

LOREN R. GRAHAM

## Gorbachev's Great Experiment

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*By restructuring science and industry, Mikhail Gorbachev hopes to make the Soviet Union a world-class economic power. But can he overcome the system's inertia?*

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Mikhail Gorbachev is trying to carry out the greatest reform of the Soviet Union in over 50 years, motivated in large part by the country's slippage in areas of high technology essential to international power and status.

For many years, the system of centralized control over science and technology worked well. In its first half century, the Soviet Union made the transition from a nation of minor significance in international science to a great research center with the largest scientific establishment in the world. And after adopting Western mass production techniques in the late twenties, the Soviet Union went on to become the world's largest producer of a number of basic industrial commodities, including steel, oil, lead, cement, and machine tools. But since the days when the patterns of Soviet science, technology, and industry were formed, other developed nations have entered a different technological and managerial phase, and the Soviets have been left behind.

As Thane Gustafson, a specialist in Soviet studies at George-town University, observed, "By any measure—whether Nobel prizes, frequency of citation by fellow specialists, origin of major break-throughs, or simple quantity of publications—U.S. scientists lead their Soviet colleagues in most disciplines, and in many there is simply no competition." While struggling to upgrade the basic quality of Soviet science, Gorbachev is also trying to energize a system that is grossly inefficient at turning scientific advances into economic benefits. In 1977, the noted Soviet economist L.V.Kantorovich and his colleague A.G.Kruglikov calculated that science had boosted the USSR's national income by 2.2 percent in 1966, but that the figure had fallen to only 0.8 percent by 1976. The Soviet Union, which from 1981 to 1985 spent 131 billion rubles on science, simply is not get-

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Loren Graham is a professor in the Program on Science, Technology, and Society at MIT and author of the recent book, *Science, Philosophy, and Human Behavior in the Soviet Union* (Columbia University Press). This article is adapted from his report, "Science and Technology Trends in the Soviet Union," which was part of a study—"Framework for Interaction: Technical Structures in Selected Countries Outside the European Community" (October 1987) funded by the European Economic Community—by RPI's Center for Science, Technology, and Policy.

ting sufficient return on its enormous investment.

The patterns responsible for this unhappy state of affairs are deeply entrenched. The centralized approach favored in the formative years of the Soviet Union—in which a single institute would do all the research for an entire industry—created a chasm between industrial research and industrial production, with research centers and factories separated geographically, organizationally, and even philosophically.

Moreover, the hands of Soviet industry have been tied by a rigid system in which prices as well as production quotas are set by the State. These restrictions have prevented the USSR from entering the new era of manufacturing, in which market sensitivity is the name of the game. In the new era, being pioneered by Japan, industrialists consider quantity less important than quality, and basic industrial commodities less significant than sophisticated products. The Japanese and their Western emulators are turning to concepts such as independent work teams and “just-in-time” inventory controls (which synchronize deliveries of parts and materials with manufacturers’ needs). And flexible manufacture—in which factory equipment can be quickly reconfigured to make new products in response to market changes—is beginning to supplant standard assembly-line production methods.

These new requirements present challenges to all industrialized nations. The United States, like the Soviet Union, has been slow to recognize the seriousness of the high-technology challenge from Japan and other competitors. Because of the nature of the Soviet system, however, finding an appropriate response in the USSR is a particularly difficult task. In addition to dulling industry’s market sensitivity, the traditional emphasis on fulfilling monthly production quotas long ago led to a decrease in quality, to the extent that relatively few Soviet industrial products meet world standards. What’s more, supply distribution in the Soviet Union has been such a perennial problem that just-in-time inventory controls would amount to a minor revolution.

Compounding the problems caused by an outmoded approach to science and technology is the deteriorating morale of industrial workers. In the September 1986 issue of the Communist Party’s main theoretical journal, the influential Soviet economic sociologist Tatiana Zaslavskaja argued that the most important change to hit Soviet factories in recent years was a “weakening of the extent to which a person can be forced, by either administrative or economic means, to work hard.” A new kind of worker had arisen in the Soviet Union, she claimed. “As workers’ education grows and their range of interests broadens, they strive to become more autonomous in their work, to participate actively in decision-making and to realize their full creative potential.” She asserted that these goals are frustrated in many Soviet factories where the management continues to order the workers around, and that as a result, the workers “often become alienated from labor and turn their interests elsewhere.” Zaslavskaja’s concerns here were very similar to those of industrialists in other countries, including the United States. Factory managers virtually everywhere are trying to improve the atmosphere of the workplace and the quality of industrial products by simultaneously reequipping factories with the latest technology and raising the status and independence of the workers.

