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IN THE ISSUE 1 (71)_2009

The Academy of Sciences is the Leader in Research and Innovations

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Professor

Our national economy acquires new quality — innovative development. It is governed by the powerful influence of technological progress converting science and knowledge into the global modernization factor.

During the last years, positive systemic changes occurred in national science and in the National Academy of Sciences of Belarus. Institutional and financial mechanisms of research activities have improved. Innovation is palpable, it is not declarative. It became possible owing to the decisions taken by the President and the government of the Republic of Belarus based on program-targeted approach to planning, grouping all research projects into 11 State Integrated Targeted Scientific and Technical Program (SITSTP), called up to attain perspective goals of modern economy in accord with the world scientific agenda, and the priorities that are in line with the mainstream of research performed in the leading foreign countries (Table 1).

In 2007, NASB completed its restructuring and became a powerful research-and-production and research and educational complex centering its potential on the priorities of modern economy formation, with focus on the tasks of innovative development of the country. At present, there are 7 research and production centers (RPC) (5 agricultural RPCs, the RPC for material science and the RPC for biological resources) functioning in the Academy, as well as public research and production associations for chemical synthesis and biotechnologies, chemicals and technologies. A number of other structural reforms were performed.

These measures proved to be effective. We build our work with the national economy focusing on two directions. The first relates to scientific support of modernization of sectors of national economy, the second aims at domestic manufacture of modern products, materials, equipment for home and export needs. The analysis of dynamics of qualitative indices of research and innovation activities of NASB testifies to progress in both directions.

The input of science to the innovation development is increasingly vigorous, the volume of work performed by the institutions of the Academy has increased (Fig. 1). Preliminary estimates for 2008 amount to BYR 691.9 billion. The progress is slower than one would wish, but lower subsidies for research from the government are obvious. Contracts, bidding for government contractual works — this is real competition to the benefit of our scientists. Research institutions identify their custom-

Table 1. Priority directions of scientific research in the Republic of Belarus and EU countries

Priority areas of scientific research of the Republic of Belarus	Priority areas of research activities of EU
Power engineering	Stable energy systems in short-term, medium-term and long-term period. Management of radioactive wastes. Radiation safety
Machinery and mechanisms	Stable development of transport
New materials and substances	Nanotechnologies and nanoscience, science-intensive, multifunctional materials and innovation processes and equipment
Preventive, diagnostic, therapeutic and rehabilitation technologies and equipment, medical products	Genetics and bio-technologies for public health care system
Food safety and effectiveness of agricultural complex	Qualitative nutrition and safety
Mathematics, physics, IT	Public computerization technologies
Innovative devices, electronics, laser-optic technology	Aeronautics and space exploration
Nature management and ecology	Global ecosystem change
Socially oriented innovation economy	
Individual, society, culture, education	Civil society and government in knowledge based environment
Defensie capacity and national security	

ers, offer them services, and compete for the right to sell their products. Besides, the burden on the state budget reduces. Most important is that self-financed R&D finds practical applications and is not wasted. Assiduous managers will do their best to find application for their scientific product. And public funds are safer from injudicious allocation. Targeted use of public money is strictly controlled. It is allocated for specific tasks, and should be clearly visible in the structure of executed works, as fundamental research and future developments shall not be ignored.

Scientific support of projects of the National Innovation Development Program performed by the NASB scientists, has been invigorated. As of today, there are 174 projects, 81 of them are developed by the Academy. In 2007, scientific and technical programs yielded more than 490 new technological items, including 100 pieces of machinery, equipment and devices; more than 130 technological processes; 100 new materials, substances and tools; more than 50 software systems and complexes, 97 varieties of plants, breeds of livestock, preparations, etc. (Fig. 2). One hundred and twenty four innovative manufacturing technologies were developed by 37 institutions of the Academy of Sciences accounting for 33.1% of the total amount of developments performed in the country and 61.7% of those created by "science and scientific service" branch. At the same time, in 2007, each sixth fundamentally new Belarusian technology was developed by the research institutions of the Academy. Starting from 2004, NASB contribution to the development of advanced technologies worked out in the country ranges within 30—38% for different years. This proves that the work is purposeful and systemic. In 2007, the research institutions of the Academy developed 14 new technologies (18.4%) out of

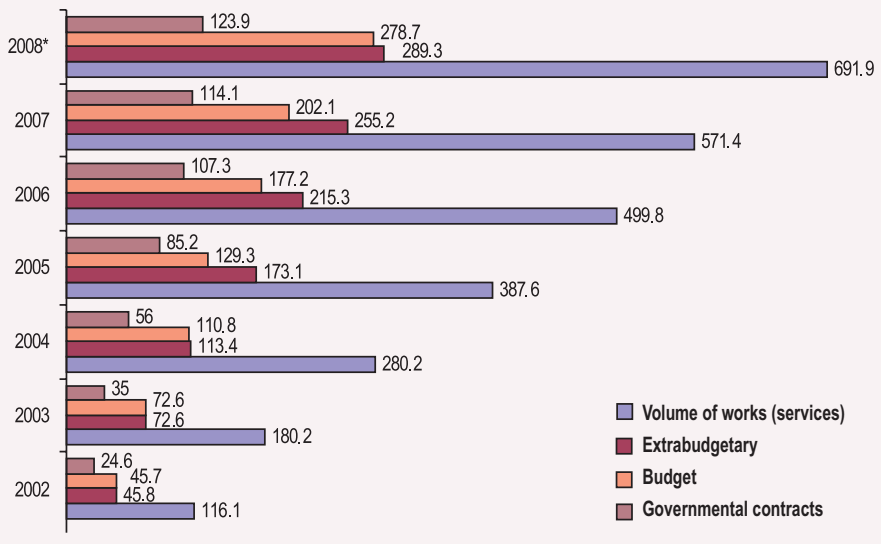


Fig. 1. Volume of works (services) performed by institutions of the NASB, from all financial sources, BYR billion (2008* — estimates)

76 (world level) were created in Belarus.

Innovation-production complex of NASB is developed: within the framework of the National Innovation Development Program, the Academy is the contractor of 23 innovation projects of its own design. In 2008, program-technical complexes for the support of product life cycle of RUE "MTZ", RUPE "BelAZ", RUPE Vitiaz" were put into operation. Complexes based on SKIF cluster and supercomputer technologies are ready to be applied in the banking system in 2009. They are planned to be used also for Earth remote sensing image processing and filing, for accomplishing science intensive tasks while designing new products. An innovation project of reproductive farm for 500 basic sows in RSUE "Zarechie" of Smolevichy District will become a break in the agrarian science.

For 5 years, since 2002, the number of submitted patent applications has increased 2.2-fold, the quantity of patents and certificates obtained increased by 3-fold.

The number of patents received by the specialists of the Academy has increased 3-fold — from 5 to 15.4% of the total number of patents and certificates in the country. In the first half of 2008, 280 industrial property patent applications were submitted and 269 patents were issued (Fig. 3).

We need to learn to sell patents, intellectual property in general, to make a practice of getting part of benefits obtained from the application of scientific achievements in production by research institutions and scientists.

In 2008, NASB exported over USD 18 million worth-intellectual products (Fig. 4). In 2007, 218 contracts of this type were signed. In comparison with 2004 (75 contracts), this indicator increased 2.9-fold and accounted for 19.5% of total for the country (1 119 contracts for export of technologies and technical services — patents and patent licenses of invention, know-how, designs, effective models, engineering services, research and development works, etc.). The value of NASB intellectual product export contracts is USD 5.4 million, and it exceeds the respective achievement of the Ministry of Industry by 1.4-fold and the Ministry of Education 3.9-fold.

No doubt, volume of export is insufficient. It should increase by stronger positioning on foreign markets, by formulating modern export strategy and scrupulously studying potential markets. At this point, there are institutional, infrastructural and legal problems.

Belarusian science is known in the world. Citation index of our scientists is high. In 1993—2006, more than 16 thousand Belarusian publications were included in one of the most authoritative database — Web of Science (Philadelphia, USA), 3 articles a day, about 55% of them originating from the members of the Academy of Sciences. The list of journals in which the above articles were published comprises 1 700 titles. Every year foreign scientists refer to the works of our researches 3.8 thousand times — more than 10 times a day.

Targeted human development measures reverted the tendency of "brain drain" and low interest of young people in science. For the first time since the Soviet epoch they have shown interest in this area. In 2007, the share of young researchers (below 29) rose to 20.9%. Modern motivation approaches — scholarships and research grants of the President for postgraduate students and gifted young people, special competitive bonus system — played a decisive role in solving this problem. This mechanism works and creates competitive environment conducive for effective

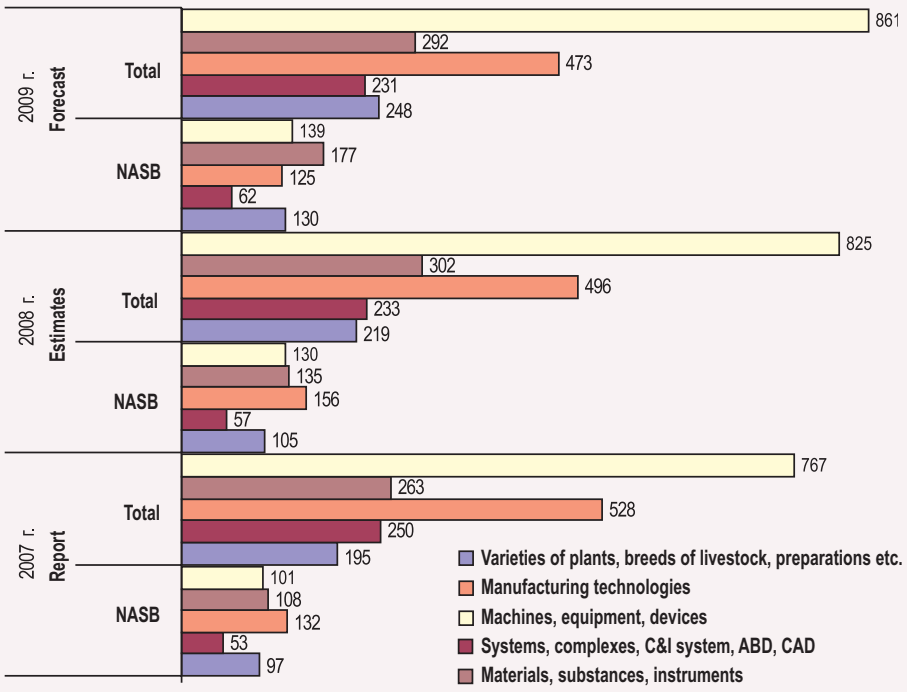


Fig. 2. Results of implementation of branch and regional research and development programs and investment projects

creative work. Differential remuneration in science should be further developed and cover all levels of researchers. Alongside with the system of bonuses and grants, we need a comprehensive approach: payment of royalties for effective developments to all researchers; premium wage system for research institutions implementing innovation projects, working under direct contractual agreements as general contractors, etc. NASB addressed the government with these proposals.

