Innovations and Science in Siberia From the Perspective of Global Management (Summary)

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The Siberian Branch of the Russian Academy of Sciences is at the heart of research in the Novosibirsk Academic Town (Akademgorodok), which was the prototype for present day technopoli and technoparks, and is a Russian research hub on a par with those of Moscow and St. Petersburg. However, the science and technology environment in the former Soviet Union and the Russian Federation has deteriorated rapidly since the collapse of the Soviet Union. To what degree has the science and technology environment in Siberia deteriorated? What are the reasons for this? Was the scientific level in Siberia actually high in the first place? What kind of scientific and technological exchange has Japan undertaken with Siberia? What are the up-and-coming fields of science and technology in Siberia? With the advance of economic globalization, how should Japan respond to Siberia and Russia from the perspective of global management? This paper identifies and discusses these issues.

1. Changes in the Science and Technology Environment in Siberia

The number of Russian researchers, who once had the highest social status in the Soviet Union, fell by around half in the ten years from 1992. Moreover, in Novosibirsk Oblast, where Akademgorodok is located, the number of people working for scientific and academic institutions was 74,300 in 1990, but had halved by 1999 to 32,500. In Siberia as well, the number of people employed in the sciences has decreased sharply in the wake of the transition to the market economy. Before the dissolution of the Soviet Union, the research institutes in Akademgorodok were financially supported by the state. However, due to the breakup of the Soviet Union, the state budget for supporting regional research institutions and educational establishments shrank and the conditions amidst which research was conducted deteriorated considerably. Furthermore, as a result of the decline of the industrial sector, above all the military-industrial complex, the sharp decline in funding from the industrial sector has added to this. In the city of Novosibirsk, wages in the science sector are low (4,965 rubles in 2002). Even at the Institute of Economics and Industrial Engineering, where we carried out our study, a problem emerged in the form of young researchers quitting the institute for jobs in finance or industry, leaving only more elderly researchers at the institute.

During the Stalinist era, the field of the actual economy, particularly the commercial sector, became dissociated from science as conducted by research institutes. This led to the decoupling of research and production, thereby impeding technological innovation in Soviet industry. Research institutes also became organizationally, geographically and philosophically separated from factories.

The centralized research institute system of scientific research institutes affiliated to the Academy of Sciences or specific ministries proved its worth in the implementation of large-scale projects requiring the mobilization of vast quantities of resources in the priority fields of hydroelectric power station construction, nuclear weapons manufacturing and ballistic missile development. However, it was not suited to projects conducted under conditions where no detailed priority issues had been set by the Communist Party, such as projects in the high-tech sector or those oriented towards the consumer goods market. Russian research institutes had neither the ability to find buyers for the technology that they had perfected, nor the ability to give the results of their development projects the level of finish appropriate to the market conditions. Thus, Russia fell behind in terms of ensuring that the outcomes of its basic research resulted in product development. The biggest problem with regard to this is the inability to develop practical applications for the outcomes of basic research.

In the West, there are experts called innovation managers or technology brokers, who mediate between researchers and developers, manufacturers and investors, and create a unified linkage between them, but such experts did not exist in Russia. In Russia, what are needed are innovation managers and technology brokers, rather than sectoral research institutes that are isolated from the actual market and speak a totally different language. Scientists and technicians implement technological development under the leadership of innovation managers, while innovation managers adapt the outcomes of their development efforts to the actual market. In addition, a structure is required in which a growing industrial sector purchases the resultant products.

The scale of research and development expenses is the extent of activities conducted in order to create and accumulate new knowledge and technology, and is a vital element in gauging the technological element. The scale of research and development expenses is a developmental yardstick demonstrating the innovative ability of a particular society and the ability to create, disseminate and use knowledge and information is increasingly important in terms of the competitiveness of an economy. However, as research and development expenses differ according to the scale of a country's economy, there are some difficulties in drawing comparisons between countries. Accordingly, if we use the research and development intensity, that is to say, the share of research and development expenses in GDP, a comparison of research and development expenses between different-sized countries becomes easier. While Japan has an intensity of 3.01%, the US 2.63%, Germany 2.38%, France 2.17%, the UK 1.87% and Canada 1.58%, Russia's intensity is just 1.06%. Among the major countries, Russia's overall expenditure on research and development is low and its research and development intensity could not be described as high when viewed from an international perspective.

