TITLE: SCIENCE IN CRISIS: Science Policy in Russia and the Ukraine after the August Coup

AUTHOR: Paul R. Josephson

CONTRACTOR: Sarah Lawrence College

PRINCIPAL INVESTIGATOR: Paul R. Josephson

COUNCIL CONTRACT NUMBER: 806-22

DATE: March 23, 1992

The work leading to this report was supported by contract funds provided by the National Council for Soviet and East European Research. The analysis and interpretations contained in the report are those of the author.
COPYRIGHT INFORMATION

Individual researchers retain the copyright on work products derived from research funded by Council Contract. The Council and the U.S. Government have the right to duplicate written reports and other materials submitted under Council Contract and to distribute such copies within the Council and U.S. Government for their own use, and to draw upon such reports and materials for their own studies; but the Council and U.S. Government do not have the right to distribute, or make such reports and materials available, outside the Council or U.S. Government without the written consent of the authors, except as may be required under the provisions of the Freedom of Information Act 5 U.S.C. 552, or other applicable law.
Science in Crisis: Science Policy
in Russia and the Ukraine After the August Coup

Paul R. Josephson
Sarah Lawrence College
Bronxville, NY 10708

SUMMARY

Russian and Ukrainian science face an uncertain future, owing to the rapid dissolution of the Soviet empire and the resulting political and economic crises. The scientific research and development community is increasingly isolated domestically and internationally. This isolation is the product of rampant inflation; aging of machinery and equipment; shortages of hard currency which preclude purchasing western scientific journals, reagents, and supplies; difficulties publishing Russian journals; and brain drain which is siphoning off top scientists in many fields. The governments of Russia and Ukraine have yet to develop systematic policies. There are uncertainties involved in cooperation with scientists in the volatile world of the Commonwealth of Independent States (CIS). Gone are many of the bureaucracies which had authority for policy making. In their place are organizations whose responsibilities are only now being defined.

Western governments, scientists, and their academic institutions should nonetheless assist the scientific community in the CIS to live through the current crisis. Science is an international activity, and scientists and engineers from the CIS will make significant contributions to it with benefit to all societies. The cost of the effort initially will be relatively small, limited primarily to fellowships, grants, equipment repair, and publication subvention in basic research, but all of the costs will have to be assumed by the west. In the short term, bilateral and multilateral agreements between academies of science and other relevant organizations should be extended. In some cases CIS researchers should be given greater access to western grant competitions. The commitment of the governments of CIS to reform, the low cost of CIS scientific labor and know-how, and the promise of high quality scientific research suggest that the benefits of cooperation outweigh the costs.

Support for applied R and D and big ticket technology items should come from the private sector.

Plans to establish "clearing houses" for personnel from the military industrial complex are premature, costly, and ineffective. Since the CIS has opened its borders and its scientists freely travel abroad it is impossible to prevent the flow of military "know-how." Control of the transfer of critical technologies, on the other hand, should be the goal of western governments with the assistance of Russia and Ukraine. It would be far more appropriate, and more effective, for the U. S. government to use diplomatic and economic pressure to prevent such nations as China and Germany from continuing to sell technologies which have allowed third world have-nots to develop chemical and nuclear capability.
Gorbachev set in motion reforms which led to the dissolution of the Soviet empire. The reforms had both direct and indirect impact upon the scientific research and development apparatus in terms of administration, structure, and funding. During the early period of the Gorbachev era, reforms were directed at democratization of the scientific research and development. The reforms were intended to return control of R and D to the scientist; speed up the retirement of scientific bureaucrats; remove barriers to the start-up of new fields; apply innovative approaches to funding basic research; engender competition among scientific centers in order to overcome institutional inertia which plagued science. On the international front, the reforms of the Gorbachev era aimed to open contacts with the west, especially in fields of "big science" where the cost is high, and in so-called "sunrise" industries where the Soviet Union must develop rapidly in order to enter the 21st century.

