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Soviet Science and Technology: Problems, Policies, and Directions

by

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I. Soviet Science is Huge in Scope and Scale

One can hardly fail to be impressed by the sheer size of the Soviet scientific establishment. It consists of more than five thousand scientific research and higher educational institutions employing more than 1.5 million professionals. About three percent of these scientists hold doctorates and nearly a third claim the kandidat degree.

While size and the quantity of inputs it absorbs may be the most impressive features of Soviet science, it would be foolish to underestimate its accomplishments in certain fields, e.g., nuclear science (both military and civilian), rocketry and space, lasers, military engineering, and many areas of theoretical work such as mathematics and physics. Despite these accomplishments, many leading Soviet scientists and political leaders are deeply dissatisfied with the state of Soviet science. To them, the returns to their huge investment in science appear disconcertingly modest.

II. There is Much Official Concern About Soviet Science and Technology

Mikhail Gorbachev and scientific luminaries, such as academicians Guri Marchuk and Evgenii Velikov, have voiced deep concern with the gaps between the state of Soviet science and technology in many fields and the world's leaders in those same fields. The Soviets hold their own or even excel in many areas of theoretical research, but worrisome gaps have opened in computers and communications technologies, most areas of medicine, manufacturing technology, and numerous other important applied fields. Worse still, from the Soviet viewpoint, is the fact that many of these gaps appear to be widening rather than narrowing with the passage of time. The general rule is that the Soviets' relative performance diminishes the farther they move from theory and research toward the development and application of new technologies.
Official Soviet concern with growing gaps across a broad front of science and technology has prompted a spate of changes and reforms designed to remedy the situation. Indeed, the general economic reforms now underway in the Soviet Union are motivated largely by and closely linked with the leadership's desire to make the country a more hospitable place for science and technological innovation. Their deep concern is that they may be left far in the rear as scientific and technological revolutions sweep the capitalist nations of Europe, Asia, and America. To lag behind the United States or even Japan, although perhaps dangerous, is not disgraceful. But to lag behind Korea, Singapore, or Brazil is another matter. Perhaps most alarming of all is the prospect of lagging behind China!

III. What Ails Soviet Science and Technology?

If Soviet science and technology is sick, as many inside and outside the USSR believe it is, then why is it so? If the symptoms of sickness are a failure to keep the pace in many areas of science and technology, then what is the nature of the disease?

In approaching this bit of diagnosis, it is important to remember that not all of the organism is sick. The military and space appendages of the Soviet science and technology corpus are certainly healthy enough. So, as I argued earlier, are many areas of theoretical science. But where the patient is sick, the causes are usually multiple, and they often act in reinforcing ways. It is useful to survey the entire range of those causes.

A. Resources are Often Inadequate in Amount and Kind

It is a law of scientific research that no scientist ever thinks he has enough resources. When we speak of appetite for space, equipment, assistants, and money, there is no such thing as satiety among scientists. Although a few top priority Soviet scientific institutions want for nothing, the vast majority face frustrating shortages.

First, there is a shortage of staff. Good people are in short supply. The institutions of higher education are not producing enough high quality graduates and their poor articulation with academic institutes means that the flow of good graduate students into research has dwindled. The applied fields are additionally impoverished because the frustrations of applied research lead the best minds into theoretical work. Furthermore, de facto tenure has combined with wage and salary constraints to force institutes to maintain the employment of many mediocre scientists while being unable to pay the best enough or to equip them well enough to do their best work.

Second is the shortage of material resources. A national building deficit means that it is difficult for research institutions to obtain proper quarters. The Soviet industrial base is narrow and researchers often find important equipment scarce or totally unavailable domestically. Computers,
from super-computers to micro-computers, are in extraordinarily short supply. To purchase equipment and supplies abroad requires an allocation of foreign exchange, which is often difficult to obtain. Even domestic items are allocated by plan, or rather by planners, through a paperwork process that is time consuming and mind-numbing. Research institutions frequently must manufacture their own equipment.