### **Slipping scientific establishment**

In a few fields, such as mathematics and some aspects of theoretical physics, the Soviet Union is a world leader in science. And it is emerging once again as the top nation in space exploration, and intends to be a vigorous competitor in offering commercial launching and satellite services to the world. It is also strong in military technology. Even in a few areas of industrial technology, such as the welding processes developed by the Paton Institute in the Ukraine, it is able to compete with other nations commercially. In most areas of science and technology, however, the Soviet Union lags the West.

This backwardness has become painfully clear in computer science. Despite the USSR’s strenuous efforts, the gap between Western and Soviet computing power has widened considerably. And the computer-aided design and manufacturing techniques that are transforming industry in Japan and the West have barely established a foothold in the Soviet Union. Not surprisingly, the country is a long way from becoming a major exporter of high technology.

Indeed, the fear that Gorbachev and his advisors have is that the nation will become less and less competitive. As Gorbachev observed in a speech on January 27, 1987, “We Communists and all Soviet people

can no longer tolerate a situation in which for years many enterprises turn out products that are hopelessly obsolete, bring serious complaints from consumers, and hold back the country's scientific and technical progress."

Moving innovations from the research laboratory to the factory floor is the perennial Soviet problem. Soviet researchers have traditionally been interested in publications and academic status, whereas factory managers have been motivated by quantitative production goals. As Academician Zh.I.Alferov observed, "Being the first to express an idea, to discover an effect, to publish an article, to propose variant applications—these are the things that make a name and confer esteem in the academic world. But the technical work of developing these ideas is considered a low-prestige matter." In the 60s and 70s, the pay of engineers declined in relation to that of other workers, further diminishing their prestige. The economist Abel Aganbegian in 1985 lamented the fact that engineers often make about the same as, or even less than, factory workers.

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Most Soviet researchers with advanced degrees work in institutes rather than in industry, compounding the problem of uniting research and production. Even as late as 1982, after many efforts to correct the system, only 3 percent of Soviet researchers with the degree of *kandidat* (roughly equivalent to the American Ph.D.) were employed by industrial plants, while in the whole country only 210 of the 40,000 researchers with the degree of *doktor* (higher than a Ph.D.) worked for plants. Furthermore, such fields as chemistry and biology seem underrepresented in Soviet science, whereas physics and mathematics are overrepresented. Despite a worldwide boom in biology and genetic engineering, from 1970 to 1980 the number of biologists in the Soviet Union dropped from 4 percent of all research personnel to 3.8 percent. (In the United States in 1983, 17.9 percent of doctoral scientists and engineers—the largest group in any one field—were in the biological sciences.)

This problem is exacerbated by the aging of the country's scientists. In the Academy of Sciences—the Soviets' most influential scientific body, governing hundreds of institutes nationwide—the average age of the researchers has increased dramatically in recent years. Between 1976 and 1986 the percent-age of researchers under age 40 holding the degree of *doktor* declined by 67 percent, and the percentage of full members (academicians) under age 50 declined by 86 percent. Western countries have experienced a similar trend, especially among university professors. But in the Soviet Union the problem has been especially severe among science administrators, who have remained in their jobs into their eighties, or even their nineties.

### **Gorbachev's reforms**

Gorbachev knows that a retarded scientific/industrial establishment will eventually lead to decreased military power and lower international stature. In order to forestall such a decline, he has promoted a wide variety of reforms aimed at clearing up different ailments of the Soviet Union's industrial economy. Some of Gorbachev's reforms affect science and technology directly, some only indirectly. His more general political and economic reforms, such as the policy of *glasnost* (openness), liberalization of political controls, and decentralization of economic activities, are meant to modernize Soviet society as a whole. Nonetheless, these broad reforms should improve the working conditions of all creative people, especially scientists, engineers, and skilled laborers.

