Merchant ships with engines manufactured in Eastern Europe	13.25 knots
Merchant ships with engines manufactured in Soviet Union	12.23 knots

(all built after 1951, i.e., after implementation of Battle Act).

SEGMENT 2: AVERAGE SPEED OF SOVIET SHIPS ADDED TO THE MERCHANT FLEET IN 1964-65
(392 ships)

Merchant ships with engines manufactured in Free World	14.93 knots
Merchant ships with engines manufactured in Eastern Europe	11.93 knots
Merchant ships with engines manufactured in Soviet Union	10.95 knots

The most obvious point to be made is that the average speed of Western supplied ships used by the Soviets in the Haiphong run was 2.4 knots (i.e. about 20 percent) above that of Soviet domestic-built ships used on the run This segment includes only those ships built after 1951 (i.e., after implementatio of the Battle Act with its stated limitation of speed and tonnage of ships supplie to the U.S.S.R.).[53] The second segment (ships added in 1964-65) indicate that the gap in speed between Western- and Soviet-built ships is widening—tha Western ships on the average are almost four knots, or 36 percent, faster tha domestic-built ships. We may conclude that not only has this discrepancy gon unobserved among export control officials, but whatever export-control princip is utilized is being eroded over time.

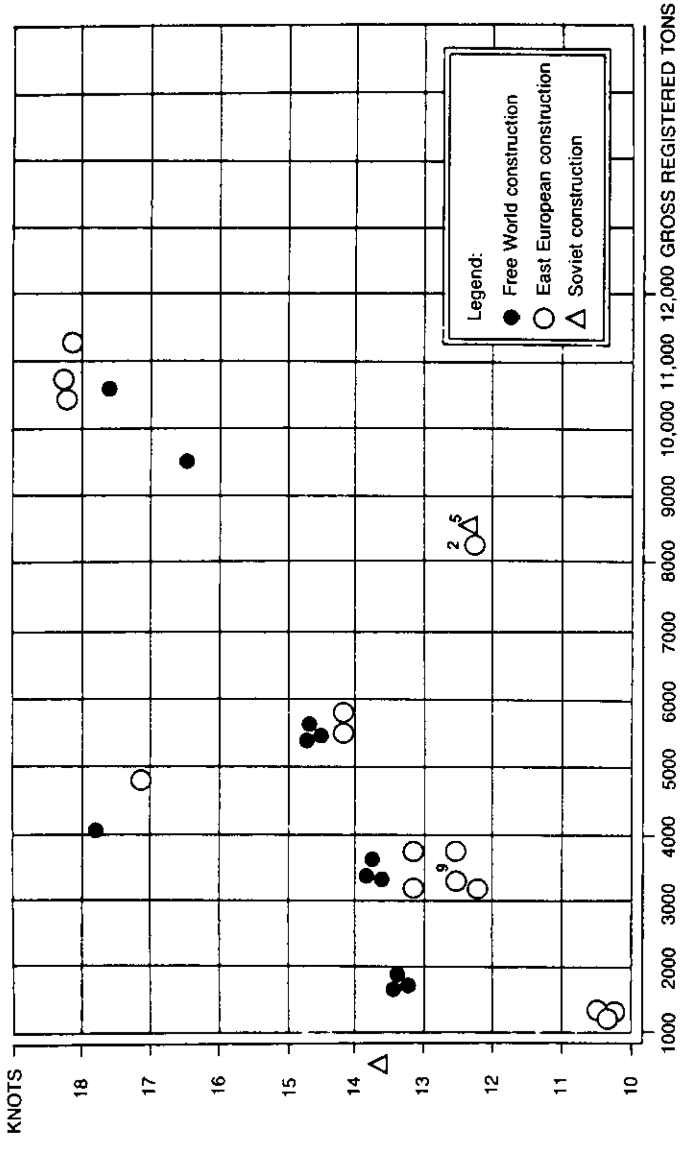
Figures 27-1 and 27-2 suggest that the lax administration applies also t weight limitations. Hence the faster, larger Soviet ships are from the Wes and the slower, smaller ships are from Soviet shipyards.

It is relevant to point out that under the CoCom provisions each natio

[53] Gunnar Adler-Karlsson, *Western Economic Warfare, 1947-1967* (Stockholm: Almquist & Wiksell, 1968), p. 93.

Figure 27-1

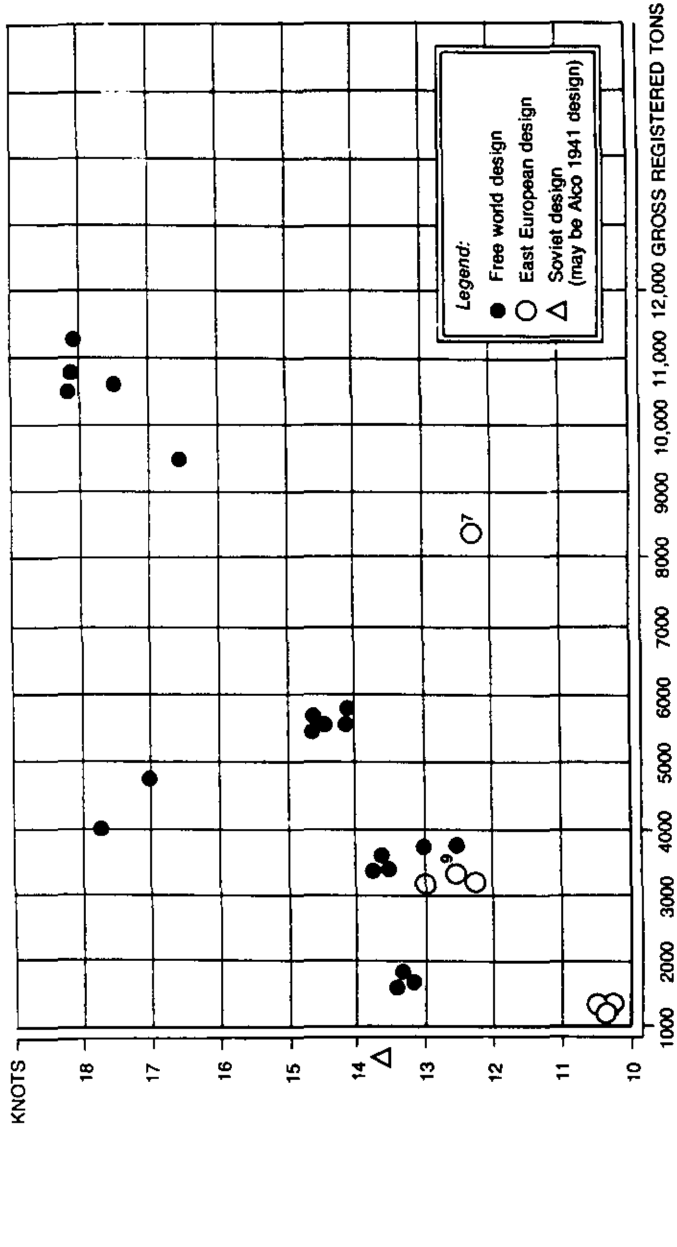
SOVIET SHIPS ON THE HAIPHONG RUN: CONSTRUCTION ORIGINS OF MAIN DIESEL ENGINES IN RELATION TO MAXIMUM SPEED AND TONNAGE



Note: small figure by side of box indicates number of vessels with this speed/tonnage characteristic

Figure 27-2

SOVIET SHIPS ON THE HAIPHONG RUN: DESIGN ORIGINS OF MAIN DIESEL ENGINES IN RELATION TO MAXIMUM SPEED AND TONNAGE



○7 *Note:* small figure by side of box indicates number of vessels with this speed/tonnage characteristic participating in the embargo of strategic materials submits its own views concerning whether or not specific items should be shipped. There is also a unanimity rule. In other words, no item is ever shipped to the U.S.S.R. unless all participating nations agree that it should be shipped. Objection by any nation would halt the shipment. Douglas Dillon, former under secretary of state, has pointed out: "I can recall no instance in which a country shipped a strategic item to the Soviet bloc against the disapproving vote of a participating member of CoCom."[54]

It must therefore be presumed that U.S. delegates participated in, and approved of, export of ships of high average speed as well as marine diesel engines, and of the Burmeister & Wain technical-assistance agreement of 1959 for Soviet manufacture of large marine diesels—all later used against the United States by the Soviets in supply of North Vietnam. In summary, the evidence suggests that the U.S. delegates to CoCom knowingly allowed export of ships above the NATO speed and weight limits that were later utilized against the United States. This possibility clearly demands further investigation.