Third is the fragmentation of available resources among too many, often mediocre, institutions. A scientific research institute has been a status symbol for countless ministries, agencies, and other organizations; this is what the Soviets call "sectoral science" because its institutions are associated with one or another "sector" of the national economy. Research and development funds are allocated via a bureaucratic budget-making process. Wheeling and dealing, pulling and hauling, log-rolling, and back scratching are standard budgeting procedures. "Equity" demands that everyone must get something and nobody should be given more than a "fair" share. Funding is too frequently divorced from performance. Even "academic science", i.e., that practiced in the central and republican academies of science and their filials, is not immune to this fragmentation of resources since regional or national pride means that each of fourteen Soviet republics has its own array of institutes in addition to those of the USSR.

B. Scientific Communications are Constricted

Compounding the problem of resource stringency and the fragmentation of their distribution is the fact that communications among Soviet scientists and with the foreign scientific community traditionally have been unsatisfactory. Various reasons account for this. Professional and organizational jealousy plays a role as does the general Soviet tendency for information to flow vertically within hierarchies rather than horizontally among organizations and individuals. The technical inadequacies of the Soviet telecommunications system impede scientist-to-scientist contacts by telephone and computer networks. Restrictions on the use of xerography blocks the flow of working papers and reprints.

Soviet scientific journals provide a coverage of most areas of inquiry that is more sparse than in the West and their quality varies greatly among fields. As a rule, better journals are found in the theoretical sciences than in the applied areas. The number of scientific books published in the USSR is impressive but, once again, they display great variation in quality. Publication plans and academic success indicators place great stress on counting the number of titles published and number of pages per title. A chronic paper shortage constrains the number of copies that can be printed and that means that many titles emerge in small runs. The consequence is that good books sell out immediately while bookstore shelves groan under the weight of mediocre tomes that nobody wants.

The political paranoia so characteristic of Stalinism, exacerbated by a perpetual shortage of hard currency, has greatly reduced the flow of scientific
information across Soviet borders. The dissemination of foreign publications has been narrowly constricted within the Soviet Union. Scientific books and journals have not been immune to this injurious form of self-isolation.

Communication with foreign colleagues, essential for science to flourish in any country, has been impeded in countless ways. Comparatively few Soviet scientists study and work abroad. Even fewer Western or Japanese scientists wish and are able to study or work in Soviet scientific institutes. Travel restrictions limit the numbers of Soviet scientists permitted to attend conferences on foreign soil. The sum result of all these constrictions on the free international flow of information has been to isolate many, if not most, Soviet scientists well behind the frontiers of science.

Not all of the isolation of Soviet science, of course, is self imposed. On our side too, cold war considerations and great power rivalries have played their parts in breeding restrictions on West-East scientific communications. Government-imposed secrecy, COCOM rules, proprietary restrictions, and various other limitations on Soviet scientists' access to Western scientific and technical information continue to take their toll despite the best efforts of the KGB and GRU to have it otherwise.

In VINITI (All Union Institute for Scientific and Technical Information), the USSR boasts one of the world's largest and most elaborate systems for producing and distributing scientific abstracts and translations. This system attempts to substitute for the free flow of scientific information and, to a degree, ameliorates the isolation of Soviet scientists. But this happens only with a time lag that is costly to research in fast-moving fields of science. A protracted delay separates the date when a foreign scientist submits a piece of work for publication from the time that it is published abroad, received in the Soviet Union by VINITI, abstracted, translated, brought to the notice of Soviet scientists, requested, copied, and sent to be read. Meanwhile, members of the international community of unfettered scientists long since have seen a pre-print of the original work and likely have taken the next several steps of scholarly investigation.

C. Organizational Problems Bedevil Soviet Science

All Soviet science is divided into three parts; the Academy of Sciences of the USSR and the various republican academies (all except the RSFSR have them), the institutions of higher education (vuzy in Soviet parlance), and the research institutes subordinate to various industrial and other (e.g., defense) ministries. Significant barriers separate these three domains and their respective powers and responsibilities have shifted with the passage of time. Each, as we shall see, presents its own set of problems.

Although the academies of science are the most prominent and best known in the West, they receive a relatively small share of the Soviet science budget. Academic scientific personnel comprise about one-tenth of all Soviet scientists whereas the vuzy constitute over one-quarter and the ministerial institutes account for the preponderance share of scientific workers. In budgetary
matters, the academies and vuzy have traditionally taken an even smaller share while the ministerial portion has absorbed the lion's share of Soviet scientific expenditures.²

1. The Academies of Science

Like nearly all other organizations in the USSR, Soviet academic science is hierarchically structured. The organizational chart of the Soviet Academy of Sciences is a huge inverted tree. At the top sits the Academy's President and Presidium which, subject to supreme will of the Communist Party, oversee all that transpires within the academic empire. At the bottom are the individual scientists in their laboratories which are grouped into institutes, departments, and filials of the Academy.

