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Russian Critical Technologies 2015

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Purpose

The Ministry of Education and Science of the Russian Federation conducted a foresight exercise aimed at identifying national S&T priorities and developing the list of critical technologies. The study was organized on a new methodological basis compared to the two previous exercises undertaken in 1996 and 2002. The results obtained were used as a background for the Federal Science and Technology Programme.

A New Approach to S&T Priority Setting

Russia's agenda setting for S&T priorities has been undergoing a transformation for the last 30 years. The last definitions for S&T priorities and critical technologies were approved in 2002 and represented research areas that were too broad to become real targets for the implementation of S&T policies by the Russian government. Neither did these priorities provide orientation for private investment. Hence, Russia's Ministry of Education and Science organized activities to revise and correct the process in the period 2003-2004.

Revision of S&T Priorities

The revision of S&T priorities was carried out during a period of sustained economic growth and great improvement of the state government system. According to international experience, long-term sustained development is achievable only as a result of high entrepreneurial and innovation activities both in production and service sectors, diversification of production and greater share of sophisticated and high-tech products. Thus concentrating resources in the areas where Russia's competitive advantages can be implemented helps faster introduction of innovation based on latest research outcomes and technologies, which at present is a key factor that determines the competitive status of the national economy. Such restructuring of the national economy is of particular importance for Russia because of its strong dependence on the international markets of fuel and mineral resources.

One of the main objectives in revising the priorities was to create an information and analysis background for defining budgeting priorities and forming the Federal S&T Program 'Research and Development in Priority Areas of Science and Technology,' as well as for other federal and sectoral goal-oriented programs, eventually resulting in greater efficiency of public funds invested into S&T.

Economic Growth as a Driver

Given Russia's new economic development model, with its goal of faster GDP growth, greater increase of competitive capacity of the national economy and its diversification based on high technologies, the revision of priorities had a practical purpose, in that the newly formulated lists of priorities and critical technologies were to be correlated with industry's needs so that they could serve as a basis for managerial decisions on intensification of innovation activities, practical implementation of the existing research capacities and concentration of public R&D funding in the most important S&T areas. The revision of the priorities had the following general objectives:

- Developing criteria for evaluating technologies,

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- Analyzing components of existing critical technologies, assessment of their use for developing innovation products, competitive in domestic and foreign markets,
- Identifying research areas within critical technologies with the greatest potential for developing such products and making a considerable contribution to increasing GDP growth and the competitiveness of the economy,
- Creating revised lists of priorities and critical technologies together with recommendations on their use,
- Evaluating the innovation potential of critical technologies,
- Developing proposals concerning practical implementation of the selected S&T priorities.

Identifying Critical Technologies for Civilian and Security related use

Critical technologies were selected based on the 10-year horizon (up to 2015) of their practical use, with a particular focus on those nearest to a practical implementation stage. The main objectives of Russia's Social and Economic Development Program for the medium term consist in overcoming factors hindering GDP growth and reducing the present dependence on the fuel and raw materials as the mainstays of the national economy. Given these requirements, it was decided to use the following **two main criteria** for correcting the lists of priorities and critical technologies:

- Their contribution to accelerating growth and enhancing the competitiveness of Russia's national economy.
- Their capacity for enhancing Russia's national security.

The capacity for enhancing Russia's national security was assessed based on the following factors:

- Overcoming dependence on imports of particularly important goods and technologies,
- Competitive capacity compared to their foreign equivalents (price and technological characteristics) of domestic technologies for reducing technogenic catastrophic risks.

In selecting critical technologies for the civil sector it was decided to restrict their number to a minimum due to the need for concentrating resources. Thus it will be possible to provide sufficient budget funding for each of the critical technologies through the federal S&T program 'Research and Development in Priority Science and Technology Areas.' Furthermore, the following additional criteria were used for evaluating critical technologies:

- Precise and accurate formulation.
- It was decided to identify breakthrough technologies with applications capable of providing growth rates in specific product groups that would far exceed average domestic growth rates, or that can generate a large range of innovations in different social and economic sectors.
- A variety of possible applications in different social and economic sectors, generation of new research areas.
- Conditions for practical implementation. Priority was given to critical technologies that might be met with demand in the most rapidly developing sectors of the national economy,
- Investment required for industrial application,
- Assessment of probable risks,
- Applicability in the framework of public programs.

