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CURRENT PROBLEMS IN THE INDUSTRIALIZATION
OF SIBERIA

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by

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SUMMARY

During the entire period of existence of the USSR the Soviet leadership has always recognized the great significance of the intensive and comprehensive development of Siberia, both for the economy of the country and for military-strategic purposes. However, in practice the extent to which eastern and especially northeastern regions were provided with resources was always determined by some single narrow goal for which all else was sacrificed, putting the entire economic structure of a huge unsettled territory into the background. Stalin's proclaimed "law of planned proportional development of the economy" can, with respect to Siberia rightly be called the "law of disproportional and unplanned development of the economy." And in the Brezhnev period also, in an industrial sense, Siberia developed as a narrowly oriented part of the national economic system. Its development was like a swollen cheek.

The industrial development of Siberia is lagging considerably behind the planned rates. It is taking place under the stamp of a policy of devoting all efforts to the forced development of the fuel-energy complex. But this is being achieved at the expense of an increasing lag in manufacturing industry and the infrastructure. Investment activity in the region is aggravating the disproportions in the industrial structure and slowing the development of production that is vitally necessary for the region.

All long-term plans for the economic development of Siberia are based on a fundamental premise--its surplus of energy. Over decades huge capacities for the production of electric power have been created.
However, since the 1970's Siberia has turned into a region with sharp and growing shortage of power, which hinders the creation of new manufacturing industry capacity there and slows the economic development of the region sharply.

The gap between the development of extractive and manufacturing branches of industry in Siberia is growing wider, and the region is becoming more dependent on western regions of the country for the majority of products of manufacturing industry.

Shifting the center of gravity of economic development to unsettled eastern regions of the country where the largest part of raw materials and energy are concentrated is becoming a more and more urgent task. But investment efforts for the creation of industrial complexes in Siberia are encountering the unpreparedness of the region's construction industry and its complete unsuitability to the scale of investment programs planned.
Preface

This report presents the results of a half year's study of the problem of carrying out investment programs for the industrial development of Siberia. Within this boundless topic, I tried to focus attention on the nerve centers of the contemporary industrial development of a huge region whose economic growth will to a decisive extent determine the rhythm and dynamics of the entire Soviet economy in the foreseeable future.

The study covers the period 1965-80 ("the Brezhnev era") and is based on data drawn from official Soviet statistical sources and articles and monographs published in the USSR. I evaluate the reliability of this sort of information completely realistically. However, in spite of all its shortcomings, in my opinion it reflects the basic trends, reveals structural changes and explains the essence of the phenomenon examined.

My previous report to the National Council gives an impression of the investment situation in the USSR, against the background of which the investment program for the industrialization of Siberia is being carried out.

In this report, with no pretensions to covering all aspects of the problem, I try to highlight the main factors and to uncover the basic contradictions of the industrial development of the eastern regions of the USSR.

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I. CHARACTERISTICS OF THE INDUSTRIAL DEVELOPMENT OF SIBERIA

1. The Main Feature

The development of Siberian industry is characterized above all by the forced development of the extractive branches and the extraordinarily slow expansion of manufacturing industry. During the past two decades there has been a tendency for this disproportion to increase.

In the period since 1965, industrial production in Siberia as a whole has developed at rates somewhat exceeding the national average. But these slightly higher rates are explained by the accelerated production of oil, gas and nonferrous metals, while in the USSR as a whole industrial growth rates have been affected to a greater extent by the forced development of machine-building and the chemical industry. The contemporary level of industrial production in Siberia is still far from that which was contemplated in substantiating forecasts of economic growth in the USSR based on the natural resource endowment of that half of the country. The share of Siberia in Soviet industrial production at present does not exceed 10%, and for machine-building, chemicals, construction materials, light and food industry, it is substantially lower.

Thus, a high rate of growth of production is characteristic of a relatively narrow group of branches in Siberian industry. These are almost exclusively branches in the initial stages of the production cycle, involved primarily in supplying consumers outside Siberia.
and only weakly participating in the formation of a balanced and integrated economy in Siberia itself.

Industry in Siberia is developing primarily as a national supplier of fuel, raw materials, nonferrous metals, and timber. The share of extractive industry in Siberia is 2.3 times higher than the average for the USSR. 1 The share of manufacturing industry is correspondingly lower. Branches of industry that produce final products (machine-building and light and food industry) have significantly lower shares in Siberia than in the USSR as a whole: 47% and 63% respectively.

Such a direction of industrial development in the region contradicts the thesis of priority (and balanced, harmonious) development of the eastern regions of the country that has been declared during the entire history of Soviet power. In fact, throughout this period and especially in recent decades Siberia has developed as a narrowly oriented part of the national economic system--as a region with an economy specialized in a few products.

In order to explain this character of the economic development of Siberia, it is necessary to examine at least briefly the collision between the regional and branch principles of administering and organizing industry that is inherent in the Soviet economy. In the Soviet press extreme manifestations of one or the other principle are called "localism" and "departmentalism," respectively.
2. Departmentalism and its Influence on the Development of Siberian Industry

Already in the first long-range plan of economic development of the USSR (GOELRO), worked out in 1920, the idea of forming the country's economy not in "Individual links" but in "economically independent regional units" was postulated. This principle governed economic planning in the 1920's and the early 1930's. The first five-year plan was elaborated with a regional breakdown. In it emphasis was placed on the comprehensive development of the economy of each region. The idea of the functional completeness and internal stability of regions of various sizes was emphasized. At the end of the second five-year plan, in the middle of the 1930's, when the process of the specialization and centralization of industry began, these ideas faded somewhat. Nonetheless, even in the third five-year plan notable attention was given to the balanced development of the economies of regions. But, by the end of the 1930's, the contradictions between regional and branch interests in economic planning became more severe and were especially noticeable whenever decisions on some economic question regarding the less-developed eastern regions had to be made. Several Soviet economists pressed for the observance of the comprehensive territorial approach in economic strategy. But as the number of branch economic committees (later renamed as ministries) multiplied and as the functions of administration and planning in all spheres of the national economy were transferred to them, the branch principle became dominant.
The fact that ministries had investment funds, that branch plans were provided with the necessary material and technical resources, that branches had a huge scientific-research, design, and information base, that all labor resources were transferred to branches and most enterprises were subordinate to them—all this transformed branches into powerful economic systems that were not counterbalanced by territorial organs of equal influence in decision making.

The interests of comprehensive regional development began to play a subordinate role and often were simply ignored. The nonconvergence of branch and regional interests was an ordinary phenomenon in the practice of planning and designing industry and locating enterprises. The majority of methodological guidelines for determining the effectiveness of investment and most forms of economic analysis were based on a branch approach. When used uncritically for the analysis of the effectiveness of developing new areas, they distort economic evaluations of the effectiveness of investment programs for their development.

The industrial development of Siberia experiences all the negative consequences of the hypertrophy of branch planning and management of the economy. Given their narrow branch interests and due to the higher capital intensity of production and the need to create an infrastructure in order to attract workers to the east, industrial ministries prefer to allocate investment to and expand production capacity in old industrial regions.
Thus, the narrow branch approach in selecting variants for distributing investments, which is strengthened as limits on investment become stricter, hinders the development of manufacturing industry in Siberia and, hence, gives rise to still greater disproportions in its industrial structure.

3. The Role of Siberia in Soviet Industrial Development

Judging from official Soviet data, there was only a slow growth in the share of Siberia in the Soviet economy in the post-Khrushchev period (see table 1). It is possible that the data presented understate Siberia's contribution to gross social product and national income. This understatement arises, first, because the internal wholesale prices on the output of extractive branches are low and the relative prices of the products of several manufacturing branches are high. Second, data on export shipments understate the real role of the region in Soviet exports. Foreign currency earnings from exports of oil and oil products, gas, coal, wood products, and nonferrous metals account for about 50% of the total volume of Soviet exports. The resources which make such exports possible are to a significant extent contributed by Siberia. But the largest part of export shipments reflected in export statistics, are made directly from regions that are closer to foreign-trade ports (for example, oil and gas is shipped from the European part of the USSR).
Tables 2 and 3 give an impression of Siberia's changing role in the country's industrial production and its growth. An examination of these two tables shows that Siberia's share of national increments to production are consistently greater than its shares of total production volumes for power, fuel, wood products, and light industry. It is important also to note the declining participation of Siberia in the production of machine-building products and construction materials, and this is taking place simultaneously with an increase in the region's share of investment.

4. Trends in Industrial Output

Studies done in the 1960's by leading Soviet scientific and planning organizations (The Scientific-Technical Commission of the Academy of Science and the USSR Council of Ministers, Gosplan, branch ministries and other organizations) showed that the rate of development of Siberia's economy should be significantly higher than the average for the USSR. For industry the growth rate should be 1.5-1.7 times higher. According to published data of the USSR and RSFSR Central Statistical Administration, Siberian industry did indeed grow at more rapid rates. However, it outpaced national growth by far from as much as was planned (see table 4).
The policy of accelerated industrial development was and remains on paper. Such high rates of industrial growth for Siberia, first, were never planned. And, second, the planned rates for Siberia were never realized, unlike the plans for the USSR as a whole (see table 5).

As this table shows, the deviation of actual from planned indicators of the growth of industrial production for Siberia was continuous and significant. The record of plan fulfillment for the USSR as a whole was considerably better.

Let us examine the trends of production growth for the major branches of industry in Siberia (according to the aggregate classification of the USSR Central Statistical Administration). Table 6 shows that growth rates fell in the last five-year period (in comparison with the previous one) in all branches except fuel (due to oil) and petrochemicals. If we exclude oil, the industrial growth rates of Siberia and the USSR as a whole are identical. It is specifically the production of oil that resulted in the slightly more rapid growth of Siberian industry in the 1970's. The fuel industry is the leading link in Siberia's economy, absorbing the largest share of capital, material, and labor resources and having a decisive impact of the trends and structure of development of Siberian industry.
The development of Siberia's fuel industry in the post-war period can be divided into three periods:

1) The period up to 1965, when essentially only coal was produced and the extraction of oil and gas was very insignificant (oil extraction in 1965 was one million tons and gas less than ten billion cubic meters).

2) 1965-1980, when the West Siberian oil and gas complex formed and was developed. A comparison of the growth of production of fuels during this period is given in Table 7. As is apparent from these data, oil production was predominant during this period. The resulting change in the structure of production of fuel resources in Siberia is shown in table 8. Most striking is the significant shift in the structure of fuel production in 1975-80—the share of oil essentially stabilized, while the share of gas grew substantially (more than 2.3 times) and the share of coal monotonically declined.

3) After 1980. The task set for the current decade is to "offset oil with gas." The essence of the energy policy planned for the 1980's is to substitute gas and coal for liquid fuel in electric power stations and boilers in order to maximize the satisfaction of oil needs for nonfuel needs and export. It has become popular among Soviet energy specialists to quote Dmitri Mendeleev" "Oil is not heating fuel. You can burn money to stay warm."
In 1981-85 the production of gas is planned to grow by 50%, which is five times greater than the growth of oil extraction (with gas condensate). In 1981-85 the entire increment of gas extraction is slated to be provided by production from the Urengoi field in West Siberia. In 1980 the correlation of oil and gas (in standard fuel units) in total production of the West Siberian oil-gas complex was 7:3. In 1985 this correlation is planned to change to 55:45, and in the second half of the 1980's the share of gas, according to the plan, should exceed that of oil. Thus, the West Siberian "oil-gas" complex is going to turn into the "gas-oil" complex. Another feature of the third period is the development of the Kansk-Achinsk coal basin and, in connection with this, the expected stabilization and then increase in the share of coal in Siberian fuel production.

In 1965-70 the Siberian fuel industry provided less than one-fourth of the increment in the country's extraction of basic fuel resources; in 1970-75 its share was more than two-thirds. In 1975-80 the Siberian fuel industry not only provided the entire increase in production but compensated for a decline in production in several oil and coal producing regions of the country. According to the plan for 1981-85 more than half of the country's basic fuel resources will be produced in Siberia. But we may note in passing that Siberia's share in the output of manufacturing industry in the country will apparently not exceed 10%.
5. Investment in Siberia's Industry

Industrial development in Siberia has been restrained primarily by insufficient investment in manufacturing industry. Between 1965 and 1975 the share of Siberia and the Far East in investment in the economy of the USSR as a whole increased by less than one percentage point. Capital investment in the economy of Siberia and the Far East increased by 150% during this period, while the investment share of the fuel industry increased 200%. More recently the share of the fuel industry has been growing at an accelerated pace, but the rate of growth of investment in the region's economy has fallen. Thus, the underinvestment in Siberia's manufacturing industry has become even worse.

Even the petrochemical industry has been starved for investment funds and, as a result, its development in Siberia absolutely does not correspond to the rapid growth of oil production. About 7% of the country's investment in the petrochemical industry in 1971-75 was in Siberia. At the same time, the overwhelming part of new production capacities for chemical fibers, synthetic rubber, and synthetic resins and plastics have been located in the European regions of the country, which are experiencing a shortage of fuel and water. The insufficiency of investment has led to the fact that, inspite of the resource saving possibilities of the region, the rates of growth of chemical and petrochemical output have slowed and been below the national rates. The growth of mineral fertilizers, synthetic resins and plastics, and
synthetic fibers has declined sharply. The construction of new enterprises was curtailed and construction was slowed on oil-gas-chemical complexes started at Tomsk, Tobol'sk, Omsk, and elsewhere.

The branch structure of industrial capital investment in Siberia in general reflects the structure of production and differs noticeably from the national structure. While the largest share of investment in industry in the USSR as a whole goes to machine-building, in Siberia this branch gets a very small share.

From one five-year plan to the next, the share of the electric power branch in total Soviet industrial investment grows. Siberia is characterized by the opposite trend. The share of investment in ferrous metallurgy in Siberia is lower than in the country as a whole. Its trends also do not coincide with the national tendency: the share of ferrous metallurgy in industrial capital investment for the USSR declined in 1966-70 and increased in 1971-75. In Siberia it has been declining for a long time. An analogous picture is observed in investment in chemicals and petrochemicals. The investment shares of the food and construction materials industries in Siberia are also declining.

In speaking of the insufficiency of investment in Siberia's manufacturing industry, it is necessary to keep in mind that in Siberia, to a greater extent than in other regions, the investment process is of an extensive nature. This characteristic is manifested as follows.

First, in Siberia relatively larger capital investments are required per unit of output, and a certain part of this additional capital intensiveness is due to objective factors (natural and climatic conditions and the underdevelopment of the infrastructure).
Second, the share of investment in the reconstruction and modernization of existing production facilities here is much lower than the average for the USSR or, even more so, the European part of the country.