The release of the famous physicist-dissident Andrei Sakharov from his forced exile in Gor'kii was a striking example of *glasnost* extended to the scientific sphere. Allowing laborers, at least in some instances, to elect factory directors is an acknowledgment that skilled workers must be given more autonomy than was necessary during the basic industrialization drive (roughly 1927–55). And the decentralization of economic activities, including price formation, is designed to foster the energizing and innovative effects of competition. Gurii Marchuk, president of the Academy of Sciences, observed that one of the effects

of these economic reforms will be to provide “feedback” to researchers and industry, letting them judge from a product’s performance on the market what kinds of items and innovations are most needed.

Another broad reform likely to affect science and technology is the “Law on Individual Labor Activity,” enacted in May 1987. This law allows private citizens, operating under a system of registration and control, to engage in profitable small-scale trade and house-hold services. Examples are appliance and automobile repair, small restaurants, taxi services, tutoring, and arts and crafts. Several prominent scientists and engineers in the Soviet Union have proposed that this law serve as a justification for providing high-tech consulting services to local industries. In fact, it is quite likely that in the next few years the Soviet Union will license independent software programmers, recognizing that giant enterprises are often less creative in software than individuals or small groups.

Beyond the more general reforms, Gorbachev has taken a number of steps tailored to improve science and technology, including his efforts to bring research and manufacturing closer together and to raise the quality of goods. Gorbachev is also trying to revamp the Soviet system of foreign trade, a campaign designed to increase access to Western technology and establish the USSR as a high-tech exporter. His agenda is as follows:

### *1. New Ways of Organizing R&D*

In recent years, Soviet administrators have made many attempts—with varying degrees of success—to bridge the gap between basic research and industrial application. They have formed a great variety of “associations,” “technological centers,” and “complexes,” each including under one umbrella all stages of the R&D cycle from basic research to production. Most widespread are the “Science-Production Associations” (NPOs). These numbered about 400 in 1986, and another 100 are scheduled. One of the best-known NPOs is the Svetlana Electronic Instrument Manufacturing Association in Leningrad, which has introduced a range of improved scientific instruments.

Although the Science-Production Associations have had some success in introducing innovations into Soviet industry, they have failed to gain the close involvement of the best fundamental researchers. The NPOs are under the control of the production ministries (government departments responsible for research and production in specific fields), and only rarely work closely with institutes in the Academy of Sciences. Furthermore, their component groups seem to be poorly coordinated; the factories, on the one hand, and the research institutes, on the other, continue to follow their own independent plans and goals.

The search for new organizational forms has continued. Since about 1980, B.E.Paton has promoted what he calls “Engineering Centers.” Controlled by the Ukrainian Academy of Sciences, of which Paton is president, they serve as links between fundamental research institutes and industry. Paton has compared them to “venture firms” in capitalist countries, organizations unafraid of new ideas and risks. The Engineering Center for Pressure Welding, formed in 1984, has been particularly successful. It has received State and Lenin Prizes and has sold industrial licenses to firms in the United States, Canada, and Japan.

Under Gorbachev, yet another new organizational framework for promoting industrial innovation has been introduced: the Interbranch Scientific-Technical Complexes, known as MNTKs. These conglomerates combine research and production facilities, just as the older associations do. But of the 21 MNTKs, only nine are under the control of production ministries. The rest are run by institutes of the Academy of Sciences, which Gorbachev considers more enlightened about modern technology and methods of management. The Academy’s MNTKs include complexes working on biotechnology, machine tools, computers, robotics, fiber optics, chemical catalysis, lasers, welding, automation, and petrochemicals.

One of the most ambitious is BIOGEN—also known as BIOTAN—a biotechnology organization modeled in part on the form of a Western-style corporation and headed by Academician Iurii Ovchinnikov, director of the Shemiakin Institute of Bio-organic Chemistry of the Academy of Sciences.

For many years Ovchinnikov had felt frustrated by the slowness of Soviet industry to adopt modern biological technology such as genetic engineering. Now he has been given his own plant near Riga, Latvia. BIOGEN also comprises the Shemiakin Institute, a research facility in Pushchino (outside Moscow), two special “construction bureaus” for building new plants, and 18 other “associated” organizations.