The achieved results are the evidence that the process of transformation of the Academy of Sciences into a large-scale research and production corporation is irreversible.

In accordance with the key task to become all-important element of national innovation infrastructure, NASB targets the development and implementation of major long-term systemic projects aimed at creating new branches advancing our economy to level IV. It means the implementation of national programs on biotechnology, development of micro- and optoelectronics, LED, laser-optic equipment, nanotechnology, updating thermal processes and energy conservation, wider usage of CALS-technology, solar power engineering, realization of public space exploration program. These tasks are beyond the scope of the National Program of Innovation Development targeted for 2010, they are set for medium- and long-term perspective.

Biotechnology

Today, our scientists cooperate in this area with industrial enterprises of 11 ministries and departments of the country. By 2010, it is planned to build 2 new production facilities, to develop 39 technologies, 253 new technical units, 38 preparations, 29 varieties of crops. The results of this research will cover 70% of the demand for domestic diagnostic preparations for most common infections (now 30—40%), reduce imports, lay the basis for biological security system of Belarus. The project of the National Program "Innovative biotechnologies" aimed at cardinally modernizing this sector using the developments of Belarusian scientists and advanced world approaches sets this as its target.

New Quality of Development of Agricultural Sector

Scientist lay down the foundation of the competitive power of Belarusian agriculture for the long-term perspective. Eighteen new production facilities, 14 innovation technologies, 590 types of machines and equipment, materials, breeds of livestock, new plant varieties, foodstuff, veterinary preparations will be created in the next 5 years. NASB will provide for the plant breeding of original seeds and supply of elite (5.5 thousand tons per year) and high reproductions of seeds of cereal crops and grasses. Four centers of hybrid selection are in the Academy of Sciences. These are new R&D facilities that will accelerate the development of new varieties

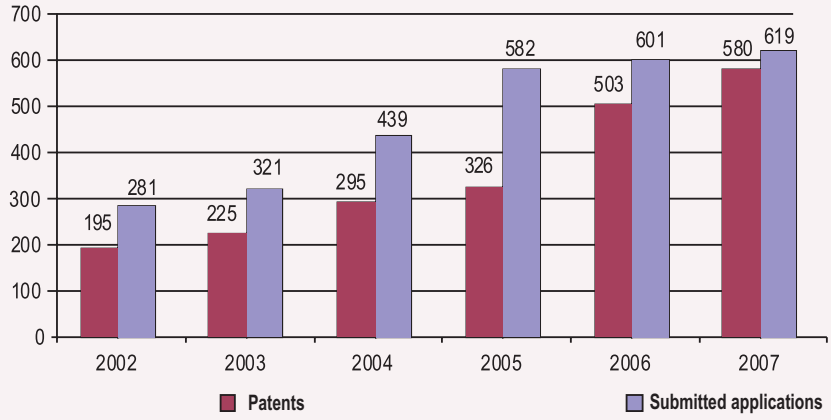


Fig. 3. NASB patent applications and industrial patents in 2002—2007

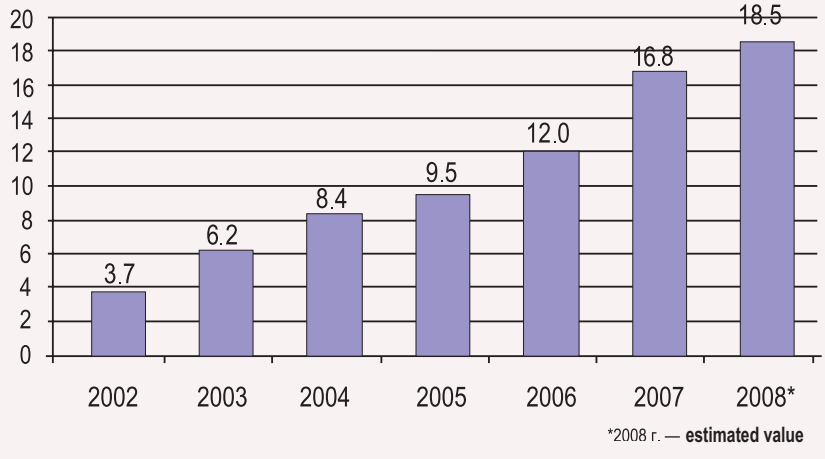


Fig. 4. Export of works (services) under foreign contracts in 2002—2007, grants, million US dollars

Samples of crude oil from Belarus oilfield

New crop varieties created in NAS of Belarus SPC of Agriculture

and breeds. The available potential will cover 50% of country's demand in stores, the dairy herd of Belarusian breeds with productive capacity of 12—15 thousand kg of milk annually against present 7—8 thousand kg. The Vitebsk biological factory and NASB will cover 70% of the demand in veterinary preparations and drugs. More than a half of them have been developed by the scientists of the Academy. The similar situation is with pesticides. These two projects will help save USD 200 million of import annually.

Innovation Technologies in Power Engineering Sector

The Academy of Sciences focuses on scientific support of tasks set in Directive No.3 of the President and the Concept of energy security and promotion of energy independence of the Republic. Scientific support of nuclear power engineering is increasing with every year. A comprehensive scientific program has been developed. The target is to find and introduce scientific and technical solutions for the optimization of technological processes ensuring higher nuclear, radiation and environmental safety, physical protection as well as effectiveness of nuclear-power engineering installations. Technologies and equipment for handling radioactive waste as well as other directions are followed.

There is a potential for upgrading thermal and electrical power generation. Technological problems of furnace, foundry and electroplating plants are worked out. There plans for design and manufacture of 80—90 new kinds of unique heat-and-mass transfer equipment and software tools for power consumption control.

We work intensively for developing the power engineering sector of the future. In the area of hydrogen power engineering, step by step introduction of new hydrogen storing technologies, local production of synthetic gas, domestic nanocatalysts for fuel elements. The scientists of the Academy develop industrial processes of semi-conducting solid solution films for solar energy conversion in visible and infra-red spectrum. Works on solar cells are performed within the framework of tasks of the Concept of energy security of the Republic of Belarus. Thin-film solar cell technologies compatible with silicon integrated circuit technologies are very promising. The Academy of Sciences worked out concepts of respective national programs and sent them to the Council of Minister for consideration.

New Chemicals and Chemical Technologies

There are plans for construction of four new and modernization of 30 existing production facilities. Fifty six new technologies and materials for the needs of enterprises of 5 ministries and departments are to be developed. Every ruble invested in the introduction of inventions yields annually BYR 6—7. This rate of return is achieved at technological levels V and VI. Enterprises of the "Belneftekhim" Concern are the leaders of economy, they are major consumers of intellectual products of NASB. Scientists and specialists of the branch develop new granular potash fertilizers with improved physical-mechanical and agrochemical properties; potassium mineral enrichment technologies have been implemented, manufacturing of mix diesel bio-fuel based on products of rapeseed oil processing has been started, production of chemicals for plant protection has been organized. New types of foaming agents for porous concrete production, raw material hardening agents for cement and concrete production have been developed for the Ministry of Construction and Architecture's enterprises; inhibited anti-icing materials were developed for the Ministry of Transport.

Research activities of the Academy of Sciences are focused on manufacturing and technologies of small-scale production of chemicals to replace imported polymeric construction materials and household chemicals on the consumer market.

Laser and Optoelectronic Systems, Radio-Electronic Instrument Making

The program "Electronics and Optics" envisages construction of 8 new production facilities for the needs of national economy, 26 existing productions will be modernized, 43 innovative technolo-

gies, 210 units of innovative equipment are being developed. Development of epitaxial heterostructures for SHF, laser and LED technology, development of radar of super-high and ultra-high frequencies are the major projects. A wide range of technologies and equipment has been created for industrial sector, new laser apparatuses passed clinical trials for medicine. Innovation offers include manufacturing of chips for RFID-tags, GIS and GPS.

LED Technology

Modern LED devices for new market demands are among strategic priorities. Science in this case should support technological level IV, Fundamental developments providing for the design of heterostructures, personnel potential and manufacturing capacities are available. Jointly with Philips, NASB works on terms of reference for the relevant business project. There are plans for construction of lighting and information LED systems. This area is very promising for energy saving. In fact, new industrial sector will be built in the country.

State-of-the-Art Materials

Material science is of paramount importance for Belarus. It is planned to build 42 new production facilities, 63 technologies, more than 500 new models of machinery. Export of new products will exceed USD 150 million a year. Nanomaterials and nanotechnologies are widely used in industry. Development of extra-hard plates, cutting tools and grinding materials for Ministry of Industry, Ministry of Construction and Architecture, Ministry of Health and “Belneftekhim” enabled to implement more than 300 items of tools, 200 more will be introduced in 2009. In 2007, 70% of domestic demand was satisfied by local production, amounting to BYR 5 billion annually. Production of rubber ferrites from waste of the Belarusian Steel Works is one of the top priorities. This production will cater for 90% of the demand for ferrite materials in the local market.

Mass production of exhaust gas neutralizers for diesel engines using nanostructural materials developed in the Academy of Sciences, will increase the competitive power of Belarusian carriers. They ensure the reduction of gas toxicity to Euro-3 and Euro-4 standards.

New techniques of creating high-qualitative membranes for treatments of water from surface sources are 6 times cheaper in capital investment and 2.5 times cheaper in production. Only few companies in Germany, Japan and USA possess these nanotechnologies.

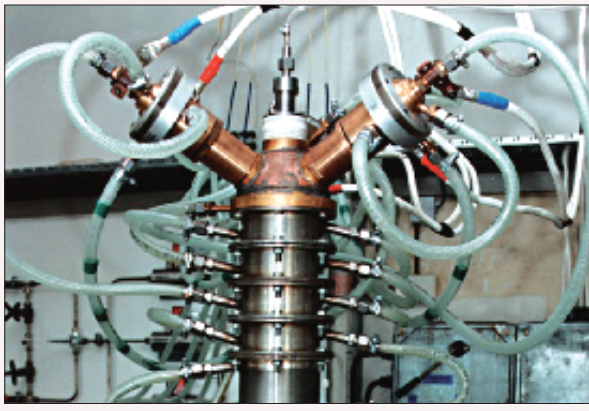
IT and CALS Technology

Fresh impetus in quality and quantity is needed for production and public life informatization. Our age is an epoch of scientific knowledge and information technologies. Without their accelerated application one should forget about the growth of competitiveness and labor productivity. Introduction of these technologies are beneficial for both industrial and public sectors. Our goal is to reduce by 2010 by one third the time and cost of preparation of documents and development of innovation products manufacturing by 30 percent due to introduction of IT. In the near future, it will be practically impossible to export many products without accompanying electronic documents in accordance with international CALS standard. We must have them for not less than 80 percent of goods and ensure information support of commodity distribution network based on CALS technology for all major productions. The scientists of NASB work out these problems in close contact with the specialists of practical sector of the economy.

