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## Tracking Soviet Modernization: Four Case Studies

A Research Paper

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# Tracking Soviet Modernization: Four Case Studies

A Research Paper

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## Tracking Soviet Modernization: Four Case Studies

### Summary

*Information available  
as of 8 April 1988  
was used in this report.*

Since the beginning of his tenure as General Secretary, Mikhail Gorbachev has established modernization of the country's industrial base as a top priority. He has set a course that includes renovation of existing facilities, improvement of the technological base, and speedier assimilation of scientific discoveries. The concept of "accelerating scientific and technical progress" predates Gorbachev by at least 15 years, but, unlike past efforts, Gorbachev's program is attempting a comprehensive overhaul of previously untouched areas of economic policy.

For the 1986-90 plan period, the Soviets have specified scores of modernization and development projects designed to revitalize key sectors of the economy. We have selected for detailed examination four of these projects on the basis of their importance to Moscow, the insights they provide into Gorbachev's modernization plan, and the availability of reliable intelligence:

- Reconstruction of the Magnitogorsk metallurgical combine.
- Development of the Astrakhan' gas-condensate complex.
- Construction of the Amur-Yakutsk branch of the Baikal-Amur Mainline Railroad.
- Modernization of the Ivanovo machine tool plant.

We found that several common problems run through most of these case studies: too little investment chasing too many tasks, insufficient infrastructure and social amenities to maintain adequate levels of skilled labor, and production and modernization plans that bear little relation to available resources and the capabilities of the enterprises or sectors that must fulfill them:

- The breakneck pace at which work is being pursued at some projects in order to meet planned targets is causing managers to cut corners, reducing ultimate production efficiency and creating safety problems. Builders of the Amur-Yakutsk branch line, for example, under pressure to meet construction deadlines, have opted to use materials that do not meet the rigorous requirements of constructing a railroad in a permafrost region.

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- Lack of infrastructure, especially housing, to accommodate the large influx of workers at Astrakhan' is creating morale and productivity problems. This reflects a lack of investment resources to accomplish both primary and support functions (a dilemma facing many industrial enterprises) and the inherent allocation bias of local managers in favor of the primary function—a bias fostered by the perverse Soviet incentive system

All of these problems are manifestations of such generic problems as an overly centralized system of control and a lack of incentives to encourage personal commitment and economically rational decisions (see table 1). Moreover, these problems are compounded by the complex interdependencies among the various industrial sectors—as illustrated in the case of Magnitogorsk—and the resultant ripple effects of shortcomings in one sector on many others. Gains from modernizing the Magnitogorsk metallurgical complex, for example, will be slow to materialize largely because of the "chicken-and-egg" nature of the complex's relationship with machine-building plants on which it depends for new equipment. Improvements in equipment are limited in part by the inability of the Magnitogorsk complex (and other Soviet steel plants) to provide high-quality steels. But improving the quality and variety of steel products depends on new and better equipment

Moscow has identified these problems, but in many cases its solutions have not translated into workable cures for ailing industrial enterprises. The economic reforms adopted at the June 1987 plenum will not solve many of the problems evident in the four case studies, largely because the basic system of centralized planning, supply, and pricing has been left intact. As a result, enterprise and project managers remain subject to a measure of central control potent enough to stifle initiative and retard industrial innovation and growth despite Gorbachev's efforts to thin the ranks of the central bureaucracy.

In the one case we examined where modernization is proceeding apace, the Ivanovo machine-building plant, achievements are coming only after a painful and costly adjustment period, and sustained success was assured only after Moscow employed its standard "fix"—preferential resource allocations. Prior to receiving such support, efforts by an "enlightened" manager to modernize the plant resulted in a loss of incentive funds, bonuses, and other employee benefits that caused an exodus of 50 percent of the plant's staff. The Ivanovo experience suggests that, on a national level, the period of painful adjustments could go on indefinitely since preferential resource allocations cannot be given across the board.

**Table 1**  
**Problems in Soviet Modernization**

	Magnitogorsk Metallurgical Combine	Astrakhan Gas- Condensate Complex	Amur-Yakutsk Mainline Branch of the BAM	Ivanovo Machine Tool Plant
<b>Poor planning</b>				
Conflicting production and modernization goals	X		X	
Lax safety standards		X		
<b>Lack of effective incentives</b>				
Use of poor-quality materials	X	X	X	
Flawed resource allocation decisions	X	X	X	X
Shoddy workmanship	X	X	X	
<b>Limited resources</b>				
Insufficient funds for housing and social amenities	X	X	X	X
Labor shortages	X	X	X	
Limited hard currency	X	X	X	
<b>Centralized control</b>				
Ministerial micromanagement	X	X	X	X
Piecemeal reforms and inconsistent instructions	X		X	X

Although our case studies can only highlight some of the key problems associated with modernizing the Soviet industrial base, they suggest that, while some productivity and qualitative gains from Moscow's modernization program undoubtedly will occur, Gorbachev's stated goal of overcoming the backwardness of Soviet industry will not be realized in the time frame he would like. A continued gap between promises of an improved and relatively independent workplace and the reality of central control over most resources and economic decisions would prolong the turmoil of the adjustment period and, in some cases, thwart modernization altogether. Unless Moscow frees its industries from the umbilicals of ministerial oversight and administered prices, a weak industrial infrastructure and impotent work incentives will almost certainly hold modernization of Soviet industry to those projects on which Moscow can lavish preferential support.

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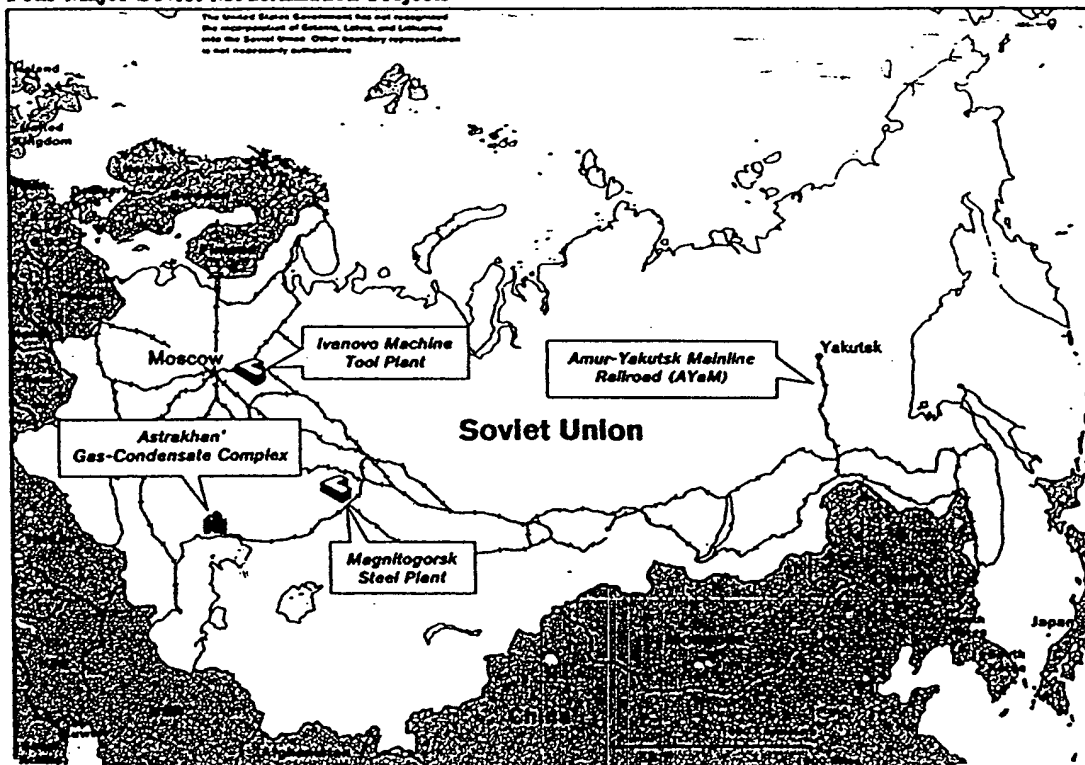
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# Scope Note

The Soviets have specified a number of major development projects to be started or completed during the 12th Five-Year Plan (1986-90). This research paper examines four such projects as a means of gaining insight into the larger problems facing Gorbachev's industrial modernization program. Drawing on [ ] as well as Soviet open sources, the study also assesses the impact of new programs such as quality control and self-financing on the pace of work. The paper complements recent DI studies of Gorbachev's broad restructuring program such as *"Restructuring" the Soviet Workplace: The New State Enterprise Law*; [ ] *The June Plenum and Supreme Soviet Session: Building Support for Economic Change*; and [ ]

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**Figure 1**  
**Four Major Soviet Modernization Projects**



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## Tracking Soviet Modernization: Four Case Studies

### Gorbachev's View of Industrial Modernization

*If good use is made of everything available . . . the targets of the 12th Five-Year Plan can be met using existing equipment. But obsolescent equipment would in one way or another drag us backward, since it would be unable to put out modern products. Old machinery must be given up. This is why we are so drastically changing our . . . policies.*

**Mikhail Gorbachev**  
*Perestroika, New Thinking for Our  
Country and the World*  
1987

Principal elements of Mikhail Gorbachev's program to improve Soviet economic performance include modernizing industrial facilities (particularly the machinery base), further developing energy and mineral resources, and strengthening the transport infrastructure. Woven into this strategy is his belief that the key to upgrading industry lies in accelerating scientific and technical progress. Recognizing that the scientific establishment has frequently failed to transform research accomplishments into practical applications for industry, Gorbachev is directing policy and organizational changes designed to improve assimilation of scientific and technical developments at home while improving the USSR's ability to export manufactured goods for hard currency. In broader terms, the regime's efforts to improve the efficiency of the industrial base have meant introducing new methods of planning, supplying raw materials, and orienting enterprises more toward profits.