Third, the share of unfinished construction is much higher in Siberia. In 1975 it amounted to 86% of annual capital investment in West Siberia and 124% in East Siberia, while the average for the USSR was 75%. This higher share of unfinished construction is explained in part by the shortcomings of Siberia's construction industry of which we will speak below, but also by the composition of construction projects, which includes a high share of enterprises with long construction cycles (enterprises of the hydroelectric, coal, metallurgy, and chemical industries).

As investment activity has shifted to the north, the significance of extensive factors has increased. Thus, due to the more difficult natural-climatic and economic-geographic conditions, the investment required per unit of output in the gas industry is 70% greater in the higher latitudes than in middle latitudes. Obviously, an ever growing share of investment will be devoured by the increasing expensiveness of construction and correspondingly less will be left for net increases in production.
Judging from the plan for 1981-85, the increasing emphasis on investment in the fuel branches at the expense of other industrial branches will continue in the current decade. Of the total volume of capital investment in the national economy planned for 1981-85, the share of the so-called "fuel-energy complex" will jump to 19% compared with 14% in 1976-80. The rate of growth of investment in industry for the USSR as a whole is to decline in 1981-85 (the average annual growth rate is to fall from 5.4% in the previous five-year plan to 4.5%), and this is in spite of an increase in the share of industry in investment in the national economy during the period from 35.3% to 39.7%. The structure of industrial investment in the last five-year plan was characterized by a slowing of investment in machine-building, ferrous metallurgy, and other branches of manufacturing industry due to an intensification of investment in extractive industry, primarily the fuel branches. The investment position of manufacturing industry will be still weaker in the first half of the 1980's. These trends will be manifested especially sharply in the investment structure of industry in Siberia, which is to supply practically the entire increase in production of oil, gas, and coal for the USSR.

Thus, investment trends will even further increase the disproportion between extractive and manufacturing industry in Siberia.
6. The Conception of Siberian Industrial Development and its Realization

If we formulate in condensed form the conception of accelerated industrial development in Siberia on a long-term basis as it was elaborated in the 1960's by scientific and design organizations, including the Institute of Economics and the Organization of Industrial Production which undertook econometric studies based on an optimizing interregional input-output model, its basic ideas would reduce to the following:

* Maintain high rates of growth of the output of extractive branches, especially fuels.

* At the same time, force the development of manufacturing industry, especially machine-building. The growth rates of machine-building production in West Siberia should substantially exceed the growth of fuel output.

* Locate energy-intensive production in the region on a priority basis, since huge fuel and energy resources are concentrated in the region and the technical and economic parameters for their extraction greatly exceed the corresponding indicators in other regions of the country.

* The level of electricity use in the economy should be especially high, much higher than for the USSR as a whole (a correlation of 3:2) since in addition to the fact that it is expedient to concentrate production with electricity-intensive
technology in Siberia, the region is distinguished by its extreme constraints on labor resources. Therefore, the use of electric power for the automation of production processes and as a substitute for manual labor in all spheres of the economy should be as great as possible in Siberia.

* Thus, a leading role in the industrial development of Siberia should be played by electric power. The production of power should exceed the production of fuel and, in general, surpass the growth of industrial production in the region.

* There should be extremely high rates of growth of construction materials output--no less than the growth of power production--and intensive development of construction.

Now, we may rightfully conclude that this conception, with the exception of the first point, was in no way realized. Moreover, the trend toward transforming Siberia into a fuel-energy appendage for the industrial development of the western regions of the country is increasing.

In order to get an understanding of the reasons for this phenomenon, we will examine the trends and directions of production of electric power, machine-building, and construction in Siberia, focusing attention on the main, most characteristic factors and tendencies.
II. PROBLEMS OF ELECTRIC POWER IN SIBERIA

The foundation of electric power in Siberia is its Unified Power System, which supplies about 90% of consumers in the region and has a unique structure: almost half of the overall capacity of its component electric stations comes from highly economical hydroelectric stations, the largest of which is the Krasnoiarsk. While the distribution of overall capacity between thermoelectric and hydroelectric plants in the power system in the European part of the country is 86:14, in the Siberian power system this correlation is 52:48. This structure in combination with cheap fuel has given the Siberian Unified Power System the lowest expenditures on electricity in the country: Siberian power is 40-60% cheaper than in the European regions of the country.

The intensive development of hydroelectric power, which was to play a leading role in the development of Siberia's industrial complex, was the object of an extensive investment program in the 1950's and 1960's located primarily in Krasnoiarsk krai and Irkutsk oblast.

During 1961-75 the production of power in Siberia increased 4.3-fold. However, the rate of development of power in Siberia has steadily declined: the average annual rate of growth fell from 16.9% in 1961-65 to 12.2% in 1966-70 and 7.6% in 1971-75. Here it is
important to distinguish the following two trends: first, the growth of power production in Siberia has lagged behind national growth rates, and, second, in the 1970's there was a tendency for the growth of power production to fall behind the growth of total industrial production in Siberia.

How can it be that a region that in all economic forecasts and all long-term plans of the Soviet economy was always viewed as a region with surplus electric power (a surplus arising from huge investments over the course of decades) could suddenly turn into a region with a power shortage?

1. The Power Shortage in Siberia and its Causes

The power shortage that appeared in the 1970's and is tending to become more serious is the direct result of a distortion in investment in Siberian power: the predominance of investment in hydroelectric power and the extremely limited investment in thermoelectric power. Such a policy, implemented throughout the 1950's and 1960's, turned out to be a major miscalculation by Soviet planners and designers. The consequences of this error will weigh heavily on the economic development of Siberia in the remaining two decades of this century. In addition to this, the construction of massive hydroelectric stations led to the flooding of vast areas of agricultural land, forests, and as yet undeveloped sites of mineral raw materials and has also had a significant impact on the region's climate (in particular, Krasnoiarsk). In short, the ecological consequences are no less severe and will last incomparably longer than the economic.
In the 1970's an incompatibility developed between the structure of generating capacities and Siberia's power requirements. Generating capacities increased primarily as a result of hydroelectric stations and almost no new thermal powerplant capacities were put into operation. As a result a situation developed in which surplus capacities were formed at hydroelectric stations that maintained a low load level throughout the year, while there was a shortfall in thermal powerplant capacities that might have offset seasonal declines in production from hydroelectric plants.

In building the Krasnoiarsk hydroelectric station (with an annual capacity of six billion kilowatt-hours, the largest not only in the USSR but in the world), which was to provide practically the entire increase in Siberian power production in the 1970's, an inconsistency was permitted between parameters of the reservoir intended for the annual and seasonal regulation of water flow and turbine capacity. The station's power generating equipment could not provide an even output on both an annual and seasonal basis and still maintain a water throughput sufficient for intensive ship traffic on the Yenisei—an important meridional transportation artery in Siberia. Therefore, the station works at half capacity throughout the year. The low utilization of this giant of electric power led to the development of a very serious situation with power in Angaro-Yenisei region (Krasnoiarsk krai and Irkutsk oblast) where it is located. And this is one of the most important industrial regions in Siberia.
The excessive increase in the construction of powerful hydroelectric stations in East Siberia led to the development of surplus hydroelectric capacities and a catastrophic shortfall in capacity at thermal powerplants where production does not depend on natural conditions. It turned out that reserve capacities should have been precisely in the thermal powerplants for which investment funds for construction and expansion were not allocated.

To get a complete impression of the existing situation, the particulars of power consumption in Siberia must be considered. It is characterized by highly concentrated use both on a daily and an annual basis: the average annual duration of maximum load is about 7,000 hours. At the same time, for many years the number of hours of utilization of the Krasnoiarsk hydroelectric station has been about 3,500 hours. Thermal powerplants must compensate for the shortfall in output of hydroelectric stations during periods of low water flow. However, due to capacity limitations they are unable to do this.

One other significant factor must be added to this: the lag in the development of the electrical network of Siberia's Unified Power System. The vastness of the territory served, the high concentration of capacities, and the relatively weakly developed electrical network noticeably reduces the quality and reliability of the electric supply to several regions of central Siberia.

Thus, Siberia became a power-short region and wasted the advantage of a region with significant energy capacity reserves that made it attractive for the development of energy-intensive production in spite
of relative capital costs that were higher in comparison with other regions of the country. The difficulties with the power supply continue to grow. Strict limitations on the consumption of power have been instituted throughout Siberia, including for energy-intensive production.

The strained situation with electric power became an additional factor hindering ministries from locating manufacturing industry enterprises in Siberia.

At the present time the only thing that might ease the situation is an increase in the utilization of thermal powerplant capacities in critical periods. To what extent can this possibility be realized?

The problem of utilizing thermal powerplant capacities in Siberia is apparently more acute than in many other regions of the USSR. One of the basic conditions of a reliable power supply is the availability of a certain reserve generating capacity. It is generally considered in the USSR that the power system should have the following reserves: for accidents, in case a generating unit goes out of operation (about 3-5%), which is a minimally necessary condition for reliability of the power supply; peak load, in case of increases in consumers' requirements (2-3%); repair (5-6%); and economic (3-5%) as a precondition for creating new or expanding existing capacities. All together, in the opinion of specialists, power system reserves should be a minimum of 10-12%, and 13-15% is desirable.
In fact, in the mid-1970's the Siberian Unified Power System had only insignificant reserves for equipment repair—much less than the norms require. The power shortage gives rise to an excessively high load on thermal powerplants above all norms. In 1975, for example, the average number of hours of operation for the thermal powerplants in the USSR as a whole was 5,741, while the average for the Siberian Unified Power System was 6,600 hours. For several power-plants this figure was 7,200-7,500 hours. Such forced loading excludes the possibility for timely repair of equipment which causes it to wear out more rapidly. The possibilities for replacing old equipment with new are being reduced from year to year because of the decline in its production in the USSR. The production of turbines has stabilized at the level of the late 1970's, and the production of turbine generators and steam boilers has declined. Even more significant is the fact that the amount of new capacity for the production of turbines introduced in 1976-80 declined in comparison with 1971-75 by almost 50% on an average annual basis.

Given such an overloading of the operation of thermal powerplants, the absence of reserve capacities in the Unified Power System, and the difficult situation with power in the region, it is absolutely impossible to take some powerplant out of operation for a time for the reconstruction and modernization of equipment.
It follows that the output of power in Siberia can be increased only by greater utilization of the capacities of hydroelectric stations. And the paradox of the existing situation is, thus, that climatic conditions play just as important a role in the power production and power supply of Siberia as in the region's agriculture.

Eliminating the shortage of power in Siberia will be a long process. It will require a fundamental restructuring of the Unified Power System in the direction of increasing the share of production of power at thermal powerplants. The optimal distribution of production of power between thermal and hydroelectric stations in Siberia must be a ratio of 75:25 in the opinion of Soviet specialists (remember that now it is 52:48). The tasks involved is to convert thermal powerplants from liquid to hard fuel, i.e., coal. The plan for solving this sizable problem is to create and develop a system of thermal powerplants using cheap coal from the Kansk-Achinsk basin.

2. The Kansk-Achinsk Node

Without exaggeration we may say that the development of electric power in Siberia in the 1980's will depend primarily on the pace and scale of exploitation of the coal fields in the Kansk-Achinsk basin. But the development of these deposits and bringing their coal into the country's fuel-energy balance goes far beyond regional problems in Siberia; it is one of the most important tasks for the Soviet economy in the current decade.
The solution of the Kansk-Achinsk problem, like any other economic problem of this scale, is permeated with sharp contradictions which it has taken decades to overcome. These contradictions, which are of an entirely objective nature, to this day give rise to bitter arguments that by themselves, naturally, create considerable difficulties in the planning and design processes, whether it is Gosplan, the Academy of Sciences, a ministry or design institute.

The Kansk-Achinsk basin adjoins the Kuznets coal basin, and these two basins in the southern part of central Siberia account for almost 68% of the country's coal reserves that are favorable for economic development.

Given Siberian conditions the location of the Kansk-Achinsk basin is exceptionally favorable. Its good mining and geological conditions are supplemented by the existence in that zone of southern Siberia of large and medium-size cities, developed agriculture, and a convenient location with respect to transportation ties: the basic deposits are located in direct proximity to existing railroad lines and others that are under construction. The entire length of the basin is crossed by the Trans-Siberian Railroad, from which the Achinsk-Abakan line runs to the south and the Achinsk-Yenisei line to the north. Apparently in the not too distant future the basin will also receive a link to the Middle-Siberian Mainline. An exceptionally important factor is the location of the basin, especially its southern part, adjacent to main centers of Siberian industry--Novosibirsk, Kemerovo, Krasnoiarsk, Novokuznetsk, and Tomsk. The basic concentrations of metallurgy, petrochemicals and chemicals, machine-building
and construction materials are located precisely in these regions of southern Siberia. At the same time, these are regions with the most developed, by Siberian standards, infrastructure. Thus, these are the most fuel-short regions.

3. The Conception of Utilizing Kansk-Achinsk and Kuznets Basin Coal

The main question that gives rise to contradictory opinions is the division of functions between the Kansk-Achinsk and Kuznets basins.

Kansk-Achinsk coal is now and will in the future be the cheapest fuel in the country. Its coal is 2-2.5 times cheaper to extract than Kuznets coal (in standard fuel units) and 7-8 times cheaper than Donets coal. Therefore, it is in the interests of the economy of the USSR to expand the mining and consumption of Kansk-Achinsk coal as much as possible and thus to release oil and gas for qualified users (not fuel uses), exports, and other needs, and to supply Kuznets coal to fuel-short regions of the Urals and the European part of the USSR.

The hypothesis about the development and use of the coal resources of southern Siberia that existed until recently was based on two fundamental postulates: 1) The Kuznets basin was viewed as the basic supplier of coking coal for metallurgy in the Urals and Siberia. At the same time not much significance was attributed to the development of the energy coal of this basin.
2) The energy coal of the Kansk-Achinsk basin should be used to cover the power shortage in the Urals and the European part of the USSR. And only about half of its coal was intended for use in Siberia itself—primarily for the needs of the central part of Krasnoyarsk krai.

The Irkutsk and Minusinsk basins and deposits in Zabaikal, were supposed to supply East Siberia with coal.

However, in the mid-1970’s new factors arose—new factors in the energy situation both for the country as a whole and for Siberia, which led to the formation of new ideas about the development of the Kansk-Achinsk basin.

First, there was an orientation toward eliminating the power shortage in the European regions primarily by constructing atomic power plants (already in 1976-80, 35% of the increase in capacity of electric power stations in the European regions was to be provided by atomic power). 20

Second, a reevaluation of the possibilities of the Kuznets basin showed that the maximum level of extraction might be increased almost two fold. At the same time, the prospects for extracting transportable fuel coal increased substantially, and new possibilities for reducing the cost of production arose.