Space Exploration and Earth Remote Sensing

In the fourth quarter of 2008, National Program of Space Exploration and Use in Peaceful Aims for the period of 2008—2012 was approved by the Council of Ministers and has been put into effect. This significant systemic project implemented under the aegis of the Academy includes such scientific and technical activities as creation of space vehicles, their basic elements and technologies, development of ground infrastructure for analyzing information received, development of satellite navigation systems

Several foreign-policy actions on joining international organizations in the area of space exploration by Belarus were worked out. Moreover, measures on legal regula-



Equipment for hazardous chemical wastes utilization

Products of SSPA of Powder Metallurgy

tion and personnel availability ensuring the process of formation of a branch being new for Belarus were envisaged.

As a whole, information technologies are developed by the scientists of NASB in the interests of hundreds of enterprises and organizations subordinated to 8 ministries.

Innovations in Machine Building Industry

We plan to build 6 new production facilities, introduce 30 innovation technologies, 600 items of new machinery. Import substitution gains will make up not less than USD 50 million per year. For the first time in Belarus 5 new models of trailing and artic trains, latest generation of buses, new models of "Belarus" tractors, 7 new models of agricultural machinery, 5 models of dump-trucks, 2 new models of tractor and automobile diesel engines of Euro-3 and Euro-4 level, 612 machine tools, machines, presses, machining centers, 2.5 thousand tools will be developed.

Public Health and Innovation Technologies in Medicine

Science intensity of this branch is comparable only to space exploration, and has always been in the center of attention of Belarusian science. "Zdorovie" SITSTP is directed to obtaining new knowledge about the origin and development of the most widespread human diseases, development of technologies of their diagnostics, treatment and prevention. With the help of scientists it is planned to build 2 new and modernize 3 existing medical equipment and pharmaceutical facilities; more than 100 new technologies of treatment and diagnostics of cardiovascular, oncological, hematological, endocrine, immunodeficiency and other diseases including surgical methods and transplantation will be developed. NASB researchers collaborate with the scientific branch of the Ministry of Health for working out problems which will define future and competitiveness of our medicine.

Contemporary Methods, Equipment and Accident, Fire and Disaster Prevention Monitoring Facilities

Among the programs being realized by the scientists, one should note "Technologies of emergency prevention and liquidation" SITSTP. Inter-sectoral problems of software and software tools for simulation of blasting dynamics and explosion effects, chemical-engineering production risk assessment, model of impurities transport on the territory of Belarus and bordering countries have been solved. Based on the research of local minerals structure and properties, super dispersed filling agent for dry powder fire extinguishers, a system of minimization of fire effects in the forests and peat bogs have been developed, domestic equipment for Belarusian rescuers has been designed.

Environmental Imperative of Social and Economic Development

Within the framework of "Nature management" SITSTP, for the needs of 8 ministries and branch departments, geological study of Earth interior aimed at developing mineral and raw materials base of the country is performed, scientific problems related to forestry, including radioactive contamination of forests, geochemical land geophysical control of underground storage facility maintenance are worked out, technologies of fuel and energy plantations of rapid-growing woody species, high growth wood species as a source of raw materials are developed. By 2010, more than 20 innovation technologies, about 50 new machinery items will be created.

Hence, with the implementation of 11 SITSTPs will enable us to establish 84 new production facilities, to develop 389 innovation technologies and more than 2 600 new pieces of machinery by 2010. The Academy of Sciences worked out proposals for another 16 innovation manufacturing facilities for the consideration of the Council of Ministers. They include pilot production of genetically engineered biological preparations for prevention and diagnostics of diseases of farm animals and poultry; solar cells and photovoltaic systems production, LED and LED-based production, large hot galvanizing plant for steel structure protection, integrated circuits production for RFID-tags, equipment for their processing as well as creation of intellectual documents and commodity flow monitoring systems on their basis; production of surgical sutures, woven and knitted articles for medical purposes, feed tryptophan and threonine amino acids to meet the needs of domestic market and for export, etc.

Benefits from the development of projects proposed and implemented by NASB, exceed significantly the planned costs, and no wonder, innovation production of advanced industrial structures is characterized by the highest added cost. We realize that the goals which we set are extremely complicated and hard to achieve. It might be that for the first time the scientific community of the Academy is faced with a serious task: do the work one is ready to do along with the work required by the motherland. We do not declaim, we state that the top national scientific institution has responsibility to its nation. Within the next few years we will have to work hard in order to create effective national innovation system, to fit harmoniously all scientific institutions in it for working out major strategic goals of the country development both currently and in the future. The National Academy of Sciences of Belarus works hard to meet the challenge, proposes new forms of integration of science and production, takes responsibility for coordination and actualization of all scientific research and developments in the country.

JOINT INSTITUTE OF MECHANICAL ENGINEERING OF NATIONAL ACADEMY OF SCIENCES OF BELARUS

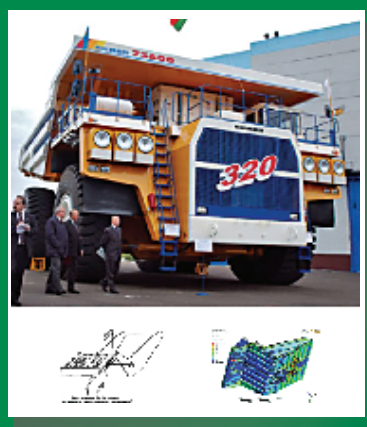
SCIENTIFIC-ORGANIZATIONAL INTERACTION WITH MANUFACTURING ENTERPRISES

MINSK AUTOMOBILE PLANT (MAZ)

MINSK TRACTOR PLANT (MTZ)

MINSK WHEELED TRACTOR PLANT (MZKT)

JOINT INSTITUTE OF MECHANICAL ENGINEERING OF NAS OF BELARUS



BELARUSIAN AUTOMOBILE PLANT (BELAZ)

MINSK MOTOR PLANT (MMZ)

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Reliance on High Technologies

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Corresponding Member

The Department of Physics, Mathematics and Informatics of the National Academy of Sciences of Belarus coordinates fundamental and applied work on priority scientific directions with account of the world science trends, available potential and the country's economy demands. The Department includes 3 state research institutions.

B.I. Stepanov Institute of Physics carries out research in the field of laser physics, nonlinear and quantum optics, creates new laser optical devices and technologies for industry, medicine, ecology, control systems, metrology and certification. It is engaged in the development, introduction of optical methods of research into the properties of molecular structures and nanomaterials and their production methods. Much attention is given to plasma physics, development and practical application of plasma technologies. Physical and technological foundation is being laid for the creation of competitive products of micro-, opto- and nanoelectronics. Research into particle physics, fundamental interactions, nuclear reactions and nuclear spectroscopy is underway.

Among the most important results of fundamental research obtained in recent years, it is necessary to mention as follows:

- creation of the world-first semiconductor heterostructure lasers working in the blue region of the spectrum and a laser source converting blue radiation into green light. This opens the door to building new integrated optoelectronic systems;
- obtaining, for the first time in the world, continuous generation in a SRS laser based on crystalline scattering media. Devices based on these media hold much promise for biology, medicine, and spectroscopy. There were also suggested and implemented methods of SRS-conversion of the radiation frequency of microchip lasers excited by continuous emission from laser diodes;
- development of original methods for obtaining and nonlinear transformation of Bessel light beams and other beams of nontrivial structure, which provides fundamentally new opportunities for practical application of laser radiation in medicine, profilometry, inspection of microelectonic products and in other fields.

The work of the Institute's researchers is aimed not only at solving fundamental physical problems but also at creating new knowledge-intensive products and technologies. For example, the created high-sensitivity methods of laser atomic spectral analysis may be used for the study of cultural heritage objects, attribution of the exhibits of the National Arts Museum and the State Historical Museum as well as in criminalistics.

Over 500 pieces of laser optic devices developed by the researchers and designed for treating a wide range of diseases were supplied to medical establishments of our country. They are *Rodnik-1, Aibolit, Seans, SNAG, Malysh, Romashka* — totally to more than BYR 2.5 billion. Introducing *Malysh* apparatuses into medical practice fully satisfied the country's demand for high-effectiveness devices for treating icterus of the newborn while the *Romashka* complexes considerably increased the treatment effectiveness in patients suffering from different kinds of wounds, traumas and pathologies.

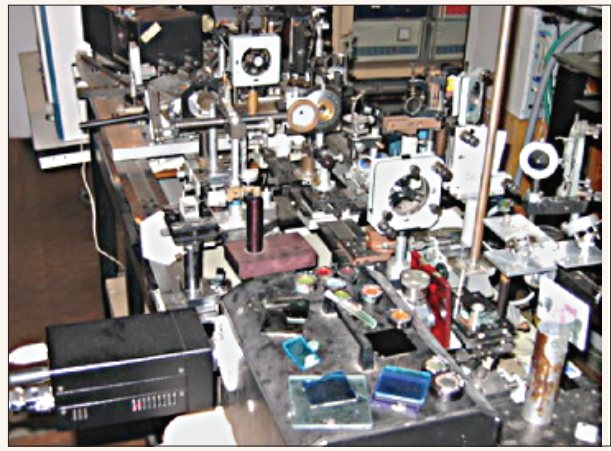
LED-type illumination, signaling and information devices are manufactured for enterprises of Belarus and Russia. A laser vision system for heavy-duty trucks operating in inclement weather conditions is being developed for BelAZ. For the Department of State Marks of the Ministry for Finance of the Republic of Belarus, there were created and introduced new methods and technologies for protecting securities, documents and goods. Two types of conventionally eye-safe laser radiation sources are being designed jointly with the UE *LEMT* and *Peleng* PLC for the needs of the defense complex of the country. The Ministry for Nature and Environmental Protection is interested in the regularly conducted lidar monitoring of the atmosphere and transboundary pollution of air.

The Institute of Physics actively participates in international scientific-and-technological cooperation. Only during the recent 2.5 years, over USD 2.5 million have been attracted from foreign countries for funding different projects.