John Maddox, editor of *Nature*, recently called

the Shemiakin laboratories “better than the best in the West, but emptier.” Indeed, Ovchinnikov recognizes that even the best-equipped biology labs in the world can accomplish little without a steady supply of talent to fill them. As mentioned earlier, one of the problems of Soviet biology is that relatively few young people have entered the field. Ovchinnikov has tried to combat this trend by establishing a strong student division in the Shemiakin Institute. Although institutes of the Academy have always involved advanced undergraduates from local universities in research projects, the Shemiakin Institute has carried this practice to a new level. Each year, it recruits 50–60 students from Moscow University, including freshmen, to work as interns. Ovchinnikov, reportedly ill with leukemia, seems determined to ensure that the commitment to advance Soviet biology does not die with him.

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In addition to bolstering Soviet research, MNTKs such as BIOGEN give the Academy of Sciences a chance to test and sell its own products on the international market. The MNTK can then use the profits to develop other products. At the Shemiakin Institute in Moscow the administrators of BIOGEN have set up an impressive display room of products for sale—including interleukin-2 and hepatitis B vaccine—have published a catalog, and aggressively promote their wares to foreign visitors.

Just how far the Academy will be permitted to go in this direction is still not clear. Officials at the Shemiakin Institute have admitted that, if a product were making lots of money, there would be a temptation to keep producing it within the MNTK instead of turning it over to Soviet industry. Yet the Academy has no previous commercial experience. And as *Izvestia* has reported, some critics have complained that it would be “inexpedient to charge the Academy with economic tasks that it does not usually perform.”

### 2. *Quality Control Through “State Acceptance”*

In order to improve the quality of Soviet products, Gorbachev has introduced *gospriemka*, or State Acceptance, a controversial system of government inspection of factories. The inspectors, who work for the State Committee on Standards, have the power to reject products that do not measure up. A similar system has long been used on products destined for the armed forces, but a result of that system was that the shoddier goods were shunted aside to the civilian economy. Now the inspection system has been extended to certain high-priority civilian products.

In early 1987, *gospriemka* encompassed 1,500 enterprises producing about 15 percent of all industrial products. It was particularly prevalent in the machine-tool industry, where nearly one-third of the output was subject to such inspection. Although the Soviet Union is the world's largest producer of machine tools, Prime Minister Nikolai Ryzhkov revealed to an International Chamber of Commerce delegation in June 1986 that only 29 percent of Soviet-produced machine tools met world standards, and then just barely.

The State Acceptance system quickly ran into difficulties. In December 1986 the Soviet newspaper *Izvestia* reported that workers at the giant KamAZ truck factory, located in the city of Brezhnev, held “stormy protests” against inspections, which had caused them to fall short of their production quotas. On March 5, 1987, the Soviet news agency TASS reported that 60 percent of the 1,500 plants subject to State Acceptance had missed their January targets because of rejects, and that the average wage at a Tinmen agricultural machinery plant had been cut by one-third because of restrictions imposed by the State inspectors. These events suggest that reforms such as State Acceptance that appeal to industrial planners may have less popularity among workers.

### 3. *Wage Incentives*

Gorbachev has criticized what he calls the “leveling” tendency of Soviet wage policy under his predecessors, noting that in some instances engineers had aban-

doned their professions for higher-paying jobs as workers in industries such as construction. He has also called for a sharper differentiation of pay that would reward particularly able engineers and scientists for their achievements rather than for formal rank or longevity. A new pay scale gives engineers employed in the development of new equipment a raise of 35 to 40 percent, and for engineers performing "especially important" work, the increase may be as high as 50 percent. Wage rates for skilled workers will rise by 40 to 45 percent, and for scientific researchers 30 to 35 percent.

It is not yet clear whether the new wage scales are requirements or merely guidelines. Nor is it clear just where this money will come from. Several Soviet sources have argued that it must come from within each enterprise from profits made by increasing efficiency. Other writers have made the more radical suggestion that "we should increase the pay of the best employees by decreasing the pay of the worst."

#### 4. Computer Initiatives

Alarmed by the computer gap between the Soviet Union and the West, Gorbachev has made repeated calls for improvement in this field. In response, science and education administrators have announced several crash programs in computer research, applications, and education. Academician Evgenii Velikhov, vice president of the Academy of Sciences, has been named head of a new "informatics" division of the Academy, where research on computer science is being pushed to top priority. In an effort to increase industrial automation, a special MNTK has been set up to develop computerized manufacturing equipment. Progress here has been less than dramatic, however, largely because the Soviets have such a long way to go. In late 1986, for example, the MNTK had just succeeded in building an industrial robot similar to a Japanese model from the mid-seventies.