Unfortunately, reforms in the name of decentralization and competition within the scientific establishment caused dislocation before August 1991. The events after the failed August coup have created a crisis. It is a crisis, furthermore, which is entirely too reminiscent of that which threatened Russian science after the 1917 Revolution. The scientific community is increasingly isolated domestically and internationally. This isolation is the product of rampant inflation; aging of machinery and equipment; shortages of hard currency which preclude purchasing western scientific journals, reagents, and supplies; difficulties publishing Russian journals; and brain drain which is siphoning off top scientists in many fields. A vice president of the Ukrainian Academy of Science described the situation as "total collapse" compounded by the lack of science policy.
For a host of reasons, western governments, scientists, and their academic institutions should assist the scientific community in the Commonwealth of Independent States (CIS) to live through the current crisis. Science is an international activity, and scientists and engineers from the CIS will make significant contributions to it with benefit to all societies. The cost of the effort initially will be relatively small, limited primarily to fellowships, grants, equipment repair, and publication subvention in basic research. In the short term, bilateral and multilateral agreements between academies of science and other relevant organizations should be extended. In some cases CIS researchers should be given greater access to western grant competitions.

While the cost of cooperation initially will be small, Western scientists and their governments will have to foot the bill for most endeavors. The commitment of the governments of CIS to reform, the low cost of CIS scientific labor and know-how, and the promise of high quality scientific research suggest that the benefits of cooperation outweigh the costs.

Support for applied R and D and big ticket technology items should come from the private sector. Plans to establish "clearing houses" for personnel from the military industrial complex (MIC) are premature, costly, and ineffective. Support for fundamental research, on the other hand, will provide positions for highly qualified engineers and scientists from the MIC.

There are uncertainties involved in cooperation with scientists in the volatile world of the CIS. Gone are many of the bureaucracies which had authority for policy making. In their place are organizations whose responsibilities are only now being defined. Most
scientists and officials believe that science policy must more closely resemble western approaches, with market mechanisms playing an important role. But all too often, they see the market as a panacea without full understanding of the dangers that rapid economic change poses for science. Western aid will provide a "safety net" for fundamental research in the CIS.

Gone also are the Communist Party and the conservative institutional momentum that characterized science policy under its direction. Surprisingly, in the short term this has had a negative impact on research. Until its last days, the Party played a central role in trouble-shooting in areas of equipment supply, access to current literature, and so on. The usual discomforts of scientific research in the Soviet Union have become worse in the CIS: travel delays, missed appointments, difficulties purchasing tickets, booking hotel rooms, and getting food consume even more time than before. Without the Party as an expediter, scientists find themselves subject to the same gross inefficiencies that long handicapped other sectors of the Soviet economy.

The Historical Legacy and the Gorbachev Reforms

The R and D system that evolved under Stalin, Khrushchev and Brezhnev was overly-centralized, administratively top-heavy, inefficient, and internationally isolated. It was capable of focusing resources in "campaigns" on the development of large-scale technologies, but impeded small-scale, high quality research in such new fields as fiber optics, biotechnology and computers. Entire fields -- genetics, plate tectonics, and lasers -- were dominated by a few individuals or an institute, often with disastrous results. In a
number of areas where the Soviets were pioneers — tokamak fusion reactors and space, for example — scientists rarely maintained a lead. An emphasis on applied science inhibited the development of new fields of fundamental research. Reforms which were intended to improve the productivity of scientific research and speed innovation in the economy failed to produce desired results.

Many of these problems were the result of political interference in research based on a distinction between socialist and capitalist science drawn during the Stalin years. This led to autarky in Soviet science. During the Khrushchev and Brezhnev years scientists succeeded somewhat in dismantling the Stalinist system, although significant bureaucratic and ideological impediments plagued their performance. Party and intelligence organizations maintained vigilant scrutiny of western journals and scientists, significantly retarded the flow of information, and restricted travel of Soviet scholars to the West.

As a result of the Gorbachev reforms, in a significant change in world view, ideological pronouncements about the superiority of Soviet science have disappeared. Officials and scientists recognize that a separate "Russian" or "Ukrainian" science cannot exist. The need to participate in the international arena through individual, institutional, and bilateral agreements is the guiding principle.

Democratization of administration led to the proliferation of official and private organizations which play a role in science policy. The outlawing of the Party in the aftermath of the August coup helped complete this process of democratization in scientific institutions. In the past prestigious "bosses" made most decisions behind closed doors. They dominated institute life on the basis of personal connections. Higher academy and party
organs appointed institute and laboratory directors according to approved lists (the nomen-
klatura). Too often conservative administrators came to dominate entire fields of research. Independent experts were seldom consulted. Now laboratory directors are elected, as are most institute directors with pro forma approval by the Academy presidium. Entrenched bureaucrats have been removed through accelerated retirement.