According to contemporary estimates, the potential for extracting coal in Kuznets basin is put at a minimum of 550 million tons per year, including approximately 200 million tons of coking coal and 350 million tons of fuel coal. 21 At present about 40 million tons of Kuznets coal
are consumed in Siberia itself. Experts believe that even if consumption in Siberia increases to 50-60 million tons the Kuznets basin could still ship 280-300 million tons of coal to the European part of the country and the Urals (250-270 million tons of standard fuel).\textsuperscript{22} For comparison we will note that coal extraction in the Donetsk basin amounts to about 150 million tons. Thus, in addition to supplying coking coal the Kuznets basin could become an important supplier of fuel for power in European regions of the country. A decline in the growth of iron smelting by the classical blast-furnace method in the USSR and also a decline in the relative amount of coke used in iron smelting will lead to a reduction in requirements for coking coal, the production of which still continues to be viewed as the main task of the Kuznets basin.

These circumstances plus the closer location of the region to regions of consumption (the Kuznets region is located about 300 kilometers west of the Kansk-Achinsk) will substantially increase the role of Kuznets coal in the fuel balance of the Urals and the European regions of the country.

The economic effectiveness of using Kansk-Achinsk coal is higher the closer the consumer is to the point of extraction. More than 140 billion tons of the coal reserves are estimated to be suitable for open-pit mining. But the brown coal of the Kansk-Achinsk basin is distinguished by its high moisture content (from 28 to 43\%) and as a result has a tendency to oxidize and even ignite spontaneously. Therefore, it is not suitable for long-distance shipment or long-term storage. Unlike Kansk-Achinsk coal, Kuznets basin coal is highly
transportable and does not require any sort of preliminary processing. In the opinion of a former Minister of Power and Electrification who was subsequently director of the Krzhizhanovskii Energy Institute, Dmitri Zhimerin, transporting Kansk-Achinsk coal long distances is extremely undesirable. Transmitting power produced from Kansk-Achinsk coal near where it is mined to the European part of the country by direct current lines would involve huge expenditures on the construction of powerful transmission lines. Thus, this approach to using Kansk-Achinsk coal to feed the energy system of European regions is also rather doubtful.

All these considerations suggest that the most expedient approach both for the near and distant future is to use the coal and power from the Kansk-Achinsk basin entirely for Siberia's needs and to aid the fuel short regions of the European part of the country with oil and gas from West Siberia and Kuznets basin coal. In this case the main user of Kansk-Achinsk basin energy (70-80%) will be central Siberia, primarily its southern part, which possesses significant resources for the development of energy-intensive production from the standpoint of its construction base, infrastructure, and relatively skilled work force.

Thus, the construction of powerful thermal powerplants on the territory of the basin and in the surrounding area within 200-300 kilometers would turn the Kansk-Achinsk fuel-energy complex into a primary energy base for Siberia, and the low cost of power would make all other regions of the country uncompetitive with the southern part
of central Siberia from the standpoint of the economic effectiveness of the development of energy-intensive production. That is the idea.

But the realization of this idea involves the solution of the following very complex economic, technological, and ecological problems.

4. Problems of Implementing the Kansk-Achinsk-Kuznets Concept

First: increasing the extraction of fuel coal from the Kuznets basin to 300-350 million tons (the approximate amount to compensate for not shipping Kansk-Achinsk coal to the west) will require the thorough reconstruction and technical retooling of many Kuznets basin mines.

Second: transporting coal from the Kuznets basin to the Urals and European regions will require the construction of special roads or pipelines. At the end of the 1970's, 30-40 million tons of coal were being shipped to the Urals and the European part of the USSR from the Kuznets basin. Shipping as much as 250-300 million tons of Kuznets coal (which, incidentally, is the equivalent of another Donbas appearing in the European part of the USSR) would be a much more difficult task given the catastrophic overloading of main transportation arteries and the accelerating growth in the flow of oil and gas in the same direction.
Third: a high concentration of coal mining and power production at thermal powerplants in the most densely populated region of Siberia would threaten the environment and make it dangerous for human habitation. Judging from the long-range plan, it is anticipated that by the end of the century a group of thermal powerplants with an overall capacity of up to 50 million kwh will be located in the western part of the basin within a distance of 100-200 kilometers of each other. It is proposed that about 200-250 tons of natural fuel will be burned at these stations. Even with an ash discharge of 5-7%, the total quantity of ash and cinders could be 12-15 million tons a year. Designs to deal with these discharges envision the construction of smokestacks 360 meters high (with a diameter at the mout of 14 meters). In this case the area over which particles are spread and settle will increase, but the atmosphere will still be dusty and in the long run a significant area of the densely populated region of Siberia will be polluted. We may add to this the huge consumption of oxygen in burning such a quantity of fuel. And a similar pollution problem will arise with water resources. The single major river here--Chulym--already supplies water to and receives waste from the growing Kansk-Achinsk industrial center, and its potential is near exhaustion. The diversion of water from the Yenesei to the Chulym could be a real escape from this situation, but this, of course, would involve major hydrotechnical construction.

It should be kept in mind that the ecological condition of the territory adjacent to the western flank of the Kansk-Achinsk and Kuznets basins is already generating concern among Soviet ecologists and physicians.
The situation has become especially serious in a center of Siberian metallurgy—Novokuznetsk. Among other factors that are damaging the environment and dangerous for man, of particular concern are the consequences of introducing electric-arc steel production technology in the process of reconstructing the giant Kuznets metallurgical combine without the necessary technology to render production waste harmless. Here is what the director of the Siberian Institute of Occupational Health, V. Bessonenko, has to say about this: "For example, we are very disturbed by the expansion of electric-arc steel production at the same technical level that exists in the branch [my emphasis, B.R.]. The point is that both in working conditions and in generating wastes of such components as chrome, selenium, and nickel, this technology is much more dangerous than open-hearth production, to say nothing of convertors."26 And it is precisely electrometallurgy that is slated to be developed using the cheap power in the Kansk-Achinsk fuel-energy complex.

Four: is the pernicious consequences of energy and industrial capacities for the highly intensive agriculture of the region, for the fertile high-yield soil. In addition to discharges into the atmosphere and water pollution, the region's agriculture will inevitably be affected by the removal of huge areas of arable land from agricultural use, which can hardly be offset by increases in the productivity of the remaining land. The latter factor and large population growth resulting from the development of industry will increase the shortage of agricultural products in the region, a deficit that must be covered by additional shipments from other regions of the country. And we should note that it is
specifically the regions adjacent to the Kansk-Achinsk basin that are Siberia's granary.

Five: is the creation of a construction complex. A comparison of the requirements for construction work with existing construction capabilities shows that the construction base must almost be created anew. The existing capacity of the construction complex is hardly sufficient for the creation of a pioneering construction base. The projected construction of several machine-building enterprises (the Krasnoiarsk heavy excavator plant, electric machine-building plant and others) will divert capacities of the region's construction organizations that are already used to the limit. Judging from the lack of coordination that has characterized the construction of the first projects for future Kansk-Achinsk thermal powerplants, (housing and structures for the construction industry), this investment program is being implemented in the worst tradition of Soviet mass-scale construction.

Six: is the decline in the production of equipment for the coal industry and turbines for powerplants, which has become more serious in the early 1980s and which must necessarily affect the supply of equipment to Kansk-Achinsk thermal powerplant projects.

In order to carry out the Kansk-Achinsk thermal powerplant program, fundamentally new technology and huge capital investments and labor resources will be necessary. Given the contemporary economic situation and technical level, the implementation of this program will
proceed at a very slow pace, with a number of palliative decisions being taken, and with alternating dampened and flourishing stages in the construction cycle. The only thing that could breathe life into this project and intensify its development is Western credits and an increase in imports. It is impossible to imagine that, given the existing political situation in the country, there are any other possibilities.

Thus, there is no reason to expect any easing of the electric power situation in Siberia in the foreseeable future from the development of the Kansk-Achinsk thermal powerplant program. It would appear that the situation will not be significantly corrected until at least the end of this decade.

III. PROBLEMS OF SIBERIAN MACHINE-BUILDING

1. Trends in Siberian Machine-Building and its Role in USSR Production

The rate of development of Siberian machine-building does not at all conform to the region's growing requirements. After 1960 machine-building was developed most intensively in the central and western regions of the USSR, and the construction of new machine-building plants in Siberia was almost stopped. The average annual rate of growth of machine-building output declined
from 13.1% in 1956-60 to 9.8% in 1971-75.\textsuperscript{28} As a result, Siberia's share in national machine-building production declined from 9.7% in 1960 to 7.5% in 1975 and 6.1% in 1978.\textsuperscript{29}

The slowing of the development of machine-building, which is characteristic not only of Siberia but the country as a whole, is explained by several factors common to all Soviet machine-building including such things as the aging of equipment, the shortage and low quality of metal, and the reduction in the average number of shifts worked. But in addition an important role is played by the negative attitude of branch ministries to investment in Siberian machine-building due to the higher relative capital costs there and the problems with the labor supply (the average number of shifts that Siberian machine-building enterprises operate does not exceed 1.4)\textsuperscript{30} and the growing power shortage. The absence of any desire to expand the capacity of Siberian machine-building is apparent in the fact that in the first half of the 1970's, for example, the region's capital investment in machine-building amounted to only about 4-5% of total investment in machine-building in the USSR.\textsuperscript{31}

The recent lag of Siberian machine-building behind the region's requirements stands out in comparing the trends of growth in industry and machine-building output against the background of analogous processes in the Soviet economy as a whole (see table 9). While the growth trends of machine-building
and industrial output in Siberia roughly paralleled those for the USSR as a whole in the 1960's, in 1971-75 the extent to which machine-building growth exceeded overall industrial growth increased for the USSR but dropped for Siberia. The development of Siberian machine-building has also lagged behind the overall development of the machine-building industry in the USSR. This is evident from the data for 1961-75 in table 10 on the difference in the growth rates of fixed capital, which reflects many years of underinvestment in Siberian machine-building in comparison with machine-building in the USSR as a whole.

The lack of dynamism in Siberian machine-building is particularly manifested in the immobility of its regional structure, which has almost not changed during the past two decades. In West Siberia, which accounts for more than 70% of all Siberia's machine-building output, Novosibirsk oblast as always provides the largest part of production growth. In East Siberia the major share of increments to output (about 75%) is traditionally supplied by Krasnoiarsk krai and Irkutsk oblast. 32
2. Lack of Correspondence of the Structure of Production to Requirements

Unlike the machine-building complex of western regions of the USSR, which have formed over decades and produce 90% of the country's machine-building output, Siberian machine-building has a very recent history. Its nucleus, formed during the war years, was composed of enterprises evacuated from western regions and their specialization was determined by the demands of war time.

In the post-war period the location and specialization of machine-building enterprises in Siberia, determined by branch ministries, was governed primarily by the interests of industrial branches. The economic structure of Siberia and the region's own requirements were given the lowest priority consideration. Therefore, first, the plants located in Siberia are extremely varied in the nature of their output, which reduces product specialization and technological cooperation within the region to a minimum. Second, the location and specialization of machine-building plants does not at all correspond to the extent of requirements for any given machine in Siberia. In other words, the structure of machine-building production in Siberia does not correspond to the structure of requirements; it does not meet the region's needs.
As a result of the fact that the output of the region's leading machine-building plants is oriented primarily toward the national market, and the list of machines and equipment produced does not coincide with the local economy's profile, the amount of machine-building products imported into Siberia is almost equal to the amount exported. And while for regions in the European zone of the USSR trade in machine-building products is characterized primarily by shipments within the zone, for Siberia it is just the opposite --less of its machine-building output ends up within the Eastern zone and more is shipped to the European zone. 33

Using the example of West Siberia, let us examine the correspondence of the structure of heavy machine-building to the region's economic specialization and its role in overall USSR machine-building for basic types of products (see table 11).

This table calls for the following comments. The relatively high share of mining machine-building, both with respect to the region and in the national context, would seem to be justified. Less warranted is the high share of agricultural machine-building since the share of all of Siberia in national agricultural production does not exceed 8%, and the share of machine tools--a very labor-intensive branch of machine-building--seems excessively high. But the shares of oil and gas MB, construction equipment, hoisting-transporting MB, chemical MB, and the automobile industry are in
sharp contradiction to the requirements of West Siberia. Let us
examine several examples characterizing the balance of production
and consumption of machine-building products in Siberia. The share
of West Siberia in national production of electric power is 7%.
while the share of energy and power machine-building is about 15%.
However, Siberia's requirements for energy and power machine-building
products are 60-65% covered by imports from other, primarily western,
regions of the country. At the same time, the lion's share of
the output of plants located in the region are shipped to the west.
Siberia produces about 9% of all metal in the USSR, but metallurgical
equipment is almost not produced there. Siberia is a region of open-
pit mining work, but as yet there is not one plant producing excavators in Siberia
(or, incidentally, in the Far East or Kazakhstan).

Of course, interregional ties for machine-building are an
entirely normal phenomenon for the economy of a huge country. But
a most important factor for Siberia comes into play here--the severe
labor shortage. Machine-building is in general the most labor-intensive
branch of industry. In Siberia machinery's share of industrial
production is about 21-23% and its share of the industrial workforce
is about 35%. And a situation in which Siberia, experiencing a severe
labor shortage (especially of skilled labor, which is chiefly used
in machine-building), produces machinery and equipment that is for
the most part (90-100% for some items) shipped to regions with
much more favorable labor balances, must be considered pathological.
And at the same time almost 80% of its own requirements (85% for
East Siberia and 73% for West Siberia) are satisfied by imports. 36
Here we must keep in mind that massive transcontinental shipments
of large-unit, difficult to transport equipment creates special
problems for the country's transportation system, which is already
overburdened with spontaneously growing shipments of raw materials
and fuel on a broad scale. And we may note that the basic load falls
on the railroad system whose critical condition is well known.

3. Hypothesis on the Development of Siberian Machine-Building

As long as Siberia maintains a 6% share of machine-building
production and ships in 80% of its equipment requirements, largely
from the European part of the country, it is unrealistic to count on
dynamic development of its economy and the opening up of its vast
unsettled and inaccessible areas. And this relates not only to economic
but to social development: the location of machine-building there helps
to retain the labor force, to prevent its migration to other regions.
Developing only extractive industry will not solve these problems.

At present, the prevailing notion is that regions in southern
Siberia should remain the zone of intensive development of machine-
building, while it is absolutely inexpedient to locate machine-building
enterprises in the northern regions. According to this conception, the southern part of central Siberia should become the center of energy and power MB, hoisting and transporting MB, construction equipment, metallurgical MB, mining, coal, oil, and gas machinery and equipment.