RELEASE OF RESOURCES, INDIRECT TRANSFERS, AND WESTERN SECURITY

The release of domestic resources is one of the most important effects of technical transfers from one country to another, and it may be the effect most difficult for the layman to appreciate. Whenever assistance is provided from outside the Soviet economic system internal resources are released, and by substitutions at the margin the Soviet Union is enabled to devote such released resources to political objectives of the system.

This substitution is of major importance to military objectives because while domestic resources are being devoted to military development the broader industrial base is being updated and fortified from abroad. The industrial base of any country is the prime determinant of its military strength and ultimately the determinant of success in military operations. The United States military does not produce its own weapons: research, development, and production are largely handled by private industry. It is the flexibility and efficiency of American private industry that is the basic resource on which the American military structure depends.

The Soviet military is equally dependent on Soviet industry. It has been estimated that between 70 and 75 percent of the annual Soviet military expenditure

[54] U.S. Senate Committee on the Judiciary, *Export of Strategic Materials to the U.S.S.R. and Other Bloc Countries*, Hearings Before the Subcommittee to Investigate the Administration of the Internal Security Act and Other Internal Security Laws, 87th Congress, 1st session, Part 1, October 23, 1961, p. 45.

goes to industry for the purchase of armaments.[55] The military has top priority, but its capabilities also reflect Soviet weaknesses brought about by the almost total absence of innovative effort. Flexibility and innovation for Soviet industry are imported from the West. Thus, ironically, the prime forces making for efficiency in Soviet military production are Western initiative and efficiency. This conclusion can be refuted only if it can be shown (a) that the transfers of innovation from the West do not take place and (b) that the Soviet military structure does not depend on the Soviet industrial structure for input materials.

Therefore, we cannot in the final analysis make any meaningful distinction between military and civilian goods. Every industrial plant directly or indirectly affords some military capability. It is the availability of Western technology that makes Soviet industry more efficient. The import of this technology releases resources for military efforts and also ensures that the Soviet industrial-military complex incorporates the latest of Western manufacturing techniques.

Nor can any meaningful distinction be made in the last analysis between technology exports to the U.S.S.R. and those to the other East European bloc countries. Recognition of political differences between Communist nations has led to Western policies based on such differences, and specifically to more favorable economic treatment of less hostile Communist countries. However, political differences among Communist nations have not led to any reduction in intra-bloc trade or transfers of technologies. Indeed, paradoxically, the Western reaction to polycentralism in the form of "more trade" has led to an increased transfer of Western technology to the Soviet Union. Processes and products embargoed for direct Soviet shipment are transferred to the Soviet Union indirectly through East European communist countries. There has been, then, an increase in transfer of technology to the U.S.S.R. as a result of the Western policies of the past two decades, policies based on erroneous assumptions concerning the extent to which polycentralism exists, and can exist, in the economic life of Eastern Europe.

As the acquisition of Western technology is a prime objective of all Communist nations, it must be further concluded that one effect on the West's response to its own interpretations of differing forms of communism in Eastern Europe has been to provide a more effective economic basis for fulfillment of Soviet foreign policy objectives. The international political objectives of Yugoslavia, for example, do not alter the fact that the Yugoslavs can and do supply the Soviets with such vitally needed items as advanced diesel engines, larger merchant ships, and copper electrical products. With their technical support to the U.S.S.R. the Yugoslavs are making a far more significant contribution to Soviet international aspirations than any possible purely political support would provide.

[55] Konstantin K. Krylov, "Soviet Military-Economic Complex," *Military Review* (Fort Leavenworth, Kans.), November 1971, p. 93.

A rational policy for any nation is one based on logical deduction from empirical observation. If a policy is based on erroneous information or on lack of facts, or if it is developed from accurate data by nonlogical, i.e., mystical, methods, the policy is not likely to achieve its objectives.

There is adequate reason to believe that Western policy toward the U.S.S.R. in the field of economic relations is based, first, on an inadequate observation of fact, and second, on invalid assumptions. In no other way can one explain the extraordinary statements made, for example, by State Department officials to Congress, by academic writers, and by 50 years of policies which prescribe first the establishment and then the continuing subsidy of a system that simultaneously calls forth massive armaments expenditures. Those countries which have been the prime technical subsidizers of the U.S.S.R. are also the countries with the largest expenditures on armaments against a presumably real threat from the Soviet Union.

The first requirement of a rational policy in economic relations between the Western world and any communist state is to determine the empirical facts governing both economic and strategic-military relations. These three volumes have established, from a precise technical examination, that the Soviet Union and its socialist allies are dependent on the Western world for technical and economic viability. At any time the West chooses to withdraw this technical and economic subsidy, the Soviet Union must either meet terms laid down by the West or effect within its own system the changes needed to achieve self-generated innovation. The major temporal and political demands of the second course suggest that the Soviet Union would come to terms. The West, then, has the option of taking major steps toward developing world peace.

To subsidize and support a system that is the object of massive military expenditures is both illogical and irrational. In other words, it calls into question not only the ability and the wisdom but indeed the basic common sense of the policymakers.

The choice therefore is clear: either the West should abandon massive armaments expenditures because the Soviet Union is not an enemy of the West, or it should abandon the technical transfers that make it possible for the Soviet Union to pose the threat to the Free World which is the *raison d'être* for such a large share of Western expenditures.[56]

[56] The numerous statements contrary to this conclusion do not stand up to penetrating analysis. For example, Assistant Secretary of State Nicholas de B. Katzenbach: "We should have no illusions. If we do not sell peaceful goods to the nations of Eastern Europe, others will. If we erect barriers to our trade with Eastern Europe, we will lose the trade and Eastern Europe will buy elsewhere. But we will not make any easier our task of stopping aggression in Vietnam nor in building security for the United States." U.S. House of Representatives, Committee on Banking and Currency, *To Amend the Export-Import Bank Act of 1945*. Hearings, 90th Congress, 1st session, April 1967, p. 64.

CHAPTER TWENTY-EIGHT

Economic Aspects of Technical Transfers

THE UNSTATED PREREQUISITE FOR CENTRAL PLANNING

The prolific literature on central economic planning published in this century contains no discussion—or even passing mention—of one apparently essential prerequisite: there must be systems not regulated strictly by central planning that are willing to provide technical services and productive units for the centrally planned system. A world of strictly centrally planned systems based on the Soviet model, or a single centrally planned world system, could not progress. It would choke on technical inertia. The Soviet state's dependence on the West was at least partly recognized by Lenin,[1] and it is effectively conceded by present-day Soviet leaders when they openly subscribe to advances in Western technology—not omitting, of course, politically necessary references to capitalism's "internal contradictions".

The outstanding achievement of central planning is its ability to realize substantial rates of growth through planned diversion of resources and efforts into chosen industrial sectors. Let us accept as a premise that over the course of 50 years Soviet growth rates in most sectors have been substantial. Iron and steel production is certainly one such sector: Russian pig-iron production was 4.2 million tons in 1913 and 70.3 million metric tons in 1966, while steel production was 4.3 million tons in 1913 and 96.9 million tons in 1966. Fertilizer production was 42,000 tons in 1913 and 6.9 million tons in 1966. Chemical fiber production was zero in 1913 and 458,000 tons in 1966.[2] Ship production totaled 1.75 million gross registered tons in 1914 and 11 million gross registered tons in 1967.[3]

In each case of exceptional rates of growth we find significant acquisition of Western technology at the start of the rise in growth; indeed, it is a matter of open record that increments in output were planned to be at least initially

[1] See for example, V. I. Lenin, *Selected Works*, J. Fineberg, ed. (New York: International Publishers, 1937), vol. 9, pp. 116-18.

[2] *Strana Sovetov za 50 let* (Moscow, 1967), p. 98.

[3] John D. Harbron, *Communist Ships and Shipping* (London, 1962), p. 140.

dependent on the West. The planned increment in production was achieved in a conscious manner, not by internal technical resources, but by the purchase of high-productivity advanced units in the West.