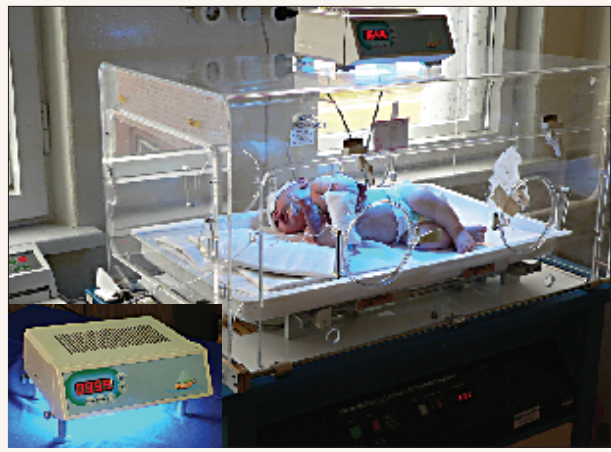
Research workers from the **Institute of Mathematics** are engaged in fundamental research in the field of algebra, geometry and theory of numbers, differential equations, system optimization and control methods, functional analysis, numerical mathematics, discrete models and algorithms, probabilistic/statistical analysis and theory of random processes. The investigations carried out by the researchers are aimed not only at the development of fundamental mathematical problems. New mathematical models and methods are being created for solving urgent applied problems occurring in cryptology, physics, mechanics, microelectronics, technology, economics, ecology, medicine, oil-processing industry, metallurgy, construction, logistics, and theory of traffic networks as well as in designing and operating emergency-protecting systems and in other fields.

The researchers of the **Joint Institute of Informatics Problems** have received a series of significant fundamental results in complex system modeling, image processing and pattern recognition (in industry, medicine, data of remote sensing of the Earth), text-to-speech synthesis; analysis methods for complicated nonlinear dynamic systems were created, etc. These scientific results are being successfully introduced at Belarusian enterprises. Over 40 medical establishments were equipped with more than 700 automated workstations which encompass all levels of activity, beginning with a separate workplace for a doctor and ending with a system for an entire region which helps improve the diagnosis quality, relevancy of medical decisions, cost efficiency and treatment-and-diagnosis effectiveness.

Jointly with Belarusian medical scientists, there was developed and put into permanent operation a CIS-unique distributed telemedical system of digital on-line fluorography based on the



The model of the femtosecond SRS-amplifier on a Raman-active crystal



***Malysh* apparatuses for treating icterus in the newborn are widely used in maternity hospitals of the country**

The lidar complex of the Institute of Physics is among the world's best ones

2nd city TB dispensary and 20 Minsk city out-patient clinics. It improves early detection of lung diseases. So far, there have been conducted over 100 thousand telemedical consultations and the system is expected to encompass the entire capital. Its core is a supercomputer of the *SKIF-Triada* personal clusters family, created jointly with the Research Institute of Electronic Computer Machines within the framework of the *Triada* program of the Union State of Russia and Belarus and exhibiting a range of performance between 50 and 500 Gflops. Earlier, the researchers of the Institute had made a significant contribution to the creation of the *SKIF* supercomputer, some models of which were on current lists of the world's top performance computer systems.

The first phase of an integrated information and organizational-and-technological structure of virtual business processes in the field of design, preproduction engineering, control, sale and use of products was developed within *CALS-Technologies* state scientific-technical program (to the order of the Ministry of Industry).

The Joint Institute of Informatics Problems is developing digital ground mapping technologies for the navigational survey service of the Armed Forces of the Republic of Belarus.

There was created and put into service the national automated information system of forming and keeping a record library and automated record banks for the Ministry of Internal Affairs. Its first phase encompasses 58 Ministry's subdivisions located in 30 towns and cities. This system is expected to cover all the regions of the country.

It is necessary to point out the coordination and performance of work in the field of space problems. Jointly with interested organizations, ministries and departments, the Institute formed and the Council of Minister approved the *National Program for Exploration and Use of Outer Space for Peaceful Purposes for the Period of 2008—2012*; there started the execution of the new *Kosmos-NT* program of the Union State of Russia and Belarus; works on the creation of the Belarusian space-based system of remote sensing of the Earth are in progress.

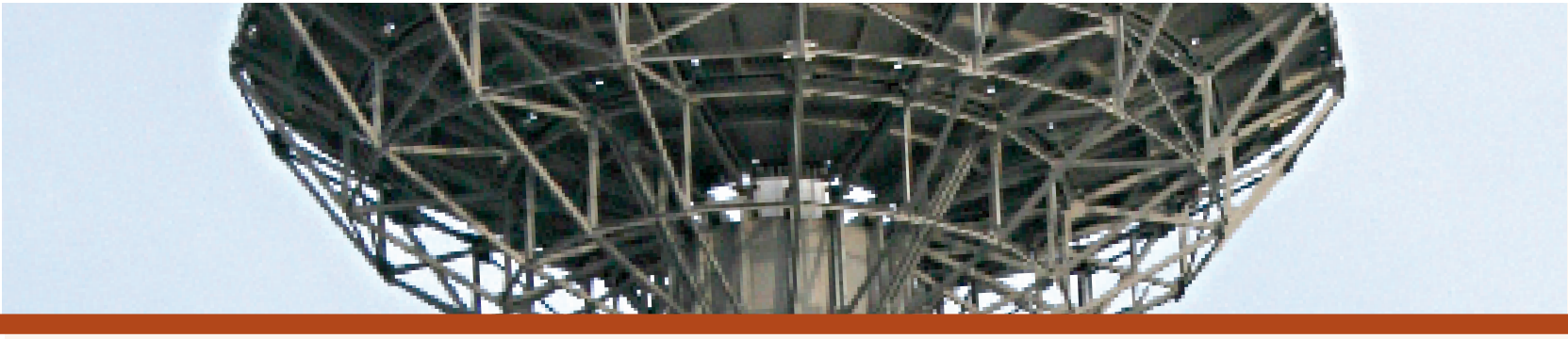
The Department also incorporates two research engineering republican unitary enterprises which deal with practical implementation of the research results.

The Research Engineering Republican Unitary Enterprise *Geoinformation Systems* created hardware/software complexes for processing satellite information designed for spotting forest and peat bog fires, controlling aerosol and gas contamination of the atmosphere, analyzing the environment after accidents aggravated by the emission of toxic substances; tools for generating digital elevation models, updating digital maps and plans. There were developed technologies for forest resources assessment, monitoring and remote sensing of forests, forest management on the Belarusian and Russian territories contaminated with radionuclides, the basic module of a corporate geoinformation system for use in the state system of prevention and elimination of emergency situations at a national, regional, district and object level.

The Inter-Branch Scientific-Practical Center for Identification and Electronic Business Operations performs a complex of technological works on managing databases of goods marked with barcodes or radiofrequency identification tags. Service is provided to over 2.7 thousand Belarusian manufacturers who mark their products with international barcodes and the barcode depository contains about 3 million item names. The Center has formed the country's first test laboratory for barcode verification and a pilot system of logistics which provides warehouse logistics and logistics of goods and packing marked with RFID tags.

The research organizations of the Department of Physics, Mathematics and Informatics perform works on 206 assignments of state programs of fundamental and applied research, 175 projects of the Belarusian Republican Fundamental Research Fund. They coordinate the state programs *Electronics, Photonics, Fields and Particles* (the head organization is B.I. Stepanov Institute of Physics), *Mathematical Models* (Institute of Mathematics), *Infotech, Reducing Emergency Situation Risks* (Joint Institute of Informatics Problems). These Institutes have research councils on corresponding programs. The Department researchers are also carrying out about 240 scientific-technical developments. In 2007—2008, they published 24 monographs, 17 textbooks and training aids, 23 collections of scientifik papers, over 1650 research articles and reports, about a thousand of paper theses; defended 7 doctoral and 26 candidate's dissertations. They filed about 200 applications for a title of protection for industrial property objects and obtained 180 positive decisions.

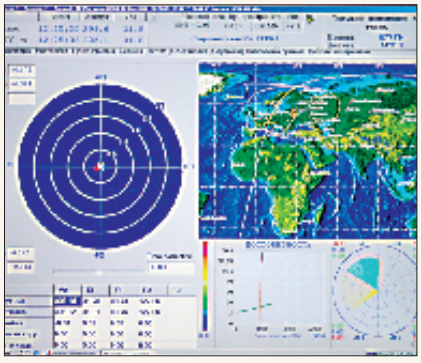
The strategic task of scientific provision and development of the scientific and innovation sphere of the country is still topical in the plans of the research organizations of the Department of Physics, Mathematics and Informatics for 2009. It will be necessary to focus the scientific potential on fundamental and applied research in the field of optics and laser physics, electronics, plasma physics, molecular physics, physics of fundamental interactions, fundamental and applied mathematics, information technologies. These are the directions on which financial, material and human resources should be focused.



Scientific and Engineering Republican Unitary Enterprise

Geoinformation Systems

The enterprise was set up in 1996 on the basis of the laboratories and departments of the Institute of Technical Cybernetics. Its researchers participated in the realization of the State space research program, joint Belarusian-Russian programs *Kosmos-BR* (1999—2002), *Kosmos-SG* (2004—2007), started execution of the *Kosmos-NT* program (2008—2011). This enterprise is one of the main developers of the Belarusian space-based system of remote sensing of the Earth and was appointed its National Operator in 2004. There were created new processing and use technologies of satellite information, modernized the existing and mounted new ground facilities for receiving this information from flying satellites as well as from those which are planned to be put into orbit. The organization acquired operating control of the unique equipment of the Satellite Information Receiving and Processing Center including receiving stations equipped with dish antennas having 1.2 m, 3.7 and 9 m in diameter and providing stable reception from space vehicles (SV) of remote sensing of the Earth (RSE) of low, medium and high resolution. The enterprise provided technical supervision of the creation of the first home-produced space vehicle *BelKA* and is currently designing and constructing a new, higher-performance vehicle. Jointly with the organizations of the Federal Space Agency of Russia, it is putting into service a ground-based complex for SV RSE control from the territory of Belarus, which is part of the Flight Control Center and Command-and-Measuring Post.



Under investigation are also problems of designing a promising SV RSE with a resolving capacity below 1 m and a communication SV for improving all kinds of communication and navigation in the country.

In addition, there were developed hardware/software complexes (HSC) for processing satellite data for spotting forest and peat-bog fires, controlling pollution of the atmosphere, for the needs of digital mapping, agriculture, water management, ecology, etc. For chemically hazardous objects, there were proposed HSC providing early detection of accidental discharges of dangerous toxic substances (ammonia, chloride, etc.), collection and processing of weather data at an accident site and during an accident, forecasting the size and dynamics of a damage volume; informing the Operations Control Center of the Ministry for Emergency Situations and providing decision-making support to duty personnel. Since 2004, over 100 enterprises of Minsk and other cities of the country have been equipped with such complexes.

There were created information-cadastral systems of gas transportation networks of the cities of Gomel, Mogilev, Grodno and Brest. Software for updating the databases of the geoinformation system of the Gomel Region State Town-Planning Cadastre was introduced.