The particular difficulty in developing Siberian machine-building, thus, is the need to simultaneously increase the rates of output growth and sharply restructure the branch composition of production, changing the specialization of machine-building enterprises. According to the calculations of the Institute of Economics of Industry of the USSR Academy of Science, the growth rate should be 11-12%, while currently it is apparently less than 8%. And in order not only to halt the sharp decline in Siberian machine-building growth rates but shift to the opposite trend, very large-scale investments will be necessary. The restructuring of production to bring the specialization of Siberian machine-building enterprises into line with the region's economic specialization is possible only by the massive reconstruction and modernization of these enterprises. But all the difficulties and contradictions of industrial reconstruction examined in the first phase of this project are redoubled in Siberia. We will note one other important factor:
the share of construction-assembly work in industrial investment in
Siberia is substantially higher than in most other regions of the
USSR, i.e., the share of investment in industrial structures is
higher and the share of investment in equipment is correspondingly
lower. The difficulties of construction work in Siberia are
aggravated by several specific factors that are examined in the next
chapter. Thus, the intensification of the development of Siberian
machine-building and bringing it closer to the region's needs requires
diverting investment resources for these purposes of a magnitude
that is impossible given the country's current economic situation
as long as existing economic and political priorities are maintained.

Thus, will the stagnant condition of Siberian machine-building
continue in the 1980's? Who might accelerate its development? What
could influence the leaders of the Soviet economy and spur them into
accelerated investment in the construction of new and reconstruction
of existing machine-building enterprises in Siberia in actuality and
not just on paper?

The extent of investment activity aimed at the development of
Siberia's machine-building and its spatial orientation depends on the
general idea on which the formation of Siberia's economy is based and
on the character of the planned development of the region.
In this context, it seems that the following alternatives should be examined:

1) the purposeful comprehensive development of Siberia in the broadest sense, determined by the geopolitical situation in that part of Asia. For this it is necessary to create conditions that would retain the population and counteract its outflow. From this point of view, the creation of a balanced structure of the economy in developing regions, with elements of autarchy, is a fundamental factor. And such a structure is unthinkable without sufficiently developed machine-building. And this means not only heavy machine-building to satisfy the requirements of the extractive branches, and not only service-type machine-building (repair enterprises, etc.), but also instrument making and, in general, machinery enterprises of varied specialization must be placed in Siberia based on a concept of planned proportional development of the region. The military-strategic interests of the USSR, requiring deconcentration of machine-building as the leading branch of defense industry, also coincide with this conception. The expansion of machine-building capacity primarily in the Novosibirsk-Krasnoiarsk zone where the primary part of Siberia's machine-building is already concentrated contradicts the logic of locating enterprises from the standpoint of military-economic planning.

2) the more narrow approach to developing Siberia oriented toward the extraction and primary processing of raw materials and fuel resources, determined as before by narrow branch interests with Siberia's role
subordinate to and specialized for national interests. It would seem appropriate to call this attitude toward the development of Siberian economy "consumerist" from the standpoint of central planning organizations. Precisely this second alternative dominates in planning calculations and projections, which outline the creation of the largest center of heavy and power machine-building of the Asiatic part of the country in the southern latitudinal belt—the soft underbelly of Siberia.

Such a position is based on objective prerequisites. The major one is the proposed availability of surplus and cheap electric power there in connection with the development of the Kansk-Achinsk fuel-energy complex (as shown above, this prerequisite is being realized very slowly). Furthermore, a powerful production potential has already been created here, concentrating almost half of the fixed capital and labor resources in machine-building east of the Urals. And other important advantages—the center of Siberian metallurgy is here, transportation conditions are, by Siberian standards, most favorable, the infrastructure and the availability of skilled machine-building workers are, again by Siberian standards, developed—make this zone of Siberia the most attractive in an economic sense for the massive development of machine-building. Nonetheless, while arguments of a strategic nature are examined in theoretical works, for pragmatists of Soviet planning concerned only about today, they remain ideas cut off from practice.
The development of heavy machine-building in the southern part of West Siberia should, in the opinion of Soviet planners and scientists, be favored by other important advantages:

-- the sharp increase in the requirements for its output in the adjacent regions of Siberia and Kazakhstan;

-- the exceptional unmatched position of the region with regard to the possibility of introducing new electric power-intensive technology, in particular shifting to electric power for smelting, heating, welding, and heat treating metals;

-- possibilities, incomparable with any other region in the country, for reducing labor expenditures (which is so important precisely for Siberia) by raising the amount of power per worker;

-- proximity to the primary metallurgical base of the Asiatic part of the USSR—Kuznets and West Siberian metallurgical plants;

-- the availability of skilled labor;

-- the most developed (under Siberian conditions) transportation network.

We may divide the listed factors into two groups: those of an economic-geographic nature and those that depend on the rate and scale of realization of the Kansk-Achinsk power project. And while factors in the first group objectively exist, those in the second group, for reasons laid out above, put off the realization of plans for the
development of a heavy machine-building center in southern Siberia to an undertermined time.

But dragging this problem out has serious consequences not only for the economic development of Siberia but for the entire Asiatic part of the USSR (especially Kazakhstan and the Far East), which, according to the idea embodied in long-range plans, should receive many necessary types of machinery and equipment from the machine-building industry of the southern zone of West Siberia.

Table 12 provides an impression of how great the difference is in machine-building production between the European part of the USSR (including the Urals) and the Asiatic part. Analysis of this table shows the importance of creating a powerful machine-building base in the eastern part of the country.

Special attention should be paid to the correlation in repair work, from which it is clear how much more worn out the stock of machinery and equipment is in Asiatic regions of the USSR than in European regions. And from this it follows that the share of replacement in investment in machine-building in Asiatic regions must be higher (possibly twice as high) than in European regions. Thus, much larger investments are required per unit of net increase in machine-building capacity in Asiatic regions.

In examining table 12, it must be kept in mind that the center of gravity of the consumption of power, transportation, chemical, oil, and several other types of machinery in the country is shifting rapidly to the east.
4. Some Special Demands on Siberian Machine-Building Production

The task of creating a machine-building base for developing Siberia's resources has a qualitative as well as quantitative aspect: Siberia's natural conditions and the unique scale of mineral resources necessitate the production of machinery and equipment that is specially suited to these conditions.

Developing the oil and gas deposits of West Siberia requires creating and producing equipment for the simultaneous but separate working of two or three strata, highly efficient pumps, and automated drilling installations that are easily erected.

Working Siberia's large coal deposits within the foreseeable future is impossible without using special powerful complexes for stripping operations and the corresponding transportation technology (rotor excavators, walking excavator-draglines, self-propelled scrappers for layer stripping, coal-carrying trucks), cutting, cleaning, and drilling equipment, and mechanisms with high unit capacity and productivity.

For thermal powerplants operating on Kansk-Achinsk coal, special boilers suitable for processing the specific brown coals of this basin are needed as well as a system for ash processing and disposal.
The huge volume of construction requires highly efficient bulldozers, trench excavators, various types of cranes with high capacity and reach, and other special-use construction equipment adapted for local operating conditions.

Transportation machine-building is given a special role. Primarily due to their inaccessibility to transport, many deposits such as, for example, Udokansk copper, Gorevsk lead and zinc, Deputatsk tin ore, Molodezhnyi chrysolite-asbestos, Zhirekenskii and Orekitkanskii molybdenum, and other no less important deposits are in a preserved condition. Transportation expenditures in regions of West Siberia where oil and gas sites are undergoing initial industrial development amount to 30-50% of production expenditures, and as work shifts farther north in Tiumensk oblast their share grows still more. In northern regions of Siberia where the landscape is characterized by huge areas of swampy tundra and a large number of water barriers, special hydrofoil-type transportation and snow and swamp caterpillars with heavy freight and long-range capabilities are needed.

Thus, the problem is not simply to increase the volume of production of machinery and equipment in line with Siberia's huge and growing requirements but to create and produce special equipment, in many cases on a fundamentally new basis. By simply adapting
existing models, created for operation under ordinary conditions, to Siberian conditions, the accelerated development of Siberia's fuel, power, and raw material resources will be impossible.

Is Soviet machine-building, given its current production capacities and its contemporary technical level, able to cope with meeting the requirements for reliable equipment with parameters that are oriented toward the regional conditions of operation in Siberia? Apparently not. The point is not only the decline in production of the majority of types of equipment mentioned but in the reduced pace of creation of new types of this equipment. Thus, according to Soviet statistics, in the second half of the 1970's the number of new models of machinery and equipment fell in comparison with the first half of the decade for power, electrotechnical, mining, pump-compressor, casting, hoisting-transporting, transportation, and construction materials industry machinery. 39

The gap between the capabilities of Soviet machine-building and the requirements of Siberia's fuel-energy complex are increasing and will increase more rapidly as investment in the fuel-energy branches outpaces investment in machine-building.

* * *
It would, however, be incorrect to suppose that this problem does not worry the leaders of Soviet planning and its theoreticians or that significant efforts are not being taken to solve it. Judging from publications in recent years, the idea of creating a nucleus of heavy machine-building for eastern regions of the USSR in the southern part of West Siberia is finding more and more proponents among representatives of the economic and scientific-administrative establishment and is receiving support in long-range plans and schemes of the development and location of industry in the period up to the year 2000. There is evidence of a growing conflict of interests surrounding this question between such scientific and economic organizations as the USSR Gosplan's Council for the Study of the Productive Forces, the Institute of Economics and the Institute of Economics and Organization of Industrial Production of the USSR Academy of Science, and Siberian regional party committees, on the one hand, which press for increasing the investment quota of Siberian machine-building by limiting investment in machine-building in western regions, and branch ministries, on the other hand, that stubbornly prefer to invest in the existing machine-building structures of the Central, North-West, Ukrainian, Volga, and Ural regions. We have no information revealing the position of Gosplan or, more important, the Military-Industrial Commission of the USSR Council of Ministers. It is possible that their position on this contradictory question has still not been formulated in final form.
Nonetheless, an analysis of the literature gives the impression that the flow of investment to Siberian machine-building became more intensive in the second half of the 1970's, and we are inclined to believe that this tendency will increase. A change in the course of concentrating machine-building in western regions of the country and overcoming an inertia in the location of this branch that has formed over many decades requires great and purposeful efforts on the part of the Soviet leadership. Equalizing the disproportion in the development of Siberian machine-building is a process that is complex both with respect to resources and technology. The decisive factor for stimulating its acceleration is the implementation of the Kansk-Achinsk energy project.

IV. SIBERIA'S CONSTRUCTION COMPLEX

Investment programs planned and implemented within Siberia are so varied in their technological specifics and in the conditions under which they are carried out that there is no sense in examining, as an object of analysis, a single Siberian construction complex. While construction conditions in regions along the Trans-Siberian Railroad essentially do not differ from average conditions for the country, construction in the higher latitudes of Siberia has special features. Investment activity and construction-installation work in Siberia is rather rapidly shifting to the north, to extreme conditions. Thus, the share of construction north of the polar circle in West Siberia increased from 16% to 33% between 1965 and 1975.41 Data
presented in the report on the first phase of this project characterizing the regional shift in investment activity in 1976-80 and the growth of investment in the oil and gas complex planned for 1981-85 provide a basis for concluding that by the end of the current decade this share will be 50%. Therefore, we will focus attention on the problems of construction in the northern regions of Siberia, especially in the northern part of Tiumen oblast where investment activity and the concentration of construction-installation work will be highest not only on the scale of Siberia but for the entire country.

We will try to formulate briefly the basic characteristics of construction in Siberia.

The first of them was just mentioned: the essential dissimilarity of all parameters of the construction process in the north and south of the region. Such regions of southern and central Siberia as Kuzbass-Altai (Kemerovo and Novosibirsk oblast and Altai krai) or the Irkutsk-Angara industrial agglomeration have mature production structures with a rather developed construction base. A large part of Siberia's production of construction materials is also concentrated in these regions (93% of cement, 60% of reinforced concrete) as well as the largest construction organizations, which formed in the process of constructing large hydroelectric stations. Therefore it is not at all correct to extend the idea of difficulties of construction in Siberia to these regions. Thus, a particular feature of Siberian construction is the growing spatial gap between the concentration of investment in
a northern direction and the developing construction base in the south.

A second feature is that the territory is as yet unsettled. The investment program there must be of a pioneering nature. In addition to productive construction, the transportation network, productive and social infrastructures must be newly created.

A third feature is the deconcentration of many small-scale construction projects as the oil and gas deposits of West Siberia are developed across a vast area: the level of capital investment per hectare for the majority of projects does not exceed 0.5 million rubles, while in the construction of machine-building enterprises in southern Siberia it is more than 10 million rubles per hectare.43 To this must be added the uncertainty about key parameters of the oil-gas investment program, which depend on the exploration for reserves. All this gives rise to special demands for high maneuverability and mobility of construction work.

A fourth feature is the extremely severe natural and climatic conditions: the eternal permafrost, seismic activity, swampiness, and low winter temperatures, all of which affects design decisions and construction equipment and technology.

The listed factors dictate the need, first, to invest initially in the creation of a construction base and the development of the production of construction materials and structures in regions where construction will be concentrated; second, to better equip construction with the appropriate construction
technology and vehicles; third, to carry out construction projects with due regard to natural and climatic conditions; fourth, to use building materials that are most appropriate for the natural and technological conditions of the construction project; and, fifth, to create on organizational form of construction that would be mobile and sufficiently universal in a technological sense. Let us examine how these demands are realized in practice.

1. Underinvestment in Siberia's Construction Industry

According to the very cautious estimates of Soviet experts, implementing the planned investment program in Siberia will require doubling the amount of construction work in the region. The first condition that must be met is the creation and rapid development of the corresponding construction base and the production of construction materials and structures. One of the axioms of the theory of Soviet planning is the rule that the growth of investment in the construction base in developing regions must be more rapid than the growth of investment in the economy of the region as a whole and must be proportional to the planned acceleration of construction-assembly work. From this it follows that the capacity of production facilities supplying building materials and services to construction must develop at rates that exceed the rate of increase in construction-assembly work. For Siberia
as a whole this difference in rates should be 150-200%, but in fact it is 110-120%. It is also perfectly obvious that the share of investment in the construction industry as a whole, including the construction materials industry and construction structures, as a percentage of total capital investment should be substantially higher in the Siberian regions of pioneering development than in the USSR as a whole or the RSFSR. However, factual data reflect just the opposite picture.

As table 12 shows, the share of investment in the construction industry in Siberia was, first, lower than for the RSFSR as a whole, and, second, while this share was growing for the RSFSR, for Siberia (and what is most notable, for West Siberia) it was declining.