Could the Soviet system have attained high rates of growth in any single sector without outside injections of technology and capacity? The answer is: apparently not. At any rate, no example has been found of a sector in the Soviet economy achieving rapid rates of growth without technical injections from outside the system. The sector that has come closest to showing indigenous technical progress is the iron and steel industry, with Western technology first absorbed and then scaled up to provide massive increments in pig iron and raw steel output. However, with this sequence the sector's progress has been limited: full modern industrialization demands not only a balanced output of iron and raw steel but also of finished rolled products. Rolling is not subject to scaling-up innovation. One can quadruple the size of an open hearth or a blast furnace, but quadrupling the size of a blooming mill, and certainly a wide-strip mill, is technically impossible. The continuous casting process was seen as a way around the problems posed by the blooming mill, i.e., as a way to replace scaling up, but here, as we have seen, too-rapid introduction brought its own problems.

The logical conclusion, therefore, is that Soviet central planning absolutely demanded from the outset, and still demands, the existence of technically balanced systems from which it might leach new processes and purchase productive capacity. In the absence of such systems, it probably could not have made great technical progress.

THE FUNCTION OF IMPORTED TECHNOLOGY IN THE SOVIET SYSTEM

The basic problem of the Soviet economy is, as we have seen, its essentially static nature. The system apparently lacks internal dynamic factors that make for indigenous technical progress other than that attained by duplication of an existing technology. On the other hand, true technical progress involves the steady substitution of ever more efficient ways of combining resources and is the most significant factor in increasing standards of living.

The function of imported technology in the U.S.S.R. is therefore to provide the missing dynamic element of technical progress, or more specifically, to supply innovation. This is achieved in several sequential steps. First, at an early stage in a sector's development the productive units themselves are imported, i.e., the machines, the boilers, the production lines. This is followed by a second stage, that of duplication or copying of the most useful of the imported units, according to a standardized design. Long runs of standard units without model change achieve the favorable growth rates noted. In certain sectors this may be followed by a third stage—adaptive innovation, i.e., scaling up. The Soviets have made excellent use of the scaling-up procedure in iron and steel and electricity generation. Such scaling up, however, cannot be applied in all sectors or in all basic technologies within a sector. As we have seen, it can be used in blast furnaces within limits, but not in rolling mills. It can be used in coke ovens within limits, but not in the production of precision machinery. It can be used in penicillin production, but not in radio-tube production. Thus the adaptive process of scaling up has significant limits.

So far as major indigenous innovation is concerned, we have seen that this is barely existent in the Soviet Union. There have been a few research achievements not found in the West (three synthetic fibers, for example), and some indigenous research has been placed into pilot production (as in the case of the Grinenko process). There is no case, however, of a large-scale productive unit based on self-generated indigenous Soviet technology. The Soviet technology that comes closest to this achievement is probably the turbodrill—but this technology is not comparable in its complexity to, say, automobile manufacturing, and in any case increasing demands for depth drilling have revealed turbodrill performance problems.

We can induce at least three contributions from technical transfer in addition to provision of technical modernization: the grant of economic flexibility (through release of resources), the grant of performance flexibility (because a standardized design is suitable for only a limited range of end uses), and the engineering contribution that inheres in foreign construction of large production units (those beyond available Soviet skills but not necessarily involving new technology).

Performance flexibility benefits may be noted in several of the sectors discussed in the study. One example can be seen with respect to marine boilers installed in Soviet ships between 1945 to 1960. All Soviet-made marine boilers are of one size and model. Flexibility for various requirements is achieved by importing boilers with nonstandard characteristics, e.g., unusual heating surfaces and working pressures. The existence of this phenomenon does not emerge from the trade and production statistics; its detection requires examination of the specifications for units produced and imported.

The engineering benefit, which is actually a variation of the flexibility contribution, is exemplified by the large number of complete plants bought abroad. It is also present in such acquisitions as refrigerator ships, where more complicated systems are purchased abroad and simpler systems are built inside the U.S.S.R.

THE SOVIET APPROACH TO IMPORT SUBSTITUTION

The Soviet approach to import substitution is of particular significance because in the Soviet Union the process results from more lengthy experience than in any other socialist economy. It appears to fall into three distinct stages: first, import of foreign equipment; second, a period of comparative testing during which both foreign and domestic copies are used side by side; and third, the elimination of imports and sole reliance on domestic-produced equipment.

Although this three-stage categorization is generally supported by the information presented here, it is possible to document the process fully in only one equipment area—steam turbines. Data are needed over a period of time (to cover the three stages hypothesized) to cover all units acquired, built, and installed and to determine their precise identification. The only source of such complete information available outside the U.S.S.R. is the Soviet Register of Shipping.[4] Of 5500 entries described in that source, 47 merchant ships are found to have steam turbines as propulsion units (there are many more in the Red Navy); these turbines are identified by type, origin, and date of installation.

When these data are plotted, it may be seen that installations fall into the three distinct periods postulated when viewed in terms of origins: first, a period from 1953 to 1957 with only foreign purchases (no domestic manufacture): second, a period from 1957 to 1960 with both foreign purchases and domestic production of steam turbines; and third, a period after 1960 with only domestic manufacture. Although import of steam turbines after 1960 would not invalidate the case (indeed, the Soviets would want to investigate any new Western design developments), in this case none appear to have been imported in the final period under consideration.

THE OUTPUT OF ENGINEERING SKILLS

A superficial conflict with the findings of this study is posed by the apparent numbers of engineers graduated in the U.S.S.R. compared to those in the U.S.A. A Soviet source gives the following statistics for engineering degrees granted in the U.S.S.R. and the U.S.A. in 1950 and 1965:[5]

U.S.S.R.	37,000 (1950)	170,000 (1965)
U.S.A.	61,000 (1950)	41,000 (1965)

According to these figures, output of engineers with degrees has increased fourfold in the period 1950 to 1965, while that of the United States has fallen by one-half in the same period. There is, of course, a relationship between numbers of engineers and level of technology.

If the Soviets had a vigorous indigenous technology, little further attention would be paid to this finding. However, the quantity production of engineers

[4] Registr Soyuza SSR, *Registrovaya kniga morskikh sudov soyuza SSR 1964-65* (Moscow, 1966).
[5] *Strana Sovetov ...*, *op. cit.* n. 2, p. 231.

since the 1930s appears to be inconsistent with the findings of this study. Some probing indicates a reconciliation. A Russian engineer is not the same as a Western engineer, particularly an American engineer. Not only is the Soviet engineer's training and experience much narrower; his level of skills is far lower. Indeed, a Soviet "engineer" may not have as high a level of technical ability as a master mechanic or ship superintendent in the United States. Moreover there is no question that top-level technical graduates are siphoned into military work and the balance go into industry; this diversion coupled with the generally lower skills requirements greatly reduces the effectiveness of the large reservoir of engineers.

This conclusion is supported by reports from at least two delegations to the Soviet Union. Appendix 9 of the 1963 Indian iron and steel industry delegation report[6] cites the engineering force and its utilization at the steel works called Zaporozhstal. Of a total of 16,829 workers, 1367 were classified as "engineers." These "engineers" were working in such locations as the telephone exchange (12), stores (8), instrument repair shop (58), water supply station (5), building repair facilities (20), and scrapyard (19). Obviously they were not engineers by any Western definition. In the West any one of the above-named operations (with the possible exception of instrument repair) can function without a single degree-qualified engineer.

Another example may be found in the report of a USDA forestry delegation.[7] That delegation inspected the Bozhenko furniture plant in Kiev and found that the 1600 employees included 104 technical people, of whom 64 had university degrees. Quite clearly if the 64 technical-degree holders in this small furniture plant are placed according to their abilities, their level of skills must be extraordinarily low. In the West such a plant with a comparable output could operate efficiently without a single technical-degree holder and rarely would there be need for more than two or three. The Bozhenko furniture plant as described by the U.S. delegation (and shown in photographs published in the report) suggests a management problem of major significance. The descriptions and photographs together depict a plant with abysmally low levels of efficiency when compared with Western plants. The factory painting facilities (a brick wall outside the plant), the intraplant "transport" (a man pushing an overloaded and wobbly trolley), and the general assembly shop could not be found in Europe or the United States: state factory inspectors would close the plant down as a hazard for its workers. If such an institution employs 64 degree holders, the logical questions must be: What are they doing? What is their training? What is their supposed purpose in the plant?

There are numerous reports of poor construction in the Soviet Union—and

[6] *Iron & Steel Industry in the U.S.S.R. and Czechoslovakia; Report of Indian Productivity Team*. (New Delhi: National Productivity Council, March 1963), p. 253.