Decentralization of power structures accompanied democratization. In the Soviet Union R and D was divided among the Academy of Sciences, where most fundamental research was performed; industrial ministries where the bulk of applied research occurs; and the universities and other higher educational institutions with training functions. The State Committee for Science and Technology (GKNT), an agency whose power and influence exceeded its budget and staff size, attempted to coordinate the national R and D.

GKNT has merged with the Ministry of Higher Education and several other bureaucracies in the newly formed Ministry of Science, Higher Education and Technology of Russia. The once powerful USSR Academy of Sciences, whose policies shaped the face of fundamental research for the entire empire, has given way to the Russian Academy of Sciences. The academies of the other states of the CIS have been left to determine their own policies. For historical and economic reasons close cooperation between the academies of sciences will continue.

A new Russian Academy of Sciences (RAN) was created in December 1991. It is the result of the unification of the Soviet Academy of Sciences, the most important scientific institution in Russia by virtue of its history, tradition, number and excellence of institutions and members, and a newly created Academy of Sciences of the RSFSR. The members of
the Academy of the RSFSR included academicians from the Soviet Academy disenchanted with the fact that all other republics had academies, but not Russia; Russian nationalists, similarly disaffected, including supporters in the Russian parliament; and scientists who failed to be elected for membership in the Soviet Academy. The new academy and the old united as the RAN. By presidential decree the RAN has acquired complete legal standing and property rights.

The former president of the Academy, G. I. Marchuk, voiced serious concerns about the reform of the academy. He feared the destruction of healthy "fraternal" ties with other academies of the CIS. New bilateral and multilateral agreements will have to be worked out with the framework of international cooperation of sovereign states. Marchuk's detractors point out that this means only that no longer will Moscow be able to call upon academies of the union republics to work for Russia. Marchuk was also concerned that market mechanisms would destroy fundamental research. Like most Russian and Ukrainian researchers, he believes that the government has the responsibility to fund fundamental research, perhaps in entirety. Finally, Marchuk criticized the notion that there could be democracy in science since "scientific truth" is not subject to majority vote. He urged the academy to avoid radical transformation in a time of political and economic uncertainty.

Marchuk's call seems to have been heard. Most of the vice presidents of the Soviet Academy have been retained. The physical sciences continue to dominate policy making in the presidium at a time when Russia's most pressing scientific problems are in the biological and ecological sciences. Some observers believe that the RAN has yet to become a fully democratic institution since full voting rights are reserved for full members of the Academy.
It remains to be seen if a charter commission will recommend later this year a reform of the charter. Still, the RAN provides its scientists and institutions with more equitable access to resources, including travel abroad, and rule by fiat which characterized administration in the past has come to an end.

The new president, Iu. S. Osipov, a specialist in applied mathematics and mechanics, is somewhat more open to reform than Marchuk. He shares concern about rapid change. In spite of his support for the creation of RAN, Osipov regrets the demise of the Soviet Academy. He has adopted a low profile to preserving and developing fundamental research, so it is too early to predict what his signature on policies will be. Existing bilateral and multilateral agreements should be maintained in the meantime to ensure access to RAN.

In addition to reform of the Academy, the decentralization of science policy has led to the creation of a host of scientific organizations. This is symptomatic of the rise of independent expertise. For the first time since the 1920s, a large number of professional societies has come into existence, including six new academies in such areas as engineering and the humanities, and tens of scientific societies which represent fields from nuclear physics to biology to sociology. These professional organizations are trying to seize initiative in the areas of policy making through the creation of independent groups of experts, fund-raising, and defense of professional interests of their members.

The intractable problems of ecological disaster, economic downturn, and political uncertainty require the input of advice from individuals with specialized knowledge. However, discussion among professional and government organizations of such issues as the nature of scientific uncertainty, the role of such analytic tools as cost-benefit analysis, and
how best to institutionalize scientific advice remains on a rudimentary level. Western professional societies could encourage the shifting of authority from higher government bodies to the institute and scientific society through the establishment of contact with these organizations.