The 12th Five-Year Plan (1986-90) specifies scores of major development projects as well as plans to modernize key industrial enterprises. As Gorbachev's program gains momentum, the success or failure of these major projects will indicate the ability of his program to reenergize the ailing economy and eventually make Soviet products more competitive on world markets.

Achievement of these goals will require a long-term commitment of investment and political support from Gorbachev and his colleagues. To maintain such commitment, Gorbachev's program will need to show positive results without posing such a large threat to the entrenched bureaucratic establishment that it attempts to undermine his efforts. Since Gorbachev assumed power, he has enjoyed more success in gathering support from the intelligentsia than from the economic bureaucracy and industrial establishment.

The need for a comprehensive modernization program is acute for all of Soviet heavy industry. Gorbachev is calling on industrial enterprises to display financial independence and act on new incentives to produce high-quality, marketable goods. He apparently hopes to break the cycle in which some industries fueled poor performance in others by providing them with low-quality materials and equipment. It is too early to judge how his remedy will affect industrial production over the long haul, but short-term results have been discouraging. Gorbachev himself has said that the success of his program cannot be measured simply in terms of meeting quantitative plan targets. His intent to bring quality-oriented performance to Soviet industry is certainly a step in the right direction, but, until positive results are verified, he risks widespread resistance and confusion over his program. The results of his efforts to modernize the industrial base will be monitored closely by opponents and supporters alike.

The following case studies represent our efforts to track the progress of Gorbachev's industrial modernization program. We selected four major reconstruction and development projects and examined the conditions under which each is currently operating—including the characteristics of management that

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affect performance—to draw some broader conclusions about the efficacy of Gorbachev's strategy. We evaluated how each of these projects has managed to cope with the recent onslaught of reforms designed to encourage some enterprises to start "running themselves" more effectively. Several of the problems identified in the projects we studied may become more widespread as Gorbachev's program for industry expands

#### Reconstruction of the Magnitogorsk Metallurgical Combine

*The giant of heavy industry—the Magnitogorsk Metallurgical Combine—is standing at the threshold of a second birth.*

Sovetskaya Rossiya  
November 1985

Modernization of the Soviet steel industry is critical to the overhaul of the USSR's antiquated industrial base. Long considered the backbone of Soviet machine building, the steel industry's ability to improve the quality and variety of its products will, to a large extent, determine the success of Gorbachev's program to produce more sophisticated machinery and equipment. Accordingly, Moscow has adopted a wide-ranging program for reequipping the steel industry and expanding the mix of output by:

- Reconstructing older steel plants.
- Replacing open-hearth steelmaking furnaces with basic oxygen or electric furnaces.
- More than doubling the share of steel continuously cast by 1990.<sup>1</sup>

Specifically, at the Magnitogorsk Metallurgical Combine, plans call for major efforts to replace outdated machinery and improve the quality of output. The modernization of Magnitogorsk is not intended to increase the combine's total production of metal, but to improve quality without an increase in the consumption of raw materials such as iron ore and coke.

<sup>1</sup> See DI Intelligence Assessment SOV 87-10004X, 2 January 1987. *Modernization of the Soviet Steel Industry: What Lies Ahead.*

The Lenin Metallurgical Combine in Magnitogorsk is the largest integrated steel plant in the world (see figure 2). According to Soviet officials, Magnitka (as the combine is popularly called) and other prewar steel plants are slated to receive "special priority" in reconstruction during the current five-year plan. The sheer volume of output from the Magnitogorsk plant—nearly 16 million tons of steel annually or about 10 percent of total Soviet output—warrants Moscow's call for reconstruction. Outdated and inefficient steelmaking methods have resulted in enormous waste. According to *Pravda*, at least 25 percent of the finished steel products produced at Magnitka end up as waste and have to be remelted

Magnitka is located in the southwest Urals, 240 kilometers south of Chelyabinsk on a site chosen for its rich deposits of iron ore. Construction began in 1928, and the plant began operations in 1932 when the first blast furnace was blown in. Open-hearth furnaces were added, followed by blooming and rolling mills, coke, chemical, and railroad facilities

At its numerous rolling mills, Magnitogorsk can manufacture virtually every category and size of flat-rolled and section steel listed in Soviet standards. The combine has 10 blast furnaces, and its products are delivered to 8,000 Soviet plants. The large number of antiquated furnaces and rolling mills, however, threatens the industry's goal of obtaining improved steel products. Magnitogorsk and other large steel plants in the USSR are beset with problems from aging capital stock such as frequent equipment breakdowns (Soviet press reports indicate that about half of the fixed capital has been in operation at least 30 years) and a pressing need for overall rebuilding, which will require billions of rubles in capital outlays.

**Moscow's Plans: A Second Wind for Magnitogorsk**  
Considerable debate on ways of effectively modernizing the plant has been under way since the 1960s. In 1975 a resolution adopted by the USSR Council of Ministers called for the plant's reconstruction. But inadequate investment and difficulties caused by

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growing disproportions between the capacities of the production shops and support services slowed efforts to revitalize production. The most recent efforts to reconstruct the plant are focused on updating antiquated equipment.

Gorbachev's program to sharply improve the quality and variety of steel products has put added pressure on Magnitogorsk and other Soviet steel plants to modernize equipment and processes for producing stronger drill pipe, high-performance electrical sheet for transformers, and special alloy steels for lighter, stronger, precision machine tools. Included in the current scheme to modernize Magnitogorsk are plans to:

- Construct large basic oxygen furnaces and phase out several of the smaller open-hearth furnaces
- Construct seven continuous-casting units.<sup>3</sup>
- Commission a new "2000" hot-rolling sheet metal mill to replace the obsolete "1450" mill as an energy-saving measure.
- Build a new sinter plant—used to prepare blast furnace feed—to replace the existing plant.
- Construct new coke batteries and reline some of the old units.

Construction teams at Magnitogorsk have made a commitment to complete the new oxygen furnaces by 30 June 1989 (in honor of the plant's 60th anniversary), six months earlier than called for in the five-year plan. Equipment suppliers have also agreed to meet the earlier deadline. Such commitments, however, are being stifled as a result of shortages of materials and an inefficient allocation of the plant's limited investment resources.

The costs of Gorbachev's steel modernization program are high, and competition for renovation and retooling funds is undoubtedly slowing some of the efforts under way at the combine.

the current financial situation in the Soviet steel industry as "abysmal,"

<sup>3</sup> The chief designer for the Magnitogorsk combine has said, "The new machines, the first of their kind in world practice, will have the capability of casting steel in two or four channels. . . the machines are distinguished by reduced metal input, and the shop in which they will be installed need not be as large."

severely restricting some plants from purchasing equipment for modernization. Soviet media reports in early 1987 noted that the "main task is to find more cash for Magnitogorsk," indicating that limited investment was hindering timely installation of costly equipment at the plant.

#### Supplies for Reconstruction: Staying Home

Although purchasing Western equipment for rebuilding the steel industry would be the quickest route for speedy reconstruction at facilities such as Magnitogorsk, reduced hard currency earnings—which could last at least through the end of this decade—have sharply limited Moscow's acquisitions of higher quality supplies and equipment from the West.<sup>4</sup> Moreover, the major East European suppliers of steelmaking equipment—Czechoslovakia and Poland—are ill prepared to greatly increase production of machinery for export. Open-source reporting suggests Poland is not in a position to satisfy a substantial portion of the

<sup>4</sup> A major steel mill project at Orel, for example, was put on indefinite hold in early 1987. The project, which originally involved \$1.3 billion in contracts for Western equipment, was close to being canceled because of hard currency shortages.

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Soviets' needs for sophisticated metallurgical machinery at Magnitka.<sup>4</sup> [ ] the Polish machine-building industry is suffering from labor shortages and may have problems increasing production enough to satisfy the country's own requirements. The Vitkovice combine in Czechoslovakia is filling orders for rolling-mill equipment at Magnitogorsk, but an obsolete quality control system has contributed to what Prague officials have called the "long-term problems" of its machine-building sector, suggesting Magnitogorsk officials may be unable to count on receiving quality machinery from Vitkovice.

Thus, Magnitogorsk will be most heavily dependent on the overburdened domestic machine-building sector. The Zhdanov Heavy Machinery Association will build the basic oxygen converters for Magnitka—the focal point of the reconstruction effort. However, the Zhdanov Association, which is also the main contractor for renovation of the Azovstal' steel plant, is reportedly suffering from manpower shortages that have delayed construction of the converters and automation and control systems for the Magnitogorsk project. In July 1986, Ukrainian party chief Vladimir Shcherbitskiy singled out the Zhdanov plant for "coping poorly with the new guidelines to reduce the amount of obsolete equipment produced by machine builders."

*Pravda* has criticized the machine-building sector in general for slowing reconstruction at Magnitogorsk. According to a November 1986 article:

*... the main partners of the metalworkers are the machine builders. Unfortunately, much of the production equipment which they supply is still inferior to similar foreign equipment in terms of metal consumption, reliability, level of mechanization and automation, relative consumption of lubricants and spare parts, and productivity per worker.*

<sup>4</sup> Poland's machine-building industry is ill equipped to produce a substantial portion of Magnitogorsk's equipment needs, but it has provided some unspecified machinery and equipment to the plant in exchange for 2 billion cubic meters per year of natural gas for the next 20 years.