Involving National Actors

All interested government agencies and ministries took part in the review of the S&T priorities and critical technologies. In 2003-2004 the Ministry for Science and Education collected their proposals and arguments in favour of keeping formerly listed critical technologies or including new ones into the revised list. They were systematized and evaluated by experts engaged by the Ministry for Science and Education.

Use of Expert Opinion

Additionally, leading Russian scholars and specialists took part in the evaluation of all the priorities, two surveys were conducted and several expert panels established for this purpose. At the initial stage, a preliminary poll was held concerning each proposed priority, with questionnaires submitted to experts in order to gather information on the most important prospective innovation products and services, as well as on technologies that might play a critical role for those innovations.

The subsequent selection procedure was used to choose the products. Each expert was asked to name 10-12 important innovation products (services) from his sphere of interest and occupation, that could be produced in Russia with the help of domestic S&T developments in the nearest decade and that would meet the following criteria:

- **Competitiveness**
- Considerable contribution to **GDP growth**
- **Overcoming dependence on imports**

The experts were also asked to describe the main features of each of the products and identify technologies that need to be developed for their creation. The information on the products thus obtained was systematized and offered to expert panels for discussions in several rounds that were held concerning each priority. During the expert panel discussions, the original set of products was reviewed and major innovation product groups were identified according to the above mentioned main priorities. As a result of expert panel discussions, there was formed a set of the most important innovation products and services that can be produced in Russia in the next 10 years. As a rule, the sets encompassed approximately 20-30 product groups in each priority area.

For each innovation product the following issues were assessed: projected annual volume of sales both in Russia and abroad, competitive capacity on both domestic and foreign markets, the possible date for launch of production, the ownership of technologies required for production, availability of production facilities, etc. Furthermore, the experts identified

several Russian organizations that possess technologies required for launching the production of major innovation products and provided other information such as barriers, measures to be taken before production can start and the availability of qualified human resources. In assessing products in the area of ecology and rational nature utilization, the questionnaires were slightly modified. Thus, instead of evaluating sales volumes, the experts were asked to evaluate the prospective annual ecological effect so as to prevent damage to ecology and reduce environmental protection costs.

Russia's Priorities Correspond to International R&D Agenda

As a result of the above described process the following documents were prepared:

- Draft of revised list of priority areas of S&T development,
- Draft of revised list of critical technologies,
- Description of the main features of critical technologies such as basis for inclusion into the list, major prospective results, key research areas, leading Russian R&D centres involved in research, tendencies and prospects for creating innovation products based on technologies in question in Russia and abroad.

In the course of the final stage of the process ministry officials and experts reduced and considerably modified the earlier approved list of priority S&T areas. The new list included eight priorities:

- Information and telecommunications systems
- Nano-systems industry and materials
- Living systems
- Rational nature utilization
- Power engineering and energy saving
- Transport, aviation and space systems
- Safety and terrorism counteraction
- Prospective armaments, military and special equipment

The first six correspond to the current international technological development priorities. They possess the greatest innovation development potential that is defining the formation of new global markets. This is particularly true for information technologies, nano-systems industry and new materials and living systems. These last two priorities on the revised list relate to national security.

Critical technologies are also instrumental in providing national defence and technological safety. Just like the list of priorities, this list underwent major changes as well.

Priority S&T Areas Content and Innovation Capacities

In **information and telecommunication systems** priority will be given to technologies for creating intelligent management systems for complex objects and navigation systems, technologies for transmitting, processing and protecting information, technologies for software development and technologies for computation systems. As a result, it will allow developing within a short period of time such novel products and services as intelligent systems for supporting complex equipment operators and creating automated production facilities; intelligent robots; smart houses and vehicles; systems for a single telecommunications network encompassing the Internet, television, radio, various multimedia and virtual reality systems; automated systems for contacts with government agencies at all levels; standard electronic identification documents; distance education and health care systems, etc. that will have far greater quality and effectiveness than similar products of older generation.

In **nano-systems industry and materials** the most important breakthroughs can be expected in the sphere of nanotechnologies and technologies for Mechatronics and Microsystems equipment development; technologies for creating crystals; developing and processing materials with special qualities, composite and ceramic materials, polymers and elastomers. There is hardly any area in the aviation and space industry, transportation, electrical power industry, oil industry, microelectronics or medicine that can develop without such materials. These critical technologies are also important for resolving the existing ecological problems. Some of the most important innovation products and services in this area, which are likely to have the greatest economic effect, are ceramic and composite materials with functional properties. They could have applications as super ion-conductors, superconductors or magnetic materials.