The Current Structure of the R and D Apparatus

In Russia, the Ministry of Science, Higher Education, and Technology Policy has taken on many of the functions and personnel of its predecessors. Perhaps seventy to eighty percent of the personnel of GKNT, the Ministry of Higher Education of the USSR, the State Committee on Education of the RSFSR, the Higher Attestation Commission (VAK), and the State Patent Committee have been retained. The new ministry thus is somewhat streamlined in terms of personnel.

VAK certifies degrees and ensures compliance with national standards in curriculum and qualifications in higher educational institutions. VAK was notorious for discriminatory policies against national minorities and political dissidents. The unwillingness to dispense with VAK and free universities from governmental control or financing too rapidly indicates that reforms in higher education will be harder to win than in fundamental research, and that the historical disjunction between higher education and science will persist for some time.

The structure and policies of the ministry of science are in flux. The minister of science, Boris Georgievich Saltykov, a specialist in science policy and an economist by training, is trying to hammer out policies in consultation with his staff, the Russian President, Boris El'tsin, the Russian Parliament, and the council of presidents of the CIS.
Except for brief comments which reveal his interest in the health of fundamental research and ways to improve industrial R and D, El’tsin has not made his policies toward S and T known.

Saltykov meanwhile hopes that market forces will play a major role in science policy. He assumes that this will give freedom of action both to those in search of funding and to potential philanthropists and investors, including Russia’s new industrialists and millionaires, and foreign sponsors. The Russian government will support fundamental research through advantageous tax laws, the creation of a small "NSF," and by willingly accepting humanitarian aid from the west. The NSF, for example, already provides funding but is limited by law to financing research conducted with American researchers as principal investigators. By such a path, through a new NSF US-USSR cooperative program, CIS researchers have successfully competed for nearly $1 million. Congressman George Brown (D-CA) has proposed creating a $200 million endowment to support fundamental science.

Saltykov is an internationalist, recognizing that Russia cannot be the leader in all fields, but ought to be part of the international arena. He encourages individual scholars to use their contacts to secure western aid. He does not fear "brain drain," but sees an unavoidable process at work. "It is better to work somewhere than nowhere at all," he said. "Let them go abroad." While many criticize privatization of state property and the formation of small profit-making firms, Saltykov sees them as serving the useful functions of speeding up innovation, supporting scientific researchers at a time when academy institutes are strapped for funds, and accelerating the closing of economically unviable research institutes.

In the Ukraine similar reforms are being applied. In January 1992, the Ukrainian
parliament passed an as yet unpublished law on science and technology policy. From discussions with Ukrainian officials, its outlines are clear. To supplement contract research, the government support will create a fund for basic science, a discretionary fund for applied science, and a special innovation fund derived from a value-added tax. Tax credits and incentives similar to those suggested in the U. S. under the heading of industrial policies will also be employed. But as in Russia, so in the Ukraine deficits, inflation, declining production, and brain drain all hamper efforts to revitalize science. One official lamented the inability of the government to raise levels of financing for fundamental research. The impact on basic science has been substantial: the attraction of the best young talent abroad, but more significant to private enterprises within Russia and the Ukraine which pay higher salaries.

For Ukrainian scientists and policy makers internationalization of science is also a major goal. The president of the Ukrainian Academy of Sciences, E. O. Paton, supports continued long-term cooperative research with other states of the CIS, in particular Russia. This is vitally important for the Ukraine. In the past roughly sixty percent of the research effort of the Ukrainian Academy was on topics of national, all-union significance, accordingly with sixty percent of financing from the Soviet government. The disappearance of these funds has created a significant financial shortfall. Some officials estimate that between 1990 and 1992 the level of funding for Ukrainian science had to increase ten-fold merely to meet inflation. At the time of the writing of this article, the budget had not been fixed, but clearly had not kept pace with inflation and shortfall.

In general, throughout the CIS there is agreement that the science policies of the
member states should complement each other. An agreement to that effect has been signed on the level of ministries, not by heads of state, and it remains to be seen how the former republican academies and ministries cooperate.