The need for computer education in the Soviet Union is especially great, since personal computers have yet to be sold there in large numbers and computer literacy is much less widespread than in the West. Academician Iurii Ershov of the Siberian Division of the Academy is leading the effort to introduce computer courses in the schools. All 9th and 10th graders are now required to take them, whether their schools have computers or not. Hardware and software are still in short supply, but as more schools acquire computers, the emphasis of the curriculum is gradually shifting from computer theory to hands-on experience.

Western specialists differ on the question of whether Soviet tardiness in mass-producing personal computers is simply a result of technical difficulties, or whether it reflects Soviet fears that widespread ownership of microcomputers complete with good printers would make it impossible for censors to control the spread of Western and dissident literature. It appears that Soviet leaders also differ in their recommendations on computer policy. Leading scientists such as Velikhov and Ershov believe that in order for the Soviet Union to catch up with the West in technology it must become a full member of the information society developing so rapidly abroad, even if this means loosening censorship. They assure the nervous ideological guardians that Soviet society is now sufficiently "mature" that certain restrictions are no longer necessary. Some Party leaders, such as Egor Ligachev, are not so sure; they continue to warn about the dangers of Western news sources commonly available through international data bases. Although this debate puts *glasnost* to a severe test, the long-term trend seems to favor openness.

#### 5. Reforms in the Academy of Sciences

Under Marchuk—who was elected president of the Academy of Sciences in October 1986—the Academy's presidium, or governing body, has enacted several changes in policy. The changes are designed to focus the Academy more tightly on the most important problems of research (especially those with practical applications), to reequip the Academy with more modern instruments and computers, and to revitalize the subsidiary academies in the Soviet republics.

Two other reforms have stirred considerable controversy within the Academy. One is the introduction of greater democracy, which includes the decentralization of the Academy's power by increasing the authority of its 17 departments. The other is an attempt to speed the rise of younger researchers into the higher ranks by forcing older academic administrators to retire. The move toward decentralization is in part a response to criticism by Academician Vitalii Ginzburg, a noted physicist. Seizing on Gorbachev's call for openness and democracy, Ginzburg com-

plained strongly in November 1986 about the abuse of authority by the presidium of the Academy, and asked for greater influence by the individual institutes and departments. In January 1987, President Marchuk said more authority would be given to the departments, but the changes he recommended are only modest replies to Ginzburg's complaints. Ginzburg will undoubtedly continue his efforts so long as Gorbachev continues to call for reform.

The Academy's new policy on age requires directors of institutes to retire at 70, thus opening the way for younger, more creative scientists and overcoming the lethargy that prevails in such institutes. Marchuk has proposed that the same age limitation be imposed on members of the ruling presidium of the Academy. Not surprisingly, senior Soviet scientists have complained that these policies will limit their privileges. In consolation, Marchuk has proposed creating the positions of "honorary director" of an institute and "advisor to the presidium" for distinguished scientists forced to step down, with consultative votes and retention of all perquisites, such as limousines and offices.

These changes are obviously designed to create more room at the top for younger Soviet science administrators. In order to make more room at the bottom, Marchuk announced that henceforth every institute in the Academy will be asked to increase its staff of young researchers and graduate students by 5 percent a year.

Skeptics will call attention to a similar resolution in 1962 that required science administrators in the USSR to retire at age 65. The resolution was ignored, and Academy President Anatolii Aleksandrov stayed in his position to the age of 83. And even Marchuk admitted that the presidium of the Academy could make exceptions to the age limit in special circumstances. But the drive to reinvigorate the Academy seems much stronger this time.

#### 6. Promoting Foreign Trade

In addition to his efforts at informing the Soviet scientific and industrial establishment from within, Gorbachev has opened the door—at least a crack—to the influence of the world marketplace. First of all, he has extended the list of ministries and enterprises licensed to conduct foreign trade. Through imports, this measure could increase the flow of Western technology into the Soviet Union. And through exports, it could allow the Soviets to use the marketplace as a laboratory—just as capitalist countries do—for the performance of their products and technologies, and refining them accordingly.