[7] U.S. Dept. of Agriculture, Forestry Service, *Forestry and Forest Industry in the U.S.S.R.*, Report of a Technical Study Group (Washington, March 1961).

construction quality is a fair indicator of engineering ability. This may be exemplified by a report in 1966 to the effect that a French construction company was negotiating to build "earthquake-proof apartment buildings in the battered Soviet city of Tashkent. Some 30,000 apartments built [previously] by the company in Tashkent survived earthquakes there earlier this year."[8]

In 1960 two Soviet engineers named Zolotarov and Shteingauz claimed a world record in building dams on soft ground, mentioning specifically the dams at Svir and Tsimlyansk.[9] Given the very low ratio of dams built to hydroelectric power potential in the U.S.S.R. and the major engineering problems of building on soft ground (indeed, the initial engineering effort usually is to locate bedrock for dam construction), some kind of training problem seems obvious.

Equipment down-time is also an indicator of quality control and engineering skills in the manufacturing process, and the evidence points to Soviet deficiencies in this sphere. For example, in 1955 some Russian tractor models averaged more than one month out of service for repairs: the STZ-NATI required a total of 56 days in 1955 for overall repairs,[10] and the DT-54 a total of 59 days. If a tractor is out of commission almost two months in a year for technical reasons, it is clearly a faulty product.

We may justifiably conclude that the number of degreed engineers in the U.S.S.R. is not a reliable indicator of the nation's engineering capability, and that the equivalent U.S. figure should include at least master mechanics, shop superintendents, and a large proportion of skilled foremen.

USE OF IMPORTS TO FULFILL PLANNING OBJECTIVES

Where planning objectives of increased output cannot be achieved by duplication or by scaling-up innovation, resort has to be made to imports. Necessarily, the processes acquired in this manner are frequently those whose development abroad required large investments in capital and skill.

Examination of Soviet import statistics for the period 1946 to 1966 indicates that while total import values increased (692 million rubles in 1946 to 7122 million rubles in 1966, or a tenfold increase over two decades), the import of machinery and equipment remained consistently at one-third of the total (197 million rubles in 1946 and 2308 million rubles in 1966). However, analysis of the expenditure components reveals that planning objectives and directives have been reflected in significant increases in imports in the affected sectors. For example, the program to build a merchant fleet got under way in the early

[8] *New York Times*, October 11, 1966.
[9] T. L. Zolotarev and Y. O. Shteingauz, *Hydroelectric Power Plants and the Main Trends in Their Development* (Jerusalem: Israel Program for Scientific Translations, 1963), p. 146.
[10] *Problems of Agricultural Economy* (collection of articles) (Moscow, 1958); translation: Washington, D.C., 1960, p. 155.

50s and the import figures reflect the calculations given elsewhere—that since then over two-thirds of the Soviet merchant fleet has been built in the West. Similarly, Khrushchev's call for a massive increase in chemical production in 1957 was accompanied by an immediate increase in chemical equipment imports, a nearly tenfold increase in ten years (from 22 million rubles in 1957 to 100 million in 1959 and an average import of just over 200 million rubles in the mid to late sixties.)"[11]

Internal shortages are also reflected in changing import figures. For example, the agricultural problems of the early 1960s resulted in massive imports not only of foreign wheat but also of foreign fertilizers and agricultural equipment (from 14 million rubles in 1961 to 62 million rubles in 1966).

Table 28-1 SOVIET IMPORTS BY SOVIET TRANSPORT CATEGORY FROM 1946 to 1966

Year	*Total imports (million rubles)*	*Machines and equipment (Groups 10-19)*	*Ships and equipment (Group 192)*	*Chemical industry equipment (Group 150)*	*Agriculture equipment and fertilizers (Groups 181, 342)*
1946	692.0	197.4	5.6	3.9	0.1
1947	670.3	119.1	3.9	1.5	0.2
1948	1106.6	99.0	5.4	0.9	0.1
1949	1340.3	193.4	23.6	1.9	1.7
1950	1310.3	281.7	25.8	1.7	6.2
1951	1791.7	372.0	33.9	6.4	0.4
1952	2255.5	486.2	71.6	9.3	0.2
1953	2492.1	684.8	106.7	18.3	0.3
1954	2863.6	875.4	201.7	23.0	0.5
1955	2754.5	832.8	237.5	22.1	6.4
1956	3251.4	805.8	273.8	19.3	6.1
1957	3544.0	846.4	215.5	22.1	13.0
1958	3914.6	958.1	214.7	45.5	10.7
1959	4565.9	1216.7	271.9	103.4	9.7
1960	5065.6	1507.7	340.4	167.0	8.6
1961	5344.9	1561.0	203.1	171.0	14.1
1962	5809.9	2020.6	332.9	141.8	24.8
1963	6352.9	2219.4	366.1	190.2	31.2
1964	6962.9	2398.5	483.9	186.4	53.1
1965	7252.5	2423.1	489.7	187.4	54.4
1966	7121.6	2308.4	493.7	208.0	62.8

Source: Vneshniaia torgovlia SSR: Statisticheskii sbornik, 1918-1966 (Moscow, 1967).

Imports provide, as has previously been noted, a degree of economic and technical flexibility to the Soviet Union; but in the cases noted above they provide more than flexibility—they provide the means for fulfilling key planning

[11] See Table 28-2.

objectives. The chemical industry plan, the synthetic fiber and rubber industry plans, and the automobile and merchant marine plans could not have been filled even by 10 percent if reliance had been solely on domestic abilities and resources.

These observations also provide a rational explanation for Soviet emphasis on domestic production of electricity, steel (simple construction sections rather than high-quality flat-rolled products), and building products such as cement and stone.[12] The perennial shortage of housing also suggests a diversion of construction material resources into other types of construction. Emphasis on the production of electricity, steel, and construction materials is consistent with massive import of foreign equipment and processes: the buildings to house imported process technology and equipment must be provided from domestic resources. Apart from the import of the steel-fabricated structure for the Stalingrad tractor plant in 1930 there is no known case of Soviet import of industrial building structures. These are built to a standard design in the U.S.S.R. from domestic materials.[13] The major inputs for industrial buildings are structural steel, plate steel, reinforcing rod, and cement. The planning emphasis on these products, then, is not founded in dogma but on practical construction demands. This also squares with observed Soviet postwar reparations practices; rather than removing fabricated steel structures (as the less experienced Western allies tried to do) the Soviets removed portable equipment and machinery of a high value-to-weight ratio. The building shell was erected in the U.S.S.R. and the equipment bedded down in its new location.[14]

THE "CATCHING-UP" HYPOTHESIS

An obvious benefit from the import of foreign technology is that it affords less developed countries the possibility of "catching-up" i.e., of establishing the basic means of production without enormous investment in research and development and long gestation periods. Presumably, when a nation attains a certain technological level of advancement it should be able to press ahead on its own.

This "catching-up" justification for basic technology import seems more logically applicable to ex-colonial areas, such as India, than to the Soviet Union.

[12] G. Warren Nutter, *The Growth of Industrial Production in the Soviet Union* (Princeton: Princeton University Press, 1962).

[13] See Sutton II: *Western Technology ... 1930 to 1945*, p. 251.

[14] See Edwin W. Pauley, *Report on Japanese Assets in Manchuria to the President of the United States, July 1946* (Washington, 1946), for excellent photographs of Soviet removal practice; the remaining portions of the plant are those needing duplication in the U.S.S.R., i.e., the building shell, equipment made of fabricated sheet steel, and machinery with a low value-to-weight ratio.

In the first place, there is a widespread misunderstanding concerning the state of technical development in Tsarist Russia. Whatever may have been the backward nature of the Tsarists' social and political system, their technology was reasonably well advanced for the time; indeed there is evidence that by 1916 Tsarist Russia had industrial units on a scale and utilizing a technology equal to that anywhere in the world.[15] Further, pre-Revolutionary indigenous Russian innovation was apparent in the beet sugar industry, in aluminum smelting (Bayer), in synthetic rubber (Ostrimilensky), and in automobiles and aircraft (Sikorsky). While a great many of the skilled workers, the management personnel, and the technicians either emigrated or returned to the villages after the revolution, the physical structure of the Russian economy was largely intact when the Bolsheviks came to power.

Moreover, various injections of foreign technology have enabled the Soviet Union to "catch up" in the 1920s, in the early thirties (mid-thirties for aircraft and oil refining), during World War II, at the end of the fifties, and in the massive plant acquisitions of the sixties. Thus a temporary need for "catching up" is not a likely explanation for the continued Soviet reliance on imported technology. A more plausible explanaton is that there is some inherent inadequacy in the system which stifles indigenous industrial development. The Soviet system is forever "catching up," by virtue of its institutional structure. Foreign technology converts this static system into a viable system.