Fundamental Research

Owing to a tradition of achievement, especially in the theoretical sciences, it is in the area of fundamental research that western partners stand the most to gain from cooperative ventures with the CIS. The economic crisis which has gripped those countries makes the infusion of western support critical. Decentralization of funding naturally has accompanied the reforms. As noted earlier, several new kinds of funding from the state budgets, contract research, scientific foundations, and western sources are available. But blurred lines of authority, inadequate reserves of hard currency, and rampant inflation make the financial picture of fundamental science in Russia and the Ukraine bleak.

The budget of the Russian Ministry of Science for 1992 is 78 billion rubles. This amount compares with 22.3 billion rubles and 4.8% of national budget in 1980, 28.6 billion and 5.0% in 1985, and 43.6 billion rubles and 6.6% in 1989. The budget is indexed, but inflation, which may exceed one thousand percent this year, will outstrip indexing. This will leave researchers and their institutes in significantly worse shape by the end of the year.

The RAN receives 10.5 billion from the ministry's budget. Its institutes and scientists compete with all other research institutes of Russia for another 1.7 - 2 billion rubles earmarked for grants. Contracts with the public and private sector also provide welcome income. Recently, the government decided to form another fund for science based on a
1.5% value-added tax on production which will generate an additional two billion rubles for
the ministry’s discretionary programs.

But these funds are wholly inadequate. Many institutes have laid off or fired
workers. Most have gone several months without paying salaries. The directors of several
institutes told me that they had to raise thirty, forty, fifty, even sixty million rubles extra
last year merely to hold the line steady against inflation. Billions of rubles and tens of
millions of dollars are needed.

The ongoing discussions in government and scientific circles about the establishment
of a national fund for fundamental research are reminiscent of the debates in the United
States regarding the formation of the National Science Foundation after World War II. First,
there is some concern about who will sit on panels. Will the “best” scholars in Moscow, St.
Petersburg, Akademgorodok, their institutions and students always dominate at the expense
of provincial science? How can geographic distribution of funds be assured? Second, some
fear science will remain conservative, dominated by traditional approaches, with panels
hesitating to support novel research which might lead to breakthroughs. Third, what is the
appropriate level of funding? Many scientists believe the government has turned its back on
science during the ongoing crisis. They see the United States, where funds for education,
medical research, science, and environmental law enforcement are cut during recessionary
periods, as a telling example of what to anticipate. Still others are concerned by the fact that
seventy years of Soviet socialism have left researchers unaccustomed to competition and
unable to write grants. How will they react to grant competitions?

The Ministry of Science has begun to compile a data base of scientific personnel who
would serve on panels and work as staff members of foundations. But it would not hurt to
learn from the American experience. Through Fulbright lectureships, IREX, NSF, and
National Academy of Sciences programs more American specialists in science policy ought
to be encouraged to share their expertise with their CIS colleagues.

A more significant problem is the shortage of hard currency. Before Gorbachev,
academies of science and military organizations had easy access to hard currency for
machinery, equipment, publications, and travel abroad. Now hard currency is available only
at the market rate (currently one hundred ten rubles per dollar). Foreign travel has nearly
ceased for scientists unless their western counterparts pay. Tickets cost between sixty and
one-hundred thousand rubles and $500 depending upon the mood of Aeroflot. With average
monthly salaries around 1,000 rubles, it is clear that few institutes --- and fewer researchers
-- can afford tickets. The result of the financial crisis is the international and domestic
isolation of science.

Contributing to domestic isolation are paper and typographic costs so high that
journals are published with great delay, and several face extinction. Leading scientific book
publishers have fallen on hard times. The hard currency shortfall nearly precludes the
purchase of foreign subscriptions. Several western publishing houses which produce Soviet
periodicals in translation have moved toward simultaneous English-Russian publication to
ease this problem. The royalties from translations serve as a vital source of hard currency.
Russian scientists have appealed directly to the west for donations for publications. Russian
and Ukrainian scientists who serve on the editorial boards of western journals often give their
subscriptions to their institutes.
Other scholars are building on contacts with the west to generate hard currency. For example, Academician A. N. Skrinskii of the Institute of Nuclear Physics in Akademgorodok and L. B. Okun' of the Institute of Experimental and Theoretical Physics in Moscow and their research teams are working closely with scientists of the Superconducting Super Collider in Texas. Scholars at CERN have discussed providing tens of millions of dollars for their CIS colleagues.