The research institutes in Akademgorodok also began to seek partners overseas by acquiring various subsidies. As a result, the extent of links with partners in business and overseas led to a progressive polarization between research institutes with abundant research funds and impoverished research institutes. Institutes with abundant research funds include the institute of nuclear physics and institute of catalysis. However, such affluent research institutes are rare.

How have the research institutes of the Academy of Sciences procured research funding?

2. Major Research Institutes in Akademgorodok

The Kutateladze Institute of Thermal Physics

In 1993, the Kutateladze Institute of Thermal Physics first concluded a contract worth hundreds of thousands of dollars with Air Products, one of the leading specialist gas production companies in the US. Furthermore, it participated in another research project commissioned by the same company, focusing on the theme "the development of new plasma chemistry technology relating to gas production", and achieved great success. Researchers proposed an original, unconventional design proposal for this theme, creating a new ozone generator and succeeding in developing an efficient technique for manufacturing hydrogen. In addition, they perfected a plasmatron design that was, in principle, completely new. Starting in 1993, the institute's contracts with global companies increased in value more than tenfold and became a major source of income. Over the year since then, they have been supporting the lifestyles of the institute's researchers.

The Boreskov Institute of Catalysis and the Budker Institute of Nuclear Physics

The Boreskov Institute of Catalysis is one of the world's largest publicly funded catalysis research institutes and has world-class technology. As a practical research institute in Russia focusing on the field of chemistry, it undertakes close collaboration with institutions undertaking research and development in the materials sector, the organic chemistry sector, and the energy and nuclear power industry sector. Moreover, in addition to research commissioned by the vast chemical industry in the West, it is an international research institution that also licenses technology. It has hardly any interaction with Japanese industry. The institute employs around 750 people, including around 350 researchers, and has an attached pilot plant and a catalyst manufacturing plant. The institute has superior catalyst technology for partially oxidizing or steam reforming methane, diesel and heavy oil fuels in order to achieve the highly efficient generation of such substances as carbon monoxide, hydrogen and hydrocarbons, and hydrocarbon reduction NOx removal catalyst technology which uses these substances as reducing agents in order to reduce nitrogen oxides to nitrogen; it conducts joint international research with Japan and countries in the West. Under the strong leadership of its director, the Budker Institute of Nuclear Physics receives many requests from within Russia for the manufacturing of accelerators, and is often asked by radiation facilities overseas to manufacture equipment associated with accelerators.

3. The IT Industry in Novosibirsk

Novosibirsk rocketed to fame as a base for the offshore development of software for Western countries and is called Russia's Silicon Valley. Novosibirsk is one of Russia's leading IT hubs after Moscow and St. Petersburg. In Akademgorodok, experts in the fields of mathematics and physics have launched a succession of new companies, and the town is a base for software. Breakthroughs in the field of software are continuing against the background of high-level education in the areas of mathematics and science. The software industry is steadily being nurtured and orders from Japan are also increasing. In June 2001, the SibAkademSoft Association was established, due to the necessity of developing infrastructure in the IT industry. The aim of the association is to "make Siberia's IT industry the best in the world", and it is receiving active cooperation from business partners overseas, as well, of course, as within Russia. The organizations affiliated to the association include the Siberian Branch of the Russian Academy of Sciences, governmental institutions in the Novosibirsk region, Novosibirsk State University, the Technopark, and software production companies in Novosibirsk City (Alekta, BACUP IT, Data East, Sibinfocenter, Signatec, SofLab-NSK, Souztelecom, Tornado, and UniPro). Russia's top brains are brought together in this Technopark, in order to develop the IT industry, and the aim is to create a center for the IT industry that is on a par with Silicon Valley in the US. Around 70 companies have been set up in the Technopark; these include not only venture companies in the IT industry, but also those in the field of biotechnology and healthcare.