Nanophotonics: Current State and Prospects

Nanophotonics as a new branch of science emerged at the interface of optics, laser physics, materials science, physical chemistry, physics and chemistry of solids. It deals with the propagation, transformation, emission and absorption of optical radiation in nanostructures and aims at using the peculiarities of interaction between radiation and matter in technology: from communication systems to biosensors and biochips.

If the characteristic size of inhomogeneity in nanostructures approaches de Broglie wavelength of an electron in crystals (2—10 nm), there occurs spatial confinement of electron motion or if it is close to the electromagnetic wave length (400—700 nm for visual range), confinement of electromagnetic wave propagation is observed. Nanophotonics is underlain by several deep physical phenomena and effects which caused the formation and separation of this interdisciplinary field as a serious independent trend of modern science and technology. These are quantum dimensional effects in solid-state nanostructures and nanoparticles of several nanometers in size, localization of electromagnetic radiation and occurrence of optical analogs with respect to electronic phenomena in solids in nanostructured dielectrics, formation of electromagnetic field singularities and densities of states in metal-dielectric nanostructures, probability change of quantum transitions under spatial confinement of electromagnetic waves. In the near future, the nanophotonics development is expected to result in the creation of optical microcircuitry engineering, micro- and nanolasers, effective light modulators and selector switches, luminescent materials, etc.

Over many decades, research in the field of nanophotonics developed within the framework of different fields of science without identifying itself as belonging to nanotechnologies and long before the appearance of this "brand" in the scientific and technical lexicon. In Belarus the precursors of systematic work in the field of nanophotonics were the works carried out by Academician F.I. Fyodorov and his school on the electromagnetic theory of emission in complex media and at their interface (1950—1960), research on the photonics of biomolecules started by A.N. Sevchenko and continued by his numerous followers (it is exactly in this sphere that the term "photonics" occurred for the first time in the Russian-language scientific literature), the construction of the theory of interaction of radiation with matter (Academicians B.I. Stepanov, P.A. Apanasevich and their followers), investigations in the field of semiconductor optics, colloidal chemistry (the schools of Corresponding Member V.P. Gribkovsky and Academician V.V. Sviridov), development of electrochemical processes of obtaining nanoporous materials and basic powder metallurgy and ceramics technologies (the schools of Academicians V.A. Labunov and P.A. Vityaz), creation of scientific foundations for producing new materials under extremal actions at the Institutes of Physics and Heat and Mass Transfer of the National Academy of Sciences.

Today, Belarusian scientists working in the field of nanophotonics are well-known worldwide. Their articles are published in the best international journals, they present their papers at prestigious conferences; they have obtained many priority results.

Systematic investigation of the optical properties of semiconductor nanocrystals has been carried out in our country. It allowed a change from fundamental to applied research aimed at obtaining new materials, laser technology components, biomarkers and biochips. These works were further developed at NASB organizations, Research Institute of Physico-Chemical Problems and Research Institute of Nuclear Problems of the Belarusian State University, Research Institute of Optical Materials and Technologies of the Belarusian National Technical University, and Grodno Ya. Kupala State University. Simultaneously, methods of generating nanoparticles and other nanostructures by using laser-plasma processes are being developed at the Academy of Sciences.

Belarusian specialists are actively involved in the study and creation of photon crystals, which implies matter structurization on a light wavelength scale for achieving manifestation of new optical properties. Researchers from B.I. Stepanov Insti-

tute of Physics jointly with the Research Institute of Powder Metallurgy proposed synthesis methods of dielectric nanostructures with 3D periodicity based on colloidal crystals; researchers from the Belarusian State University of Informatics and Radioelectronics suggested methods for generating 2D periodicity structures by means of electrochemical processes and methods for "building-in" phosphors into these structures, which is important not only for fundamental research on the interaction of light with matter, but also for practical use of nanostructures in displays, light sources and converters (N.V. Gaponenko and co-workers).

In the study of interaction of light with matter, a special place belongs to the understanding of the dynamics of quantum transitions in photonic crystals. Researchers from the NASB Institute of Physics constructed a consistent quantum-electrodynamic theory of light emission in photonic crystals (Prof. S.Ya. Kilin, Prof. D.S. Mogilevtsev), carried out experimental studies of the dynamics of quantum transitions in photonic crystal colloidal structures, are developing the theory of resonance and Raman scattering of light in nanostructures. Among theoretical investigations, worth mentioning is also the creation by the researchers of the Institute of Molecular and Atomic Physics (IMAPh) of the theory of radiation propagation in ordered disperse media with account of multiple scattering and interference of scattered waves (A.N. Ponyavina and co-workers), creation of the theory of planar photonic crystal waveguides which allow light flux manipulations in microdevices (A.V. Lavrinenko and co-workers, BSU).

The development of the photonic crystal concept also influenced such a traditional applied optics sphere as thin-film and layered-medium optics. In recent years a method has been proposed and implemented for creating planar wide-angle dielectric mirrors, a theory has blen developed of wave propagation in media

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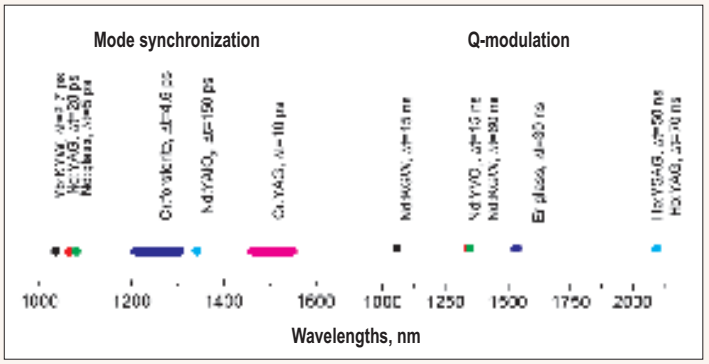
Corresponding Member

with fractal geometry (BSU and IMAPh), optimized methods for producing thin-film nonlinear optical elements (Institutes of Physics and Applied Optics, NASB, A.P. Voitovich and A.V. Khomchenko with co-workers). Systematic research on ultrafast processes in nanostructures with femtosecond time resolution was started (S.A. Tikhomirov and co-workers).

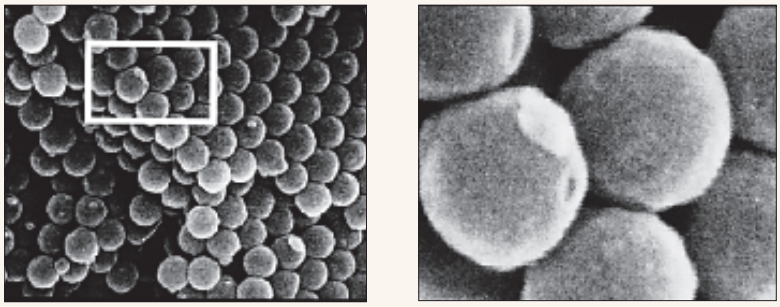
In modern nanophotonics, a significant place is occupied by a purposeful study of optical processes in metal-dielectric nanostructures. Such nanostructures allow locally inducing a giant electromagnetic field due to size-dependent plasmon resonances in metal nanoparticles and excitation of surface plasmon modes. Under the guidance of Prof. S.A. Maskevich, researchers from Grodno Ya. Kupala State University developed practical methods for creating active metal dielectric nanostructures where the intensity of Raman scattering of light is increased by several orders. It is essential for high-sensitive spectral analysis in ecological, medical and biological research.

Special emphasis should be laid on the high creative tonicity of Belarusian scientists in the field of nanophotonics. In recent years, several literally brilliant doctoral theses have been defended (A.N. Ponyavina, A.V. Lavrinenko, D.S. Mogilevtsev). At the Institute of Physics alone, three talented young researchers became Candidates of Science in the year of the 80th anniversary of the National Academy of Sciences.

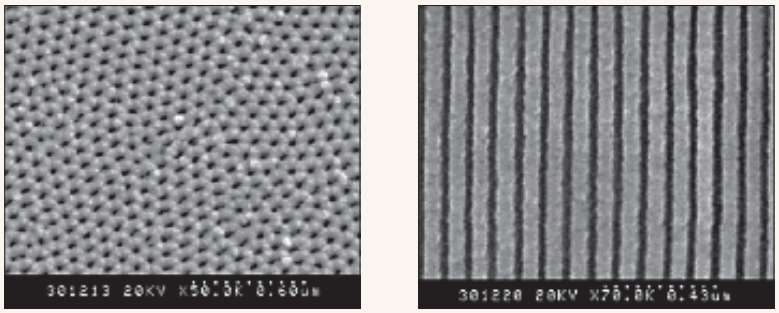
The above review of the research directions in the field of nanophotonics is the evidence of a significant contribution of the Belarusians to this branch of science and technology which is proved by the frequency of citing their works in world literature and their participation in international projects. According to Thomson Scientific, our country ranks 20th in aggregate citation in the field of nanocrystals, 16th in photonics as a whole, and 6th in the sphere of photonic crystals. Belaru-



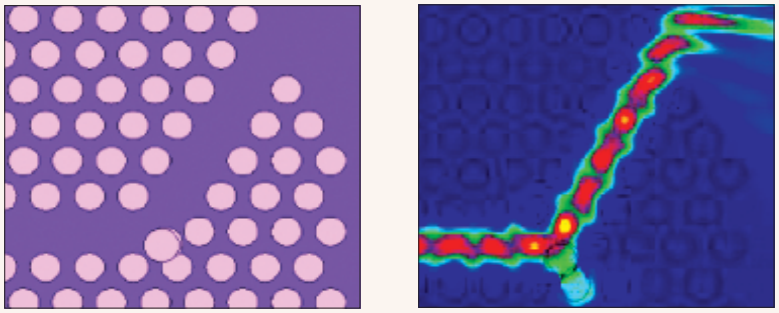
Duration of light pulses and emission spectra of new solid lasers employing semiconductor nanocrystals (results were obtained at the Research Institute of Optical Materials and Technologies of BNTU)



Self-assembly of dielectric nanoparticles into a structure of a "photonic crystal" type (B.I. Stepanov Institute of Physics jointly with the Institute of Powder Metallurgy)



Nanoporous aluminum oxide is used for creating new light-emitting structures (the Belarusian State University of Informatics and Radioelectronics)



Planar photonic crystal waveguide: geometrical construction (on the left) and calculated intensity of electromagnetic field (on the right). Calculations by A.V. Lavrinenko (BSU)

sian researchers are participants of the European Nanophotonics Network created within the VI Framework Program of EU; they participate in its sections, have executed several ISTC and about 10 INTAS projects.