Investment in the construction materials industry as a share of total capital investment in Siberia declined during 1971-75 from 0.91% to 0.88%, and for West Siberia from 0.74% to 0.56%. As a result the production of construction materials and the growth of the construction base in general lagged farther behind the planned rates. This lag is characteristic of the construction complex of the country as a whole, but in Siberia (especially West Siberia) it is much more clearly evident.

Still more significant is the disproportion within the construction complex itself: construction work is not very intensive, but it is developing nonetheless, while at the same time its base—the construction materials industry—is stagnating. The trend in fixed capital put in
place is convincing evidence of this. While annual fixed capital put in place in construction increased from 234 to 300 million rubles between 1971 and 1975 in Siberia as a whole, including a gain from 162 to 185 million rubles in West Siberia, fixed capital put in place in the construction materials industry in Siberia declined during this period from 85 to 69 million rubles for all of Siberia and from 47 to 27 million rubles for West Siberia.46

According to estimates by Soviet specialists, the share of investment in the material-technical base of construction in the developed regions of Siberia should be 3-4% of total investment in the economy, and in newly developing regions (which includes, first of all, the northern territory of Tiumen oblast) it should be 10%. Thus, the actual value of this indicator (see table 13) is much lower than what is needed, and all the troubles of the region's construction sphere center around this lag, this disproportion.

2. The Absence of Construction Technology and Designs that Meet the Extreme Conditions of Construction on Northern Regions of Siberia

A direct consequence of the insufficient investment in Siberia's construction complex is the low technological level of construction organizations. West Siberian construction organizations have 22 kopecks of fixed productive capital per rubel of construction-assembly work, while the average for the USSR is 34 kopecks. The low level of
capitalization of construction in Siberia must be viewed together with the severe shortage of labor.

But more important is the fact that machinery and equipment operated in the northern regions of Siberia must meet the demands of natural and climatic conditions. In the severe Siberian climate, construction equipment wears out faster and breaks down more often than in other regions. In the north of West Siberia automobiles, tractors, bulldozers, and scrapers last for only 30-35% of their normal service lives. Idle time is extremely high due to breakdowns and accidents. But even equipment in good repair is used with low productivity. For example, the work rate of excavators in Yakutia in winter is reduced by 40%. The reason is that the stock of construction and road-building machinery is absolutely not suited to conditions in the north due to the low cold-resistance of metal used in machine-building, the rapid wearing out of moving parts, the lack of suitable low-temperature engine starters, operator cabin construction that is inappropriate for normal conditions of operation in the north, etc.

Maintaining ordinary equipment under conditions of the north requires strengthening buildings—modernizing, winter-proofing, additional heating and lighting—and this must be done before machinery is put into operation. However, such work is not done in the majority of cases.
The reliability of ordinary equipment drops sharply under the influence of low temperatures, and the amount of repair work and expenditures on spare parts grow. While repair expenditures grow sharply, the repair base of construction organizations in Siberia and its equipment is at a low level of development; the quality of repair is correspondingly lower, much lower, than at similar sites in the country's middle zone. Practically all construction organizations manufacture many types of spare parts for their equipment themselves.

Conditions of the Siberian north make it expedient to use machinery and equipment with a higher unit capacity intended for low temperatures, permanently frozen ground, and swampy land. However, paradoxically, the share of such machinery in the stock of construction road-building, and other equipment in northern Siberia is lower than in the country as a whole. And it should be noted here that in general the production of large-capacity construction machines in the USSR comprises a small share of the production of construction equipment. For example, 250-hp bulldozers comprised only 1% of total bulldozer production in the mid-1970's and more powerful models were not even produced.

The main factor hindering the production of special equipment for the north is not insufficient attention to the problem on the whole and not a lack of ideas from scientific and design work. Many models of machinery for northern use have been created in Soviet scientific and design organizations. The main obstacles are a lack of
production capacity in machine-building for serial production of these models and a shortage of highly cold-resistant steel. The first factor was discussed in the report on the first phase of this project. Therefore, we will look briefly only at the second.

Soviet operational experience and experiments conducted by specialists in the northern regions shows that parts made of steel and iron in serially produced automobiles, tractors, and construction machines have a tendency to shatter due to brittleness when subject to blows or overloading under operating temperatures below 40° C. In northern regions of Siberia the temperature in winter gets down to 60° C, and quite often when winds are high. Under such low temperatures the tensile strength of steel falls and in certain temperature intervals, depending on the load conditions, steel frequently becomes brittle and it is then possible for machinery parts to shatter, even under loads that are less than nominally permissible. Therefore, under such climatic conditions special cold-resistant steel alloys with high tensile strength are needed, but the production of such steel, like the production of heat-strengthened rolled metal is in a completely insufficient level. It is precisely this steel that the USSR imports from Japan and West Germany, and the import possibilities are very limited.
Therefore, there are no grounds for optimism in evaluating the possibilities for increasing the production of construction and transport equipment for northern use in the USSR in the foreseeable future. And it is hardly likely that imports of low-alloy steel will increase substantially.

In addition, the difficulties with developing and producing special tires, gasoline and diesel fuel for use in the north, northern types of motor oil and lubricants, etc. should be mentioned. These technologies are lagging greatly in the USSR and Western help is needed here also.

But in order to implement construction programs in Siberia not only special technology but also construction designs adapted to the extreme conditions are needed. It should be noted above all that standard designs are used extremely widely in housing and productive construction in the USSR. In the mid-1970's the share of construction using standard designs was 81% for the country as a whole. The goal in creating and using designs on a mass basis is to economize on resources, struggle with wastefulness, and discipline both clients and contractors. The practice of standard design is the only means of limiting the exaggeration of estimated construction costs. However, the striving for standardization in any and all types of construction has gone beyond all rational limits and turned into "stencil-construction." Siberian cities are built primarily with
exactly the same standard buildings as are constructed in western and southern regions of the country. The same relates to industrial construction.

As far as we know, the only, or at least one of very few, standard design for residential buildings in regions beyond the polar circle was developed and introduced in Norilsk when the director of the Norilsk Combine and, hence, the city's boss was current candidate member of the Politburo, Vladimir Dolgikh. But between the polar circle zone of Siberia and, say, the foothills of Altai or the Minusinsk hollow, there is a vast territory with diverse natural and climatic conditions. And the construction of production structures and social infrastructure projects in these areas is based on one or two standard designs. It is shocking but a fact that in buildings erected in Siberia wood is used just as sparingly as in the steppe regions of the Ukraine. And this is a consequence of the excessive standardization of designs.

It is impossible to understand or explain the existing construction practice in Siberia without dealing with at least the basic factors determining the level and character of the contemporary stage of development of the Soviet construction industry as a whole.

3. **Retardation of Design and Industrial Construction Technology in the USSR**

A fundamental factor hindering the realization of Soviet investment plans, including investment programs in Siberia, is the obsolescence of design principles and methods of erecting buildings and structures and the
incompatibility of construction technology with the tasks that it faces. We will try to analyze briefly the factors underlying this phenomenon.

During the years of its existence the Soviet construction industry has experienced two revolutions: 1) the construction boom of industrialization in the 1930's (the rejection of seasonal construction work and the introduction of hoisting--transporting equipment into construction), and 2) the second half of the 1950's--the Khrushchev housing construction explosion (the transition to the production line, completely prefabricated construction). In both the first and the second instance a radical change in construction technology gave rise to a sharp increase in labor productivity: both in the 1930's and in the second half of the 1950's the rate of growth of labor productivity increased and amounted to about 9%.52
Beginning in 1966 the rate of growth of labor productivity in construction has exhibited a steady downward trend and has lagged behind the analogous indicator for industry. It would seem that the renewal of fixed capital that has taken place at a more rapid rate in construction than in other branches of the economy (fixed capital in construction in 1980 was 256% above the 1970 level, while in industry this figure was 216% and in agriculture 225%) should have averted this tendency. But this did not happen and the reason apparently is that the increase in fixed capital involved the extensive development of the traditional technological base of construction and not the introduction of new technology.

In the 1970s the average annual growth rate of labor productivity was 3.6%, and in the last three years of the decade (1978-80) it fell to 0.7%. In other words, the growth of labor productivity in construction almost ceased at the beginning of the 1980s. If we add to this the fact that employment in construction has almost not grown in this period (an average annual increase of 0.5%), the need for a radical overhaul of construction technology in the USSR becomes obvious.

The revolution in the construction industry's technology in the USSR in the 1950s was due to an unprecedented jump in housing construction in the first five years of the Khrushchev period. Investment in housing construction increased by more than 400% during 1950-1960. Its share in the total volume of investment in the national economy jumped from 19.5% to 25.1% in only three years (1956-58). Thanks to these efforts a record increase in construction output for the entire postwar history of the USSR was achieved in 1956-60 (about 90%), and the amount of new housing
introduced during that five-year period increased by almost 250\%.\textsuperscript{56}

But the implementation of this investment program was possible only because of the massive introduction of prefabricated concrete in construction, the unification of construction components it provided, and the sharp increase in the share of factory-produced components that are merely put in place on the construction site. This was the essence of the construction revolution in the USSR, for which a new branch—the production of prefabricated reinforced concrete—was actually created. This in turn required a significant increase in the production of cement and metal. During the decade 1950-1960 the production of cement increased by 447\%, steel by 240\%, and prefabricated concrete by 2500\%.\textsuperscript{57} However, after 1965 the effect resulting from the mass use of prefabricated concrete technology diminished.

Here is the opinion on this of authoritative Soviet experts:

"From the moment of enactment of the decree of the Central Committee of the CPSU and the USSR Council of Ministers on the production of prefabricated concrete, its output increased more than 20 times, exceeding the level of production in the U.S., France and the F.R.G. taken together. As the branch fully absorbed constructions of prefabricated concrete, the increase in technical-economic indicators declined, and by now the orientation toward further expansion of the use of prefabricated concrete contradicts the requirements of scientific and technical progress.

Moreover, a tendency is now observed toward heavier refabricated protective constructions for buildings and
structures, which leads to heavier supporting
structures and, hence, to higher material-intensive-
ness and, above all, metal-intensiveness of construc-
tion. As a result the prime cost and labor intensity
of construction are growing.58

The expansion of the production of reinforced concrete and its
broader use to the point of replacing other types of construction materials
everywhere went beyond the optimal boundaries already in the second half
of the 1960s and is now in contradiction with technical progress in the
design and erection of buildings and structures. This contradiction has
increased with the growing volume of construction in the northeast, in
unsettled regions with extreme natural and climatic conditions where special
principles of design for industrial enterprises and objects of the infra-
structure are needed as well as construction components and materials that
are suitable for these conditions.

Let us examine briefly the essence of this contradiction. For this
we will compare the real state of affairs in the USSR with the modern level
of technological progress in design and construction of production struc-
tures, which the Soviet Union must attain if it is to carry out its
ambitious investment program.

In Soviet design practice to date, primary attention is devoted
to durability, to creating long-lasting production buildings. Under these
conditions the tendency toward heavier prefabricated components for build-
ings and structures becomes more and more noticeable, and as a result
the relative expenditure of cement, metal, and other materials grows,
labor expenditures increase, construction times stretch out, and the subsequent reconstruction and modernization of enterprises is made more complex and more expensive.

The main idea of modern industrial construction is the transition from multipurpose to functional, inexpensive, and easily dismantled buildings, maximally adapted to the demands of specific technological processes. Their service life is substantially reduced and approaches the service life of the basic technological equipment. Thus, excess durability of structures is excluded and construction time is shortened.

One of the basic principles of modern design for industrial enterprises is the convertibility of new enterprises—creating the possibility for a transition from an old to a new technological scheme. The rapid replacement of models and the constant renewal of the assortment of goods produced generates a demand for movable equipment installations and the possibility of assembling equipment and productive structures from standard units. The practice of creating "flexible shops" and enterprises that can, without special difficulty, expand or retool to produce a new product has been widely developed in advanced industrial countries.

In such enterprises a system of bridge cranes as the main intrashop and intraplant means of transport loses its significance. Crane operation requires the construction of massive walls and supports designed for heavy loads. Characteristic of a "flexible shop" are widely developed floor transportation, conveyer systems, pneumatic transportation, and other means that create the possibility for varied and mobile transport schemes. It is important to note that rejecting the traditional use of bridge cranes
leads to a reduction by several times in construction height and in over-all weight of the components of industrial buildings.

The idea of the "flexible shop" has been widely introduced in machine-building and in light industry. This principle is especially important in military industry and, above all, in such branches as rocket construction, instrument building, and electronics where the possibility of a rapid transition from one type of product to another is of decisive significance.

In branches of industry such as metallurgy, chemicals, and cement where the basic technological equipment is in large stationary units, technical progress in construction is manifested not in the creation of "flexible" shops but in the use of lighter, less massive buildings.

Against the background of these modern trends, the design of industrial buildings in the USSR appears absolutely anachronistic. The obsoleteness of construction methods is manifested primarily in the wide use of bridge cranes as intraplant transportation and the absolutely insufficient use of floor transport or light suspended hoisting-transporting apparatus. For the majority of branches of industry, industrial buildings are designed and constructed to be equipped with bridge cranes. According to data of the Central Institute of Industrial Buildings (in Moscow), about 60% of all shops are equipped with bridge cranes.

The use of light constructions in such shops yields an insignificant effect. Characteristically for Soviet industry, an increase in unit capacity of equipment means an increase in weight and unit size, which in turn requires using cranes of larger freight capacity and presupposes
increased demands on the size of industrial buildings and the weight and capacity of structures. Bridge cranes widely used in Soviet plants have a capacity of 200-300 tons, and in oxygen-converter shops 450 tons. At a plant producing equipment for nuclear power stations (Atom mash), the capacity of bridge cranes reaches 1,200 tons.

According to Soviet standards, if there is a bridge crane in a shop, even one of lowest capacity, the height of the structure cannot be less than 8.4 meters, even if the height of equipment does not exceed 1-2 meters. All the rest of the heated, lighted, and ventilated building space is nothing other than the zone of movement for the bridge crane.

In modern industrial buildings of Soviet enterprises equipped with bridge cranes, the size and mass of columns, foundations, and beams is more than two-thirds dependent on crane loads.

It would seem that under such circumstances designers should make strict calculations in the choice of bridge crane capacity and strive to limit it as much as possible. However, in practice the design of crane capacity is based on the maximum possible mass of technological loads. The number of cranes is determined not by the volume of work but by obsolete standards for installing a unit of hauling equipment per 60 meters of hauling distance.

Planning and design decisions on the part of construction for modern Soviet industrial buildings depend much more on the type of bridge crane adopted in the design than on the technology of production. For example, structures of shops producing enamelled pots and pans that weigh no more than 2-3 kilograms differ very little in scale and weight from those of a rolled metal shop in a metallurgical plant. The construction of
The carcasses of electric powerplants is just as heavy as in the casting and other shops of machine-building enterprises producing very heavy products.