4. Japanese Initiatives

Japanese Governmental Initiatives

With regard to multilateral cooperation, there is cooperation with such international institutions as the United Nations and the OECD in providing support to Russia, as well as cooperation implemented by the International Science and Technology Center. This center was established in March 1994 with the aim of facilitating a switch in the focus of researchers who had been involved in the development of weapons of mass destruction in the former Soviet states, moving away from military issues and towards civilian ones. In addition to such explicit agreements between governments, agreements, joint research and technological cooperation with Russia are conducted on the basis of individual research budgets, such as cooperation in the ITER (International Thermonuclear Experimental Reactor), the space station plan, and the Japan-Russia FBR (fast breeder reactor) cycle. Such joint research and technological cooperation are provided for in the governmental budget.

The international scientific and technological cooperation relating to Russia undertaken on the basis of the governmental budget is characterized by the fact that the areas of cooperation are the fields of engineering and technology, and joint research and technological cooperation relating to space and nuclear power projects correspond to this. Amongst the various research and development programs (excluding joint research relating to space and nuclear power projects), most involve financial assistance in the form of contributions to international institutions. The budget for joint research and technological cooperation is extremely small. The majority of the governmental budget allocation is for cooperation conducted within multilateral cooperative frameworks, and the budget for cooperation within bilateral cooperative frameworks is extremely small.

The Center for Northeast Asian Studies at Tohoku University

In 1996, Tohoku University established the Center for Northeast Asian Studies and it is dynamically conducting academic exchange with the Siberian Branch of the Russian Academy of Sciences. Jun'ichi Nishizawa, at that time President of Tohoku University, is an honorary foreign member of the Russian Academy of Sciences and had had contacts with researchers in the Siberian Branch for a number of years. At the end of 1980, the Soviet government began to cut its research funding for the Soviet Academy of Sciences (as it was known at the time), due to financial difficulties. A sense of crisis regarding the future arose within the Siberian Branch and it began to seek a way to conduct joint research with foreign research institutions; in 1990, the Siberian Branch sent a top official to Tohoku University. Professor Nishizawa responded sincerely to the requests of the Siberian Branch of the Russian Academy of Sciences and explored the possibilities for academic exchange between Tohoku University and the Siberia Branch. He made approaches to the Ministry of Education (as it was known at the time), with the aim of securing the establishment within the university of a research center that would deal with academic exchange between the two institutions. As a result, the Center for Northeast Asian Studies was established in Tohoku University in 1996.

Professor Nishizawa is one of Japan's greatest researchers. He invented all three fundamental components of fiber optic telecommunications systems: light-emitting elements, optical transmission lines and light-receiving elements. However, his world-class original research outcomes went unrecognized in Japan and only received the acclaim they deserved overseas. In Japan, there is little inclination to "respect the laws and principles of nature", and a rigidly authoritarian mentality in which "established theories are to be believed unquestioningly" prevailed. Professor Nishizawa felt strongly that creative technology could not be nurtured amid an autocratic atmosphere in learning, in which everyone had an almost religious belief in dogma and an excessive reverence for the West. He was meticulous about creativity, trying to evaluate original research correctly and nurture it carefully. Professor Nishizawa, who thought that fiber optics would become an advanced technology that was one of Japan's assets, requested that Japanese companies put it to practical use in various areas of their work. However, it received absolutely no recognition whatsoever and, regretfully, Professor Nishizawa turned it over to a US company. Now, Japan has to pay a huge patent fee in order to use fiber optics. Holding such creativity in high esteem, Professor Nishizawa's attention was caught by the plasma technology developed by the Siberian Branch of the Russian Academy of sciences and promoted joint research with that institution.

Professor Itaru Watanabe of the Center for Northeast Asian Studies has now taken over this task. In addition, he is the representative for the project aimed at introducing to Japan the plasma technology developed by the Siberian Branch's Institute of Thermal Physics. If plasma technology could be used to raise the temperature of incinerators instantly, rubbish incinerated in them would not generate any toxic gases. It is said that Russians discovered the fundamental principles of incineration techniques, but they did not get as far as applying them in practice. Apparently, attempts are being made to establish a waste disposal company using Russian plasma technology, with funding being provided by a private sector company in Sendai. This is a good example of the matching of Russian fundamental science with Japan's ability to modify and upgrade inventions.