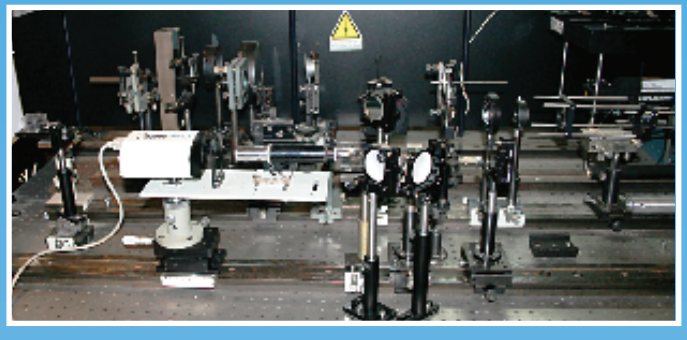
Many specialists think that the scale of long-term technological and social impact of future development of nanophotonics may be equal to the influence semiconductor electronics had on the technological advance and improvement of the quality of life. In this context, it would be expedient to discuss possibilities of practical realization of the knowledge accumulated in Belarus and its commercial application. From the viewpoint of sensitivity and readiness of results for implementation, the first place apparently belongs to laser optics industry, which is quite natural since it is exactly at the interface of optical and laser research that nanophotonics arose. The Belarusian laser optics branch complies with the world standards, exhibits sustained positive dynamics and has a pronounced export potential. This is due in many ways to the decisive role the National Academy of Sciences has been playing in the birth and development of laser technology production in our country. The branch dealing with the production of state papers and securities is also adoptive to nanophotonics achievements. This direction also arose owing to the activities of the Academy of Sciences, primarily, the Institutes of Physics, Molecular and Atomic Physics, General and Inorganic Chemistry. However, despite the importance of this sphere for state needs, it does not have an independent economic value and export prospects. The third place in our forecast is occupied by electronic and optoelectronic technology which can be proposed new display components, spectral converters for silicon photodetectors and solar cells. This branch has a high export potential but development of new technologies in optoelectronics requires heavy investments. The decision to build a plant for manufacturing light-emitting diodes in our country will certainly cause a demand for many developments in the field of luminescent materials and light sources. The world market of such articles is practically insaturable in the next 10—20 years. At the same time, the development of the production of photonic crystal components and optical micro- and nanoswitches for microcircuitry in Belarus is apparently possible only with a serious cooperation with leading states because of the high costs of industrial submicron technologies, which is calculated in billions, and the necessity of functional and technological integration of products into an end product. And, finally, home-produced biomedical applications will be introduced into practice. Though, because of the specific character of this branch and inaccessibility of foreign markets for our medical developments, it makes sense to orient towards the CIS region.

NASB B.I. STEPANOV INSTITUTE OF PHYSICS

Optical diagnostics laboratory offers

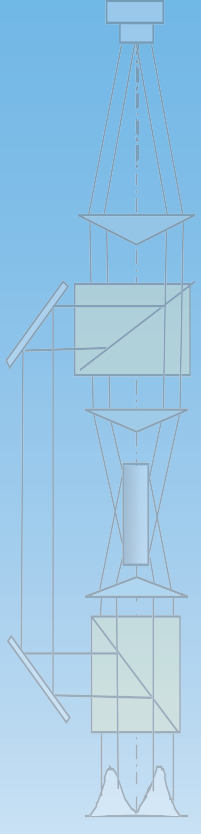
OPTICAL PROFILOMETER

This device provides diagnostics without employing light beam scanning. It is used for express analysis and control of manufactured goods at engineering works.



STEP-TYPE PHASE POLARISCOPE

This device is designed for quality control of polycrystal silicon slabs (wafers) and solar cells. It is expected to be used in a production line for rejection of defective solar cells in the process of mass production. An improved version of the device will be introduced to the market next year.



THERMO-OPTICAL SPECKLE PHOTOMETER

This device provides contactless measurement and diagnostics of mechanical and thermophysical properties of metal articles, such as hardness, fatigue and heat conductivity.

INTERFERENCE PROFILOMETER

This device is used to measure surface parameters of microstructures to a precision of nanometer. The development advantage consists in the ability to operate under vibration conditions, inaccurate positioning of a sample and large working distances.

DOUBLE-PHOTON CONFOCAL LASER MICROSCOPE

This device is designed for intracellular diagnostics of changes in human tissues caused by ecological and radiological factors. It is helpful in revealing development mechanisms of diabetes and other diseases, controlling local drug concentration in a cell and optimizing a drug dosage in therapy.

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Innovative Developments in Engineering Sciences

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The organizations of the Department of Physical and Engineering Sciences (DPES), National Academy of Sciences of Belarus (NASB) have been building up its scientific potential and progressing in the main directions of fundamental and applied research to meet the needs of such critical sectors of the Belarusian national economy as the machine-building, power engineering, agribusiness, radio-engineering/electronic, chemical industries and others. Annually, new materials, state-of-the-art processes, devices and equipment are developed and implemented to satisfy their demand.

To strengthen influence of engineering sciences on development of the real sector of the economy, a number of actions has been taken: Scientific and Practical Center of Materials Science and Institute of Energy, NASB, have been established; State Research and Production Association (SRPA) of Powder Metallurgy, SRPA "*Tsentr*", Designing Republican Unitary Enterprise of Scientific Instrument Making and Experimental Design Bureau "*Akademicheskoe*" have been incorporated into the DPES, NASB.

Innovative Materials and Technologies

Developments of the SRPA Scientific and Practical Center of Materials Science, NASB, are being widely introduced and comprise as follows: innovative magnetic and piezoceramic materials and products for the radioelectronics industry, with 70—80% of its demand being met; synthesis processes for production of superhard tool materials which are applied at the largest enterprises (Minsk Tractor Works, Minsk Automobile Plant and Engine Plant); and production of micropowder diamonds. Magnetic separators for concentration of mineral ores and cleaning various loose products from impurities and also sensitive precision sensors supplied to Russia and other countries by the leading Belarusian enterprises are in a high demand in the market.

R&D in the sphere of nanomaterials and nanotechnologies being coordinated within the framework of the state integrated program of the same name have been intensified. Implementation of the program has resulted in development of over 270 units of innovative equipment, including 50 machines, equipment models and instruments, about 120 innovative materials and substances and over 50 processes. The Research and Production Private Joint-Stock Company Sinta commercially synthesizes nanodiamonds using the Center's developments and it has capacities to produce up to 2 tons of ultrafine diamonds. A number of results being critical in theoretical and practical terms have been obtained in the field of carbon nanotubes and fullerenes, superhard, high-melting and magnetic nanomaterials; polymer composites and films, lubricating and ceramic filtering materials for the machine-building, power-engine-

ering, transport, medical, electronic and chemical sectors.

Among the highly efficient technologies of the Physical and Technical Institute (PTI) commercialized by the Belarusian industry are as follows: automated cross-wedge rolling systems; laser systems for materials thermal treatment, cutting and welding; processes and equipment for pulse and magnetic abrasive machining, applying corrosion-resistant, heat-resistant and decorative coatings and aluminum waste recycling; processes for large-scale production of pistons with a reinforcing insert for high-power engines and so forth. The PTI is a developer and producer of a nickel-free high-strength cast iron, cast eutectic and antifriction aluminum and graphite materials. A number of studies is being conducted based on the contracts with organizations of Russia, Ukraine, USA, China, Switzerland, Poland and Latvia.

The V.A. Belyi Institute of Mechanics of Metal-Polymeric Systems has developed and introduced asbestos-free friction materials, metal-polymeric surface coatings, protective properties of which surpass those of any paint-and-lacquer coatings, and special-purpose composite materials (self-lubricating, wear-resistant, sound-proofing and filtering materials with high mechanical, thermophysical, electrical and other properties). Over 30 production shops and areas have been established to implement the PTI's developments and polymer coating application lines are in operation. The Belarusian Metallurgical Works commercialized the process of manufacturing friction materials and pioneered production of nearly 40 product items from them. The Belarusian Metallurgical Works plans to produce large-size parts for the automotive equipment and agricultural machinery. The estimated output may be not less than 5 thousand tons a year.

The Institute of Metal Technology (IMT) offered a number of highly productive and ecology-friendly processes which had been widely commercialized. This includes casting of copper-based alloys, reinforced copper chloride band for water-activable power sources, continuous cycle dip-forming process for production of cylinder liners for engines/pneumatic compressors, various piston and packing rings, manufacturing bimetallic castings with increased span of life, zinc anodes from waste for using in electroplating industry, aluminum-silicon alloys with nanostructured silicon, etc. The IMT produces cylinder liners and piston rings for the "Belarus" tractors and trucks of Minsk and Mogilev Automobile Plants and cast iron packing rings for the Belarusian engine repair enterprises and exports its products to Russia, Ukraine, Lithuania, China, Republic of Korea, India, Poland, Iran and Turkey.

The Institute of Technical Acoustics has synthesized a range of nickel-titanium-based shape memory alloys to be used in machine-building adaptive systems, robotics and medical industries. Techniques of producing coatings with low internal stress on bone implants and synthesis of such coatings with a regular mezostructure in magnetic fields have been developed. Layered ferroelectric materials maintaining performance characteristics up to a temperature of 900—1 200 °C have been developed. Processes and equipment for machining products from synthetic diamonds and hard alloys, shape cutting of sheet glass and glass packs, ultrasonic welding of thermoplastic polymers (vehicle beam deflectors) and manufacturing monolithic products of electronic technology (chokes and transformers) were introduced into production.

The Research Center for Resources Conservation has offered ecology-friendly cross-linked hot-melt adhesive and also filtering materials with degree of filtration up to 5 μm. A new research sphere has emerged here — foot biomechanics — to produce individual orthopedic products from fibroporous polymer.

Heat-resistant luminescent pigment for flexooffset protective ink. Product of the Institute of Chemistry of New Materials

Mogilevkhimvolokno OJSC-produced fiber dyed with the ICNM-developed fluorescent dyes (UV light)

The Institute of Chemistry of New Materials (ICNM) has proposed for the first time in Belarus a process for producing polaroid sheets for liquid crystal devices, latent image control instruments, polarization filters for optical and laser equipment used as a counterfeit protection means. The ICNM has also developed increased-reliability luminescent dyeing agents and pigments, which are used for production of protective dyes, fibers, and compositions and technologies for producing new water-soluble lubricating fluids.

Among the most efficient developments of the SRPA of Powder Metallurgy are as follows: production of strontium hexaferrite powders using waste (sludge) produced by pickling plants of the Belarusian Metallurgical Works at the Molodechno Powder Metallurgy Plant with an output of 500 tons/year; technology for producing parts of a Belarus tractor gear box synchronization unit to substitute the import of parts, thereby saving up to 8 million (in arbitrary units)/year and building up an export potential. The output of friction discs for the tractor transmissions of Minsk Tractor Works increased fivefold. Ceramic membrane filters with a nanoporous structure and ceramic membrane filter-based plants for ultrafiltration of process liquids at the Belarusian enterprises of metallurgical, chemical and electronic industries have been developed. Currently, activities are underway to launch a large-scale import-substituting production of a wide range of arc welding power supply units at Molodechno plant "Sputnik" with an output of 250 units of each model a year.