A generally observed benefit of foreign technology import is that it enables the recipient country to avoid research and development costs. This saving may indeed be substantial, but it is minute compared with another factor, i.e., the avoidance of expenditures on innovations that fall by the wayside, the so-called wastes of competition. To allow the market to select the most efficient method, or the several most efficient methods for the manufacture of any given product, several hundreds may be taken partway to production (i.e., through pilot-plant stage) and several dozens actually placed into production. The market is the final test of efficiency. This process is vital to the dynamic progress of a market system, and for this reason the wastes of competition are not wastes at all: if it is necessary for purposes of efficiency to allow rejected processes to fall by the wayside, it is just as necessary to a viable economy that they be introduced into the market in the first place.

There is a cost incurred in the development of these fallen processes, however, and it is one that can be avoided by importing technologies after they have passed through the discipline of a market economy. The Soviets have been remarkably adept at selecting processes, after the initial shaking down to two or three that have ultimately been determined by the foreign market place to be the most efficient. They chose the Ford automobile in the late 1920s (not Cord, Maxwell, or any of the hundreds of others that have since fallen by

[15] See Sutton I: *Western Technology ... 1917 to 1930*, pp. 183-84.

the wayside). They chose the Douglas DC-3 within a year of its inception—an aircraft that proved to be the most efficient air transport of its time. They chose the Rust cotton picker. They have shown a remarkable ability to appreciate the market economy in operation, to acquire full knowledge of competing processes, and to step in as soon as a particular process has shown itself to have advantages not shared by others. A Western firm that has had its process or equipment chosen by the Soviets should use the fact as an advertising slogan—for Soviet choice has been so remarkably accurate that it is almost a badge of acceptability.

Finally, the Soviet Union (or any other importer of technology) can avoid the long gestation periods of modern technologies. The Soviets acquired the wide-strip mill within a few years of its introduction in the West. It would have taken decades to reproduce the technology within the U.S.S.R. They acquired the German jet and turboprop engines at a time when they had themselves hardly mastered the manufacture of piston engines. They obtained in the late fifties and early sixties numerous complete chemical plants far beyond their own technical abilities and certainly not then duplicable in the Soviet Union in the foreseeable future. Such gains in time are vital to the fulfillment of Soviet ideology, which requires a dynamic technical front.

The gestation advantage comes out most clearly in those technologies which involve a high degree of construction skill and cannot be imported. Atomic reactors, for example, require a lengthy construction period, cannot be legally exported from the West, and demand a high degree of construction skill. After a flashy start in the 1950s the Soviets had only four reactors in operation in November 1969 (the same number as in 1965), which is a far cry from the impressive predictions advanced in the 1950s for atomic power development in a socialist system.

The Soviet economy is always a few years behind the West, but under censorship conditions this has presented no great problem. By a combination of careful concealment and clever promotion,[16] the Soviets have had little difficulty in presenting to foreign observers the facade of a vigorous, sophisticated technology.

[16] "In the developing countries of Asia and Africa, Soviet aid places great stress on modern scientific symbols. A nuclear research lab is set up in Cairo, a fully automatic telephone exchange in Damascus, a technological institute in Rangoon—these tokens of advanced technology are intended to convey an image of Soviet progressiveness in human discovery and inventiveness in the application of science to peaceful progress." Hans Heymann, Jr., *The U.S.S.R. in the Technological Race* (Santa Monica: RAND Corp., 1959), Report no. P-1754, p. 6.

CHAPTER TWENTY-NINE

Conclusions

EMPIRICAL CONCLUSIONS: 1917 TO 1930

The first volume of this study concluded that the Soviets employed more than 350 foreign concessions during the 1920s. These concessions, introduced into the Soviet Union under Lenin's New Economic Policy, enabled foreign entrepreneurs to establish business operations in the Soviet Union without gaining property rights. The Soviet intent was to introduce foreign capital and skills, and the objective was to establish concessions in all sectors of the economy and thereby introduce Western techniques into the dormant postrevolutionary Russian economy. The foreign entrepreneur hoped to make a normal business profit in these operations.

Three types of concessions were isolated: Type I, pure concessions; Type II, mixed concessions; Type III, technical-assistance agreements. Information was acquired on about 70 percent of those actually placed in operation. It was found that concessions were employed within all sectors of the economy except one (furniture and fittings), although the largest single group of concessions was in raw materials development. In the Caucasus oil fields—then seen as the key to economic recovery by virtue of the foreign exchange that oil exports would generate—the International Barnsdall Corporation introduced American rotary drilling techniques and pumping technology. By the end of the 1920s 80 percent of Soviet oil drilling was conducted by the American rotary technique; there had been no rotary drilling at all in Russia at the time of the Revolution. International Barnsdall also introduced a technical revolution in oil pumping and electrification of oil fields. All refineries were built by foreign corporations, although only one, the Standard Oil lease at Batum, was under a concessionary arrangement—the remainder were built under contract. Numerous Type I and Type III technical-assistance concessions were granted in the coal, anthracite, and mining industries, including the largest concession, that of Lena Goldfields, Ltd., which operated some 13 distinct and widely separated industrial complexes by the late 1920s. In sectors such as iron and steel, and particularly in the machinery and electrical equipment manufacturing sectors, numerous agreements were made between trusts and larger individual Tsarist-era plants and Western companies to start up and reequip the plants with the latest in Western technology.

A.E.G., General Electric, and Metropolitan-Vickers were the major operators in the machinery sectors. Only in the agricultural sector was the concession a failure.

After information had been acquired on as many such concessions and technical-assistance agreements as possible, the economy was divided into 44 sectors and the impact of concessions and foreign technical assistance in each sector was analyzed. It was found that about two-thirds of the sectors received Type I and Type II concessions, while over four-fifths received technical-assistance agreements with foreign companies. A summary statement of this assistance, irrespective of the types of concession, revealed that all sectors except one, i.e., 43 sectors of a total of 44, had received some form of concession agreement. In other words, in only one sector was there no evidence of Western technological assistance received at some point during the 1920s. The agreements were made either with dominant trusts or with larger individual plants, but as each sector at the outset comprised only a few large units bequeathed by the Tsarist industrial structure, it was found that the skills transferred were easily diffused within a sector and then supplemented by imported equipment. Examination of reports by Western engineers concerning individual plants confirmed that restarting after the Revolution and technical progress during the decade were dependent on Western assistance.

It was therefore concluded that the technical transfer aspect of the New Economic Policy was successful. It enabled foreign entrepreneurs and firms to enter the Soviet Union. From a production of almost zero in 1922 there was a recovery to pre-World War I production figures by 1928. There is no question that the turn-around in Soviet economic fortunes in 1922 is to be linked to German technical assistance, particularly that forthcoming after the Treaty of Rapallo in April 1922 (although this assistance was foreseeable as early as 1917 when the Germans financed the Revolution).

It was also determined that the forerunners of Soviet trading companies abroad—i.e., the joint trading firms—were largely established with the assistance of sympathetic Western businessmen. After the initial contacts were made, these joint trading firms disappeared, to be replaced by Soviet-operated units such as Amtorg in the United States and Arcos in the United Kingdom.

It was concluded that for the period 1917 to 1930 Western assistance in various forms was the single most important factor first in the sheer survival of the Soviet regime and secondly in industrial progress to prerevolutionary levels.

EMPIRICAL CONCLUSIONS: 1930 TO 1945

Most of the 350 foreign concessions of the 1920s had been liquidated by 1930. Only those entrepreneurs with political significance for the Soviets received compensation, but for those few that did (for example, Hammer and Harriman), the compensation was reasonable.

The concession was replaced by the technical-assistance agreement, which together with imports of foreign equipment and its subsequent standardization and duplication, constituted the principal means of development during the period 1930 to 1945.

The general design and supervision of construction, and much of the supply of equipment for the gigantic plants built between 1929 and 1933 was provided by Albert Kahn, Inc., of Detroit, the then most famous of U.S. industrial architectural firm. No large unit of the construction program in those years was without foreign technical assistance, and because Soviet machine tool production then was limited to the most elementary types, all production equipment in these plants was foreign. Soviet sources indicate that 300,000 high-quality foreign machine tools were imported between 1929 and 1940. These machine tools were supplemented by complete industrial plants: for example, the Soviet Union received three tractor plants (which also doubled as tank producers), two giant machine-building plants (Kramatorsk and Uralmash), three major automobile plants, numerous oil refining units, aircraft plants, and tube mills.