Applied and Industrial Research and Development

In the short-term, because of historical and economic reasons, branch, or industrial R and D is in worse shape than basic research. It also lacks the prestige and vocal clientele of fundamental science. This has great significance for the economic health of the CIS. If those countries are to compete in international markets -- let alone domestic markets -- with foreign goods, industry will have to modernize. It is hoped that a changeover to economic incentives will trigger investment in new technology. But in a time of budget shortfalls and rampant inflation, investment in new capital and technology is last on the list of most enterprises.

The lag in investment in modern technology is an historical problem. Each ministry had a fund for science and technology, but the amounts were small and there were barriers to its efficient use. Once capital was in place, the goal of managers, planners, and government and party officials was the fulfillment of the plan. The emphasis on short-term rather than long-term goals and the absence of competition discouraged investment in new processes and technologies. Emphasis on the development of military technologies also limited funds for
industrial R and D. In a number of cases, according to extensive documentary evidence, ministerial and military officials actively opposed innovation in favor of theft of technology or reverse engineering, for example in computers.

As a first step toward reform, in 1990 line items for industrial R and D were eliminated from ministerial budgets, with the hope that economic incentives to modernize and contract research from a variety of sources -- private, public, and ministerial -- would soon replace those funds. But the elimination of all Soviet ministries, the painful, step-by-step establishment of new ones, the economic downturn, and the budget crunch have left enterprises understandably showing little interest in R and D. In addition, the weakness of "consumer demand" discourages investment in industrial research.

A possible solution is the creation of an industrial policy with targeted areas, both so-called sunrise industries at the cutting edge of modern technology, and expensive, large-scale technologies of high financial risk but great potential benefit to society such as ecologically clean power stations.

The private sector has not been dormant in R and D. New organizational forms are critical in such sunrise industries as biotechnology, computers, lasers, high temperature superconductivity, and fiber optics where the USSR lags far behind the US, Western Europe and Japan. The MNTK (interbranch regional scientific-technical association), which usually consists of an academy institute at the head with ministerial and branch laboratories and design bureaus under its jurisdiction, is one approach. Like artificial intelligence and biotechnology firms which have arisen around universities throughout the United States, the MNTKs are supposed to help bridge the gap between scientific advances and the production
process, and are intended to be attractive to venture capitalists and government alike. To date, owing to reliance on organizational remnants of the Soviet system and persistent bureaucratic impediments to performance, the MNTK has not lived up to its promise.

The rapidly growing number of scientific cooperatives and independent research enterprises suggest that they are the most promising alternative to centralized, state funding of R and D. Usually cooperatives are small scale. Their numbers have been estimated in the thousands. They are widespread in Moscow, St. Petersburg, Novosibirsk, and elsewhere. They have been created for such areas of research as instrument building, catalysts, medicine, biotechnology, artificial intelligence, and superconducting films.

There is great risk associated with investment and cooperation with MNTKs and cooperatives. Tax and investment laws are in a state of flux. Many entrepreneurs and enterprise directors are inexperienced. And most western investors prefer joint ventures with firms engaged in extraction of raw materials to those involved in manufacture of finished products or R and D.

**The Conversion of Military R and D**

Conversion of military R and D to civilian tasks is a daunting problem. In the past, military R and D attracted the best resources and personnel with salaries and equipment much better than average. This is not to say that the best personnel always worked in the military sector, since scientists preferred the prestige of the Academy to the largesse of the military. However, just as in the United States where universities generate millions of dollars in contracts with defense agencies, so academy institutes relied heavily on military financing
to keep other fundamental research programs afloat.

According to officials in the Ministry of Science, until recently roughly half of expenditures on R and D went to the military. By way of comparison, in the U. S. at present around sixty percent of total government expenditures on science is for military R and D. Twenty-five percent of the current Russian science budget is for military purposes, with additional funds for conversion to civilian purposes. Many researchers from military institutes have already left this sector for other positions, both in scientific fields and in new businesses. This process demands continued attention since the El'tsin administration plans to close sixteen military research cities which employ a total well over one-hundred thousand scientists. Some military enterprises expect forty to fifty percent of their employees to be laid off this year, although the generally high qualifications of engineers will enable many to find jobs quickly.