This year, the SRPA "Tsentr" accounts for over one third of the total NASB export. Jointly with researchers of the A.V. Luikov Institute of Heat and Mass Transfer and Physical and Technical Institute, the SRPA "Tsentr" has developed a basic model and commercialized production of an automated sheet metal plasma cutting system corresponding to the level of the best world models. The SRPA "Tsentr" incorporates an Innovation Incubator — a joint project of the UN Development Program and the Government of the Republic of Belarus — to promote small and medium business. A technology development zone is to be established using the SRPA "Tsentr" facilities in the near future to comprise the Minsk Free Economic Zone.

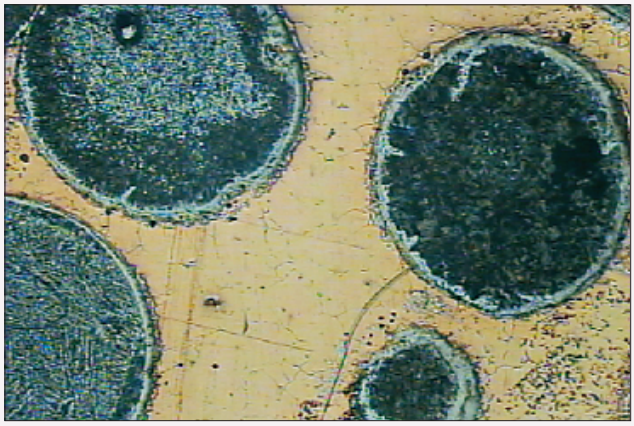
Machine-Building and Instrument Making

The software and results of designing a number of systems and load-bearing elements of the automotive equipment and techniques and software for simulating its traction and dynamic performance and fuel efficiency developed by the Joint Institute of Machine Building have been embodied in designs of the road-train models of various modifications, low-floor and super low-floor buses of the Minsk Automobile Plant and other equipment. Over 60% of the output of new equipment is to be exported.

Researchers of the Institute of Applied Physics have proposed 100 types of conceptually new patent-protected non-destructive testing methods and devices. This includes a computer-aided unit which has no analogues in the world to control properties of rolled steel moving on the production line, portable devices of the "*Impuls*" series to measure physical and mechanical characteristics of metal and industrial rubber goods, methods and devices for ultrasonic structurescopy and defectoscopy of castings, pistons and cylinder block liners, high-precision turn-to-turn short circuit/insulation quality control equipment, an eddy-current defectoscope for automated 100% control of defects of diesel engine cylinder liners on the production line and so forth.

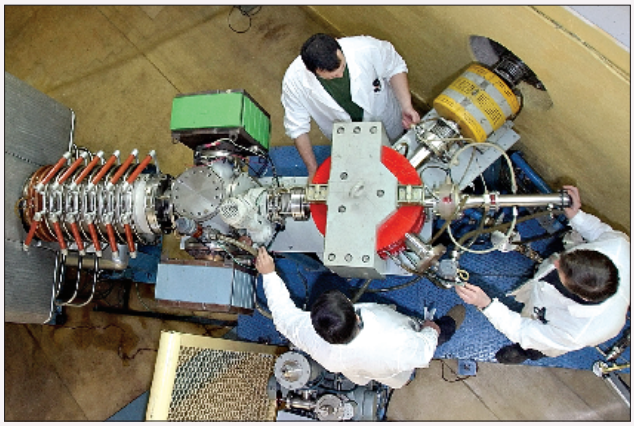
The Designing Enterprise of *Scientific Instrument Making* has developed a 2nd protection class laminar flow hood technical characteristics of which are on a par with the best foreign analogues. To prevent and treat a number of diseases, a transcranial pulse electrotherapy apparatus was developed.

Products of the Institute of Powder Metallurgy



Nanodiamonds

Giatsint physical-power nuclear reactor



NG-12-1 neutron generator

A number of models of parking terminals to be installed at the municipal parking lots has been developed on request of the Minsk Municipal Executive Committee.

Power Engineering and Energy Saving

The A.V. Luikov Institute of Heat and Mass Transfer has the following developments to offer: equipment systems for heat networks; a new class of filtration gas burners allowing up to 25% of fuel to be saved and harmful emissions to be reduced; steam and hot-water boilers with 60—90% efficiency; and wood impregnation processes increasing bio and fire resistance 4—6-fold. The chimney-type evaporative cooling tower projects saving up to 1 thousand tons of fuel/year at each power plant have been implemented at the Minsk Thermoelectric Plant No. 4 and at Grodno and Bobruisk Thermal Power Plants jointly with the Republican Unitary Enterprise BelNIPIEnergoprom (Power Engineering Research and Designing Institute). Over 20 timber drying plants were manufactured and put into operation in Osipovichi, Novogrudok, Borisov and Zhitkovichi forestry enterprises.

A series of advanced research has been conducted in the hydrogen energy field to result in the following developments: a process of thermochemical conversion of biomass to hydrogen and a basic design of a generator for commercial production of synthesis gas and pure hydrogen; a process of synthesis of nanomaterials for fuel cells that would reduce their cost by 25—30%; a technology of chemically-bound hydrogen storage, implementation of which could increase purity of produced hydrogen up to 99.95—99.98%.

The Joint Institute for Power and Nuclear Research *Sosny* (JIPNR) has developed a model of the Belarusian fuel and energy sector, methods of calculating and designing conceptually new nuclear power plant safety systems of new generation. The JIPNR participates in implementing a package of measures to develop nuclear power engineering in our country. A library of nuclear constants of main minor actinides has been compiled, models of surface migration of contaminants have been studied; a software and database system has been developed allowing selection of effective protection actions in case of accidental radioactive contamination; and basic characteristics of decontamination waste disposal sites located in the country have been systematized.

A unique experimental radiation technique infrastructure has been established to comprise as follows: radiation and technological system based on a multipurpose electron accelerator, an NG-12-1 neutron generator, a subcritical physical power reactor and other equipment.

The arsenal of the Experimental Design Bureau "*Akademicheskoe*" comprises samples of new equipment for the power engineering and chemical machine-building, food, pharmaceutical and processing industries. The Bureau has accomplished the following work in the JIPNR "Sosny": a booster subcritical assembly and a critical stand of the physical power reactor. The Bureau has manufactured plants for aircraft water filling and deicing treatment (Minsk Airport), continuous sterilization units (Ministry of Public Health), a long-term carbon dioxide storage reservoir (Production Association *Minsk Automobile Plant*), equipment for producing ecology-friendly fuel for industrial wastewater treatment and recycling of various types of waste (medical, industrial-rubber waste) with a gas cleaning system and others.

Intensive efforts are being taken in the engineering sciences sphere to implement research-based developments into the Belarusian national economy. However, to address the tasks of the country's innovative development, there is a need to expand these efforts and introduce innovative energy/resource-saving technologies, materials and equipment at a larger scale to increase quality and competitiveness of the Belarusian enterprises' products — these are the objectives the DPES seeks to attain.

Frontiers of Belarusian Machine Engineering

To maintain and enhance competitiveness of the machine engineering sector's products, there is a need in advanced approaches to development and design refinement of locally made machines and their components. With this in mind, the designing is the focus of attention. Technological cost of machines and their success in the market are dependent on thoroughly elaborated principles of designing the equipment structures and proper engineering of new equipment models.

Experience of a number of large foreign and Belarusian enterprises proves that the process of developing high-turnover products in the machine engineering sector has evolved from an individual to a standardized development and currently it is nearing a stage of a modular engineering designing. This process implies that a product is to be split into a number of main sub-systems which are to be formed subject to specific requirements and with consideration for compatibility with other sub-systems. A finished product is assembled from completed modules with specific functionality, thereby defining design characteristics. Such an approach allows high-tech ranges of high-performance machines to be developed. In designing each unit or component (an engine, a gearbox, an axle, a suspension, a steering), it should meet not only its functionality, but also contribute to reduction in the machine weight, fuel efficiency, higher safety and environmental profile.

Given the available developments, there is a need to formulate new approaches to designing new equipment and supplying to the sales market within the shortest time possible. They would imply integrating the processes of designing, virtual and physical testing, certifying and preproduction of the machine engineering products into a single system by using state-of-the-art information technologies. Fig. 1(a) shows a block-diagram of a conventional development of a new machine. Integrating computer technologies into the process allowed a number of components to be reduced, but could not fully eliminate them. Therefore, efforts should be focused on standardization of virtual testing of new products. Referring to Fig. 1 (b), changing approaches to engineering followed by computer testing, on the one hand, allows certification of the equipment to be immediately started and, on the other hand, a preproduction to be commenced. It is noteworthy that the full-scale testing should be upgraded to a qualitative level. This would significantly increase its role as a tool for assessing not only perfection

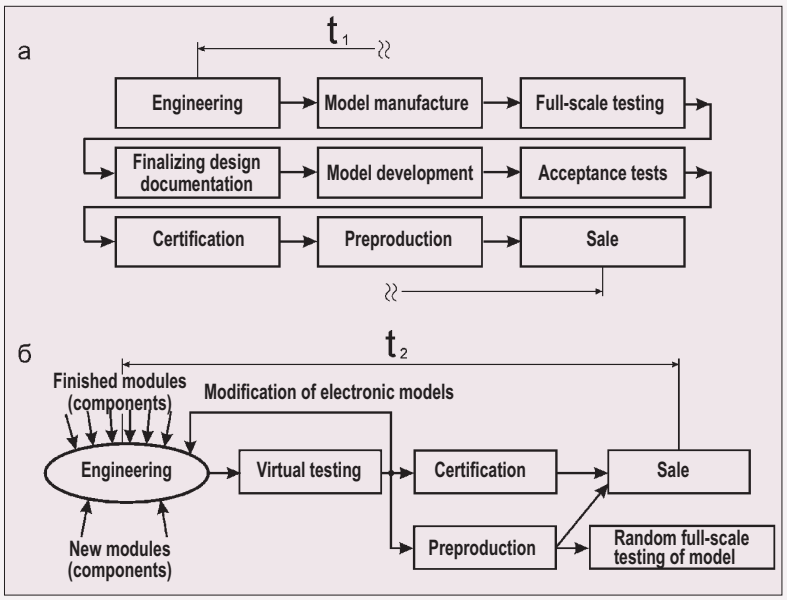


Fig. 1. Approaches to developing new equipment: a — conventional; b — innovative

of the design, but also the entire machine manufacturing technological cycle.

This technique would make it possible to engineer more sophisticated ranges of mobile machines, the models of which will be standardized, highly manufacturable and will allow the market's demand to be fully met. It is noteworthy that differing from a conventional approach, the innovative approach would help eliminate cost-intensive stages, thereby reducing the time and cost of machine manufacture.