Published data on the Soviet "Plans" neglect to mention a fundamental feature of the Soviet industrial structure in this period: the giant units were built by foreign companies at the very beginning of the 1930s, and the remainder of the decade was devoted to bringing these giants into full production and building satellite assembly and input-supply plants. In sectors such as oil refining and aircraft, where further construction was undertaken at the end of the decade, we find a dozen top U.S. companies (McKee, Lummus, Universal Oil Products, etc.) aiding in the oil-refining sector and other top U.S. aircraft builders in the aircraft sector (Douglas, Vultee, Curtiss-Wright, etc.).

Only relatively insignificant Soviet innovation occurred in this period: SK-B synthetic rubber, dropped in favor of more useful foreign types after World War II; the Ramzin once-through boiler, confined to small sizes; the turbodrill; and a few aircraft and machine gun designs.

The Nazi-Soviet pact and Lend Lease ensured a continued flow of Western equipment up to 1945.

In sum, the Soviet industrial structure in 1945 consisted of large units producing uninterrupted runs of standardized models copied from foreign designs and manufactured with foreign equipment. Where industrial equipment was of elementary construction (e.g., roasters and furnaces in the chemical industry, turret lathes in the machine tool industry, wooden aircraft, and small ships), the Soviets in 1945 were able to take a foreign design and move into production. One prominent example (covered in detail in this volume) was the Caterpillar D-7 tractor. The original, sent under Lend Lease in 1943, was copied in metric form and became the Soviet S-80 and S-100. It was then adapted for dozens of other military and industrial uses.

Thus in the period 1930 to 1945 the Soviets generally no longer required foreign engineers as operators inside the U.S.S.R. as they had in the concessions of the 1920s, but they still required foreign designs, foreign machines (the machines to produce machines), and complete foreign plants in new technical areas. By 1945 the Soviet Union had "caught up" at least twice; once in the 1930s (it could also be argued that the assistance of the 1920s constituted the first catching-up) with the construction of the First Five Year Plan by foreign companies, and again in 1945 as a result of the massive flow of Western technology under Lend Lease. While the technical skills demonstrated by the Tsarist craftsmen had not quite been achieved,[1] it may be said that in 1945 the nucleus of a skilled engineering force was once again available in Russia—for the first time since the Revolution.

EMPIRICAL CONCLUSIONS: 1945 TO 1965

In the immediate postwar period the Soviets transferred a large proportion of German industry to the Soviet Union—at least two-thirds of the German aircraft industry, the major part of the rocket production industry, probably two-thirds of the electrical industry, several automobile plants, several hundred large ships, and specialized plants to produce instruments, military equipment, armaments, and weapons systems. The stripping of East Germany was supplemented by a U.S. program (Operation RAP) to give the Soviets dismantled plants in the U.S. Zone. By the end of 1946 about 95 percent of dismantling in the U.S. Zone was for the U.S.S.R. (including the aircraft plants of Daimler-Benz, ball bearings facilities, and several munitions plants).

Manchuria and Rumania also supplied numerous plants. And as we have seen, Finnish reparations which supplemented the pulp and paper industries and ship construction were made possible by U.S. Export-Import Bank credits to Finland.

In the late 1950s all this industrial capacity had been absorbed and the Soviets turned their attention to the deficient chemical, computer, shipbuilding, and consumer industries, for which German acquisitions had been relatively slight.[2] A massive complete-plant purchasing program was begun in the late

[1] Tsarist-era technology was of a higher standard than is generally believed: it had achieved capability to produce aircraft, calculating machines, and locomotives. Foss Collection, Hoover Institution; see Sutton I, pp. 183-84.

[2] For typical articles that appeared in Western journals as the Soviets took steps to start a massive acquisition program to fill major technical gaps in the Soviet structure, see: Raymond Ewell, "Soviet Russia Poses a New Industrial Threat," *ASTM Bulletin*, no. 239 (July 1959), 43-44; W. Benton, "Are We Losing the Sheepskin War," *Democratic Digest*, July 1956; "From Revolution to Automation in 37 Years," *American Machinist*, November 19, 1956; G. Marceau, "Exceptionnelles possibilités du forage en U.R.S.S.," *Industrie du petrole*, 28 (November 1960), 47-49; "Soviet Scientists Emerge from Curtain to Crow about Progress," *Business Week*, September 14, 1957, pp. 30-32.

1950s—for example, the Soviets bought at least 50 complete chemical plants between 1959 and 1963 for chemicals not previously produced in the U.S.S.R. A gigantic ship-purchasing program was then instituted, so that by 1967 about two-thirds of the Soviet merchant fleet had been built in the West. More difficulty was met in the acquisition of computers and similar advanced technologies, but a gradual weakening of Western export control under persistent Western business and political pressures produced a situation by the end of the sixties whereby the Soviets were able to purchase almost the very largest and fastest of Western computers.

Soviet exports in the late sixties were still those of a backward, underdeveloped country. They consisted chiefly of raw materials and semimanufactured goods such as manganese, chrome, furs, foodstuffs, pig iron, glass blocks, and so on. When manufactured goods were exported they were simple machine tools and vehicles based on Western designs, and they were exported to underdeveloped areas. When foreign aid projects fell behind—although they had been given first priority on Soviet resources—they were brought back on schedule with the use of foreign equipment (e.g., British and Swedish equipment was used at the Aswan Dam). And while great efforts have been made to export to advanced Western markets Soviet goods with a technological component (i.e., watches, automobiles, tractors, and so on), a technical breakdown of these goods reveals in all cases examined either a Western origin or the substitution of Western parts where the products are assembled in the West.[3]

As a further indicator of Soviet technical backwardness, it may be noted that some Western firms selling to the Soviet Union have found "so many gaps in the control schemes proposed"[4] that a two-phase quotation format has been adopted: first a feasibility study is conducted (for which the Western company is paid), and then the actual quotation is determined for a complete system based on the feasibility study. In other words, technical inadequacy is such that the Soviets have not been able to specify exactly what is wanted. What this reflects is not a lack of scientific skill; it shows a lack of information on the technical constituents of a modern industrial system.

In the few areas where indigenous innovation was identified in the earlier period, we find a move back toward the use of Western technology. This is visible in the use of Western synthetic rubbers to replace SK-B, a renewed research effort on rotary drilling as a result of efficiency problems encountered in the use of the Soviet turbodrill, and instances of abandonment of the Ramzin boiler in favor of Western designs. The research and development effort has continued, but its results in practical engineering terms have been near zero. From the technical viewpoint the Soviet Union at 1970 is a copy—a rather imperfect copy—of the West. Generally, initial units are still built by Western

[3] For the example of watches, see *Business Week*, June 6, 1960, p. 74.

[4] *Control Engineering* (New York), November 1958, p. 80.

companies and subsequent units built by Soviet engineers are based on the original Western model, and imported equipment is used in key process and control areas.

ORIGINAL WESTERN INTENT FOR TECHNICAL TRANSFER

It may be unwise to attempt to read into an historical sequence of events as important as those described, any rational objective on the part of Western statesmen. Although the policies concerning trade and technical transfers appear vague and often confused, there is one fundamental observation to be made: throughout the period of 50 years from 1917 to 1970 there was a persistent, powerful, and not clearly identifiable force in the West making for continuance of the transfers. Surely the political power and influence of the Soviets was not sufficient alone to bring about such favorable Western policies. Indeed, in view of the aggressive nature of declared Soviet world objectives, such policies seem incomprehensible if the West's objective is to survive as an alliance of independent, non-communist nations. What, then, are the wellsprings of this phenomenon?

In the years 1917-20 a variant of the modern "bridge-building" argument was influential within policymaking circles. The Bolsheviks were outlaws, so the argument went, and had to be brought into the civilized world. For example, in 1918 a statement by Edwin Gay, a member of the U.S. War Trade Board and former Dean of the Harvard Business School, was paraphrased in the board minutes as follows:

> Mr. Gay stated the opinion that it was doubtful whether the policy of blockade and economic isolaton of these portions of Russia which were under Bolshevik control was the best policy for bringing about the establishment of a stable and proper Government in Russia. Mr. Gay suggested to the [War Trade] Board that if the people in the Bolshevik sections of Russia were given the opportunity to enjoy improved economic conditions, they would themselves bring about the establishment of a moderate and stable social order.[5]

At about the same time American businessmen were instrumental in aiding the formation of the Soviet Bureau, and several hundred firms had their names on file in the bureau when it was raided in 1918.[6] Hence there was Western business pressure through political channels to establish Soviet trade. No one appears to have foreseen the possibility of creating a powerful and threatening enemy to the Free World. There was widespread criticism of the Bolsheviks,

[5] Minutes of the U.S. War Trade Board, December 5, 1918, vol. V, pp. 43-44.