There is great concern in the Russian and Ukrainian press that researchers from nuclear and bio-chemical sectors of the MIC will leave the country to the highest bidder, and assist have-nots in the third world to develop nuclear and chemical weapons. Of course, this is a real danger. The press campaign has convinced many in the west, in particular in the United States, to propose the creation of "clearing houses" to keep these specialists in Russia. Although in keeping with the American belief that it can control the spread of weaponry to its enemies, the establishment of clearing houses would be an expensive and unsuccessful enterprise.

A handful of specialists could provide the know-how to build such weapons. A clearing house cannot ensure that military scientists remain at home. Rather, the
internationalization of Soviet science and the embrace of market mechanisms guarantee that scientists with military know-how -- and not necessarily from the MIC -- will find employment abroad. The study of technology transfer has shown that such international regimes as the non-proliferation treaty and U. N. nuclear safeguards are far more effective in the control of critical technologies. Greater danger comes from the willingness of such countries as China to sell weapons and know-how.

Space and nuclear science in particular will fall on hard times as a result of conversion. A scathing four-part series on the costs and failures of the Soviet space program published in Izvestiia in mid-December will surely scotch efforts to resurrect funding in the short-term. For space, the most optimistic prognoses see funding in 1992 at twenty-five to thirty percent of the 1991 level. Clearly, this is inadequate to support researchers in hundreds of institutes and scientific-production associations. This explains the increasingly vocal efforts of Russian scientists to join with American in a Mars program. Recent management changes at NASA, costs estimated at tens of billions of dollars, and the scientific uncertainties of the Mars mission supported by the Bush administration suggest that policy-makers should be wary of embracing Russian overtures without complete prior agreement of the two parties on costs and contributions.

Some Russian officials are concerned that hasty privatization of the scientific cities of the military industrial complex will reveal secrets of great commercial value. Around Moscow alone there are ten scientific cities including Kaliningrad, Zelenograd, Khimki, Zhukovskii, Dubna, Chernogolovka, and Troitsk with international reputation for first rate R and D programs. Others argue that the unique equipment in the MIC is not designed for
serial production and cannot easily adjust to consumer demand. The cost of retooling is prohibitive. Still others argue that military enterprises, accustomed to access to goods and services outside of market mechanisms, will never compete efficiently in the production of civilian products.

The Eltsin administration should ease the pain of conversion with contracts with the MIC in areas of demonstrated technological superiority and immediate social benefit. In particular, the contracts should be directed to rebuild an aging and woefully inadequate infrastructure, for example telecommunications needed to enter twenty-first century markets. This kind of investment will accelerate conversion and fight unemployment at a cost significantly less than western firms.

Conclusions

The decision to allow economic factors to play a major role in science policy in the CIS is a decided break with the past. The danger is that scientists, research programs, or entire institutes of value to society may fall by the wayside. It is critical that there be a safety net. Western governments and scientists can help protect science through bilateral and multilateral agreements, grants and research contracts, and humanitarian aid. This support will ensure the health of the scientific community and overcome international and domestic isolation. Public resources should be limited to basic science. Support for industrial research and development should be left in the hands of the private sector. Underwriting conversion of military R and D to civilian purposes should be encouraged, but not through expensive and ineffective organizations such as clearing houses.
In all cases, cooperation will be made difficult by economic and political uncertainty which require a circumspect approach. But the danger of the loss of the scientific potential of the former Soviet Union also requires immediate action.

**Recommended Reading**

Harley D. Balzer, complete reference to be provided. Article in *Issues in Science and Technology* some years back.


Paul Josephson teaches in the Science, Technology, and Society Department at Sarah Lawrence College. He is the author of *Physics and Politics in Revolutionary Russia* (Los Angeles: University of California Press, 1991). Paul Josephson is at work on a history of Akademgorodok, and a study of postwar Soviet nuclear and high energy physics. He would like to thank the Office of Soviet and East European Affairs of the National Academy of Sciences, the Fulbright Hays Faculty Research Program, and IREX for supporting two recent trips to the USSR.

Home: 27 Bayview Road or RRC
Durham, NH 03824 Harvard University
603-868-1935 Cambridge, MA 02138

February 15, 1992