In addition to the excessive increase in bridge cranes, many other obstacles lie in the path of creating more efficient construction designs. One of them, for example, is strict standards for the "span" of arrangements of technological equipment, which leads to the incomplete use of production floor space and building volume and to a significant lengthening of transport, power, and communication lines.

A leading Gosplan worker notes in this regard: "No one would get the idea of building an airplane, ship, or even a house in which two-thirds of the volume or up to one-fourth of the floor space was practically not used. In industrial construction given the existing approach to design such a phenomenon has become the norm." 60

We have revealed the situation with bridge cranes in such detail in order to demonstrate how archaic industrial design in the USSR influences the technology and methods of construction. The technological scheme adopted and the equipment used predetermine the massiveness of production structures, the properties of building components, and, thus, construction materials.

One of the consequences of the demands of technical progress under conditions of competition within and between countries was a striving to synchronize the service lives of buildings and basic technological equipment in industrially developed countries, and this, in turn, gave rise to the idea of the "flexible shop" and the corresponding type of building.

Constructing lighter types of buildings became possible because of the wide use of new construction materials, light and cheap construction and protective building components of prefabricated and collapsible elements.
In connection with this there was a sharp increase in the use of light panels of aluminum, asbestos-cement and steel sheets with foam rubber insulation, glass-fiber slabs and other light fillers.

It is difficult to say just what is the first cause: whether routine design in the USSR does not stimulate the development of contemporary construction components and materials or, just the opposite, the shortage (and in many instances, absence) of such components and materials hinders progress in the design of industrial enterprises. These phenomena are interconnected.

But we will try to vindicate the designers and examine just what the possibilities are for using light metal components, polymers, and other modern construction materials in construction.

Soviet specialists recognize the need to change the structure of building materials used in construction, to reject the hypertrophy of prefabricated concrete, and to widely introduce light metal construction components. In characterizing the effectiveness of such a restructuring, Academician Nikolai Mel'nikov presents the following data: light components make it possible to reduce total building mass by 4-5 times in comparison with reinforced concrete, to reduce labor expenditures on outer walls by 10-30 times, and to reduce labor expenditures on support structures and the roof of a building by 1.3-1.5 times. The author devotes special attention to the advantages of aluminum and its alloys as a base material for the production of construction components in comparison with prefabricated concrete.

However, in the sense of steel, aluminum, and chemical products availability, the Soviet construction industry is on starvation rations. According to the estimate of the USSR Minister of Construction, G. Karavaev,
construction's requirements for progressive construction components and materials is only 30-40% satisfied. The use of components, parts, and materials from mineral raw materials predominates. In the final analysis, everything boils down to the sharp and growing deficit of high quality steel and aluminum, and this shortage is forecast to continue in the 1980s. In Mel'nikov's opinion the production of such steel should be tripled (or more) in comparison with the existing level in order to fully satisfy construction's requirements. With respect to aluminum construction components, they began to be produced only in the first half of the 1970s, and they are much less used in the USSR than in industrially developed countries. The decline in metal production in the USSR, beginning at the end of the 1970s, does not promise an optimistic future for the construction industry. The only hope is imports.

Such are the deep-seated factors underlying the crisis in construction technology and very substantially affecting the effectiveness of the entire investment sphere of the Soviet economy.

4. Impact of Obsolete Construction Technology on Siberia

The symptoms of Soviet industrial design and construction technology examined above are characteristic of investment activity in Siberia to a still greater extent. Bulky buildings and structures erected on the basis of standard designs of heavy reinforced concrete components and almost without consideration of natural, climatic, and economic particulars have a pernicious effect on the growth rates and effectiveness of Siberian construction and, ultimately, on the realization of plans for the industrialization of Siberia.
In Siberia as in no other region of the country there is a need for designs adapted to specific conditions and for labor-saving, modern construction technology. It would seem that precisely Siberia should serve as the proving ground for experimenting with all sorts of innovations in the construction industry. However, new materials and components are invented, developed, and introduced primarily in the cities of the European part of the country.

In the northern zone of Siberia, the use of heavy reinforced concrete components is stipulated for carcasses, roofs, and other building elements in the majority (80-90%) of designs. Outer walls of brick or cement block are used in about half of all designs. In spite of the wealth of timber in many of these regions, the use of wood components is stipulated very rarely.

Just what the use of reinforced concrete and not steel components means is evident from the comparative characteristics presented in table 14.

The use of steel and aluminum components and wall materials in the northern regions of Siberia provides a much greater effect than in other regions of the USSR. There, one-story buildings comprise about 80% of all floor space of industrial buildings. And it is precisely in this type of building that the use of all-steel carcasses and light outer-wall components, galvanized steel roofs insulated with foam rubber, and aluminum panels in place of reinforced concrete make it possible to greatly reduce the cost and shorten construction time. The use of wood in place of reinforced concrete in these regions is much more economical. The high
effectiveness of such construction technology is proved by construction experience in northern regions of Canada and the United States where reinforced concrete has been almost entirely supplanted by light materials and components shipped in and by wood. The use of such materials and components with a high degree of factory preparation justifies the use of air transport to deliver them to the construction site. Assembling them does not require a complicated crane system, a large stock of vehicles, or a large number of construction workers.

But in northeast regions of the USSR, in spite of the special natural, climatic, and transport conditions, almost the same types of construction components and materials are used as in central regions, and above all reinforced concrete.

According to Academician Mel'nikov's data, experience with the use of aluminum components under northern conditions in Siberia (Dikson, Mirnyi, Chukotka, and Magadansk oblast) showed that in comparison with traditional construction components, the mass buildings was reduced by a factor of 20, the volume of shipments by 10-15 times, construction time was reduced by a factor of four and labor expenditures by a factor of five; the cost of construction of one square meter of production floor space was reduced by 50%. 65

However, aluminum and steel components are used to a very insignificant extent in construction in the northeastern regions. Reinforced concrete components play the leading role, and the share of metal components in the total volume of construction materials used in the northern part of West Siberia at the end of the 1970's was only 0.3%. 66 Even in the main point of the country's current investment activity--the construction of the oil-gas complex in the north of Tiumen oblast--reinforced concrete dominates. Here is what a well-known Soviet specialist in the area of the
That reinforced concrete has been adopted as the leading material also in the construction of the Tiumen oblast oil-gas complex, where the lack of roads, swampy land, and weak ground foundations create great difficulties in the use and shipment of sites of heavy reinforced concrete components, is a matter of concern. Wood materials that are traditional for Siberia are almost not used. For example, in Tobolsk residential buildings are constructed from panels shipped thousands of kilometers from Omsk; at the same time the wood from the area cleared for the construction site is not used. 67

At the same time as the volume of construction in Siberia grows and the region's share in construction output of the USSR significantly increases, as does its share of reinforced concrete consumption, production of the latter is concentrated in the European part of the country (72.6% in 1977). At the end of the 1970s Siberia's share of investment in the national economy was 20%, while its share of production of reinforced concrete was 10%. Production of reinforced concrete per ruble of construction work in Siberia is half that in European regions of the country. 68 It is natural, therefore, that in 1975 80% 69 of the reinforced concrete used in Tiumen oblast was shipped in to supply the colossal scale of construction and, accordingly, consumption of reinforced concrete that is characteristic of that region.

Given such a shortage of reinforced concrete and such a spatial polarization in its production and consumption, a huge quantity of this heavy, difficult to transport material is shipped for distances measured
in several thousands of kilometers in spite of the near absence of normal roads and means of transportation suitable to the task. The shipping of reinforced concrete components in these regions diverts 3-9 times more workers for transportation than for carrying out the construction work itself. Transportation expenditures greatly exceed the cost of production. Thus, the production of construction materials and components for the industrial development of the Medvezh'e (Tiumen oblast) gas deposits cost an average of 52 rubles per ton and shipments to the site almost 93 rubles.

Thus, the mass use of prefabricated concrete and the absolutely inadequate production and use of light metal and aluminum components and modern construction materials is one of the basic obstacles to realizing Siberia's investment programs. How much are they aware of this situation in the USSR? Can we expect that substantial changes for the better will be implemented in the foreseeable future and that construction in Siberia will get a new intensifying impulse?

The problems examined above are well known to the leaders of the Soviet construction industry. Already in the early 1970s the author of this work repeatedly participated in sessions at Gosplan, Gosstroi, and the Ministry of the Construction Materials Industry where decisions were made about changing the structure of construction components in favor of metal, about rejecting the universal use of prefabricated concrete, etc. The economic expediency of using steel components in place of reinforced concrete in northern and hard to reach regions had already been proved, and "Technical Rules" had already been elaborated and published, which stated that design and construction organizations, in erecting production buildings and structures on permafrost ground and in hard to reach areas, should use
steel components, light roofs and walls from galvanized steel, aluminum sheets, and asbestos-cement slabs.  

However, to this day little has changed and, judging from numerous sources, the intensive use of reinforced concrete in these regions continues. What are the reasons for such a situation?

The first and main reason was already mentioned: the growing shortage of quality steel and rolled metals, production of which is declining. Increases in the production of chemical products and raw materials for the production of polymer construction materials are also falling. The increase in the production of synthetic resins and plastics in the second half of the 1970s fell in comparison with the first half of the decade by 32%.

Another reason is mentioned by the author cited above, Victor Krasovskii:

"The preferential use of heavy components in construction, and above all heavy reinforced concrete which accounts for 35-40% of the value of all materials consumed, is explained not so much by economical or technical necessity as by narrow branch interests. As we know the overwhelming part of prefabricated concrete is produced at enterprises of contract construction ministries. The price of prefabricated concrete has provided for a comparatively high enterprise profitability—about 20-25% and higher. Until recently the cost of reinforced concrete was included in the fulfillment of plans for construction-assembly work, which, in turn, stimulated the preferential use of specifically this heavy and expensive material."
Krasovskii also informs us that more than 2,000 prefabricated concrete plants are in operation in regions of concentrated construction and that the volume of production of reinforced concrete in the USSR is much higher than in the U.S. or in all European countries combined. However, construction ministries plan a still greater increase in the construction of such plants, i.e., a still greater increase in the production of reinforced concrete in the future.

5. Traditional Forms of Organization of Construction

It is not only the fact that designs and construction technology employed in Siberia are unsuited that slows the execution of investment programs there. A no smaller share of the shortcomings is due to transferring to newly developing Siberian regions the methods of organization of construction that are in effect in the old economically developed regions of the European zone of the country.

As a result of the extending of organizational cliches to the developing regions of Siberia, the basic organizational unit of construction work is the "general construction" trust—a general contractor that as a rule includes dozens of varied projects in its work program. Such a trust is not so much an organizer of the construction of all these projects with the aid of specialized subcontracting organizations as it is a universal performer of almost all types of work. It is a stationary combine of production and transportation enterprises located in a particular place.

As a rule, such trusts functioning in major industrial regions always find work for themselves. The need for their services in such
regions is always great—demand exceeds the possibility of satisfying it with contractors. After being created initially to carry out some sort of major project, they shift after it is over to other, usually no less large-scale, tasks. For example, the giant Kuibyshev gidrostroi construction trust, after carrying out the basic part of the work on the construction of the Kuybyshev hydroelectric station, was shifted to the construction of the Volga Automobile Plant located in the same region. Incidentally, the decision to locate the plant in this place (Tol'iatti) was determined to a significant extent by the existence there of a ready-made, large-scale construction organization that was capable of constructing an automobile giant.

Transferring the form of organization of construction that had proven itself under conditions existing in urban industrial agglomerations to the developing regions of Siberia has a number of serious consequences for many spheres of the economies of these developing regions.

In the initial period of creation of an industrial center, a stationary construction trust is not only the leading but the only economic organization that devotes any interest to the development of an infrastructure, to its scale and nature. Since construction workers comprise the permanent population, nodal industrial developments are from the very beginning subject to the danger of despecialization and spontaneous growth that far exceeds the limits of the initial design. The projected structure of production, both basic and auxiliary, the optimal number of populated sites and the population distribution plan, the scale and development of the social infrastructure, and, above all, housing construction are all deformed under the influence of the self-generating,
expanding construction complex. The real needs of the construction trust, which are auxiliary to its functional role of organization, often displace some of the requirements of basic producers. The development of cities contrary to initial plans is determined in such cases not by the functioning of future enterprises but by the level of construction activity at the time of the maximum scale of its work. In order to support this level, more and more new construction projects with no direct relation to its primary specialization are included in the scheme of the industrial center.

Thus, a tendency develops for Siberian cities to grow out of proportion to the future requirements of normal exploitation of the developing region's resources. Bratsk is an example of this sort of spontaneous development. The same thing is happening now in Nizhevarovsk and in other cities of developing regions. 75

Another factor of an organizational nature that has a significant impact on the progress of construction in Siberia is the scattering of construction work among many specialized construction ministries and the absence of a single regional organ that can direct or correct the execution of construction work, regulate relations between contractors and subcontractors, and possess real power in the distribution of resources.

The essence of the branch system of administration of the economy of the USSR is that the decisions made by branch ministries are egotistically oriented only toward the effect within the framework of the branch. No large-scale decision can be implemented other than through the system of branch ministries. Therefore, projects that fall outside the circle of interests of branch ministries lose priority. It is much more difficult to implement them in spite of energetic intervention by central government or party organizations. At the same time, experience with
the sovnarkhozy showed that shifting the accent from the branch principle to the regional does not solve the problem but modifies it. To date no way has been found to break this vicious circle.

Arguments about the need to develop a fundamentally new system of administration for long-term investment programs of the type involved in developing the West Siberian oil and gas deposits have appeared in the works of Soviet economists. Here it is emphasized that this should not be a branch administration, since enterprises and organizations of many industrial and construction ministries participate in such a program, but it should also not be a regional administration, since as a rule such a program spreads over the territory of several regions, and its design and implementation involves enterprises and organizations located in various places. Most often this new principle of administration is called "program." However, all these theoretical arguments are of a very general nature, are far from practice, and have not found and, indeed, cannot find any real application.

Thus, no clear impression of some sort of proportional distribution of administrative functions between branch ministries and regional organs exists at present. The primacy of branch administration remains the main principle of economic administration. And while the theoreticians of Soviet science on administration struggle over a solution to this unsolvable problem, numerous ministries, each in its own manner, create numerous construction trusts on Siberian territory, none in any way connected with the other, and each with its own construction base, transportation and repair enterprises, housing, hospitals, stores, and cafeterias, in other words, as disintegrated as possible both in the
production sphere and in the sphere of infrastructure.