[6] New York [State] Legislature, Joint Legislative Committee to Investigate Seditious Activities (Lusk Committee), Albany, N.Y., 1919.

but this was not allowed to interfere with trade. In sum, there was no argument made against technical transfers while several influential political and business forces were working actively to open up trade.

The lack of clear policy formulation and foresight was compounded by the apparent efforts of some State Department officials in the 1930s to discourage collection of information on Soviet economic actions and problems. While the First Five Year Plan was under construction by Western companies, various internal State Department memoranda disputed the wisdom of collecting information on this construction.[7] For example, a detailed report from the U.S. Embassy in Tokyo in 1933 (a report containing precisely the kind of information used in this study) was described in Washington as "not of great interest."[8] It is therefore possible that no concerted effort to examine the roots of Soviet industrial development has ever been made within the U.S. State Department. Certainly internal State Department reports of the 1930s provide less information than the present study was able to develop. Such lack of ordered information would go far to account for many of the remarkably inaccurate statements made to Congress by officials of the State Department and its consultants in the 1950s and 1960s—statements sometimes so far removed from fact they might have been drawn from the pages of *Alice in Wonderland* rather than the testimony of senior U.S. Executive Department personnel and prominent academicians.[9]

In brief, a possibility exists that there has been no real and pervasive knowledge of these technical transfers—even at the most "informed" levels of Western governments. Further, it has to be hypothesized that the training of Western government officials is woefully deficient in the area of technology and development of economic systems, and that researchers have been either unable to visualize the possibility of Soviet technical dependence or unwilling, by reason of the bureaucratic aversion to "rocking the boat," to put forward research proposals to examine that possibility. This does not however explain why some of the outside consultants who were hired by all Western governments

[7] See U.S. State Dept. Decimal File, 861.50/Five Year Plan/50.

[8] U.S. State Dept. Decimal File, 861.5017/Living Conditions/709, Report no. 689, Tokyo, August 31, 1933.

[9] A former assistant chief of the division of research of the Department of State has formed equally harsh conclusions. Bryton Barron has listed four examples of highly strategic tools whose export to the U.S.S.R. was urged by officials of the Department of State:

"1. Boring mills essential to the manufacture of tanks, artillery, aircraft, and for the atomic reactors used in submarines.

"2. Vertical boring mills essential to the manufacture of jet engines.

"3. Dynamic balance machines used for balancing shafts on engines for jet airplanes and guided missiles.

"4. External cylindrical grinding machines which a Defense Department expert testified are essential in making engine parts, guided missiles, and radar."

Barron concludes: "It should be evident that we cannot trust the personnel of the Department to apply our agreements in the nation's interests any more than we can trust it to give us the full facts about our treaties and other international commitments." See Bryton Barron, *Inside the State Department* (New York: Comet Press, 1956).

in such profusion, have not systematically explored the possibility.[10] If it is argued, on the contrary, that Western Governments *are* aware of Soviet technical dependency, then how does one explain the national security problem, outlined in chapter 27?

An argument has been made that a policy of technical assistance to the U.S.S.R. before World War II was correct as it enabled the Soviets to withstand Hitler's attack of June 1941. This is *ex post facto* reasoning. The German Government financed the Bolshevik Revolution with the aim of removing an enemy (Tsarist Russia), but also with postwar trade and influence in mind. This German support was largely replaced in the late 1920s by American technical assistance, but until the mid-1930s the Germans were still arming the Soviets; it was only in 1939 that Hermann Goering began to protest the supply. Thus in the twenties and the early thirties it was not possible for anyone to foresee that Germany would attack the Soviet Union.

The Bolsheviks were assisted to power by a single Western government, Germany, and were maintained in power by all major Western governments. The result is that we have created and continue to maintain what appears to be a first-order threat to the survival of Western civilization. This was done because in the West the political pressures for trade were stronger than any countervailing argument.

This conclusion is supported by the observations that in both the 1930s and the 1960s the U.S. State Department pressed for the outright transfer of military technology to the U.S.S.R. over the protests of the War Department (in the thirties) and the Department of Defense (in the sixties). When in the 1930s the War Department pointed out that the proposed Dupont nitric acid plant had military potential, it was the State Department that allowed the Dupont contract to go ahead.[11] A Hercules Powder proposal to build a nitrocellulose plant was approved when the State Department accepted the argument that the explosives produced were intended for peacetime use.[12]

In the 1960s we have the extraordinary "ball bearing case" of 1961, which revealed that the U.S.S.R. was to receive 45 machines used to produce miniature ball bearings (in the United States almost all miniature ball bearings are used in missiles). That proposal was called a "tragic mistake" by the Department of Defense but supported by the State Department. In 1968 came the so-called "Fiat deal" under which the United States supplied three-quarters of the equipment for the Volgograd plant, the largest automobile plant in the U.S.S.R. This agreement ignored an earlier interagency committee finding that 330 military items can be produced by any civilian automobile industry and that the automobile industry is a key factor for war. It also ignores an argument particularly stressed

[10] See p. x.
[11] See Sutton, *Western Technology ... 1930 to 1945*, p. 101.
[12] *Ibid.*, p. 113.

here—that any automobile plant can produce military vehicles. The supply of U.S. equipment for the Volgograd plant was diametrically opposed to any policy of denial of exports of stratetic goods to the Soviet Union, for under any definition of "strategic" the Volgograd plant has clear and significant military weapons capability. Yet the State Department was strongly in favor of the shipment of the plant equipment. The developing story of the Kama plant suggests history is repeating itself.

Under these conditions, where policy is so far removed from logical deduction, it would be imprudent to arrive at any conclusion concerning Western intentions. If logical intentions exist—and in chapter 27 it is suggested that our strategic policies are not logically derivable from observable fact—they are obscure indeed. The writer leans to the position that there is gross incompetence in the policymaking and research sections of the State Department. There is probably no simple, logical explanation for the fact that we have constructed and maintain a first-order threat to Western society.

IMPLICATIONS FOR THE SOVIET UNION

The Soviet Union has a fundamental problem. In blunt terms, the Soviet economy, centrally planned under the guidance of the Communist Party, does not constitute a viable economic system. The system cannot develop technically across a broad front without outside assistance; internal industrial capacity can be expanded only in those sectors suitable for scaling-up innovation and duplication of foreign techniques.

Quite clearly a modern economy cannot be self-maintained, however skilled its planners and technicians, if technical adoptions in basic industries are limited to processes that lend themselves to scaling up or duplication. Further, the more developed the economy the greater its complexity; consequently the planning problems associated with the acquisition of information must surely increase in geometric ratio.

Logically, then, a system that is strictly centrally planned is not efficient either for rapid balanced growth or for any growth at all once the economy is past the primitive stage. Beyond that stage, the chief function of central planning, so far as the economy is concerned, becomes the retention of political control with the ruling group. There are few economic functions, and certainly no technical functions, that cannot be performed in a more efficient manner by a market economy.

How have the Russian Party member, the Politburo, Stalin, Khrushchev, and Brezhnev looked upon Western technology in relation to Soviet technology? This is indeed a fascinating question. Party injunctions, for example in *Pravda*, suggest that on many levels there has been a deep and continuing concern with lagging Soviet technology. The general problem has long been recognized, ever since Lenin's time. But Lenin thought it curable;[13] the current Politburo must at least suspect it is incurable.

It is however unlikely that either the Party in Russia or the Communist parties in the West have fully probed the depths of the problem. First, their writings mirror a persistent confusion between science and technology, between invention and innovation.[14] Second, it is unlikely that most Marxists appreciate how important an indigenous innovative process is to a nation's self-sufficiency (in contrast to their clear understanding of the value of scientific endeavor and invention). Even breakaways from Marxist dogma still find it difficult to absorb the notion that virtually *all* widely applied (i.e., innovated) technology in the Soviet Union today may have originated in the outside world. Third, Russian designers and engineers may have succeeded in deceiving the Party and even themselves. By claiming as indigenous Russian work designs which in fact originated in the West, they may have obscured the realities of Soviet technology.