Initiatives Involving Local Authorities and Private Sector Companies: The Magnus Windmill of Mecaro Akita

One initiative is being undertaken in Akita Prefecture. In June 2003, the technology transfer team from the Akita Prefectural Government's Industry, Economy and Labor Division brought back with them from ITAM (the Institute for Theoretical and Applied Mechanics) at the Siberian Branch of the Russian Academy of Sciences a prototype Magnus windmill that had yet to be put to practical use. This team approached Nobuhiro Murakami, President of Mecaro Akita, a precision instrument manufacturer, and Professor Jun Ito of the Akita National College of Technology, who had been conducting research into windmills for some time; the participation of lecturers from Akita University and Akita Prefectural University was also secured and development work began, with the involvement of representatives from the worlds of industry, government and academia. Then, by adding spiral cylinders devised by Mr. Murakami of Mecaro Akita, a wind power generator with a generation capacity more than twice as high as existing generators was developed. Thus, it became possible to generate twice as much electricity as conventional windmills. Compared with propeller-type wind power generators, the new Magnus windmills have a good level of generating efficiency, are cheap to build and are capable of withstanding strong winds. They are characterized by the fact that they do not have any propellers; instead, rotating cylinders to which spiral structures are attached turn the windmill. The completed test model is two meters in diameter and can generate 16,000 kWh annually, assuming an average wind speed of six meters. When a battery is used to rotate each of the five cylinders, dynamic lift is generated and the whole windmill begins to revolve. It can apparently convert the power of the wind efficiently into energy.

Conventional windmills could only operate within a wind speed range of around 4–25 meters, but this new windmill has extended that range to 2–100 meters. As it can be used with both slight breezes and strong winds, it could apparently increase the annual operating rate to 90%

in areas where conventional windmills currently achieve an operating rate of 60%. The price of a commercial model is anticipated to be ¥10 million and there are plans to supply them to local authorities. Academic exchange has continued even since the development of this model, with Mr. Murakami visiting Novosibirsk to ask the Russian team to undertake additional research and to report on the results that have been generated by the Japanese team.

This can be described as an example of discerning Japanese researchers in the field of the natural sciences spotting original basic research and commercializing it by means of collaboration between the worlds of industry, government and academia. It is necessary for people who understand and have a discerning eye for basic and applied research in the natural sciences to carry out "technology-spotting", which involves the collection of information about technology. This must be conducted by people with an appreciation of new knowledge, who have the ability to predict new technology and markets, who are familiar with knowledge concerning basic and applied research, and who have a discerning eye and the ability to integrate these two types of research. Researchers in the field of the natural sciences can fulfill this role. Without such personnel, it will be difficult to make use of the basic research conducted by the institutes of the Russian Academy of Sciences, which does not see the light of day.

5. The Level of Basic Research in Russia

Is the level of basic research in Russia really high?

Research and development activities consist of **basic research**, which involves the discovery of scientific knowledge, **applied research**, which involves applying this scientific knowledge and examining the possibilities for its commercialization, and **developmental research**, which is aimed at actually developing new products or new production methods. It is usual for the outcomes of basic research to be collated and published as papers, so the share of papers is an indicator of the position that the outcomes of basic research occupy in research and development worldwide in quantitative terms. Moreover, if a paper is cited in various situations, it suggests that that paper has been evaluated as being of high quality, so the citation index of a paper is an indicator of the position that the outcomes of basic research occupy around the world in qualitative terms. Accordingly, let us conduct a comparison by country of the number of presentations and the number of citations, based on database compiled by the ISI (Institute for Scientific Information).

The average number of citations per paper is called the relative citation index. Among major countries, the US has the highest relative citation index, at 1.5, followed by the UK at 1.36, Canada at 1.24, France at 1.06 and Japan at 0.84. Russia's level is even lower, at just 0.45. Japan also has a level below 1 and occupies the lowest position of any major country, but Russia's relative citation index is even lower than that. It is not possible to describe Russia's relative citation index as high, so judging by this indicator alone, the level of Russia's basic research certainly could not be described as high.

6. Conclusion

Neither Russia's relative citation index nor its research and development intensity can be described as high. Given this situation, should we in Japan just stand by and watch as science and technology in Siberia declines?