The Ural Heavy Machinery Plant (Uralmash) is also playing a leading role in Magnitogorsk's modernization efforts. But in return for Uralmash's production

of continuous-casting equipment, Magnitka is to supply high-quality metal to Uralmash.<sup>5</sup> Both Uralmash and Magnitogorsk have been criticized for producing inferior products (by world standards) that do not meet the demands of modern machine building (see inset). With both organizations producing low-quality output for each other's needs, their interdependence has created a "catch-22": the capacity for Magnitogorsk's renovation is inextricably linked to dependable deliveries of quality equipment, while the production of the continuous-casting equipment at Uralmash requires metals Magnitka has difficulty producing.

#### Adapting to New Economic Disciplines

In addition to Moscow's demands for retooling, many plants such as Magnitogorsk face the additional burden of adapting to new programs that pressure workers and plant managers to change their work habits.<sup>6</sup> At a plenary session of the Chelyabinsk Oblast Central Committee in March 1987, party members criticized steelworkers at Magnitka who reportedly had not fulfilled contractual shipment commitments and were poorly prepared for the introduction of state acceptance.<sup>7</sup> Workers were also criticized for failing to make a smooth transition to multishift work schedules.

<sup>5</sup> In a "Magnitogorsk-Uralmash work agreement" signed in early 1986, management at Uralmash pledged "to manufacture and deliver in a timely manner" continuous casters for Magnitka. [ ]

[ ]  
<sup>6</sup> Difficulties in adapting to new quality control guidelines are not unique to Magnitogorsk. Since the introduction of state acceptance (*gospriyemka*) at 40 ferrous metals enterprises in January 1987, disruptions in production have prompted brigades and shop managers to beef up in-house quality control mechanisms in an effort to minimize the disabling effects on plant operations. This is a burdensome task for workers at Magnitogorsk, however, since they are faced with the additional task of meeting planned output goals during reconstruction. The trade union incentives to exceed plan goals testify to the traditional Soviet unwillingness to let go of the "quantity over quality" thinking that has long characterized Soviet industry.

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### *Quality of Soviet Machine Building*

*Distrust toward equipment produced in the USSR has become deeply ingrained in Soviet plant managers. Officially, at least, the Soviets discourage this attitude, claiming it inflicts "unjustified harm" on the development of domestic research and production resources in various branches of industry. Leaders in the scientific and technical community have argued that if foreign imports are avoided, it will promote domestic efforts to speed up technological progress and ultimately lead to advancements in Soviet science and technology. In a 4 March 1988 speech, Gorbachev noted: "Today, many heads of enterprises . . . often see only one way—purchasing as much imported equipment as possible. This is not a way out of the situation . . . one should rely on one's own, Soviet engineering."*

*The current state of Soviet machine building, however, suggests domestic solutions have been insufficient to renew the machinery base. A deputy chairman of the State Planning Committee said in late 1986 that the machine-building industry and its base of production technology are still a long way from completely meeting the requirements of rapid economic development. Bureaucratic separation of research facilities from production enterprises slows the introduction of new technology into the production process. Moreover, the specialized equipment needed for renovation projects such as Magnitka requires an innovative approach, which the current incentive system discourages. Uncertainty over the working characteristics of new materials or processes and the availability of supplies tends to discourage innovation. Under increased pressure to boost output, Soviet machine builders tend to continue producing the same types of equipment they have been making for years.*

The disruption of production lines that occurs during any reconstruction project has been exacerbated by the difficulties of adapting to these new disciplines.<sup>4</sup>

<sup>4</sup> Renovation of rolling mills, for instance, usually requires that the facility be shut down. In some instances, however, shutdown is not required. After two basic oxygen furnaces are built at Magnitogorsk, for example, the Soviets report that an open-hearth shop at the plant will be "phased out." Although this will help keep production up during renovation, it will do little to improve quality in the usual drawn-out construction period.

In April 1985 the Trade Union Central Committee sent "start-to-finish brigades" to troubled enterprises within the ferrous metals industry to improve management and render practical assistance in eliminating production shortfalls. Such a brigade is working at Magnitogorsk, and, according to a Soviet metals industry journal, the brigades have eased some problems related to the transition to new equipment by establishing special material incentives for shifts that exceed production plans. The Ministry of Ferrous Metallurgy has also instructed enterprises to move workers from more successful production lines to those that have problems meeting production quotas.

In 1985 Magnitogorsk was put on a self-financing experiment—a new reform that was applied on a wide scale throughout Soviet industry in January 1988. The Soviets report self-financing helped the plant achieve a 3-percent increase in labor productivity (as much in one year as it had accomplished in the previous five years), but the level of profits is insufficient to meet the demands of self-financing. The enormous reconstruction costs, for example, have left little for new housing and social amenities in a city where the average waiting time for new apartments is 10 years.<sup>5</sup> According to plant officials, the combine is currently devoting about half of its profits to pay for reconstruction. The remainder is used to pay for new housing and other social amenities. According to the combine's chief economist, Yuri Levin, "... for that, we still don't have enough."

Gorbachev's reforms have also placed greater emphasis on timely contract deliveries. As production lines are shut down for retooling and labor is diverted to the combine's reconstruction, Magnitogorsk faces

<sup>5</sup> A series of reports indicating support services in Magnitogorsk were not prepared for the large influx of workers reportedly prompted the local trade union in late 1986 to reallocate close to 10 percent of the capital allocated for the reconstruction effort to nonindustrial construction, presumably to build more housing. According to Soviet estimates, two to three times more workers than are currently on site are required for the overall reconstruction effort, including engineers, construction personnel, and intra-industry consultants.



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costly problems meeting its contracts; the plant paid some 3 million rubles in fines for failing to meet delivery schedules in 1986. The wisdom of levying such heavy fines on plants under reconstruction has been the subject of some discussion in the local press.<sup>10</sup>

#### Prospects for Success

We believe that the heart of the reconstruction effort—the basic oxygen workshop—will be close to completion near the end of 1989. This facility is a critical link in Magnitogorsk's production capability, but chronic problems in other areas of the plant, such as frequent equipment breakdowns, will have to be solved before the combine will realize the benefits of improved steelmaking methods. Thus, the construction teams' commitment to finish the workshop by June 1989 may result in "symbolic completion," but the equipment probably will not be ready for full-scale production for some time. The systems for remote control of furnace operations—which are usually produced domestically—typically do not function properly, the main lines of machine tools for cutting metal at Magnitka have been described as "unreliable," and rolling mills have generally been equipped with leaky hydraulic systems.

Soviet press reports also suggest that the overall modernization project is behind schedule and that delivery of the equipment could be delayed. At the 13th Congress of Metallurgical Industry Workers in early 1987, industry leaders hinted at a lack of cooperation among the construction workers, machine builders, and metalworkers at Magnitogorsk.

<sup>10</sup> In July 1987, a Western scholar visiting Magnitogorsk wrote a series of articles for the local newspaper—*The Magnitogorsk Worker*—describing the problems faced by the workers at Magnitogorsk. In addition to commenting on the poor state of housing and food services in the area, his candid observations reportedly sparked a lively debate in the newspaper about problems in the modernization plans for the steel plant.

#### Development of the Astrakhan' Gas-Condensate Complex

*The scale and rates of work in Astrakhan' are comparable to such gigantic sites as the BAM. . . .*

*Vyacheslav Sheremet  
Deputy Minister of the Gas Industry  
March 1987*

Development of the Astrakhan' complex is one of four key oil and gas projects scheduled for completion during the current five-year plan. Moscow is intent on fully exploiting the rich resources at Astrakhan' to offset declines in production from the Orenburg and North Caucasus natural gasfields. Currently entering the second of three, and perhaps four, phases of planned development, Astrakhan' is already producing gas, but the drilling and completion of wells are years behind schedule (see inset). Eventually, nearly 9 billion cubic meters of gas, 5.9 million tons of condensate, and 700,000 tons of liquefied petroleum gas are to be recovered annually.<sup>11</sup> In addition, up to 5.8 million tons of sulfur are expected to be recovered each year and will be used to make sulfuric acid and fertilizers.

The Astrakhan' complex is located in the southwestern part of the North Caspian Basin in the Volga River delta, about 55 kilometers northwest of the city of Astrakhan'. It covers an area of some 30,000 square kilometers and consists of many individual oil and gas deposits. The geology of the area is complex, and operating conditions are extremely severe because of the great depth and high formation pressure of the sour gas deposits, which contain hydrogen sulfide and other nonhydrocarbon compounds.<sup>12</sup> Extensive, sophis-

<sup>11</sup> In some high-temperature and high-pressure natural gas reservoirs, large quantities of liquid hydrocarbons may be produced with the gas. These liquids do not originate in a distinct oil zone, but are in a gaseous state in the reservoir. This liquid fraction is called condensate, and the reservoir is known as a gas-condensate reservoir.

<sup>12</sup> According to Soviet studies of the area, reservoir pressures at Astrakhan' are about 10,000 pounds per square inch, reservoir temperatures are 110 degrees C (230 degrees F), and the gas may contain up to 24 percent hydrogen sulfide and 14 to 24 percent carbon dioxide.