Academy management has the task of charting the direction of scientific research within the various disciplines, institutes, etc., of approving the long- and short-range plans to accomplish accepted objectives, of allocating resources, and of controlling the fulfillment of plans. In fact, numerous quasi-independent power bases exist within this structure, and the power does not all flow downward from the top. Republican academies of sciences with their subordinate hierarchies are to be found in Kiev, Riga, Erevan, etc. Despite this proliferation of academic sub-trees or branches, the structure is highly bureaucratized and much more highly centralized than in any western nation.

The centralized, bureaucratic management system of the academies brings both advantages and disadvantages. On the plus side, as the Soviet leaders see it, is the fact that centralization makes possible (although not automatic) the concentration of resources on top priority objectives. Wasteful duplication can, in principle, be avoided. The disadvantages resolve themselves into two main negatives: First, centralized authority magnifies the power not only of "enlightened" leadership, (e.g., Boris Paton) but also of misguided scoundrels (e.g., Trofim Lysenko).³ It also places a heavy burden of responsibility on the leadership to know or be able to discern the most appropriate research avenues to pursue. Second, the decision-making process is ponderous, inflexible, vulnerable to cronyism and obstructionism, and unresponsive to new realities and bottom-up initiatives. Given the rapid pace of scientific progress in the modern era and the frequency of unexpected new directions that deserve exploration, these are heavy handicaps.

2. The Institutions of Higher Education (The Vulzy)

These institutions have traditionally fallen under the purview of the Ministry of Higher and Specialized Post-Secondary Education or jointly under that ministry and various industrial ministries. Their role has been mainly one of delivering instruction and not of furthering research. Teaching loads are usually heavy and resources for research are very limited. Although the vuzy account for over a quarter of the people counted in the Soviet establishment, they receive only about a tenth of the budgetary allocations for
science. With few exceptions, therefore, the intellectual output of these institutions is qualitatively unimpressive even though the quantity of their printed output is far from inconsiderable. Scholarly interactions between the vuzy and academic or "big science" is limited.

That most Soviet post-secondary educational institutions tread the intellectual backwaters is a fact that currently agitates the Soviet political and scientific leaderships. Two important negatives are seen to flow from this isolation. First, of course, the scientific life of the nation is impoverished by a paucity of good research and a cornucopia of mediocrity from the vuzy. Second, the education of undergraduate and graduate science students often suffers because instructors conduct so little original research.

3. The Ministerial Research Institutes

These institutions include the so-called "scientific-research institutes" of various ministries, branches, and other mainly industrial organizations as well as certain ministerially responsible "academies" outside the Academy of Sciences of the USSR (e.g., the Academy of Agricultural Sciences, the Academy of Medical Sciences, and the Academy of Pedagogical Sciences). Military research institutes are included in this category because they are ministerially accountable. Collectively, these institutions are sometimes called "branch science" or "sectoral science."

Sectoral science is intended to be concerned with the application of science and the implementation of technology. Being the creatures of ministries and other task-oriented agencies, these institutes are supposed to be responsive to the practical needs of their sponsors. In recent times, however, much of sectoral science has come in for heavy criticism for being slothful and irrelevant. Featherbedding is seemingly rampant and sectoral scientific management is accused of toadyism and obsequiousness before ministerial aparatchiks. Lofty bureaucratic barriers are said to block inter-sectoral cooperation and to frustrate scientific collaboration even when it is considered vital.

Relations between sectoral science and that of the academies frequently have been less than harmonious. The alleged parochialism of the ministerial creatures combines with their "swollen" budgets to produce academic anger and envy. Sectoral science accounts for well over half of all Soviet scientists and garners as much as nine-tenths of all scientific budgetary allocations. It is the body of the Soviet scientific dog and academic science is the tail. Who will wag whom is a question that has never been finally settled. While the academics consider themselves the nation's scientific elite, they have never wielded the budgets available to sectoral science.