Global companies are competing on a global scale to develop innovations. The reason for this is that they have acquired diverse ideas and management resources from across the globe and have reinforced their innovative base. The more important the source of the innovation, the more likely it is to be in an unexpected place, so it is necessary to develop a swift, accurate recognition of this. The main obstacle to this is a stereotypical viewpoint. In this knowledge-based society, it is not possible to survive by adhering to stereotypes in searching for innovations on the basis of general knowledge about which countries are strong in what areas. The question of how to unearth valuable innovations around the world is the main challenge in global innovation.

Currently, we live in an age in which intellectual assets are used on a global scale. It is not necessarily the case that a country's strengths or the strengths of innovation clusters within a country will continue in a stable manner in the long term, as has been the case until now. There are cases in which fields that had given a country a competitive edge decline rapidly, with the advantage being surrendered to another country. It is no longer an age in which stereotypes of which country is powerful in which area can be maintained stably in the long term. In the new economy, unexpected innovations emerge from remote regions. Knowledge spreads rapidly on a global scale and it is possible for the green shoots of innovation to sprout in places where they would not have been expected, when considered on the basis of conventional common knowledge. Adopting an approach constrained by conventional stereotypes, with hubs of innovation being allocated and adjusted on the basis of existing strengths will lead to potential opportunities being missed.

The industrial goods that were the "products" of the Soviet Union had little international competitiveness when considered on the basis of the criteria of leading industrialized countries. In the Soviet Union, technological development was oriented towards military demand. However, it is not the case that the research outcomes generated as a result of the vast potential of the researchers–accounting for 30% of all researchers worldwide–confined within this military superpower were of no use at all in improving the lives of the people. The products of such research include advanced technology that countries are now competing furiously with each other to develop as high technology, and Russia still has many intellectual resources that have yet to be put to practical use. If one can seek these out and put them to practical use, it may become possible to link them to actual business, as in the case of the initiatives undertaken by Tohoku University and Akita Prefecture. Moreover, as in the case of Ajinomoto, one could develop a strategy in which basic research and research and development are contracted out to Russian research institutes, while respecting those institutes' own ideas and creativity.

In order to do this, technology spotting, which involves gathering information about technology, is required. Unless researchers in the field of natural sciences, who understand both basic and applied research in the natural sciences and can spot projects with potential, conduct technology spotting and seek out budding innovations, it will be difficult to make use of the research conducted by the research institutes of the Russian Academy of Sciences in Siberia.

Novosibirsk has the third largest accumulation of IT companies in Russia. Furthermore, software development is taking place at a high level, on the basis of the advanced scientific and mathematical education being provided by such institutions as Novosibirsk University and Novosibirsk State Technical University. Moreover, Japanese language education is flourishing in Novosibirsk and there is an abundance of IT engineers who can deal with the Japanese language. Costs are high compared with India or China, but Novosibirsk has a competitive advantage in that its IT people can apply non-standard approaches and seek paths that have not previously been tried. It is cheaper to develop software aimed at the Japanese market here than in Japan; it is possible to request software developers to do this and they have a proven record of achievement in this area.

In Northeast Asia, Russia currently occupies a vulnerable position, but in the long term, Russia will have a much bigger impact on this region, as it is anticipated that bilateral and multilateral relationships between Russia and the countries of Northeast Asia will continue to develop. The major countries of Northeast Asia, i.e. China, Japan and the ROK, are highly dependent on imported energy and Russia is home to oil and gas resources. Consequently, Russia has the potential to increase its role in diplomatic relations in Northeast Asia, and its influence will become very strong. This is because it is anticipated that Russia will become a bigger presence in the Northeast Asian economy. As Professor Valery Kuleshov, Director of the Institute of Economics and Industrial Engineering at the Siberian Branch of the Russian Academy of Sciences, has said, if Russia joins the WTO, it will become involved in international specialization, participating in both the EU and the Northeast Asia Economic Subregion; through this process, the role played by Siberia, with its abundant resources, will undoubtedly increase.

For Japan, Siberia is a resource-supplying region that can supply such resources as oil and natural gas, and it is also a resource-processing region. Moreover, it is also an outsourcing region for such fields as software development, and a region in which technology can be sought and joint research conducted. As well as seeing Siberia as a “market” that we can expect to grow in the future, should we not also pay attention to its status as an area containing the potential for a variety of innovations?