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### *Phases of Astrakhan' Development*

#### *Phase I*

- *Drilling of 56 development wells.*
- *Completion of 500 kilometers of pipeline.*
- *Construction of gas-processing plant.*
- *Construction of a 630-kilometer carbon dioxide pipeline to Gur'yev oilfields.*

#### *Phase II*

- *Drilling of 200 additional wells.*
- *Expansion of gas-processing plant.*

#### *Phases III and IV*

- *Drilling of additional wells as old wells are retired.*

licated technology is needed to remove these impurities before the gas can be transported via pipeline. Moreover, the gas-processing and transport facilities require corrosion-resistant materials, leak-proof controls, and other expensive equipment to ensure safe and effective exploitation of the deposits

The largest single deposit at Astrakhan'—Shir-yayevo—was discovered in 1976, but exploration was put on hold because of a lack of corrosion-resistant tubing, casing, and drill pipe. The first phase of Astrakhan' development—started in 1981—was characterized by substantial delays in drilling activity and well completions due to poor-quality domestic equipment and difficulty assimilating new technologies acquired from the West. The decision to purchase state-of-the-art technology and equipment from the West reflected Moscow's recognition that Astrakhan' development would be seriously hindered without computer technology, high-quality drilling equipment, special steel tubing, and technical integration systems. For example, deficiencies in domestic equipment led to a major blowout in 1984 due to corrosion and collapse of the well casings.

Nevertheless, work on Phase II began shortly after the French engineering firm, Technip, was awarded a contract for expansion of the gas-processing plant in

April 1985 (see figure 4). Despite the use of Western equipment, lax safety standards have continued to plague the project. Another explosion in March 1987 at an underground gas-condensate storage facility, for example, killed four persons and resulted in a temporary shutdown of the gas-processing plant (see inset).

Because commercial exploitation in the Pre-Caspian Basin is extremely difficult and expensive, increased acquisition and assimilation of Western technology will be essential if exploration and development are to accelerate. Since Gorbachev assumed power, he has instituted several changes in the foreign trade rules designed to improve the ability of individual enterprises to purchase Western equipment and arrange joint ventures. Such arrangements are essential to developing Astrakhan', where most of the success achieved to this point in exploration and drilling could not have been achieved if only domestic equipment—much of it unsafe and ill suited to the geological environment there—had been used.

#### *Turning to the West for Assistance*

Contracts for Western equipment have been awarded to France, the Netherlands, West Germany, Sweden, Canada, Japan, and the United States (see table 2). The Soviets have recently shied away from Western—particularly US—equipment purchases, telling Western businessmen in early 1987 that hard currency constraints have been responsible for the on-and-off nature of recent negotiations.

Moscow has generally preferred non-US suppliers because they can offer state-of-the-art equipment at more competitive prices and with more attractive financing. Although the Soviets have run into some stumblingblocks because of Western export regulations, Moscow has managed to arrange delivery of an impressive variety of computers, drilling accessories, and seamless tubular steel. In spite of the tight budgets under which many Soviet industrial projects are forced to operate, development at Astrakhan' has

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been given relatively high priority." Two of the largest Western contracts for Astrakhan' development—with Technip of France and Mannesmann of West Germany—amount to over \$800 million. The Soviets have estimated total investment for developing Astrakhan' fields and constructing facilities at \$1.4 billion. (

#### **Domestic Equipment for Astrakhan'**

Although the Soviets have purchased a sizable amount of equipment from the West, they still must rely heavily on domestic skills and equipment. In particular, they have continued to use domestic drilling equipment, despite problems with quality and reliability. Even with quality hardware purchased from the West, the Soviets do the construction and

assembly work themselves, and, in many cases, the results do not measure up to Western standards.

Thus, many of the problems encountered at Astrakhan' result from shortcomings common to much of Soviet industry—such as those illustrated in the case of Magnitogorsk—and demonstrate the difficulty Moscow will have trying to modernize basic facilities and simultaneously maintain forward momentum on projects such as Astrakhan'. For example, development of the Astrakhan' deposits depends heavily on a variety of domestic machine-building and metallurgical industries, all of which have been heavily criticized in the Soviet press for their lack of support:

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*The 1987 explosion at Astrakhan' served as a sobering example of the dangers involved in developing sour gas deposits. Scores of safety violations were documented in a series of articles in the Soviet newspaper Sotsialisticheskaya industriya in March 1987:*

- *Visitors were permitted to enter an area of "increased danger" from toxic gases without wearing protective gas masks.*
- *Buses intended for use in an emergency evacuation of families living in the area were found unequipped with necessary medical supplies; during a test of emergency procedures, none of the drivers answered the alarm.*

- *A special investigation into the death of a senior operator revealed no one had discovered his absence during a work shift. His body was found "accidentally," and even though a medical team had to travel only about 10 kilometers, they arrived 90 minutes after they were called.*

- *A system of intercoms between various installations designed to enable quick communication in the event of an emergency was not in operation. (C NF)*

*The list of violations also includes imperfections in welded seams of pipelines carrying toxic materials, a lack of instruments to warn of the presence of toxic gases, and flagrant carelessness over established safety procedures.*

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**Table 2**  
**USSR: Western Equipment for Astrakhan' Development \***

Country and Firm	Equipment/Technology	Value (million US \$)	Date of Contract
Canada—Canadian Fracmaster	High-pressure pumping equipment	4.5	February 1987
Canada—Partec-Lavalin	Field development equipment	150	Early 1987
France—Technip	Gas-processing plant for Phase I	395	December 1982
France—Technip	Expansion of gas-processing plant for Phase II	236	April 1985
France	Sulfur extraction plant	NA	Early 1986
France—Rhone Poulenc	Sulfur-recovery catalysts	NA	1986
Japan—Sumitomo Metal Industries	Corrosion-resistant pipe for transporting gas	NA	January 1987
Netherlands	Unspecified equipment	NA	NA
Sweden—Trelleborg	Protective clothing, respiratory devices, gas detectors, personnel training	NA	February 1987
United States	Pipeline ball cocks	NA	1986
United States	Computerized oil exploration and mud logging system	0.6	February 1987
West Germany—Mannesmann	Field development materials	200	January 1983

\* This table includes only contracts that have been awarded. Negotiations are currently under way with the United States for purchasing hydrofracturing technology.

- The Ministry of Heavy, Power, and Transport Machine Building was singled out for failing to produce equipment for drilling deep wells at Astrakhan'.
- The ferrous metals industry, continuously criticized for failure to improve the quality and variety of its products, has been berated on several occasions for not developing corrosion-resistant pipes.
- The Ministry of Chemical and Petroleum Machine Building has been censured for "failing to master the output of antidischarge equipment to prevent blowouts to ensure on-site safety."
- The Ministry of Instrument Making, Automation Equipment, and Control Systems has come under fire for its slow pace in producing instruments and automation equipment."

"Although the purchase of Western equipment and technology has facilitated progress, it is clearly disconcerting to some in the domestic sector. As one Soviet journalist visiting Astrakhan' recently put it, "... we can, we are able to make this equipment! But we purchase it." The Soviets purchased technology for producing effective blowout preventers from the West several years ago, for example, but continue to import the equipment because they have been unable to assimilate the technology.

#### **Limited Help From Eastern Europe**

The Soviets have purchased only a limited amount of equipment from Eastern Europe. East European capabilities for producing drilling and production equipment are severely limited, leaving the Soviets to rely largely on domestic and Western equipment for the task. The Soviets are depending on Bloc labor to help complete pipeline work, however, and are relying on Bulgarian specialists to build a Soviet-designed compressor station along the carbon-dioxide pipeline from Astrakhan' to the Gur'yev oilfields. East German, Polish, and Czechoslovak construction workers are helping build the first section of the pipeline.

#### **Local Support Services Strained**

Lack of infrastructure, especially housing, to accommodate the large influx of workers at Astrakhan' is creating morale and productivity problems—like

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those at Magnitka—and reflects the lack of investment to accomplish both primary and support functions and the inherent allocation bias of local managers in favor of the former. At the January 1987 Central Committee plenum, General Secretary Gorbachev described the situation at Astrakhan':

*Here they have assimilated more than 1.5 billion rubles worth of capital investment . . . there is an army of 8,000 workers and specialists employed there, but only 3,000 of them have permanent housing. Moreover, the lag in the construction of housing, polyclinics, dining rooms, and other facilities of the social and cultural sphere had been built in the plans from the very beginning. This is the sad result of an incorrect, erroneous approach to social problems. . . .*

The housing situation in Astrakhan' was in poor shape before the discovery of the gas deposits, but it has worsened with the need to accommodate thousands of new workers. Moreover, a gas ministry decision not to build a separate settlement for plant workers—probably as a means to save limited investment resources for purchasing equipment—has created the additional problem of transporting workers from the city of Astrakhan' to the gas deposits.

Delays in the work there were largely attributable to commuting difficulties that had become a day-to-day aggravation for foreign technicians working there. Housed some 27 kilometers from their work sites, West German technicians found travel to the work site inefficient since they invariably spent four or more hours per day commuting, including a long wait for a ferry. Since then, the Soviets have built a bridge over a side branch of the Volga River that serves as an alternate commuter route and also have opened up a railway line linking the town of Astrakhan' to the gas-processing complex.

Some of the problems associated with labor transport have been solved, but Astrakhan' city authorities still find themselves with over 2,000 people who have no housing at all, many of whom sleep in railcars.