Here, for example, is how the Tobol'sk petrochemical combine—one of the most important projects in Siberia—was constructed. The combine was designed as a "model project" that used the latest achievements of both Soviet and foreign (imported) chemical technology and machine-building. Upon the completion of construction this combine will be the largest petrochemical association in the USSR. But the end of construction is still a long way off: construction work is extremely dispersed. Sixteen ministries are involved in building the combine, while construction is directly carried out by four general contractors (Ministry of Construction, Ministry of Construction Industry, Ministry of Transport, Ministry of Power and Electrification, and Ministry of Construction-Assembly Work), each of which has its own large construction organization. Labor and material-technical resources are scattered among many construction organizations. It is impossible to concentrate them under one head on some most important top priority projects. They are dispersed absolutely irrationally from the standpoint of the normal schedule and order of work envisioned in the design of the construction process. Investments that have been put into operation starting in 1974 through 1980 are only 70% of the planned level. And this is an example typical of Siberian construction.

It is important to note that this sort of construction organization accumulates its own autonomous infrastructure and strives to expand and increase its share in the distribution of labor and material resources. This practice aggravates the already severe shortage of labor and makes construction in Siberia take longer and cost more.

Organizational forms of construction in Siberia do not correspond to the specifics of construction production in the region. Large
construction organizations are justified in constructing enterprises on the scale of the Tobol'sk combine cited above. But departmental dispersion and the absence of a single head dictates their low effectiveness.

The creation of long-term stationary construction bases in areas of new natural resource development, where mobile forms of construction organization oriented toward relatively small volumes of work are needed, is absolutely not justified by any sort of economic expediency.

V. BASIC TRENDS IN THE ECONOMIC DEVELOPMENT OF THE EASTERN REGIONS OF THE USSR

A dilemma arises in the practice of Soviet planning in determining the strategy of development for new regions: to form the new element only as a narrowly oriented part of the entire economic system of the country, completely dependent on it, or to give this new formation a definite functional completeness and a sufficient degree of internal stability while preserving specialization in a few products.

To date the first alternative has always been victorious. It is possible to see in this a manifestation of a definite policy which has at its basis a striving to integrate the various regions of the empire. This is undoubtedly correct when the regions at issue are national republics (Uzbek, Lithuanian, etc.) where aspiration to economic autarchy is decisively suppressed. But, in our opinion, this feature of Soviet policy in the area of regional economics should not be used to explain the practice of economic development of the eastern outskirts of Russia, populated primarily by Russians with insignificant disseminations of national minorities. In these regions there are no political or nationality grounds for centripetal forces to arise. At the same time, arguments
of a military-strategic nature should induce Soviet strategists to create autonomous economic regions—an idea that to some extent found expression in so-called "territorial production complexes."

Every argument about high expediency always fell into the background when faced with the immediate need for the rapid satisfaction of acute requirements for some sort of raw material, rare metal, or fuel, whether it was Kolyma gold during the war years or Tiumen oil and gas in our day. Such a narrowly directed tactic, which in essence boils down to pumping out unique resources with a barbarian attitude toward the ecological problems of the region, determines the "point" character of the development of the unsettled territories of Siberia.

In generalized form, the basic features of this type of development of new regions are the following:

1. A single-product, or nearly so, orientation to production in each region.

2. Forced development and exploitation of specialized production and the subordination of all material and labor resources to this. This involves a sharp lag in the infrastructure.

3. A striving for the fastest and cheapest development of the social infrastructure without regard to the future.

4. Even temporary expansion of the output of products of specialization receives priority in comparison with measures and investments of a long-range nature. In other words, the primacy of production over reproduction is clearly manifested.

5. A new region requires ever growing investments, and the effectiveness of additional investments begins to decline quickly due to the need
that develops to move on to the exploitation of more difficult to
reach or less rich deposits. These difficulties are aggravated by the
lack in the infrastructure.

As a result of this sort of development, the living requirements of
the new region are supplied by shipments from other regions of the country. As the new region develops and its population grows, its infrastructure lags still further behind needs, and the demand for imported goods from other regions becomes more extensive and diverse. The extent to which the region supplies its own needs grows little. The dependence on other regions increases at the same time that transportation, especially main lines (east-west) become a bottleneck in the country's economy.

VI. THE CROWING DEPENDENCE OF SIBERIA ON WESTERN REGIONS OF THE COUNTRY
AND THE CURRENT TRANSPORTATION SITUATION IN THE USSR

According to data for 1975 for Siberia as a whole, consumption exceeded production for gross product, for total industrial output, and for ferrous metallurgy, machine-building, construction materials, light, and food industries.

In 1970 for East Siberia, imports of various types of freight from the European part of the USSR amounted to 50% of the total weight of freight received. Here it is worth noting that the average price of imported freight was two and a half times higher than the average price of exported freight, and the most expensive goods are shipped into East Siberia from the farthest European regions: Central, Baltic, and Transcaucasus. The largest part of imports (about 80%) are products of machine-building, light, and food industries.
"But it should be kept in mind that the rapid increase in freight shipments and the volumes shipped do not correspond to the development of the transportation network. Moreover, a growing lag is observed between the development of transportation arteries and the economy's requirements: during the 1960s for each 1% increase in gross social product there was a 0.81% increase in all dry-land transportation arteries in the USSR; for 1971-75, this figure was 0.78%. For each 1% increase in freight shipped by railroad, truck, and pipeline, the length of arteries increased by 0.85% in 1961-70 and by 0.66% in 1971-75.\(^79\)

In this connection it seems appropriate to characterize briefly the specifics of the transportation situation in the USSR.

The principle difference in the transportation situation in the USSR is that, unlike the leading Western countries, it cannot make large-scale use of ocean shipping for raw materials and fuel. As is well known, the intensive use of the raw material and fuel resources of a significant part of the world to a substantial degree became possible and economically justified for the industrially developed countries of the West thanks to the widespread use of ocean shipping by specialized fleets. At present the local shipment of ores by rail even for a short distance is significantly more expensive than shipping them a long distance by sea.

A particular feature of the USSR is the unavoidability of long distance dry-land shipments. The USSR cannot replace overland shipments by ocean shipping to the extent that Western countries can since it must be oriented primarily toward drawing into use its own resources located deep within the continent. Also to be considered is the fact that the basic ocean coastline of the USSR that provides an exist from the newly developing regions supplying the increase in production of oil and many
raw materials is free of ice for only a short time during the year.

In spite of the progress attained in the development of pipeline transport, the main role in the transportation system of the USSR in the foreseeable future will be retained by railroads (see table 15). Railroads play the main role in transcontinental freight shipments between Siberia and the western regions of the USSR. It is well known that railroad transportation in the USSR is in a very difficult situation. And this relates first of all to Siberia, where the length of the rail network amounts to 10% of the total for the USSR as a whole, while Siberia is involved in 17% of all freight shipments in the country.

Here it is appropriate to emphasize that the transport system in the USSR differs sharply from that in the U.S. both in structure and in rate of development. Table 16 gives an impression of these differences. During the quarter century after 1950, the length of dry-land arteries of all types increased by almost three times in the USSR and by only 50% in the U.S. But already in 1950 the U.S. had transport arteries with a length 4.3 times greater than in the USSR in 1975. During 1950-75 the increment in the length of the over-land transportation network of the U.S. was more than three times greater than in the USSR.

The throughput capacity of rail and truck transportation in the USSR lags further and further behind the growing transcontinental freight flows (in 1971-75 alone shipments of fuel freight from east to west doubled), and the transportation difficulties in the country are growing. The difficult situation with rail transport, its inability to cope with freight volumes that are growing in a geometric progression, is in many cases a reason for the increasingly frequent idleness of plants in the western
regions of the country due to shortages of raw materials and fuel from
the east and for the halting of construction of enterprises in the east
due to failures to receive machinery and equipment from the west. The
circulatory system of a giant organism skips a beat ever more frequently;
the load on it is too great.

CONCLUSION

At present there are two tasks on the agenda stimulating the Soviet
leadership to expand investment in Siberia. The first is to increase the
exports of Siberian raw materials, primarily fuels, in order to import
vitaly necessary goods to save the country's seriously ailing economy.
Second is to strengthen the military-industry potential of Siberia in case
of a world war or a military conflict with China.

The economic situation in the USSR and the external political situa-
tion are pushing the Soviet leadership to solve these two super-tasks at
any price and in the shortest time possible. The development of Siberia
is being carried out not on a broad front, not on a planned basis, and not
in accordance with any long-range strategy, but on an emergency basis,
spasmodically, ignoring the region's interests as an independent economic
system, and with a predatory attitude toward its natural resources and
maintaining an ecological balance.

As a result, growth rates of production are slowing and the
disproportions in Siberia's industry are deepening. Extractive industry
is becoming more cut off from manufacturing, and the economic dependence
of Siberia on western regions is growing.

Under the existing conditions the Soviet leadership objectively
cannot shift still greater investment resources to the industrial
development of Siberia since the industrial base in the western part of the country is in such a difficult state and requires ever increasing resources in order to maintain the existing level of production. But even these additional resources would be useless at present: the resources that are being allocated are not being used efficiently because the industrial structure of Siberia (like, incidentally, that of the entire country) is absolutely not prepared in either an organizational or scientific-technical sense to implement such a large-scale investment program. There is not sufficient labor. The capacity of the construction industry and the condition of the construction base in no way measure up to the tasks with which they are faced.

Economic development of Siberia at accelerated rates is not a local task but a decisive condition for supporting the economy of the entire country. It is appropriate to recall Lomonosov's prophecy: "The might of Russia will be increased by Siberia and the Northern Ocean."

Hopes for the accelerated development of the industrial potential, for the smoothing out of disproportions in the economy, can arise only if the (new) Soviet leadership, under the threat of ruin and economic collapse, accepts compromises both in internal and external policy, reduces military expenditures, and receives Western credits, and perhaps revives the practice of concessions.

But for this the new Soviet leader will need the courage of Sadat and the patriotism of Solzhenitsyn.
Table 1. Changes in Siberia's Share in the Economy of the USSR (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross social product</td>
<td>8.1</td>
<td>8.5</td>
<td>9.1</td>
<td>9.5</td>
</tr>
<tr>
<td>Produced national income</td>
<td>7.5</td>
<td>9.1</td>
<td>10.0</td>
<td>10.5</td>
</tr>
<tr>
<td>Gross industrial output</td>
<td>8.1</td>
<td>8.4</td>
<td>8.9</td>
<td>9.5</td>
</tr>
<tr>
<td>Capital investment</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Industrial fixed capital</td>
<td>10.5</td>
<td>11.0</td>
<td>11.5</td>
<td>12-13</td>
</tr>
<tr>
<td>Construction-assembly work</td>
<td>12.2</td>
<td>12.2</td>
<td>13.2</td>
<td>14-15</td>
</tr>
<tr>
<td>Freight hauled, all types of transportation</td>
<td>13.7</td>
<td>14.2</td>
<td>15.7</td>
<td>17-18</td>
</tr>
</tbody>
</table>


Table 2. Siberia's Share in USSR Gross Industrial Output by Branch (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>11.3</td>
<td>13.6</td>
<td>15.5</td>
<td>16.2</td>
</tr>
<tr>
<td>Fuel</td>
<td>12.8</td>
<td>14.6</td>
<td>17.0</td>
<td>22.1</td>
</tr>
<tr>
<td>Chemicals</td>
<td>6.2</td>
<td>12.0</td>
<td>9.5</td>
<td>9.7</td>
</tr>
<tr>
<td>Machine-building</td>
<td>9.7</td>
<td>7.5</td>
<td>8.1</td>
<td>7.5</td>
</tr>
<tr>
<td>Wood products</td>
<td>12.6</td>
<td>14.9</td>
<td>14.9</td>
<td>15.4</td>
</tr>
<tr>
<td>Construction materials</td>
<td>8.6</td>
<td>9.0</td>
<td>9.1</td>
<td>8.6</td>
</tr>
<tr>
<td>Light industry</td>
<td>4.2</td>
<td>4.2</td>
<td>5.0</td>
<td>5.8</td>
</tr>
<tr>
<td>Food</td>
<td>6.4</td>
<td>6.9</td>
<td>6.7</td>
<td>6.6</td>
</tr>
</tbody>
</table>

Source: Sibir' v edinom narodnokhoziaisstvennom komplekse, p. 33.
### Table 3. Siberia's Share in the Increments to Gross Industrial Output for the USSR as a Whole by Branch (%)

<table>
<thead>
<tr>
<th>Branch</th>
<th>1961-65</th>
<th>1966-70</th>
<th>1971-75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>16.1</td>
<td>19.0</td>
<td>18.0</td>
</tr>
<tr>
<td>Fuel</td>
<td>23.6</td>
<td>24.1</td>
<td>38.4</td>
</tr>
<tr>
<td>Chemicals</td>
<td>16.4</td>
<td>6.4</td>
<td>10.0</td>
</tr>
<tr>
<td>Machine-building</td>
<td>5.6</td>
<td>8.8</td>
<td>6.7</td>
</tr>
<tr>
<td>Wood products</td>
<td>35.5</td>
<td>14.9</td>
<td>17.9</td>
</tr>
<tr>
<td>Construction materials</td>
<td>9.7</td>
<td>9.2</td>
<td>7.5</td>
</tr>
<tr>
<td>Light industry</td>
<td>4.3</td>
<td>6.5</td>
<td>8.6</td>
</tr>
<tr>
<td>Food</td>
<td>8.6</td>
<td>6.2</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Source: *Sibir' v edinom narodnokhoziaistvennom komplekse*, p. 34.