In **living systems**, technological development is going to be defined by cell technologies, R&D in stem cells and bioengineering and biosensor technologies. Bio-information technology development together with genome and post-genome technologies for creating pharmaceuticals will lead to the emergence of a new generation of pharmaceuticals using membrane proteins and receptors as targets. Among other notable innovation products and services based on living system, critical technologies that can be launched into the economic turnover in the nearest future are, for instance, new analytical devices for medical diagnostics, the introduction into practical farming of transgenic plants with improved features and using them for producing various physiologically active substances.

In **rational utilization of nature**, the main areas of technological development will result from more sophisticated technologies for environmental monitoring and forecasting together with the introduction of technologies for ecologically safe mining and oil and gas extraction, as well as for processing and utilizing technogenic substances and wastes and decreasing the risks and minimizing the consequences of natural and technogenic catastrophes. The following products with the

greatest ecological effect can be named here: technologies and devices for minimizing negative consequences for human health and environment of natural and technogenic emergencies and systems for utilization and burial of highly toxic wastes, for restoring water quality in surface water objects, for industrial and public waste and drainage water treatment, treatment of medical wastes and biological wastes from food industry and agricultural facilities.

In **power engineering and energy saving**, the most important areas are fast neutrons nuclear reactors, hydrogen power research, broad scale introduction of various renewable energy sources, and power generation from organic fuels. There are domestic technologies in these areas as well as production facilities for manufacturing plants and equipment for hydrogen power generation, ecologically safe and highly efficient hybrid power plants based on high-temperature fuel elements, highly efficient steam and gas turbine plants, and other competitive products meeting the best foreign equivalents. Some of the most important priorities for technological development are creating power-saving transportation systems, heat and electricity distribution and consumption systems based on superconductor and semiconductor devices, etc.

In **transport, aviation and space**, priority will be given to technologies providing production of new competitive types of high-speed land transport, navigation systems, aircrafts, rockets and long-distance space ships, as well as integrating Russian technologies into global value-added chains.

Technologies and Their Estimated Contribution to Growth

The experts pointed out that the area of **information and telecommunications systems** has the greatest innovation capacity. According to some estimates, the export of software amounted to approximately US$ 400 billion as early as 2000, mostly accounted by offshore programming services. Export forecasts for 2010 are as high as US$ 2-4 billion. Recent government initiatives aimed at developing ICT innovation centres to make the industry's prospects even more optimistic.

The area with the next greatest possible production volumes is **power engineering and energy saving**, where Russian companies are capable of achieving sales volumes of US$ 3-4 billion, with several dozen million dollars' worth of exports.

In **biotechnologies**, the 2004 exports of immuno-biological and antibiotic substances alone amounted to US$ 35 million, and they may reach US$ 100-120 million by 2010.

In **rational and sustainable use of nature** the highest economic effect can be expected from hydro-meteorological support of various sectors of the economy, from accurate forecast and prevention of natural and technogenic catastrophes, from ecologically safe mining and prevention of ecological damage.

Competing on the Global Market

If Russia succeeds in developing these technologies, it has a chance to retain front-rank positions in many S&T areas. In many of these fields the country has stable research teams, capable of conducting R&D at the best international standards, and in some of them Russia is an acknowledged leader. Most of the critical technologies can provide innovation products with large potential markets within a short time period and at comparatively low additional investment cost, thus contributing to the declared task of doubling GDP and improving the quality of economic growth by increasing the share of science-intensive products.

Input to the National S&T Programme

The new list of S&T priority areas and Critical Technologies has been approved by President of the Russian Federation. It was used by the Federal Agency for Science and Innovation as a background for the Federal Science and Technology Program implemented in 2005-2006. The new National S&T Program to be implemented in 2007-2012 is also designed in line with the lists of S&T priorities and Critical Technologies. The detailed results obtained during the exercise were used for selection of big innovation projects jointly funded by the government and private businesses. The lists also create a basis for development of S&T priorities for particular regions and industrial sectors.

Sources and References

http://www.mon.gov.ru/science-politic/conception/2240/