Second, Soviet enterprises are now permitted to set up joint ventures with Western partners inside the USSR. The chief aim here is to improve access to foreign technology. Although trade within the Soviet bloc over the last five years has increased, exports and imports between the Soviet Union and developed non-Communist countries have declined.

The trade position of the Soviet Union has been made more difficult by the drop of world oil prices; oil is the Soviet Union's main hard-currency earner. During the first nine months of 1986, the Soviet deficit in trading with the "industrial capitalist countries" was 1.1 billion dollars. The Soviet newspaper *Pravda* observed in September 1986 that "The USSR's share of world trade is not in keeping with the achieved level and needs of the country's economic development."

Although it may be tempting to conclude simply that the Soviet Union produces little that the rest of the world wishes to buy, trade has also been hindered by bureaucratic difficulties in doing business with the Soviet Union. For example, Western businesses wishing to deal with Soviet firms have not been able to do so directly, but instead have been forced to go through the official foreign trade organizations (FTOs), which have had a monopolistic right to conduct foreign trade. There are about 80 of these organizations, most of which fall under the Ministry of Foreign Trade.

On January 1, 1987, the Politburo of the Soviet Communist Party and the USSR Council of Ministers extended foreign trade rights to 21 ministries and to 72 large enterprises, and indicated that other such licenses may follow. This reform is a major step toward decentralization of Soviet economic activity, but just how major remains to be seen. So far, few direct have been made. Furthermore, as Charalambos A. Vlachoutsicos, of the International Chamber of Commerce, has pointed out, there are about 4,300 large enterprises in the Soviet Union producing about 50 percent of Soviet GNP. So it becomes clear that giving 72 of them foreign trade rights is only a drop in the bucket. Still another limitation on the reform is the fact that so far the Ministry of Foreign Trade has retained control of trade in certain key areas, including raw materials, food, and about 60 percent of ma-

chinery imports.

Soviet enterprises do not seem eager to take the financial and political risks that direct deals with Western companies entail. The habit of hiding behind the central ministry or the foreign trade organization is so deeply ingrained in the behavior of Soviet enterprise directors that it may take years before they are willing to use the new rights that are granted to them.

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The other major reform in Soviet international business practice—joint ventures with the West—may be implemented even more slowly. Before 1987, Soviet economic administrators would consider joint ventures with Western companies only if they operated outside the USSR. Now “a limited number” of such ventures will be permitted inside the country, as long as they meet certain conditions, such as 51 percent Soviet ownership and employment of mainly Soviet personnel.

Soviet economic administrators have expressed strong interest in joint ventures in fields such as the textiles, machine-building, petrochemicals, pulp and paper, agriculture, electronics, and communications industries. They have run large advertisements in such places as the *International Herald Tribune* and *The Wall Street Journal*, promoting themselves as business partners. For the first time in Soviet/West relations, a joint task force has been established by the Soviet Chamber of Commerce and the International Chamber of Commerce for the purpose of studying the legal and administrative framework of joint ventures in the USSR. Soviet trade officials have mentioned as promising areas “chemicals for use as pesticides, dyeing agents, chemical fibers.” Already, a number of American, Japanese, and West European companies are negotiating agreements, including Monsanto, Occidental Petroleum, Archer-Daniels-Midland, Combustion Engineering, and Siemens.

Most Western specialists on Soviet trade believe that some fruitful joint ventures will be established, but they doubt that the number will be great. A senior Soviet trade official has been quoted as saying that initially 10 or 12 joint ventures with Western companies will be created. Further development of the concept will depend on the success of the early efforts.

The permitting of joint ventures and the decentralization of trading rights signal a much greater willingness on the part of Soviet leaders to relax controls on trade than in the past. Even so, they have not yet embraced the view that free trade, especially a heavy flow of foreign products, is a good thing. E. K. Ligachev, a member of the Politburo, warned in October 1986 that “statesmanship and concern for the country’s long-term interests caution against mindless enthusiasm for imports. In today’s complex, contradictory and struggle-filled world, our country has stood and continues to stand firmly on its own two feet. This is a great achievement of Soviet science, technology, and industry and of our cadres. It must be cherished.”