According to one Soviet press report, some Astrakhan' workers are envious of those who sleep in railcars, since they are unable to find any accommodations whatsoever. Some reports indicate Astrakhan' workers are forced to camp inside abandoned shacks with sleeping bags or to rent cellars from coworkers. Gas ministry officials are becoming increasingly concerned that many workers may quit their jobs out of sheer frustration with housing problems and the poor safety record. The chief of one of the project's drilling administrations exclaimed in March 1987, "How long can they go on like this . . . another year or two? Then no amount of money will keep them here. . . ." Shortages of medical facilities and public services are also growing at Astrakhan'. As Phase II expands, Soviet and Western labor complaints may rise unless housing construction and the sphere of social services is expanded.

#### Future Developments

The fatal accident at Astrakhan' in 1987 is a symptom of the multilayered problems the Soviets face in developing the rich gas deposits of the Pre-Caspian Basin.<sup>13</sup> Unsound technology, poor construction techniques, and insufficient training of personnel in using new equipment, along with the chronic equipment problems that plague much of Soviet civilian industry, create a prescription for delay. With additional Western help and a reliable flow of hard currency, the Soviets could hasten the otherwise slow Astrakhan' development. The Soviet press has indicated that another gas-processing unit will be manufactured by domestic industry, but in light of the poor performance of the machine-building sector, we believe that development will continue to proceed slowly.

We expect Moscow to remain committed to Astrakhan' development, but the potential for another catastrophic accident increases every day the Soviets drill without the use of sophisticated blowout preventers and instrumentation currently available in the West. Corrective measures were taken following the latest accident, but the Soviets seem to learn technical lessons slowly in this area and will have to move

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carefully to avoid more safety-related delays. Moreover, the housing problem will continue as long as investment resources remain taut and the construction sector continues to perform poorly."

#### Construction of the Amur-Yakutsk Branch of the Baikal-Amur Mainline Railroad

*The absence of this . . . artery is holding back both the development of Yakutia's production forces and the growth of the republic's contribution to the country's national economy.*

Yuriy Prokop'yev  
First Secretary of Yakutsk  
Oblast Party Committee  
March 1987

The largest Soviet transport construction task since the Trans-Siberian Railroad—the Baikal-Amur Mainline (BAM) railroad—is another example of Soviet planners running ahead of available resources and construction capabilities. Traversing difficult environment between Tayshet in East Siberia and Sovetskaya Gavan' on the Pacific coast, the BAM was officially declared complete in 1984, although full operation of the railroad is years behind schedule because of numerous construction defects and unfinished tunnels and bridges. Moscow's plans call for the BAM to be brought into full operation by 1990, but kilometers of unused track are now rusting and many serious engineering problems remain unsolved."

A major post-BAM project—the "Little BAM"—consists of a north-south line running nearly 400 kilometers from Bamovskaya, a small station on the Trans-Siberian Railroad, north through Tynda on the BAM to Berkakit in Yakutia (see figure 5). A single-track extension of the Little BAM—the Amur-Yakutsk Mainline, or AYAM—will connect Berkakit

"Gorbachev and other leaders have recently indicated that more resources will be made available for housing on a national basis. Whether these promises are followed up by real investment allocations, however, remains to be seen. (C NF)

"See DI Intelligence Assessment SOV 84-10193/1A 84-10083 (Secret), 1 November 1984. *The USSR's Baikal-Amur Mainline Railroad: Driving the Golden Spike.*

with Yakutsk, passing through Chul'man, Aldan, and Tommot. Together, the AYAM and Little BAM comprise a 1,230-kilometer northern branch, the major transport development project of the current five-year plan. If completed, the AYAM will mark the first time that a railroad has penetrated the Yakut ASSR and will represent the fulfillment of a Soviet goal that dates back to the turn of the century (see figure 6). An extension of the AYAM to Magadan on the Pacific coast—after the AYAM is fully operational—is under discussion."

Despite the importance that Moscow has attached to construction of the AYAM, a lack of adequate investment resources has already slowed this project to a near halt. An article in *Soviet Geography* suggests that the AYAM project—started as an outgrowth of the enthusiasm during the early years of the BAM—may be symptomatic of the type of massive and somewhat futile development schemes criticized by Gorbachev in his June 1985 speech to the Central Committee. According to the article:

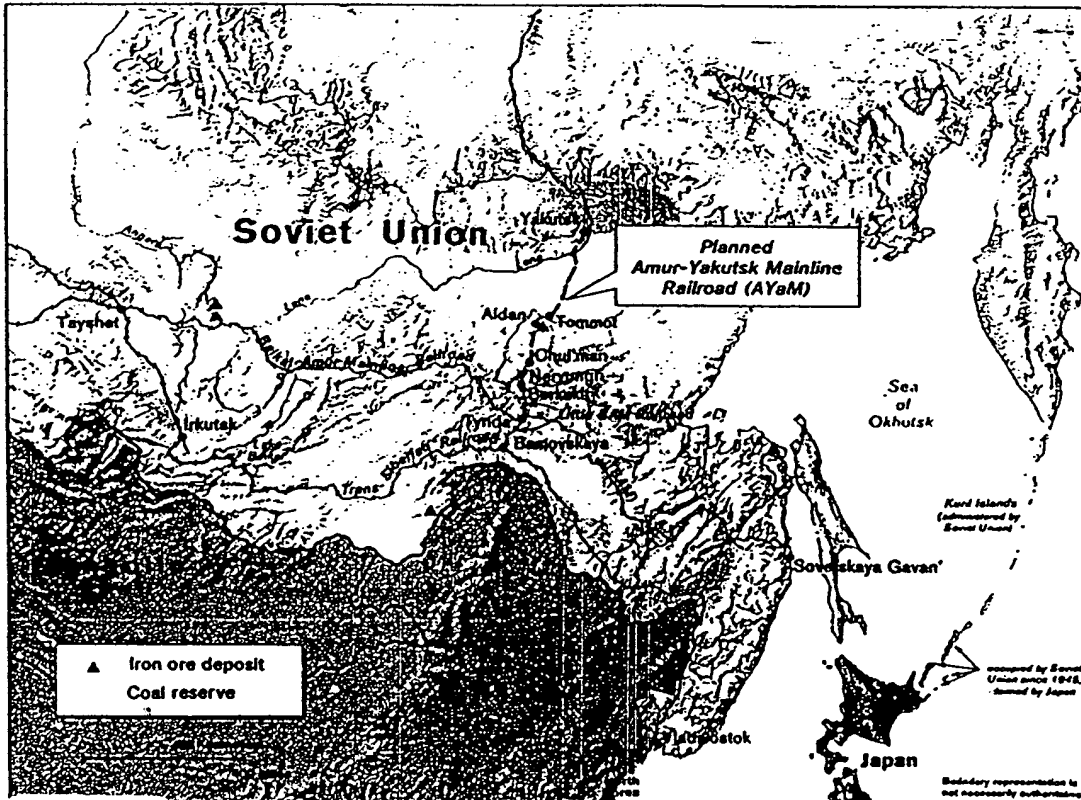
*. . . the region is justifiably considered by Soviet planners to be a graveyard for investment capital. Capital and labor are used less productively here than in any other major economic region in the RSFSR*

Like the BAM, the AYAM was conceived as a badly needed transportation link and a catalyst for the development of a vast resource frontier. Just as the BAM appears to have become the "white elephant" of Soviet transportation projects, however, the AYAM is in danger of following a similar course. Funding for the project came under close scrutiny when Gorbachev consolidated his power in the summer and fall of

"Construction of the Little BAM's southern section between Bamovskaya and Tynda began in 1972, before Brezhnev's 1974 announcement of the BAM project. When Soviet literature talks about "construction of a 1,200-kilometer northern branch of the BAM," it approximates the combined distance of the Little BAM and the AYAM. The Little BAM was completed to Berkakit in 1978.

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**Figure 5**  
**Amur-Yakutsk Mainline Railroad (AYaM)**



1985, and real funding problems for the project began early in 1986. Gorbachev has not canceled the project, but he appears to be taking a hard look at the feasibility of large projects like the AYaM before spending massive resources on them. ( )

#### **Exploiting Rich Resources: Plans for the AYaM**

The route of the AYaM runs north toward Yakutsk over the Aldan and Lena Rivers, crossing mountains and permafrost. Large-scale development of the region's mineral deposits was started in the postwar years, but it has been plagued by supply problems

largely because of a poor transportation network. In addition to lowering the costs of cargo shipments from Yakutia and the northeastern part of the country as a whole, the AYaM is the single most important link to exploiting the untapped resources of the area. The Soviets eventually plan to develop southern Yakutia into one of the country's largest metallurgical centers.



Large reserves of valuable raw materials that will become accessible upon completion of the AYAM include:

- **Coal.** According to Soviet estimates, some 40 billion tons of coking coal could eventually be extracted from the region. Commercial mining is already under way at the Neryungri coalfield, yielding some 13 million tons of coal per year.
- **Iron ore.** Soviet press accounts claim there are some 20 billion tons of iron ore in the immediate area around Yakutsk.
- **Apatite.** Apatite reserves of nearly 2.5 billion tons are said to have been found in the area. The discovery of the Selegdarskiy apatite deposits has already prompted Moscow to give the go-ahead to build a high-capacity apatite beneficiation facility that could eventually provide Siberia and the Soviet Far East with 40 percent of their phosphate fertilizer requirements.

Deposits of manganese ore, silver, and copper are also reported to be abundant in the AYAM region. Soviet planners expect a big payoff from the exploitation of these mineral deposits as well as the area's virgin timber resources.

