The reform of Russian science

Six years after the end of Communist rule in Russia, attempts to reform Russian science have produced a mixed scorecard. There have been some substantial achievements, but there is still need for further changes.

Boris G. Saltykov

When discussing the relationship between science and society, attention is often focused on the likely effect of the results of research and development on the style and quality of life, at both the national and international level. But of equal interest is the opposite question — how political and economic processes affect the potential of science and the ability of the scientific community to produce new knowledge and promote social progress.

It is from this angle that I will consider some results of a unique social and political experiment — the transformation of Soviet science between 1992 and 1996.

The inheritance

Science in the USSR was an integral part of the economy. The organizational pattern of research and development under Communism was based on the principles and mechanisms of the command-and-control economic system. This system had several characteristics: first, Soviet R&D was strongly militarized. Even as late as the Gorbachev era (the second half of the 1980s), military-oriented R&D spending accounted for about 75 per cent of the federal science budget (in contrast, it has never exceeded 60 per cent in the United States). Similarly, by all other measures, such as the number of researchers or the level of investment in equipment per worker, the resources concentrated in the military R&D sector were well above average.

Second, Soviet science was always kept extremely restricted, so contacts with the international scientific community were limited and strictly supervised. At the same time, many of the results of Soviet research were never made available to the public.

Both of these factors — which can be linked together under a more general principle of requiring both the country's economy and its research to be 'self-supporting' — inevitably led to the emergence of the concept of the need to maintain an 'overall research front'. In other words, the strategy was to carry out research in virtually all existing directions of international science.

The third factor that strongly influenced the effectiveness of Soviet science was its strictly departmental organization. Every research unit was affiliated to a particular ministry or agency — or to the Russian Academy of Sciences — which tightly controlled its research agenda, resources, relations with other economic bodies, and so on. This departmentalization, the dominant

Boris G. Saltykov was appointed Minister of Science and Technology Policy in President Boris Yeltsin's first government in November 1991, and held this position until August 1996. A physicist by training, he is currently director of the Russian House for International Scientific and Technological Cooperation in Moscow.

principle on which Soviet science was organized, led to the unnecessary duplication of research, inhibited flexibility in the allocation of resources, and eventually undermined the way these resources were used.

Under this system, the choice of research priorities was strongly influenced by the priorities (or administrative 'weights') of government ministries and agencies. Furthermore, scientific criteria — and even the very system of values in science — were often replaced in deciding on priorities by the values of the command-and-control system of administration. Managerial obedience and tolerance of the view of 'bosses' were valued more highly than freedom of creative work, and an administrative career, rather than one based on scholarly achievements, became the predominant characteristic of Soviet science.

Another feature of the system was the separation of basic and applied research from the sphere of education. Also, scientific resources tended to be concentrated in large research complexes, in some cases employing thousands of researchers and engineers:

Attempts to overcome the traditional bureaucratic attitudes of ministries and academies have frequently failed

there was a complete lack of smaller institutions. Because salaries in the sphere of intellectual work (as, indeed, throughout the economy) were extremely low, Soviet science developed in a labour-intensive and labour-excessive way. Finally, the Soviet R&D system possessed a feature unique for advanced industrialized economies — it was totally state owned. Everything that happened within Soviet science, including all results of intellectual activities, belonged to the state.

But it would be a serious mistake to concentrate only on the negative aspects of the Soviet pattern of managing science. The system had a logic of its own, and was tailored to meet the principles of the command-and-control economy. It permitted enormous intellectual and technical resources to be focused on selected fields of science and technology, and in this way contributed to impressive achievements in basic research and in military-oriented technologies.

Indeed, many still believe that the former Soviet system, which combined a reasonable degree of freedom in the choice of research topics with lack of any responsibility for the way in which public resources were spent, provided almost ideal conditions for carrying out basic research and development work. The intellectual and educational level of researchers was very high, and some excellent basic research was produced by a system which inevitably relied heavily upon the traditions of pre-revolutionary science in Russia.

But the drawbacks of that system are also obvious. It was wasteful of resources and excessively rigid, and so placed a heavy burden on the state budget. Inflexible planning and administration, as well as a lack of any incentive to reform professional activities, inhibited the movement of researchers between institutions. The system was only able to work smoothly by relying on a permanent influx of new researchers.

Indeed, studies have suggested that Soviet science achieved its most impressive results in the 1960s and 1970s, when the rate of recruitment to the scientific community was between 5 and 7 per cent per year. When the rate of recruitment started to fall in the early 1980s, eventually reaching almost zero, the effectiveness of the way that the system was organized fell dramatically, and Soviet science began to lag behind that in the West.

Perestroika paves way to reform

In the mid-1980s, at the beginning of the period known as *perestroika*, Soviet science was, at least when measured by quantitative factors such as the overall number of

researchers or the share of the gross domestic product devoted to research, comparable to that of the United States. After the collapse of the Soviet Union in 1991, and the subsequent formation of newly independent states, Russia inherited approximately half of the former Soviet Union's population, and a much greater share — between 65 and 70 per cent — of its science resources.