### **Prognosis: uncertain**

Will Gorbachev’s reforms work? Many of the changes being introduced are belated attempts to catch up with technical and managerial developments that began 10 or 15 years ago in other advanced countries. But already, Soviet technology has shown signs of improvement. For example, senior Soviet trade officials who visited New York City in December 1986 managed to sell U.S. companies systems for electromagnetic casting, large-diameter gas-pipe welding, and ion-gun hardening of industrial cutting tools. In addition, several of the MNTK’s have sold biological products—including interleukin-2, hepatitis B vaccine, and single-cell proteins—on international markets.

Yet the most significant changes so far have been psychological. Who would have dreamed a few years ago that Andrei Sakharov would call on Soviet intellectuals to rally behind the country’s head of state? Sakharov’s endorsement of the new tide of reforms was a tremendous victory for Gorbachev, even if Sakharov continues to cause embarrassment in other ways. During a recent visit to the Soviet Union, I

found the country's intellectuals more supportive of the leadership than I had ever seen them in many trips over the past 26 years. By easing political control and creating a more vital cultural scene, Gorbachev has strengthened his case among the elite, who favor modernization and on whom he depends for farther progress.

In judging these early successes, though, one must remember that Gorbachev has before him a truly Herculean task. His goal, after all, is not merely to improve the situation but to make the Soviet Union a world-class competitor in high technology. Here the other great industrial nations have a big advantage: their open economies and convertible currencies expose their weaknesses early enough so that they can take corrective action. The Soviet Union, still largely shielded from international competition in trade in high technology, often does not even recognize how far it has slipped until the gap is very wide.

What's more, Gorbachev's reform efforts contain tensions and seeming contradictions that may limit their effectiveness. He calls for raising the quality of industrial products at the same time that he insists on increasing the quantity of output. He wants individual enterprises to increase their economic independence while at the same time he imposes new wage scales from above. He asks for greater democracy in the choosing of administrative leaders and industrial executives while he retains the system of *nomenklatura*, under which the top Party organs name the leading executives. He wants to increase capital investment in equipment and increase the wages of research personnel at a time when the Soviet Union faces particular financial difficulties—some external, such as the decrease in the price of oil. And he calls for rapid economic growth after a decade-long slump, in which GNP growth averaged just over 2 percent a year in 1976–85.

Even if Gorbachev succeeds in his domestic reforms, he must still strengthen his country's technical and economic relations with the West. In terms of Soviet policies and regulations, the possibilities for such exchanges are probably greater now than in many years. Under Gorbachev's leadership, Soviet administrators have declared themselves ready. Nonetheless, Western businesspeople, industrialists, and scientists are justified in being cautious. Other socialist countries, such as China, have made similar calls for cooperation in the recent but have ended up providing fewer opportunities than many Westerners had expected, particularly for joint ventures. The Soviet stipulations that joint ventures must be controlled by Soviet executives and must follow strict labor guidelines may herald problems for such partnership.

Another pitfall here is that, in approaching joint ventures and the licensed sale of Western commodities in the Soviet Union, the two sides have rather different goals. The Soviet authorities see these agreements as ways to obtain foreign technology, but are anxious not to become dependent on foreign sources for that technology, or to expend amounts of hard currency on it. They would prefer to find ways in which they can learn about the technology, possibly through limited sales or joint ventures, and then produce it on their own. The Westerners are primarily interested in gaining access to the potentially huge Soviet market.

Economic exchanges are also hampered by the Soviets' shortage of hard currency and by the inconvertibility of the ruble. Quite recently, Soviet authorities have been talking about decentralizing price formation in the Soviet Union, achieving realistic exchange rates between the ruble and Western currencies, and possibly even making the ruble an internationally convertible currency. These changes would ease technical cooperation enormously between the Soviet Union and countries outside the socialist bloc. But achieving full convertibility for the ruble is easier said than done. The Hungarians, after a long period of economic deregulation, are only now approaching the goal of making their currency fully convertible.

There are obstacles to technical cooperation on the Western side as well. Nations belonging to the Coordinating Committee on Multilateral Export Controls, or CoCom (which represents Japan and all of NATO except Iceland), have agreed not to export any of a long list of militarily critical technologies to the Soviet bloc. Soviet officials see these regulations as severely limiting to trade. And even where no technology is involved, many Western scientists are reluctant to engage in academic exchanges with the USSR as long as large numbers of Soviet Jews are forbidden to emigrate. The release of several prominent Soviet scientists from prison or house arrest, including Sakharov, Shaiansky, and Orlov, has mollified some

Western scientists. But expanded cooperation still depends on the degree to which the Soviet Union loosens controls over its own scientists, and changes its emigration policy.