Current plans call for the AYAM project to be completed in 1995. Many regional officials are pressing for faster development of the railroad, however,

claiming that while the BAM was intended for the long-range future, the AYAM is a necessity now for deliveries to and from the Yakutsk region. In an interview in the Soviet construction journal, *Stroitel'naya gazeta*, the first secretary of the Yakutsk area party committee claimed that absence of a rail line to Yakutsk has substantially held back the development of Yakutia's mineral wealth." The AYAM will also facilitate trade with Japan, North Korea, and China. In the short term, it will allow better use of already exploited mineral deposits and hasten deliveries to the BAM for further transport to processing facilities or delivery to seaports. The AYAM is also a critical link in the integrated development of the entire Yakutia region, helping to aid long-term exploitation of the region encompassed by the Yakut Territorial Production Complex (see inset).

"The transport resources of the area are already stretched to their limits. Currently, about 6 million tons of freight are delivered to Yakutia via the Lena River annually. The Lena is growing shallower each year, however, and Soviet scientists expect this problem to grow progressively worse. Plans call for over 9 million tons of freight to be hauled into the area by 1990—far more than the overburdened river can handle. Although other methods of transport are available—air, winter ice roads, and a small road network—they are expensive and often do not provide a reliable, year-round means of transportation. Moreover, the costs of delivering goods to Yakutsk have risen rapidly over the past 10 years. Some local officials claim it is necessary to burn a ton of fuel to deliver a ton of freight to Yakutsk.

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### **The Yakut Territorial Production Complex**

*The Soviet concept of regional development has no real counterpart in the West. "Regionalization" is designed to maximize the potential for a given area. Territorial Production Complexes (TPKs) have been designed to foster complementary and economically related development within a region.<sup>a</sup> Many of Moscow's plans for the eastern transportation network, including the AYAM, are designed to ensure development of the Yakut ASSR.*

*The economic life of Yakutia is tied to the Lena River, its main transportation trunk line. But its capacity to handle large volumes of freight has become severely restricted. The success of the Yakut TPK depends heavily on a reliable transportation network to haul raw material and fuel to metallurgical plants in the Soviet Far East. This TPK is the first in the AYAM region and is oriented toward the Pacific coast to which it has been linked via the Trans-Siberian Railroad. It is being developed as part of a long-term compensation agreement with the Japanese Government initiated in 1974, in which Japan agreed to provide the Soviet Union with credits worth \$450 million for purchase of equipment and some consumer goods. In return Tokyo received the right to purchase 6 million tons per year of coking coal from 1983 to 1999. Future development of the Yakut TPK will include the large iron ore deposits near Aldan and other nearby mineral deposits. Much of the region's new mineral production will probably be used, at least initially, for export.*

<sup>a</sup> The concept of the Territorial Production Complex was first introduced in 1941 by N. N. Kolosovskiy in *Problemy ekonomiki*. Specifically, he wrote: "The name production complex is given to an economic (interrelated) combination of enterprises at an industrial site in an entire region, whereby a definite economic effect is achieved through a successful (planned) choice of enterprises in accord with the natural and economic conditions of the region, and with its transportation and economic-geographic situation."

The first 380-km section of the AYAM—from Berkakit to Tommot—is scheduled for completion by 1990, with the remaining 450 kilometers to Yakutsk to be finished by 1995. Unlike the BAM, AYAM construction does not require tunnels. Builders believe that the

project can proceed on schedule, but financing problems and labor shortages may dash this hope.

### **Obstacles to Progress**

Financial difficulties—specifically, lack of investment—and problems attracting workers will not be easy to overcome and will probably delay completion of the project by many years, slowing development of the region. Some of the problems are similar to those experienced during BAM construction—lack of housing, poor-quality equipment, and hostile weather conditions—but certain difficulties, unique to the AYAM, were unforeseen by planners and have raised serious concern about the ability of those charged with AYAM construction to complete the project.

**Financing Problems.** In January 1987 the Soviet Bank for Financing Capital Investments (Stroybank) announced it had stopped all "special financing" for the AYAM project. Touting the need for stricter financial discipline, Stroybank claimed that the USSR Ministry of Railways had diverted some 30-million rubles intended for the AYAM to other projects, such as completion of unfinished sections of the BAM. According to an *Izvestiya* article, the Ministry assumed Stroybank would "resupply" the necessary funds for the AYAM and therefore saw no reason to hesitate over diverting capital to the BAM.<sup>a</sup> Financing problems notwithstanding, a limited amount of construction on the AYAM continues today. A late November 1987 press report indicated "general purpose funds" allocated by the Ministry of Railways are currently being used to fund AYAM construction.

Soviet transport officials have expressed growing concern that financial problems will be resolved too late to ensure completion of the project on schedule, which could result in dangerous and hasty end-of-plan

<sup>a</sup> Aside from causing administrative confusion, the fuss surrounding the cutoff illuminated other obstacles the AYAM faced. According to *Izvestiya*, the Ministry of Railways had not examined and approved the AYAM project design created by the Moscow State Transportation Design Bureau. Ministry officials suggested that, even if the additional funds were available, construction still could not be carried out immediately since the specific design plans for the AYAM were still unclear to project planners.

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"storming" to finish tracklaying. Many of the defects discovered on the BAM—such as unfinished bridges, buckling tracks, and unnecessarily steep grades—have been attributed to such last-minute rush work. One Yakutsk official is pressing for the establishment of a special transport construction trust to handle these problems.

**Housing and Labor Shortages: The Chicken and the Egg.** Workers are hesitant to settle permanently in the area, both because adequate housing is unavailable and out of fear AYam financing will continue to flow erratically, threatening bonuses and construction of health care facilities and schools. A *Stroitel'naya gazeta* article in March 1987 noted that the lack of comfortable housing and the remoteness of the area were scaring workers away, and that if this situation remained unchanged, the economic development of the area would be threatened. The article concluded, "... those, for whose sake it was built, will not be able to use its services." A Soviet report on the BAM noted that, on average, one-third of the workers in the area leave each year, chiefly because of the shortage of housing and schools. The AYam area, with an even less developed infrastructure, is having at least an equally difficult time attracting and maintaining an adequate labor force. The 1986-90 Five-Year Plan calls for the construction of some 340,000 square meters of housing along the AYam route; according to the Soviet press, the actual amount of living space per individual along the AYam is only one-third the USSR national average.

The USSR as a whole has been unable to meet housing construction goals for some time, but the situation along the AYam is particularly acute because of the remoteness of the area. Without an adequate work force, however, little additional housing can be built. Moscow has suggested to Vladimir Brezhnev, Minister of Transport Construction, that an AYam housing construction combine be established to solve the problem. Establishing such a combine is only an idea at this stage, and, although it might prove effective in the long run, it could create additional delays for the AYam project.

**Poor Planning.** The Little BAM is already suffering because the volume of freight traffic was underestimated during the planning stage. In 1986 the Little

BAM already carried a volume of freight that was planned for 1990. Despite this experience, there are strong indications that planners are making the same mistakes in their calculations for the AYam. According to a Soviet television report, each day several freight trains are delayed because of major repairs being carried out on the Little BAM. Like the Little BAM, the completed sections of the AYam extension are already showing signs of overuse, and transport specialists observing the construction have commented that planners on the AYam—like those on the BAM—are too concerned with meeting deadlines and are cutting corners with poor-quality materials such as rail and ballast. Moreover, they have opted to build a single-track line, despite preconstruction estimates that indicate the area will require at least two tracks to handle projected traffic volumes. The Little BAM was built as a single-track line to save time and money and already has difficulty coping with the coal traffic from the Neryungri deposit."

**Technical Problems.** Fiscal, housing, and planning problems aside, the Soviets are faced with several technical obstacles that will continue to delay construction. Building a railroad in a permafrost region is an immense technical challenge, but Soviet experience building bridges and laying track for the BAM indicates that such obstacles are not insurmountable (see inset). On the AYam, the Soviets will need to build 17 bridges, including a 3.5-km span across the Lena River. According to the manager of the AYam's bridge-building trust, the Lena River Bridge will require at least eight years of work. But survey results, feasibility studies, and general plans for the bridge have not yet been completed. Although construction of the Aldan River Bridge south of Tommot has started and is currently scheduled for completion in 1990, Stroybank's cutoff of funds in January 1987 brought work to a standstill.

"Initial studies of the area indicated that two tracks would be necessary to handle the timber, coal, iron ore, and machinery freight in the Little BAM region, but planners opted for one track so that progress would come quickly. The local industries are already feeling the pinch; the short-lived success of completing the Little BAM was quickly overshadowed. A construction chief on the project commented, 'Its capacities were completely used up three years ago.'

### Permafrost Construction Problems

*The hostile climate of Siberia presents formidable technical obstacles to building a railroad that require specialized civil engineering. In the winter, the frozen ground is as hard as rock, with temperatures dipping to minus 50 degrees Centigrade. In summer, the ground thaws unevenly to a depth of as much as 2 or 3 meters. Beneath this thawed layer, the ground remains frozen and soil drainage is restricted. As a result, the upper ground layer becomes a quagmire. Rail ties, tracks, and roadbeds settle unevenly into the thawed ground layer. This process is reversed in winter when the topsoil layer freezes, swells, and tends to eject ties and track. Even if extreme care is taken in construction by using appropriate materials, repair of the damage to the roadbed and to track alignment requires sizable annual expenditures. Moreover, permafrost causes immense logistic problems for project planners in arranging delivery of construction materials to building sites along the track.*

### Looking Ahead

Given the investment, labor, and technical problems to be overcome, the optimistic target date for completing the Berkakit-Tommot section of the AYAM will probably not be met, and construction of the final section to Yakutsk will fall behind correspondingly. Soviet press reports indicate four bridges have been built across the Chul'man River, and only about 60 kilometers of the railbed is completely prepared for tracklaying. The "major transport project" of the 1986-90 plan, thus, will probably extend well into the 1990s.