Taking into account only the more efficient parts of the research system, especially basic research and that carried out for military purposes, Russia's share of the Soviet scientific inheritance was even larger. When, at the end of 1991, the government headed by president Boris Yeltsin and prime minister Egor Gaidar came to power in Russia, and the decision was made to move to a market economy and create a democratic state, we faced the problem of drawing up an appropriate strategy for the reform of Russian science. As a result, the era of Soviet science, with all its merits and faults, came to an end in 1991.

It rapidly became clear that, as soon as the broad demilitarization of Russia's economy began, and the state gave up its responsibility for many types of activity — it stopped paying everyone out of public funds — much science would be left without funds and contracts. Under new economic conditions, and, initially, against the background of a severe economic crisis, the new Russian federal state (which is only one half of the former USSR) would be unable to preserve the whole of Soviet science on its previous scale.

Realistic goals

To cope with the inevitable shrinkage of Russian science, several principles were accepted as the basis of reform. Russia had to give up its commitment to maintaining an 'overall research front' and preserve only those lines of research where we possess world-class abilities. This meant a transition to selective science funding and a careful choice of priorities. It was also essential to secure legal and economic measures to ensure the freedom of scholarly work, as well as publicity for the development of science policy. We also intended to develop the idea that the openness of Russian science was an important principle of its functioning, and to promote its incorporation into the international scientific community.

Finally, one of the most important objectives of the reforms that we introduced was to create a new legal base for science, in particular new regulations concerning the protection of intellectual property rights. All these principles, as well as various other factors, were included in a special decree known as the 'Doctrine of the Development of Russia's Science', enacted by Yeltsin in June 1996.

As far as the creation of modern mechanisms for financing basic research is concerned, the main achievement in recent years has been the establishment of the Russian

Annual average employment in science and science services in Russia, 1985–96.

Foundation for Basic Research, followed by the Russian Foundation for Humanities. At present, 5 per cent of all federal spending on science should by law be distributed through these two foundations, although in practice the figure has been considerably lower.

The administrative patterns of both organizations have been based on that of the US National Science Foundation. Publicly-funded science and technology programmes proved to be an effective lever over scientific and technological priorities. Between 1992 and 1996, financial support was provided to about 40 research programmes in both fundamental and applied fields, ranging from particle physics, biotechnology and research into the human genome to new materials and technologies for processing and storage of foodstuffs.

Overall, the greatest emphasis was placed on the development of the life sciences. Between 1992 and 1994, the number of programmes supported by the Ministry of Science and Technology Policy increased considerably. Unfortunately, however, Russia's economic crisis and other difficulties resulted in a severe underfinancing in 1996, with the result that, by the end of the year, government-funded science and technology programmes had only received 25–30 per cent of the funds that had been promised.

Overall, the shift in science finance has been dramatic. In 1992, the first year of the reform, government spending on science, measured in constant prices, fell by about half, and it continued falling until 1994, when it reached a level of about 30 per cent of what it had been in 1991. In fact, the situation for most research groups was even worse, because the impact of the budgetary cuts was compounded by two other negative factors. One was the drying-up of orders from industry, with the result that government agencies

Russian science has had to give up its commitment to across-the-board strength, and adopt selective funding and clearer priorities

became virtually the only source of finance for research institutions. The second factor was an enormous escalation of the costs of electricity, heat, water and other utilities — which had previously been negligible — that followed the liberalization of prices in 1992.

One result of these various factors was that the average official salary for scientists dropped dramatically to about 65 per cent of the national average in 1992. Later, it grew slowly, and had reached 80 per cent of the national average in 1996. (In the years preceding the reforms, the average salary in science was 10 to 20 per cent higher than the national average.)

Unsurprisingly, this resulted in a significant internal brain drain out of research, with a substantial exodus of scientists and engineers towards new or modernized parts of the domestic economy such as commercial banks, financial and legal companies and the telecommunications industry, as well as general administration and management. Admittedly, this improved the prospects for those who stayed in research. And the brain drain was probably inevitable, since at the beginning of the post-Communist era science and education were the only sources of recruits for the new sectors of Russia's economy. But unfortunately those who left science were often the most energetic and highly motivated young researchers.

The most radical transformations of the Soviet R&D system were those that affected the so-called 'branch sector' of Russian science, where the reduction in the number of both employees and research institutions was substantial. Many institutes, design offices and prototype-engineering organizations were turned into privately-owned enterprises. While the overall number of these institutions decreased by 600, the number of research institutes in both the government and the academic sector grew from 586 in 1992 to 787 in 1995. But much of this was accounted for by the splitting up of large institutions into two, three or even more smaller ones.

A more objective measure is provided by figures for employment in science. By the beginning of 1996, the number of those employed in science and related services had fallen by 57 per cent from its level in 1991 (see graph above). The smallest reduction was in the academic sector — down 17 per cent.