4. Summing Up the Organizational Problems

Soviet science consists of three large bureaucracies. Centralization of authority has been the norm. Politics, spelt with both upper and lower case
"p"s, determines its course. High bureaucratic barriers impede inter-institutional and inter-disciplinary collaboration. Since most useful applied work necessitates such collaboration, that type of work is frustrated and frustrating. This reinforces the preference of many of the best scientists for theoretical research and deters them from participating in applied science.

The hierarchial organization of Soviet science does not mean that it is a top-down, command-and-obey organization. Once a course is set, the approval of many individuals at various levels of the hierarchy is necessary to produce any significant departure from that accepted course. Extraordinarily little freedom exists for new research entities to arise except through established channels. Despite this, certain individuals have proven capable of manipulating the system, of gathering power unto themselves, and of creating R&D empires. Entrepreneurship as it is known in the West has been completely absent. The inflexibility and ponderosity of the system mean that it responds sluggishly to new scientific and technological possibilities. At the same time, unpromising ventures are subject to weak correctives and often persist undeservedly long.

IV. Linkages: Science <-> Design <-> Production <-> Users

The application of scientific knowledge to practical problems is a complex process with at least four sets of activities or stages: scientific research, engineering development and design, manufacturing or other production, and final use. Direct communication, collaboration, and feedback are necessary throughout the process which ought to be thought of as circular rather than linear in construct. To the extent that these essentials are absent or underdeveloped, the process performs badly. The pathologies of Soviet science and technology have much to do with breakdowns of communication, collaboration, and feedback.

The earlier remarks have been addressed mainly to problems within Soviet scientific establishment, i.e., the first stage of the process as sketched here. No less important, however, are the problems that attend the implementation activities of design and production. To these we now turn.

A. A Few Key Features of the Soviet Economic System

To understand the problems of technological innovation in Soviet society, it is important to understand certain key features of the Stalinist economic system inherited by today's generation of Soviet leaders. What follows is a short digression on these features.

1. Inflationary Pressures and the Sellers' Market

Soviet economic planning traditionally has tried to force the pace of development of certain favored sectors of the economy at the expense of others less favored. Central planners in the State Planning Commission (Gosplan) and elsewhere have attempted to direct the flow of resources to achieve the planned
goals. Market mechanisms have been abjured in favor of central direction and allocation. Planners have usually favored "taut" or overly-ambitious plans. The consequence has been deficits of (excess demand for) many end and intermediate products. Under these circumstances, producers have little incentive to innovate or to improve products since they can easily dispose of all that they can produce. Prices, in their turn, are based on production costs. Thus there is no market incentive to innovate or to become more efficient. Nor is there any marketing push to sell new technology, to try to induce others to use new technology.

A combination of chronic shortages, concentration of power in producers' hands, and a sellers' market produces powerful inflationary pressures. Producers face a nearly irresistible temptation to raise prices on "new" or "improved" products even when the degree of actual improvement is altogether marginal. The circumstances also render producers indifferent to the service side of technological innovation. Users are told, in effect, "Here it is. Install it and figure out how to use it by yourself. Fix it yourself, too, when it breaks. You're lucky to get it. Take it or leave it."

2. Perverse Incentives for Producers

The rules of the Stalinist economic game provide producers with handsome rewards for fulfilling the annual output plan and serious penalties for failing to do so. The producer has every incentive, therefore, to understate his production potential and overstate his input requirements in the hope of bargaining for a plan target that is easy to achieve. As for the risk that inevitably accompanies product or process innovation, that is just asking for trouble. So the cards are stacked against the decision to innovate. The incentives are to stick with the familiar.

The incentive structure also discourages the producer's concern with quality. So long as the quantity of output meets the plan, quality is of decidedly lesser importance. Indifference to quality, whether it is of maintaining established standards or implementing new processes and products, has produced a culture of shoddy workmanship.

Designers and engineers find that their incentives also encourage them to behave irrationally from the point of view of sensible technological innovation. Their plans are couched in terms of the value of the products and processes that they design; they are paid on that basis too. Consequently, they have little incentive to produce less costly and more efficient designs.

3. Implications for Implementing the Fruits of Science

The upshot of this discussion of certain features of the Stalinist economy is that it creates powerful dis-incentives to technological innovation. The atmosphere is hostile to considerations of quality, service, and marketing.