In constructing the AYAM, at least to this point, the Soviets have relied largely on domestic inputs of machinery, but the project is at such an early stage that contracts with Western firms could still make a contribution. Judging from similar construction needs on the BAM and machinery shortages for the AYAM cited in the Soviet press, the Soviets may seek additional heavy machinery (bulldozers, tractors, excavators, and cranes, for example) from Japan and the

United States. A rise in sentiments in favor of cutting future investment by canceling further construction is also possible, however, particularly considering Gorbachev's insistence that profitability become the byword for Soviet development projects. The Soviets estimate the cost of constructing the 830-km AYAM at about 1.5 billion rubles, which a high-ranking Yakutsk official claimed would be amortized within three to four years once the railroad becomes fully operational.

In the interim, the Soviets will rely heavily on the Little BAM and could attempt to secure funds to begin construction of a second track to cope with heavy freight volumes. Uncompleted sections of the BAM will continue to eat up valuable Srobybank funds and compete with the AYAM for financing. Although Moscow recently injected some "new blood" into its banking system, meaningful reform of capital allocation is still years away and does not necessarily translate into a greater share of funding for transport projects. Moreover, we expect little additional foreign investment in the region over the next few years to help finance development. Moscow may end up settling for the achievement of secondary objectives in the short term—such as increased movement of coking coal—but will have to wait until well after 2000 to witness any full-scale development of the area's other mineral resources.

### Modernization of the Ivanovo Machine Tool Plant

*What some places are still striving for and still approaching was achieved [at Ivanovo]... a long time ago.*

Pravda  
March 1987

The Ivanovo machine tool plant represents a rare example of achievement within a poorly performing industrial sector. Preferential support from Moscow and the efforts of a local manager determined to change the plant from what was basically a repair

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#### Plans for Ivanovo

Plans for upgrading the Ivanovo plant predate Gorbachev's accession to power but have received new emphasis and priority with the recent effort to bring Soviet industrial automation up to international standards (see inset). The plans derive from Moscow's intention to make products from the plant genuinely competitive on world markets. In addition, the Soviets expect to improve the efficiency of the country's machinery base by producing parts and equipment of higher quality than is possible with traditional manufacturing processes. The focus of efforts through 1990 is on developing and building new, more productive machine tools rather than on simply modernizing previous models. Moscow recognizes the need to develop better machine tools and views Ivanovo as one of the country's leading enterprises in bringing improved technology on line quickly. For these reasons, Ivanovo benefits from "preferential treatment" in terms of resource allocation.

The heart of the effort at Ivanovo—and the reason Moscow has placed such high hopes in work there—is the development of advanced flexible manufacturing systems (FMS).<sup>22</sup> In the near term, Ivanovo managers aim to build completely new machining centers rather than simply upgrade older models. To operate the machining centers, the plant is building computer-numerical-control (CNC) systems, and plans call for 95 percent of Ivanovo's machine tool output to be CNC by 1990. Such an increase would represent more than a 50-percent jump in the share of CNC machine tools produced at the plant over a period of only three years. By the end of the current five-year plan, Ivanovo plans to offer a range of machine tools using lasers for cutting to its clients abroad and further increase the automation of its machining centers to improve their adaptability to FMS.

<sup>22</sup> FMS most commonly refers to a cluster of fully automated machine tools or other metalworking machines under the direction of a supervisory computer used to manufacture a variety of parts. The advantages of FMS include the ability to maintain consistent part quality, eliminate human error, and reduce labor costs. FMS also allows quick response to shifts in engineering design or customer demand.

facility into a state-of-the-art machine-building enterprise have made Ivanovo a plant recognized for advanced machine tools in the USSR and abroad. In the current five-year plan, Moscow wants to upgrade Ivanovo's operations by reequipping major areas of the plant to enable continued production of advanced machine tools and to double production of machining centers by 1990.

Located some 450 kilometers northeast of Moscow, Ivanovo's principal production facilities began operating in the late 1950s, and in the late 1970s the first numerically controlled (NC) machining centers were built. Currently, Ivanovo's main products are machining centers of various sizes (see figure 7).

the plant produced 450 machining centers in 1986. as of March 1987, the plant was using 200 numerically controlled machine tools in its own manufacturing operations

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### **Improving Factory Automation and Machining Technology**

*To meet the changing requirements of a technologically complex economy, the Soviets are seeking to improve their machine tools by adding more state-of-the-art components such as instruments, controllers, programming devices, and diamond and sintered carbide cutting tools. The drive to modernize and improve factory automation, however, has met with powerful resistance because it tends to disrupt existing systems of planning and production. The backwardness of Soviet electronics and computer technology, managerial restrictions, and a policy of concentrating resources on mass production has left the USSR behind the industrialized West by as much as 10 years in some areas of manufacturing technology. (C NF)*

*To reverse this trend, Moscow has adopted a program for incorporating advanced technologies into its industrial production system, including machine tools, by:*

- Increasing the level of investment in the civilian machine-building and metalworking industries during 1986-90 by 80 percent over the 1981-85 level.*
- Focusing a new quality control system on enterprises in the machine-building industry.*
- Instituting a more flexible foreign trade policy that allows enterprises to form direct business relationships with foreign firms.*
- Increasing the volume of metal parts produced fourfold to fivefold by shifting from manual machines to computer-numerical-control machine tools.*

### **Yesterday's Upstarts, Today's Heroes**

The Ivanovo plant is one of only a handful of manufacturers in the USSR that managed to produce state-of-the-art machining centers in the late 1970s. This achievement did not come easily, however, as the history of the plant attests. Ironically, many of the events that brought about the changes that receive so much praise today were the result of unusual managerial initiatives that broke with traditional Soviet practice, coupled with unusual support in terms of resource allocation priority. Since Vladimir Kabaidze

became general director of the Ivanovo Machine Tool Association in 1970, he has sought to produce advanced machine tools and develop flexible manufacturing systems despite bureaucratic snags and resistance from ministry officials that sometimes resulted in loss of income and bonuses to his employees (see inset). Indeed, during the period from 1978 to 1982, the plant lost 2 million rubles in incentive funds, and members of its engineering and technical staff lost 1,800 rubles each in bonus money. The plant never had its plan for moving into series production of NC machine tools formally approved by the Ministry of the Machine Tool and Tool Building Industry, for example, and the enormous costs for electrical components and service forced Ivanovo management to underfund housing, vacations, and other employee benefits, which caused an exodus of 50 percent of its staff in the late 1970s.

Kabaidze's persistence, however, led Moscow to recognize the advantages of his vision for the plant, and since about 1983 Ivanovo has benefited from improved resource allocation and support from Moscow. Today Ivanovo's success in developing and producing machining centers and advancing its capability in FMS is hailed in the Soviet press as an example of local initiative and how the Soviet machine-building industry should operate under the new conditions of restructuring (see inset). An August 1987 *Izvestiya* article praised Ivanovo for being one of the few enterprises with quality standards high enough for its products to be competitive in world markets.

### **Equipment and Technology Requirements**

Currently, five different NC systems are employed in the machining centers at Ivanovo. These systems include equipment and technology provided by Japan, West Germany, and Italy, as well as one of Soviet manufacture. Two machining centers—originating in the United States—operate alongside 11 large East German-built machines. Nearly all the controls used on Ivanovo's own equipment were purchased from Japan's Fanuc, which the plant's management considered superior to other foreign sources of control equipment. The heavy reliance on foreign expertise is

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### *Why Aren't You More Like Ivanovo?*

*Newspapers frequently feature articles praising Ivanovo for its commitment to manufacture world-class machine tools and attacking other plants for failing to accomplish what Ivanovo has. Plant director Vladimir Kabaizde's frankness in defending his insistence on producing "only the best" has played well in such press coverage.*

*In early 1987, Pravda ran a feature titled, "Second Echelon: Why Don't Enterprises in Ivanovo Use the Methods of Local Machine Tool Builders":*

Indeed, why don't they? . . . This is a remarkable collective of fighters and innovators. We might add that it has subjected itself to severe self-discipline. . . . Isn't it time we started using the methods of the Ivanovo machine tool builders?

*When local plant managers scoffed at the suggestion they emulate Ivanovo, claiming it has received more resources than other plants, Kabaizde replied that Ivanovo's special treatment is well earned: "One has to earn a right . . . we consider everybody a customer and that includes servicing as well. Here . . . we try to make providing service to the customer a top priority."*

*The special treatment that Ivanovo enjoys has created resentment among directors of other machine-building enterprises, particularly in the area around Ivanovo. Generally, most plant managers claim Moscow cannot realistically expect the work at Ivanovo to be duplicated at other plants because the country lacks the resources and bureaucratic commitment to provide materials and personnel to more than a handful of showcase plants. Pravda asked directors of other machine tool factories in the area why they had not copied the success at Ivanovo. The general director of Tochpribor—a plant across the street from Ivanovo—said, "There is a difference between them and us. They are given, we are not. They get imported components. On the whole, Ivanovo lives under greenhouse conditions!"*

clear, but unlike many sectors of Soviet industry, Ivanovo's development of FMS has depended on more than imports of Western equipment: it boasts a relatively impressive record of success at integrating Western technology with its own.