### Table 4. Average Annual Rates of Growth of Industrial Production, USSR and Siberia (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>USSR</td>
<td>8.2</td>
<td>8.6</td>
<td>8.4</td>
<td>7.4</td>
</tr>
<tr>
<td>Siberia</td>
<td>8.8</td>
<td>8.6</td>
<td>9.4</td>
<td>8.2</td>
</tr>
</tbody>
</table>

Table 5. Planned and Actual Growth of Gross Industrial Output (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>USSR</td>
<td>180 plan</td>
<td>184 act.</td>
<td>150 act.</td>
<td>147 act.</td>
</tr>
<tr>
<td>Siberia</td>
<td>250 plan</td>
<td>185 act.</td>
<td>166 act.</td>
<td>163 act.</td>
</tr>
</tbody>
</table>


Table 6. Growth of Gross Industrial Output in Siberia by Branch, 1961-75 (%)

<table>
<thead>
<tr>
<th>Branch</th>
<th>1961-65</th>
<th>1966-70</th>
<th>1971-75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>16.9</td>
<td>12.2</td>
<td>7.6</td>
</tr>
<tr>
<td>Fuel (oil, gas, coal)</td>
<td>6.5</td>
<td>9.2</td>
<td>11.3</td>
</tr>
<tr>
<td>Ferrous metallurgy</td>
<td>6.9</td>
<td>7.2</td>
<td>4.6</td>
</tr>
<tr>
<td>Chemical and petrochemical</td>
<td>22.8</td>
<td>7.4</td>
<td>10.9</td>
</tr>
<tr>
<td>Machine-building and metal</td>
<td>10.2</td>
<td>13.2</td>
<td>9.8</td>
</tr>
<tr>
<td>Wood products</td>
<td>5.7</td>
<td>5.8</td>
<td>5.6</td>
</tr>
<tr>
<td>Construction materials</td>
<td>9.5</td>
<td>8.7</td>
<td>6.3</td>
</tr>
<tr>
<td>Light industry</td>
<td>2.3</td>
<td>12.1</td>
<td>7.6</td>
</tr>
<tr>
<td>Food</td>
<td>6.0</td>
<td>5.3</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Table 7. Growth of Fuel Production in Siberia, Standard Fuel Units (%)

<table>
<thead>
<tr>
<th></th>
<th>1965-70</th>
<th>1970-75</th>
<th>1975-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>11.1</td>
<td>31.4</td>
<td>159.3</td>
</tr>
<tr>
<td>Oil</td>
<td>44.4</td>
<td>170.2</td>
<td>240.9</td>
</tr>
<tr>
<td>Coal</td>
<td>14.5</td>
<td>25.7</td>
<td>13.9</td>
</tr>
</tbody>
</table>


Table 8. Shares of Gas, Oil, and Coal in Siberian Fuel Production, Standard Fuel Units (%)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>0.01</td>
<td>6.6</td>
<td>10.8</td>
<td>25.2</td>
</tr>
<tr>
<td>Oil</td>
<td>1.41</td>
<td>26.6</td>
<td>54.0</td>
<td>55.8</td>
</tr>
<tr>
<td>Coal</td>
<td>98.58</td>
<td>66.8</td>
<td>35.2</td>
<td>19.0</td>
</tr>
</tbody>
</table>

Source: Maksimov, "Dobycha," 1982, p. 34.
Table 9. Comparison of Growth Rates of Industrial and Machine-Building Output in the USSR and Siberia

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual output growth (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Industry</td>
<td>8.6</td>
<td>8.4</td>
<td>7.4</td>
<td>8.6</td>
<td>9.4</td>
<td>8.2</td>
</tr>
<tr>
<td>b. Machine-building</td>
<td>12.35</td>
<td>11.7</td>
<td>11.1</td>
<td>12.45</td>
<td>12.4</td>
<td>9.8</td>
</tr>
<tr>
<td>Ratio of (b) to (a)</td>
<td>1.44</td>
<td>1.39</td>
<td>1.58</td>
<td>1.44</td>
<td>1.32</td>
<td>1.19</td>
</tr>
</tbody>
</table>


Table 10. Basic Indicators for Machine-Building in the USSR and Siberia, 1961-75 (%)

<table>
<thead>
<tr>
<th></th>
<th>Output</th>
<th>Employment</th>
<th>Fixed capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>USSR</td>
<td>11.5</td>
<td>4.85</td>
<td>12.2</td>
</tr>
<tr>
<td>Siberia</td>
<td>11.0</td>
<td>4.2</td>
<td>9.35</td>
</tr>
</tbody>
</table>

Source: Ocherki ekonomiki Sibiri, p. 281.
<table>
<thead>
<tr>
<th>Branch structure</th>
<th>USSR</th>
<th>West Siberia</th>
<th>West Siberia's share of USSR production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine-building (excluding metalworking and repair)</td>
<td>100</td>
<td>100</td>
<td>5.1</td>
</tr>
<tr>
<td>Energy and power MB</td>
<td>1.9</td>
<td>5.47</td>
<td>14.7</td>
</tr>
<tr>
<td>Electrical MB</td>
<td>12.0</td>
<td>13.3</td>
<td>5.7</td>
</tr>
<tr>
<td>Mining MB</td>
<td>1.77</td>
<td>3.71</td>
<td>10.7</td>
</tr>
<tr>
<td>Machine tools</td>
<td>4.29</td>
<td>5.35</td>
<td>6.45</td>
</tr>
<tr>
<td>Automobile industry</td>
<td>11.54</td>
<td>3.8</td>
<td>1.64</td>
</tr>
<tr>
<td>Tractors &amp; agricultural MB</td>
<td>11.0</td>
<td>17.5</td>
<td>8.2</td>
</tr>
<tr>
<td>Metallurgical MB</td>
<td>1.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Oil and gas equipment</td>
<td>0.95</td>
<td>0.78</td>
<td>4.2</td>
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<tr>
<td>Construction equipment</td>
<td>2.06</td>
<td>0.68</td>
<td>1.7</td>
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<tr>
<td>Logging and paper MB</td>
<td>0.39</td>
<td>0.12</td>
<td>1.55</td>
</tr>
<tr>
<td>Construction materials MB</td>
<td>0.7</td>
<td>0.34</td>
<td>2.52</td>
</tr>
<tr>
<td>Chemical industry MB</td>
<td>0.95</td>
<td>0.78</td>
<td>4.2</td>
</tr>
<tr>
<td>Hoisting-transporting MB</td>
<td>1.6</td>
<td>0.1</td>
<td>3.1</td>
</tr>
<tr>
<td><strong>Total for 13 branches</strong></td>
<td>51.4</td>
<td>52.0</td>
<td>5.17</td>
</tr>
<tr>
<td><strong>Other branches</strong></td>
<td>49.6</td>
<td>48.0</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 12. Distribution of Machine-Building in the European (including the Urals) and Asiatic Part of the USSR (%)

<table>
<thead>
<tr>
<th>Branch</th>
<th>Gross output</th>
<th>Employment</th>
<th>Fixed Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>European</td>
<td>Asiatic</td>
<td>European</td>
</tr>
<tr>
<td>Machine-building and metalworking</td>
<td>86.7</td>
<td>13.3</td>
<td>86.1</td>
</tr>
<tr>
<td>of which, machinebuilding:</td>
<td>88.0</td>
<td>11.2</td>
<td>88.4</td>
</tr>
<tr>
<td>Heavy, power, and transportation MB</td>
<td>89.4</td>
<td>10.6</td>
<td>89.1</td>
</tr>
<tr>
<td>Chemical and oil MB</td>
<td>91.1</td>
<td>8.9</td>
<td>91.1</td>
</tr>
<tr>
<td>Light and food industry MB</td>
<td>91.7</td>
<td>8.3</td>
<td>92.5</td>
</tr>
<tr>
<td>Automobile industry</td>
<td>96.9</td>
<td>3.1</td>
<td>96.2</td>
</tr>
<tr>
<td>Tractors and agricultural MB</td>
<td>84.0</td>
<td>16.0</td>
<td>82.5</td>
</tr>
<tr>
<td>Electrical industry MB</td>
<td>84.8</td>
<td>15.2</td>
<td>85.6</td>
</tr>
<tr>
<td>Machine tools; tools and dies</td>
<td>89.1</td>
<td>10.9</td>
<td>89.1</td>
</tr>
<tr>
<td>Instruments</td>
<td>95.3</td>
<td>4.7</td>
<td>94.4</td>
</tr>
<tr>
<td>General machine-building</td>
<td>99.1</td>
<td>0.9</td>
<td>98.6</td>
</tr>
<tr>
<td>Other branches of machine-building</td>
<td>94.0</td>
<td>6.0</td>
<td>94.8</td>
</tr>
<tr>
<td>Metal wares and metal structures</td>
<td>83.4</td>
<td>13.6</td>
<td>86.2</td>
</tr>
<tr>
<td>Repair</td>
<td>72.3</td>
<td>27.7</td>
<td>73.9</td>
</tr>
</tbody>
</table>

Table 13. Investment in the Construction Industry as a Share of Total Capital Investment

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>RSFSR</td>
<td>4.0</td>
<td>4.1</td>
<td>4.2</td>
<td>4.1</td>
<td>4.4</td>
</tr>
<tr>
<td>Siberia</td>
<td>3.0</td>
<td>2.7</td>
<td>2.3</td>
<td>2.5</td>
<td>2.7</td>
</tr>
<tr>
<td>West Siberia</td>
<td>3.4</td>
<td>2.8</td>
<td>2.2</td>
<td>2.5</td>
<td>2.6</td>
</tr>
<tr>
<td>East Siberia</td>
<td>2.5</td>
<td>2.6</td>
<td>2.4</td>
<td>2.5</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Source: Sibir' v edinom narodnokhoziaistvennom komplekse, p. 203.

Table 14. Technical-Economic Indicators of Reinforced Concrete and Steel Beam Roofs for One-Story Buildings with Flat Roofs, for Construction in Chita Oblast (per beam)

<table>
<thead>
<tr>
<th>Building span (m)</th>
<th>Estimated load (kg/m²)</th>
<th>Cost, rubles</th>
<th>Component weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Steel</td>
<td>Reinf. concrete</td>
</tr>
<tr>
<td>6</td>
<td>460</td>
<td>57</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>700</td>
<td>63</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>830</td>
<td>69</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>104</td>
<td>252</td>
</tr>
<tr>
<td></td>
<td>560</td>
<td>128</td>
<td>266</td>
</tr>
<tr>
<td></td>
<td>750</td>
<td>160</td>
<td>289</td>
</tr>
<tr>
<td>12</td>
<td>350</td>
<td>180</td>
<td>433</td>
</tr>
<tr>
<td></td>
<td>450</td>
<td>220</td>
<td>442</td>
</tr>
<tr>
<td></td>
<td>550</td>
<td>268</td>
<td>457</td>
</tr>
<tr>
<td></td>
<td>650</td>
<td>264</td>
<td>505</td>
</tr>
<tr>
<td></td>
<td>750</td>
<td>315</td>
<td>524</td>
</tr>
<tr>
<td>18</td>
<td>550</td>
<td>561</td>
<td>695</td>
</tr>
<tr>
<td></td>
<td>650</td>
<td>690</td>
<td>695</td>
</tr>
<tr>
<td></td>
<td>750</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>850</td>
<td>846</td>
<td>1,210</td>
</tr>
</tbody>
</table>

Table 15. Distribution of Freight Hauled by Type of Transport, 1981 (%)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All Freight</td>
<td>100</td>
</tr>
<tr>
<td>Railroad</td>
<td>55.3</td>
</tr>
<tr>
<td>Truck</td>
<td>7.2</td>
</tr>
<tr>
<td>Ocean ships</td>
<td>13.4</td>
</tr>
<tr>
<td>River ships</td>
<td>4.0</td>
</tr>
<tr>
<td>Pipeline</td>
<td>20.0</td>
</tr>
<tr>
<td>Air</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Source: Planovoe khoziaistvo, no. 9, 1982, p. 38.

Table 16. Comparison of the Transportation Systems of the USSR and the U.S.

<table>
<thead>
<tr>
<th>Transportation arteries (1,000 km)</th>
<th>USSR</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1950</td>
<td>1975</td>
</tr>
<tr>
<td>Railroad</td>
<td>116.9</td>
<td>138.3</td>
</tr>
<tr>
<td>Hard-surface automobile roads</td>
<td>177.3</td>
<td>660.5</td>
</tr>
<tr>
<td>Pipelines</td>
<td>5.4</td>
<td>56.6</td>
</tr>
<tr>
<td>Total</td>
<td>299.6</td>
<td>855.4</td>
</tr>
</tbody>
</table>


5. Ibid., p. 38.


T. Baranova, "Dinamika zanitatosti, proizvoditel'nosti truda i osnovnykh prizvodstvennykh fondov v promyshlennosti Sibiri," Izvestiia Sibirskogo otdeleniia AN SSSR, seriia obshchestvennykh nauk, no. 6, vypusk 2, 1980, p. 110.


15. Sibir' v edinom narodnokhoziaistvennom komplekse, p. 144.


18. Sibir' v edinom narodnokhoziaistvennom komplekse, p. 146.

19. Ibid., p. 147.


22. Sibir' v edinom narodnohozjaisstvennom komplekse, p. 149.

23. Ibid.

24. Ibid., p. 148.


32. Tendentsii ekonomicheskogo razvitija Sibiri, pp. 80, 81.


34. Ocherki ekonomiki Sibiri, pp. 278-79.

35. Sibir' v edinom narodnohozjaistvennom komplekse, pp. 36, 182.

36. Ibid., p. 183.
37

38
Sibir' v edinom narodnokhoziaistvennom komplekse, p. 181.

39

40
Planovoe khoziaistvo, no. 3, 1980, p. 35.

41
EKO, no. 4, 1981, p. 75.

42

43
Sibir' v edinom narodnokhoziaistvennom komplekse, p. 201.

44
Dolgosrochnye programmy kapital'nykh vlozhenii, Moscow, Ekonomika, 1974, p. 134.

45
Sibir' v edinom narodnokhoziaistvennom komplekse, p. 203.

46
Ibid., p. 204.

47

48
Ibid., p. 139.

49

50
E. Kushchev, "Osnovnye napravleniia i organizatsiiia rabot po sozdaniiu tekhniki dlia Severa," Problemy Severa, vol. 19, Problemy povysheniia
It is appropriate to compare with 1970-80 when capital investment in housing construction increased by only 33%, its share in 1980 was 13.4%, and the amount of housing introduced in 1975-80 decreased by 2%.

63 V. Sarychev and V. Gladkova, "Sovershenstvovanie proektnykh reshenii v promyshlennom i transportnom stroitel'stve," Problemy Severa, p. 43.

64 Ibid., p. 44.

65 EKO, no. 9, 1980, p. 11.

66 I. Kariagin, V. Bulatov and V. Tandalov, Razvitie gazovoi promyshlennosti severa Tiumenskoi oblasti, p. 43.


68 G. Tersh, Material'naia baza stroitel' stva, Moscow, Ekonomika, 1979, pp. 109-111.

69 R. Samuseva, Perspektivnoe planirovanie razvitiiia regional'nogo stroitel'nogo kompleksa (na primere Tiumenskoi oblasti), Moscow, Stroiizdat, 1979, p. 122.

70 Problemy Severa, p. 56.

71 I. Kariagin, V. Bulatov and V. Tandalov, Razvitie gazovoi promyshlennosti severa Tiumenskoi oblasti, p. 39.

72 Tekhnicheskie pravila po ekonomnomu raskhodovaniiu osnovnykh stroitel'nykh materialov, Moscow, Stroiizdat, 1973.

73 Narkhoz SSSR v 1980, p. 163.

74 Planovoe khoziaistvo, no. 3, 1980, p. 46.
75

76
Ekonomicheskie problemy razvitiia Sibiri, p. 219.

77
Sibir' v edinom narodnokhoziaistvennom komplekse, p. 206.

78

79