In the final analysis, however, intense and intimate scientific and technical interaction between the Soviet Union and Western nations can come only as foreign relations in general improve. The summit meeting in Washington in December gives hope for a new and better era in these relations. If Gorbachev at the same time succeeds in his campaign to loosen up Soviet society internally, scientific cooperation with Western nations is certain to grow.

But whether internal or external, the challenges faced by Gorbachev will test his considerable abilities. So far, he has done remarkably well in garnering political support for his reforms. Now his ultimate success probably tests on economic results. By the end of the Twelfth Five-Year Plan (1990) or the beginning of the Thirteenth (1991), there should be sufficient evidence to judge how well his plans are succeeding. This evidence will surely determine the fates of both his reforms and his political career.

### *Recommended reading*

A.Aganbegyan, "On a New Stage of Economic Construction," *EKO* no. 8 (1985): 16 (Russian).

Zh.I.Alferov, "The Effectiveness of Temporary Laboratories," *Izvestiia*, January 13, 1987, 2 (Russian).

Malcolm W.Browne, "Technology from Russia Finds a Niche in U.S. Life," *The New York Times*, December 16, 1986, C1.

Central Intelligence Agency and Defense Intelligence Agency, "Gorbachev's Modernization Program: A Status Report." Paper presented to Joint Economic Committee, U.S. Congress, March 19, 1987.

M.S.Gorbachev, "On Restructuring and the Party's Personnel Policy" (speech at Plenary Session of the Central Committee on January 27, 1987), *Pravda*, January 28, 1987, 1-5 (Russian).

Loren Graham, *Science, Philosophy and Human Behavior in the Soviet Union*. New York: Columbia University Press, 1987.

Thane Gustafson, "Why Doesn't Soviet Science Do Better Than It Does?" in *The Social Context of Soviet Science*, Linda Lubrano and Susan Gross Solomon (eds.) Boulder, Colo.: Westview Press, 1980, pp. 31-67.

Philip Hanson, "Gorbachev's Economic Policies; Technology and Innovation," in *The Comparative Economics of Research, Development and Innovation in East and West: A Survey*, P.Hanson and K.Pavitt (eds.) Harwood Academic Publisher (in press).

L.V.Kantorovich and A.G.Kruglikov, "A Global Evaluation of the Contribution of Science and Technology to the Economy," *Achievements and Prospects* no. 4 (1977): 30-38 (Russian).

E.K.Lipchev, "Key Role of Science;" *Pravda*, October 17, 1986, 3 (Russian).

G.I.Marchuk, "The Reconstruction of the Scientific Activity of the Institutions of the Academy of Sciences in Light of the Decisions of the XX VII Congress of the Communist Party," *Herald of the Academy of Sciences* no. 1 (1987): 3-13 (Russian).

"On Measures to Fundamentally Improve Foreign Economic Activity," *Pravda*, September 24, 1986 (Russian).

B.E.Paton, "The Task of Integrating Science, Technology and Production," *EKO* no. 6 (1986): 25-41 (Russian).

Andrew Rosenthal, "A Soviet Voice of Innovation Comes to the Fore" (interview with Tatiana Zaslavskaja), *The New York Times*, August 28, 1987, A6.

Blair Ruble, "The Expansion of Soviet Science," *Knowledge: Creation, Diffusion, Utilization* 2, no. 4 (June 1981): 529-553.

*USSR Technology Update: A Bi-Weekly Report on Soviet and East European Developments*. Delphic Associates, Inc. (especially November 5, 1986 issue).

Charalambos A.Vlachoutsicos, "Gorbachev's Trade Reforms: Treadmill or Dynamo?" *Harvard International Review* (April 1987): 44.

Viktor Yasmann, "Boris Tolstykh: The New Chairman of the USSR State Committee for Science and Technology," *Radio Liberty Report* (February 11, 1987): 1.

V.Zhamin, "The Intensification of Science," *Economic Sciences* no. 4 (1985): 34 (Russian).