To realize its ambitious goals to build new machining centers and to increase the number of numerically controlled machine tools in use by 1990, Ivanovo managers will continue to pursue purchases from the West under revised Soviet trade rules designed to facilitate technology and equipment acquisition. The ability to arrange purchases directly with foreign firms will—according to Minister of the Machine Tool and Tool-Building Industry Nikolay Panichev—enable the plant to be more responsive to technology needs and reduce bureaucratic obstacles to timely purchases. Panichev has indicated that Moscow is not interested in acquiring more Western machine tools, but instead wants know-how that will permit the Soviets to better integrate disparate machine tools into one system.

buyers from Ivanovo submitted formal requests for price quotations in January 1987 to a US firm for materials-handling equipment and a control system to link mechanical design and postprocessing equipment to FMS. Kabaizde is said to prefer a "low-level agreement" so that politics will not interfere with the arrangement. Nevertheless, much of the additional equipment needed at Ivanovo such as computers, software, CNC units, and compatible machine tools remain controlled by COCOM.

Western technical specialists visiting Ivanovo have reported that Ivanovo is also facing shortages of funds for purchasing foreign equipment. A slowdown in exports to hard currency countries from Ivanovo left the plant "cash poor,"

that the plant had insufficient funds to purchase software for the control system of a flexible manufacturing system

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In the past, production of machine tools at Ivanovo was primarily geared to the Soviet market and other Communist countries; according to plant representatives, 93 percent of the plant's output currently stays in the USSR. Under Gorbachev's new plans, however, increased production of CNC tools is designed to stimulate sales to hard currency countries.

The Soviet machine tool ministry has solicited the aid of an Italian machine tool manufacturing association to advise the USSR on export promotion strategies and quality control measures.

#### What Lies Ahead?

To maintain its reputation and keep up with international standards, Ivanovo will need to accelerate its production of flexible manufacturing systems and will probably need to continue to rely heavily on foreign expertise. Western industrial automation specialists who have traveled to the Ivanovo plant and met with officials there observed that the Soviets did not appear to understand some critical concepts in developing FMS such as the importance of not cutting corners on system engineering design work and specialized software development. They further noted that some cost-saving measures implemented at the plant in response to cash shortages would reduce the efficiency of the FMS. Such observations suggest that in spite of Ivanovo's preeminence among machine tool builders in the USSR, the plant is not completely immune from the inefficiencies and addiction to traditional practices that plague much of Soviet industry. Moreover, because many machine tool plants are currently upgrading their production equipment and resources are being divided among them, Ivanovo will suffer from pressure to produce more and more at a time when the plant itself is undergoing substantial renovation.

#### Outlook: Moving Ahead in Fits and Starts

Several common problems run through these case studies: too little investment chasing too many tasks, insufficient infrastructure and social amenities to

maintain adequate levels of appropriately skilled labor, and production/modernization plans that bear little relation to available resources and capabilities of the enterprises or sectors that must fulfill them. All of these problems are manifestations of an overly centralized system of control and a lack of incentives for personal commitment to the job. Moreover, these problems are compounded by the complex interdependencies among the various industrial sectors and the resultant ripple effects of shortcomings in one sector on many others.

With the introduction over the next several years of the economic reforms adopted at the June 1987 Central Committee plenum—including the streamlining of economic planning and the introduction of wholesale trade—and the redirection of investment resources, Gorbachev hopes to eliminate many of the difficulties associated with modernization. These initiatives, however, will not solve many of the problems evident in the four case studies, largely because they do not go far enough in promoting enterprise autonomy and individual initiative. For example, the reforms do nothing to ease the pressure to fulfill quantitative targets. Moreover, in the short term, we will probably see disruptions in accustomed patterns of doing business, causing confusion and apprehension among bureaucrats who develop and administer the often conflicting plans and workers and managers who must carry them out. In several of the cases we examined, work is being carried out hastily to avoid production shortfalls. Dangerous safety shortcuts, poor-quality construction work, and little regard for the long-term health of the enterprise frequently results. The Ivanovo experience implies that success—even under “greenhouse conditions”—occurs only after a painful period of adjustment. Applying some of the lessons from Ivanovo on a broader scale, we believe that on the national level economic conditions are likely to worsen before they improve. This case also demonstrates that preferential treatment by Moscow may be required to overcome bureaucratic obstacles to innovation and managerial risk taking.

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Our case studies suggest that the likelihood for successful modernization of Soviet industry will depend on Moscow's ability to modify its policies in several areas:

- Moscow will need to stop punishing enterprises for the inevitable production disruptions and shortfalls that occur during reconstruction. To accomplish this, output plans will have to be cut back to give enterprises the "breathing space" necessary to improve production processes and manufacture higher quality goods.
- Enterprise ability to command higher quality materials and equipment from suppliers will depend on the successful transition from a centrally administered supply system to a new system of wholesale trade, scheduled for completion in 1992.
- Moscow must focus on funding projects that promote consumer welfare and personal commitment. This is particularly necessary if Moscow is to encourage labor relocation to more remote regions of the country where the dearth of housing and consumer goods and services is discouraging skilled workers from permanent resettlement.
- Enterprises must be allowed to fail and new businesses to start, as provided for in the new Law on State Enterprises. Soviet industry will be hard pressed to improve overall performance if the state continues to protect enterprises from genuine market forces.
- Wholesale price reform—scheduled to begin in 1990—must allow flexible prices that respond to supply and demand. Without genuine price reform, the self-financing program will remain only a half measure.

Plant managers and industry leaders have been able to identify many of the key problems facing reconstruction projects, but solutions are often difficult to implement because of limited investment and labor resources. Moreover, the gap between the promises of an improved and relatively independent workplace and the reality of central control over most resources

and decisions is still apparent to workers and managers at the enterprise level. A Western observer studying the situation at Magnitogorsk noted, for example, "... they know the problems perfectly well, have many capable and knowledgeable people dealing with them, and yet it seems, even so, getting them solved is an extremely slow process." Reconstruction projects will need to show positive results quickly for Gorbachev's program to gather the necessary momentum and support to justify sustaining his overall modernization plan for Soviet industry.

In addition to these internal challenges, Moscow will also be looking outward for help revitalizing the industrial base. The purchase of foreign equipment and expertise is not a panacea for modernization because of traditional difficulties assimilating Western technology and equipment, but the Soviets will aggressively pursue trade contacts with the West for certain critical projects. For those projects that must rely largely on domestic suppliers—particularly the machine-building sector—we believe Moscow will accelerate its campaign to censure plants that fail to meet contract delivery schedules and hamper reconstruction efforts. The General Secretary's admonishment of Uralmash for failing to provide equipment in a timely manner for Magnitogorsk's reconstruction efforts typifies what we expect to see from the reform-minded Kremlin leadership in terms of reproaching poor performers. In traditional Soviet fashion, notable successes will be accredited to "the system," while failures will be blamed on individual managers, ministers, and party bureaucrats.

Gorbachev's economic program will probably effect changes over the next few years—both welcome and unwelcome—in the pace of the individual projects we examined:

- At the Magnitogorsk steel plant, shortages of equipment for reconstruction are likely to continue as suppliers scramble to meet contracts from other plants competing for limited resources. Once retooling nears completion, Magnitogorsk should be able to turn out somewhat higher quality products.

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- Development of the Astrakhan' gas-condensate complex could be hastened if Moscow allows the project planners to improve the timeliness of imports of Western equipment by continuing to loosen restrictions on foreign trade.
- Construction of the Amur-Yakutsk railroad probably will be hurt by competition for funds from BAM builders, particularly if pressure to complete that line multiplies every year the BAM operates below capacity. If Gorbachev continues to insist that profitability become the byword for development projects, construction of the AYAM could be postponed until a much later date, if not canceled.
- The Ivanovo Machine Tool Plant will probably continue to enjoy an excellent reputation and improve its export promotion strategies to gain more hard currency earnings as long as it continues to receive preferential support from Moscow. But Ivanovo may find it difficult to finance projects in the social sphere under the guidelines designed to transfer more responsibility for improving the local infrastructure to individual enterprises.

As a whole, Moscow's plans to upgrade its industrial base through rebuilding and retooling production lines are fraught with institutional conflicts between bureaucrats and reformers, with the former standing to lose their positions if Soviet factories ever do start "running themselves" more effectively as Gorbachev would like. Some ministerial officials have already been forced out of jobs and more severe personnel cuts are planned over the next few years. Meanwhile, at

the enterprise level, factory managers are faced with what may be, at least in the short term, an impossible task: assimilating reforms such as self-financing and wholesale trade while attempting to improve quality and maintain output at planned levels.

Because the success of Gorbachev's modernization effort depends, to a large extent, on a better motivated work force, Moscow will need to make good on pledges to provide decent housing and other social services, as well as improve availability of quality consumer goods, to obtain better results. Up to this point, workers have been instructed to work harder and faster but have yet to realize any meaningful reward for their sacrifices. Some productivity and qualitative gains from Moscow's program to upgrade the industrial base undoubtedly will occur, but Gorbachev's stated goal of overcoming the backwardness of Soviet industry will not be realized in the time frame he would like. A continued gap between promises of an improved and relatively independent workplace and the reality of central control over most resources and economic decisions would prolong the turmoil of the adjustment period and, in some cases, thwart modernization altogether. Unless Moscow frees its industries from the umbilicals of ministerial oversight and administered prices, a weak industrial infrastructure together with impotent work incentives will almost certainly hold modernization of Soviet industry to those projects on which Moscow can lavish preferential support.