The vertical structure of industrial organization and the pressures to fulfill output targets tend to create ministerial empires that stubbornly
resist lateral influences. It is one thing to respond to vertical pressures from within the ministry or above (e.g., Gosplan). It is quite another to become involved in inter-ministerial collaborations, especially when they are directed by authorities outside the ministry. But modern science and technology normally requires new combinations of talents and resources that, in the vertical Stalinist structure, are resident in different research institutions and production ministries. The departmental barriers profoundly impede such coordination.

With its incentives against innovation, those in favor of quantity at the expense of quality, and its lofty departmental barriers, the Stalinist system is intrinsically hostile to innovation. That such a system should lag in implementing the results of science is hardly surprising.

V. The Gorbachev Reforms

Mikhail Gorbachev & Co. came to power with the aim of rejuvenating the Soviet economy and society. Along with greater openness (glasnost’) and restructuring (perestroika) came a drive to intensify the economy, and to harness science and technology far better than in the past. Immediately upon his ascent to power, Gorbachev opened discussions with leading scientists about ways to make Soviet science more responsive to society’s needs. A series of policy changes have ensued; personnel shifts, altered patterns of resource allocation, organizational changes, and limited structural reforms have all found their places in a medley of measures. Each deserves some comment.

A. A Reorientation of Priorities

Detailed budgetary data on the direction of Soviet scientific investments are not yet published and the sketchiness of available information makes it difficult to see where the Soviet leaders are actually placing their bets. Judging by the statements of political and scientific leaders, however, it appears that investments in many basic and applied fields of academic sciences are being increased. Among the favored fields are materials sciences, the information sciences and technologies, biotechnology, and manufacturing technology (especially machine-building). Academic science and the vuzy now appear to be receiving greater resource allocations, presumably at the expense of sectoral science.

B. Toward the Intensification of Production

The true meaning of intensifikatsia as currently understood by the Soviet leadership can be taken as, "work smarter." It is supposed to mean the introduction of a higher level of technology broadly across Soviet industry. The nation’s capital stock is to be largely replaced with newer and better machinery. Soviet science, in particular, hopes to be re-equipped with modern equipment, instruments, and computers. The Gorbachev leadership intends the machine-building sector to be the jewel in the crown of intensifikatsia.
C. Personnel Changes in Soviet Science

The most prominent shift among the Soviet scientific elite has been the 1986 appointment of Guri Marchuk to the presidency of the Academy of Sciences of the USSR. Academician Marchuk made his name first as a geophysist then a computer scientist before shifting into scientific administration. He is the former Chairman of the Presidium of the Siberian Section of the USSR Academy of Sciences in Novosibirsk, and until his most recent appointment, was the Chairman of the State Council for Science and Technology.

By appointing Marchuk to the Academy’s top job, the Kremlin leadership passed over academicians Evgenii Velikov and Boris Paton, both rumored contenders for the job. It is tempting to conjecture about the reasons for preferring Marchuk over the others but that would serve little purpose here. More significant is the fact that Marchuk’s appointment signifies an intensification of the party leadership’s desire to see the Academy take a more active role in applied science and technology.

Marchuk is a man who built his reputation by forging collaborative combinations of institutions and individuals for the service of Soviet science. On his watch in Novosibirsk, he worked to build bridges between science and industry by promoting the formation of problem-oriented collections of scientists and engineers to focus on specific development and implementation tasks. Later, at the State Committee for Science and Technology, Marchuk was charged with the task of trying to coordinate the efforts of disparate ministries and institutes. Now, at the Academy of Sciences, he is again attempting to overcome institutional barriers to inter-sectoral cooperation in science and technology.

D. Organizational and Administrative Changes in Soviet Science

Recent years have brought several significant organizational changes in Soviet science and technology, some of them predating Gorbachev’s ascent to power. Many new institutes have been created in the academies of sciences to pursue top priority research objectives. Various higher level academic coordinating bodies have been struck to further intra- and inter-academy cooperation.

Outside and above (?) the Academy of Sciences, the Gorbachev regime has created more than twenty inter-sectoral scientific and technical complexes (MNTKs) to ramrod research, development, and implementation in various high-priority areas. Among the MNTKs are the following:

- Mikrokhirurgia glaza for optical surgery.
- Rotor for rotary conveyor lines.
- E. O. Paton for electric welding.
- Tekhnologicheskie lasery for lasers.
- Biogen for biotechnology.
- Personal’nye EVM for personal computers.
- Nadezhnost’ mashin for machinery reliability.
• Termosintez for thermal synthesis.
• Nefteotdacha for petroleum extraction.
• Robot for robotics.