This rapid transformation of the government's research activities made the preservation of Russia's leading scientific and technological institutions a priority. With this in mind, in 1993 we launched a programme to create State Research Centres (SRC). From thousands of R&D organizations, 61 institutes carrying out research in priority fields, such as electronics, aviation, shipbuilding, chemistry and new materials, were selected and given the status of SRC. Between 1993 and 1995, 34–54 per cent of the Ministry of Sci-

ence budget was spent on financing SRC projects. The effectiveness of the SRC programme was demonstrated by an exhibition held in St Petersburg in 1996 of new technologies developed by the centres.

The remaining government-funded laboratories experienced large-scale privatization so that, by 1995, 1,100 R&D organizations — about half of the sector as a whole — had been privatized. Where there have been shortcomings in the privatization of government research, this often appears to have been the result of inadequate methods of assessing the value of intellectual property as a proportion of the total value of privatized scientific and technological organizations.

A new arrival on the Russian research and development scene is a large number of small institutions — many privately run — concerned with promoting innovation. There are now more than 50,000 such institutions, which are becoming real sources of modernization of the national economy. Many of these are supported through a programme set up in 1996 by the State Committee for Science and Technologies to support small innovative business. Even earlier, in 1992–93, the system of state funds for financial support of innovative projects had been established.

Another important development during the post-Communist era has been the laying down of a new legislative framework for science. In particular, a new patent law and a Law of the Right of Authorship have been adopted. In 1996, after three years of heated discussion, the fundamental law 'On Science and State Scientific and Technological Policy' was finally enacted, giving a legal status to most of the new organizational principles on which Russian science is now based, including that of the Russian Academy of Sciences and other academies, and granting intellectual property rights to individuals rather than the state.

The transformation of Russia's scientific community has been greatly influenced by a new policy of openness and support for international cooperation. Not all aspects of this have been positive. For example, Russia has suffered considerable losses because of the brain drain. It has been estimated that between 11,000 and 12,000 scientists and engineers have emigrated from Russia during the past five or six years, and a similar

Under the former Soviet system, managerial obedience and a desire to please the 'bosses' was more important than creative freedom

Helping hand: US Vice-President Al Gore (right) signs an agreement on scientific cooperation with Russian prime minister Victor Chernomyrdin in January 1996.

number are working abroad on (supposedly temporary) contracts.

This exodus is an inevitable, if unfortunate, consequence of Russia's continuing economic crisis. But the effect of the unprecedented growth and increased effectiveness of international scientific contacts should not be underestimated. Russia's new science policy has helped to attract large amounts of foreign aid for our scientists.

The leading role here has been played by George Soros' International Science Foundation, and by aid from European countries through the INTAS programme. Support has also come from many private foundations, including the MacArthur Foundation and the Howard Hughes Medical Institute. Credit must also be given to the support provided to Russia's scientists by foreign learned societies and professional associations.

Another consequence of the openness of present-day Russian science is a significant growth in the number of commercial contracts agreed between Russia's scientific and technological institutions and foreign organizations. The increase in international scientific and technological contacts has made possible a more objective identification of high-quality elements in our scientific activities.

Present-day problems

Many important components of the reforms set out in 1991 and 1992 have now been put into effect, but the transformation of Russian science is not yet complete. The strongest negative factor, which not only hinders the reform of science but also threatens the very existence of science in Russia, is undoubtedly the current budget crisis. The government has virtually excluded science from the list of priorities, as illustrated by the fact that, in 1996 — by far the hardest of the past five years for science — science only received 60 per cent of the funds it had been promised. As a result, many new initiatives, such as state scientific and technological programmes

and state research centres, have yet to become operational.

At the same time, the controlled reform of the network of research institutions has ended in failure, particularly in the academic sector. Ministries and agencies are still keeping many of these alive, even when there are no properly working leaders in institutes, and their equipment is desperately obsolete. At the same time, the use of (limited) funds for the construction of scientific establishments remains far from rational: rather than being concentrated on the most important projects, funds are being distributed across a large number of construction sites, many of which involve projects that span several years. This situation must result in inefficient spending of federal budget resources.

All this stems from the weakness of state-controlled, centralized efforts to implement a genuine science policy and to reform the research system. Attempts to overcome the traditional bureaucratic attitudes of ministries and academies, many of whose officials still cling to a belief in the Soviet methods of management, repeatedly fail.

These are some of the most critical challenges now facing Russian science. But its potential, together with that of the national educational system, remains remarkably high. Acknowledged for the high quality of its basic research, Russia, even in times of deep economic crisis, continues to invest heavily in science, and so in the production of knowledge. Russian universities and institutes still train excellent specialists, many of whom subsequently move to developed countries, including the United States. We are rapidly advancing towards full integration into the world scientific community.

I therefore believe that Russia's scientific community will find both the strength and the ability to overcome its present crisis, to carry through the necessary reforms, and to become, as it was in the past, one of the world's most productive sources of new knowledge and technologies. □