The dilemma facing the Soviets in 1970 is stark and overwhelming, and periodic reorganization and adjustments have not identified the basic cause. Indeed, each reorganization either stops short of the point where it may have lasting effect or leads to yet further problems. This is because the Party continues to demand absolute political control while a viable economy increasingly demands the adaptability, the originality, and the motivation that result from individual responsibility and initiative. Attempted solutions through use of computers may temporarily ease the problem, but ultimately they too will result in confusion because accurate information still has to be acquired and analyzed. The computer is only as useful as its human operators are capable and as its data input is sound. In any event, who will supply the computers?

Moreover a communist regime *cannot* yield political power; doctrine demands continuance of power in the hands of the Party. The economy demands diffusion

[13] V. I. Lenin, *Selected Works*, J. Fineberg, ed., vol. IX (New York, International Publishers, 1937), pp. 116-118.

[14] Another and more puzzling facet of the Soviet concept of what begets innovation is found in descriptions of the innovatory process in practice. For example, an article by G. B. Nagigin on innovation in the glass industry states: "Technical offices were established [in one factory] before the start of the competition. Leading engineers and technologists were on duty in these offices and gave practical assistance to innovators who turned to them for advice, consultation, etc. The technical offices are equipped with reference literature and other material needed by innovators and inventors. For example, there is a drawing board and the necessary instruments in the technical office of the Gushkovskii Works. The establishment of well-equipped technical offices, with qualified engineers on duty, naturally had a very favorable effect on the development of innovation and invention work in the factories." *Steklo i keramika* (New York), vol. XIV, no. 2. p. 66. A table is included in the article giving "results." We have to assume that this scheme to encourage competition was a serious attempt to induce the innovatory process—although one is tempted to dismiss it as naive in the extreme. It need only be said that anyone with the slightest knowledge of invention and innovation would conclude that little that is worthwhile can be achieved by such a forced and artificial process.

of power. What will be the result? If Russian historical precedent is any indicator, then the outlook is gloomy indeed. The Russian Revoluton was a gigantic and violent upheaval. The first revolution achieved what had been attained by evolutionary means elsewhere, the substitution of relatively democratic control for autocracy. Then the briefly emergent democratic forces in Russia were caught between the autocracy of the right and the Bolsheviks of the left and were rendered impotent. A new absolutism took power. Today there is no question that a fundamental change has to come again; what is unknown is the form that change will take and whether it will be revolutionary or evolutionary.

It is also clear—and the writer makes this assertion only after considerable contemplation of the evidence—that whenever the Soviet economy has reached a crisis point, Western governments have come to its assistance. The financing of the Bolshevik Revolution by the German Foreign Ministry was followed by German assistance out of the abysmal trough of 1922. Examples of continuing Western assistance include the means to build the First Five Year Plan and the models for subsequent duplication; Nazi assistance in 1939-41 and U.S. assistance in 1941-45; the decline in export control in the fifties and sixties; and finally the French, German, and Italian credits of the sixties and the abandonment of controls over the shipment of advanced technology by the United States in 1969. All along, the survival of the Soviet Union has been in the hands of Western governments. History will record whether they made the correct decisions.

IMPLICATIONS FOR THE WESTERN BUSINESS FIRM

The Western business firm has been the main vehicle for the transfer process, and individual firms have, of course, an individual right to accept or reject Soviet business in response to their own estimation of the profitability of such sales. There is ample evidence in the files of the U.S. State Department, the German Foreign Ministry, and the British Foreign Office that Western firms have cooperated closely with their respective governments in negotiating for such sales.

Historically, sales to the Soviet Union must have been profitable, although the Russians are reputed to be hard bargainers and there have been numerous examples of bad faith and breaches of contract. Firms have accepted theft of blueprints and specifications,[15] duplication of their equipment without permission or royalties,[16] and similar unethical practices and still deemed it worthwhile to continue trade. This applies particularly to larger firms such as General

[15] Sutton II, pp. 263-67.
[16] *Ibid.*

Electric, Radio Corporation of America, Ford Motor, Union Carbide, and Imperial Chemical Industries, Ltd. There is evidence that larger firms are able to demand and obtain somewhat more equitable treatment from the Soviets, partly by virtue of the fact that respective foreign offices are more willing to back them up and partly because the Soviets are aware of the relatively few sources for their new technologies. But less well-known firms such as Lummus, Universal Oil Products, and Vickers-Armstrongs (Engineers), Ltd., apparently also have found that Soviet business pays.

This profitability must be balanced against possible loss of domestic sales in the face of hostile domestic publicity. American Motors found itself in this trap in 1966, when it had no more than vaguely contemplated sales to the U.S.S.R.[17]—and other firms have suffered boycotts. As long as these sales and the impact of such sales on Soviet capabilities were relatively unknown, however, the possibility of boycotts was not great. It appears that some reevaluation may be in order in the light of the findings of this study; i.e., the factors entering into the tradeoffs in considering such business may change. This applies certainly to sales to Red China, where we now stand at a point equivalent to about 1921-22 with the Soviet Union. It is eminently clear that comparable sales over a period of 50 years could place Red China on an equal industrial footing with the U.S.S.R. The difference between the early seventies and the early twenties is that we now have the example of the U.S.S.R. before us: trade has built a formidable enemy, while hopes for a change in ideology and objectives not only have gone unfulfilled but are perhaps more distant than they were 50 years ago.

IMPLICATIONS FOR SOCIO-ECONOMIC SYSTEMS

The Soviet problem is not that the nation lacks theoretical or research capability[18] or inventive genius. The problem is rather that there is a basic weakness in engineering skills, and the system's mechanisms for generating innovation are almost nonexistent.

Table 29-1 suggests the sparseness of Soviet innovation; engineering weaknesses are implicit in continuing plant purchases abroad—while such purchases continue the Soviets are not building plants using their own laboratory discoveries. Why does the Soviet system have such weaknesses?

There is certainly no choice among competing inventions using market criteria, but if more useful Soviet processes existed they would be adopted whether market-tested or not. Absence of the marketplace is not, then, sufficient

[17] See *Milwaukee Journal*, January 22, 1967.

[18] For example of Russian research capability see A. V. Zolotov, *Problema tungusskoi katastrofy 1908 g.* (Minsk, 1969), a fascinating empirical study of various hypotheses relating to the gigantic meteorite that fell in Siberia in 1908.

Table 29-1 INDIGENOUS SOVIET INNOVATION, 1917-65

1917 to 1930	*1930 to 1945*	*1945 to 1965*
Primitive tractors	Turbodrill	Electro-drill
	Alumina from nepheline	Aircraft
	Synthetic rubber; SK-B	*Sputnik*
	Once-through boiler	Medical sutures
	Machine guns	Electro-slag welding
		"Scaling up"

Source: Based on table 25-2.

reason to explain the absence of innovation. There may be, as has been suggested elsewhere, no compelling pressures to develop innovation despite the fact that the Party is constantly exhorting technical progress. But the explanation that most adequately covers the problem is one that has been previously mentioned though not heretofore stressed--the "inability hypothesis." The spectrum of engineering skills required to build a complete polyester plant, a large truck plant, a fast large-capacity computer, *and* a modern marine diesel engine just does not exist in the Soviet Union. Sufficient engineering skills do exist for limited objectives—a military structure can be organized to select and marshal the technology of war, or a space program can be decreed and realized through top-priority assignment of resources. But the skills are not present to promote and maintain a complex, self-regenerative industrial structure.

The point to be stressed is that if there *were* adequate engineering ability some innovation would be forthcoming in the form of original new processes, and such innovation would appear in many sectors of the economy. This is generally not the case. In most sectors the West installs the initial plants and subsequent plants are duplicates based on that Western technology. Once the sector has been established, major new innovations within the sector tend to be either imported technologies or duplicates of imported technologies. Therefore pervasive "inability" in engineering seems the most likely basic explanation. For some reason—and this study has not explored the diverse institutional factors within the system that might be responsible—Soviet central planning has not fostered an engineering capability to develop modern technologies from scratch, nor has it generated inputs (educational, motivational, and material) to achieve this objective.

The world is now presented with 50 years' history of industrial development in the most important of socialist experiments, and censorship can no longer hide the problem. Every new Soviet purchase of a major Western technology is *pari passu* evidence for a central lesson of this study: Soviet central planning is the Soviet Achilles' heel.

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Index