The MNTKs are intended to be horizontal coordinating bodies capable of bringing together scientists, engineers, and producers from various institutes, ministries, enterprises, etc. They attempt to introduce elements of a "matrix" form of organization to overcome the vertical proclivities and parochialisms so characteristic of traditional Soviet organizations. Evidence of the greater prominence given to the Academy of Science in promoting applied science has been the designation of various academic institutes as the senior institutions of many of the MNTKs.

Among other significant organizational steps recently taken at the Academy of Sciences have been its rejuvenation by the election of many new and younger academicians, the creation of new regional departments of the Academy in the Urals and Far East, the imposition of age ceilings on academic leadership positions, and restructuring of the method by which junior (at least) administrative positions are filled.

E. Attempts to Emulate Entrepreneurial Initiative and Innovation

The fact that the United States owes much of its technological dynamism to entrepreneurial companies is no secret to the Soviets. They recognize also that their traditional institutional structure contains no such dynamic counterpart. Among the policy initiatives of the Gorbachev era have been several designed to obtain the benefits of entrepreneurship without having entrepreneurs.

For example, they have experimented with "temporary scientific-production collectives" that pull scientists and engineers from various institutions and set them to work as task forces on particular projects. A case in point would be the "Start" group in Novosibirsk that has worked for several years to design and produce a Soviet super-computer. Closer to the entrepreneurial model are the few cooperatives that have recently been formed to provide engineering and cooperative services.

F. Management Reform

Perestroika has brought a tentative form of financial and managerial autonomy to many Soviet research institutes and production enterprises. Since the beginning of 1988, those enterprises are instructed to be self-financing, to cover all their costs with their revenues. They are also expected to accumulate sufficient surplus to replace their depreciated capital and to finance a larger share of their future investments. The intent of these reforms is to make Soviet enterprises more responsive and accountable to their customers.

Another aspect of managerial reform is supposed to be greater decision-making autonomy at the enterprise level. Enterprises and research institutions are supposed to be freed from the petty tutelage of ministries and other higher-
standing bodies. Gorbachev seeks the fruits of decentralization, of greater initiative and accountability. It remains to be seen how far the decentralization process will be allowed to go.

To the extent that they are actually allowed to take effect, the reforms will significantly impact Soviet science on both the supply and demand sides. On the supply side, they are calculated to force much-needed discipline on research institutions grown complacent by years of more-or-less guaranteed budgets. Many applied research institutes, especially those of "sectoral science" are expected to become financially self-sustaining. They are to supply contract research and development services to other enterprises who are to pay for the services received. They are to move off the state and ministerial budgets and to pay their bills from the fees that they earn. To the extent that the new provisions are enforced, they will administer an icy shower to institutions long accustomed to the cozy warmth of budgetary financing.

On the demand side, the buyers of applied science are likely to become much more demanding of their contractual partners. If the reform works, they will think carefully and bargain hard before contracting for research services. They will also have an incentive to more carefully examine the quality and quantity of services received. A few Soviet research institutions are likely to be sole suppliers of specialized services and will be tempted to taste the forbidden fruit of monopoly rent. Most will have to hustle.

VI. What Prognosis for the Gorbachev Changes?

The outlook for Soviet science and technology is mixed. Unfortunately for Mr. Gorbachev, the most serious ills of the patient arise from attributes inherent in the economic system that he inherited. Soviet society cannot become technologically dynamic until the Stalinist structure is dismantled and replaced with a market-driven system. So far, only the first and most halting steps have been taken in that direction.

The organizational changes introduced since 1985 are reasonable but insufficient to force Soviet science and industry into a high-tech union. Whereas a more sophisticated and "intensified" economy requires a broader technological base, the vertical structure of Soviet industry, with its powerful ministries and their vested interests, remains a stubborn roadblock along the path toward a flexible and dynamic economy. The institutions, such as the MNTK, that have been created to deal with inter-organizational barriers, generally lack teeth. Few have either the resources or the mandate to do the jobs assigned them. Their responsibilities dwarf their powers.

Perestroika, if it persists long enough to achieve a genuine and lasting devolution of responsibility and autonomy to the enterprise level, should eventually enhance the ability of the Soviet system to absorb modern technology. But as industrial managers adjust to the emerging realities and uncertainties of reform, it is not obvious that in the short run they will become more tolerant of risk and receptive to innovation. Just the opposite may, in fact, occur.
The reorientation and refocussing of official priorities that is occurring under Gorbachev seem likely to be salubrious. Important segments of Soviet science and technology, ignored or allowed to languish in the later Brezhnev years, should experience generation or regeneration. Similarly, the rejuvenation of academic cadres seems a good thing to do. 'Glasnost' and recent attempts to open the windows of Soviet science to foreign breezes, to the extent that they continue, should exercise a stimulating and cleansing effect.

VII. What Implications do these Changes Hold for U.S.-Soviet Relations?

Most of the significant changes in Soviet science and technology initiated under Mikhail Gorbachev are targeted domestically. The current Soviet leadership, perhaps unlike that of the Brezhnev era, understands that lasting improvement cannot be imported. The ills of Soviet science and technology have domestic causes and must have domestic cures. Foreign capital, technology, and management can play a contributing role but the main job can only be done by the home folks.

So severe are the problems of the Soviet economy and society that many years will be required to set them right even under the best of circumstances. If he is to grapple effectively with those problems, Gorbachev needs a protracted period of international calm. He must dismantle the walls that isolate Soviet scientists, engineers, and managers from the world outside. He needs the discipline of world markets to induce greater efficiency at home. In short, he needs to open up the USSR to the world to avoid slipping farther backwards.

Some observers fear an abrupt and dangerous conservative reaction to the Gorbachev changes. That can hardly be excluded as a possibility, but I think it improbable. The Stalinist stratagem of focussing domestic attention on a putative foreign threat would be counter productive because a reimposition of the Stalinist garrison state with its command economy would be a guarantor of perpetual Soviet backwardness. That perception of reality is, I believe, widely if not uniformly shared among the Soviet elite. It is a perception that strongly militates against a conservative backlash.

VIII. How Should the United States Respond?

We should respond calmly. We should constantly try to understand what is happening behind the Iron Curtain. We should try to understand our own true interests and be guided by them. We should speak softly and carry a big stick. We should be wary of worst case and best case assumptions and scenarios. We should fear less the unanswerable questions about the Soviet Union than the unquestionable answers.

The Gorbachev changes in Soviet science and technology belong to a set of broader and more profound changes being attempted in the Soviet economy and society. The odds against success are considerable, especially in the short
run. But failure is hardly preordained. Gorbachev will have succeeded if he proves able to have initiated a **process of change** that maintains its direction and gathers strength as it moves. So far, the direction is toward greater openness, more truthfulness, less official arbitrariness and deceit, greater pragmatism and less dogmatism, more autonomy for individuals and enterprises, and greater freedom of thought and expression. That much ground remains to be traveled is quite clear and the journey may take a generation or more. But that Soviet society will benefit from continued movement in this direction is beyond doubt. That such movement is also in our interests seems also quite obvious.

Full realization of the Gorbachev reforms, however long that might take, would mean a freer but richer and more powerful Soviet Union. Should we fear that? Will a richer Russia be a friendlier one? The truth is that no one can say for sure. But Russian cannot become rich without greater economic democracy and, if history is any guide, that is likely to involve greater political democracy as well. Time is on the side of democracy.

We should keep our powder dry but take cheer because, despite all the bad news on the evening news, the tide of events is running in the right direction.

**END NOTES**

1. In most fields of science, the Soviet *kandidat* degree is roughly comparable to the American doctoral degree. The Soviet doctorate, being a more advanced degree than the American doctorate, has no counterpart in this country.


3. Although Lysenko was associated primarily with the Institute of Agricultural Sciences, his deleterious influence was felt throughout Soviet science. The centralized structure made opposition to him and his acolytes a risky and costly venture.

4. It is worth mentioning a few of the exceptions to this harsh generalization. They would include the universities of Moscow, Leningrad, Riga, Novosibirsk, Kiev, and some other republican capitals. Very few beyond that circle deserve praise for the quality of their research.

5. That would leave only some hair and a few fleas for the *vuzy* in this canine metaphor.