Of a particular significance in this process is the equipment virtual test technology during homologation (or approval) of a vehicle type in potential product consumer-countries. The effective certification procedure requires an extensive range of tests to be conducted resulting in substantial costs and frequently leading to failure or serious damage of a model being tested. In a number of cases, it is not actually possible to perform full-scale tests of unique machines, for example, heavy-duty dump trucks, because the necessary testing equipment is not available. During virtual tests, not a real situation is tested, but only its computer (mathematical) model. The advantage of this method resides not only in its relatively low cost, but also in possibility to test the product at the engineering stage. It is noteworthy that the number of options of computer models is limited only by the testing time.

In particular, the technique of full-scale vehicle passive safety tests is regulated by the respective international rules or national standards. Their objective is to test the ability of a vehicle to maintain a living space required for the people to survive inside it in case of an accident, to restrain acceleration of the passengers' bodies during braking and so forth. These tests may include both static and dynamic tests which are time and cost-intensive as it was mentioned above. Despite obvious simplicity of this technique, it allows for thoroughly analyzing interaction of all

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load-bearing elements and systems providing (or not providing) maintenance of the living space or other characteristics in the test process. Only final or intermediate results are recorded, while a new structure needs to be manufactured for re-testing.

The Joint Institute of Machine Engineering is intensively involved in developing techniques of virtual testing of the automotive and agricultural machinery to assess their performance and consumer characteristics, durability and service life (Fig. 2). For example, the cost of computer diagnostics of lateral stability of a road-train comprising a MAZ-4471 tractor and a semi-trailer is substantially lower than full-scale testing, thereby reducing production start-up by 4—6 months, while efficiency of virtual testing of load-bearing structures (a frame, an axle casing, an axle beam) of a MAZ-551603 truck compared to the full-scale testing is over BYR 80 million and a time required to launch the product manufacturing is reduced by about a year (finalizing documentation, re-manufacturing, additional tests). Testing an MTZ-2025 tractor cabin frame saves over BYR 10 million and reduces implementation period by 2—6 months.

In contrast to full-scale testing, virtual testing makes it possible to conduct in-depth qualitative and quantitative analysis of behavior and interaction of all elements and systems of the structure with the required discreteness and accuracy. It should be noted that many technical regulations, including the UN EEC rules Nos. 58, 73, 93 and others allow for replacement of the full-scale testing by computational tests, provided they are adequate.

Commissioning of the national test facility for studying, testing and certifying mobile machines and integrated assessment of their influence on the road infrastructure has given a powerful impetus to development and upgrading of the national system automotive equipment full-scale testing. The most crucial points dealt with hereinafter need to be emphasized.

Currently, the Belarusian manufacturers have to test and certify their equipment on the test facilities in Russia, Germany, France, the Netherlands and Czech Republic. Therefore, Belarus spends substantial currency funds which could be reasonable used to finance construction of its own test facilities and development of the national certification system. It should be pointed out, in particular, that Belarus discloses its know-how to potential competitors testing models abroad, thereby seriously threatening the state's economic and national security.

Three trans-European corridors and thoroughfares comprised in the CIS highway network run through Belarus. Upgrading their performance to the world level is one of the current high-priority tasks. To address it, the following needs to be implemented: conducting research into variable-strength road structures with al-

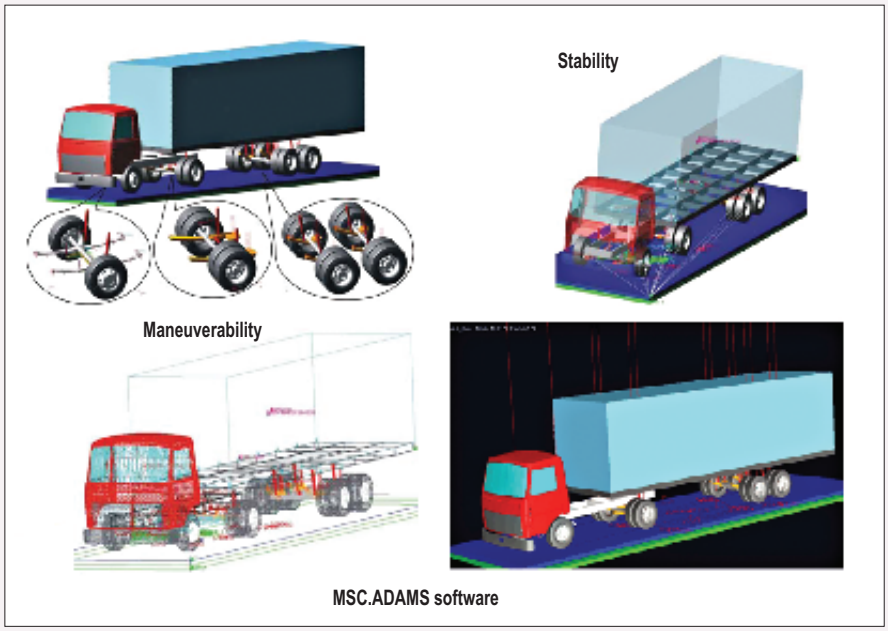


Fig. 2. Virtual testing of a medium-duty articulated road-train

lowance for dynamic action of equipment, testing guard rails and noise screens and assessing performance of passive road traffic safety means. Reduction in hazardous emissions and vehicle noise is one of the urgent targets of environmental protection and healthcare.

Currently, our Institute is implementing the largest investment project of construction of the first phase of the National Test Facility to be used for testing and development of the automotive machines.

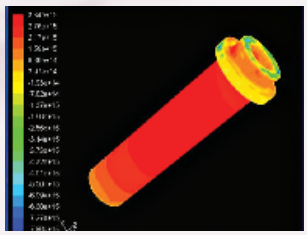
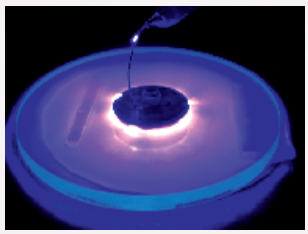
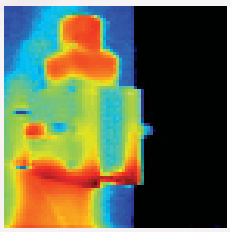
The priority objective of the science is to accelerate innovative development of the Belarusian machine engineering sector. Subject to Directive No. 3 of the President of the Republic of Belarus, the scientific and industrial sectors are tasked to jointly reduce energy and material intensiveness of products and total production costs at least by 15% as soon as possible. It is extremely important to diminish dependence of the sector on imported products, specifically in the field of high-tech components — automotive electronics, electronic and electrohydraulic control systems, state-of-the-art structural and protective materials, diesel engines and other component parts. In addition to technical problems, the Belarusian machine engineering industry needs to address institutional problems to be in the tideway of world innovative development trends.

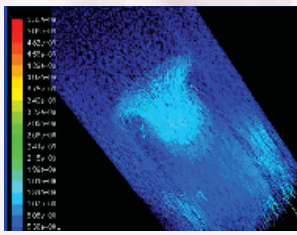
Belarus as a transit country should produce conceptually new transportation facilities — modular articulated road-trains for transcontinental haulage along the West-East corridor from Brest to Beijing and Tokyo. We are working in this field within the framework of the State Research and Technical Program *Machine Engineering* using the most advanced engineering solutions and components — both local and external — which comprise a hybrid power unit with an in-built individual wheel electric drive, an automatic coupling hitch length control, a system of automatic electronic control of power units of articulated members, an electrotransmission and systems of computerized electronic steering control. The project may serve as a driving force of progress in the Belarusian automotive industry to become a worldwide leader in road train manufacturing.

This is a critical problem requiring an immediate solution. The machine engineering sector may efficiently develop based on a comprehensive state support by conducting R&D and experimental and engineering works within the framework of state programs of various levels (fundamental and fundamentally oriented research, applied and research-engineering developments).

In general, assessing the results of the recent decade, it should be pointed out that an efficiently operating state system of scientific support has been established in the machine engineering sector over these years. It served as a basis for an integrated scientific and technical complex. The innovative development of the basic sector of the Belarusian economy — automotive and agricultural machinery industry — up to 2010 is promoted through support of the state targeted program Automotive and Combine-Harvester Industry and an input of scientific developments within the framework of the State Integrated Targeted Scientific and Technical Program *Machine Engineering* (coordinator-customers — Ministry of Industry and National Academy of Sciences of Belarus, coordinating agency — Joint Institute of Machine Engineering). It is designed to coordinate current and future R&D and experimental and engineering works and encourage efficient use of scientific results and developments in the national economy.

Specifically this approach integrating the potential of the industry, academic and university science contributes to intensive innovative development of the Belarusian machine engineering in the XXI century.

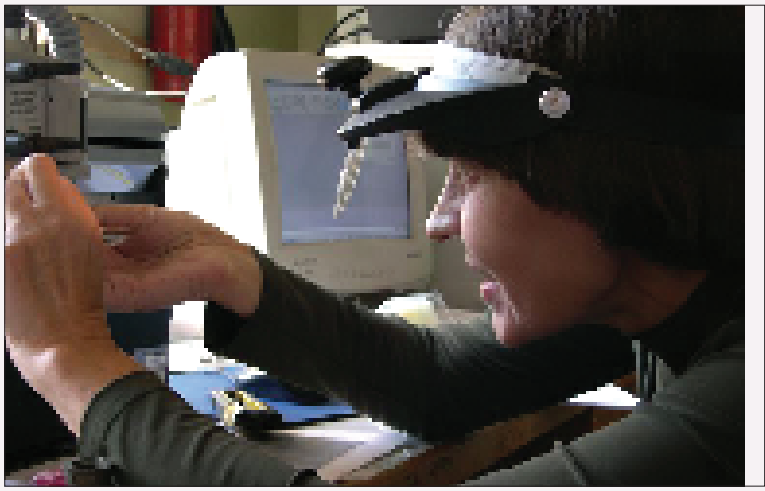


Hydrogen Energy Laboratory

The subdivision is mainly involved in performing consistent research in the hydrogen energy sphere, formulating the national concept of its development, taking efficient decisions in developing low-temperature fuel cells and producing functional carbon nanostructures with predetermined properties.

The Institute's researchers have developed highly efficient methods of synthesizing carbon nanomaterials based on improved CVD and PVD technologies by using strong electric and magnetic fields which resulted in formation of single-wall and multi-wall carbon nanotubes and nanocatalysts based on them. Numerical simulation and integrated experimental research have yielded conceptually new scientific findings which were practically proved in developing fuel cell models and carbon nanomaterials and allowed heat-transfer properties of nanocomposites based on them to be explored within the temperature range up to 900 K. New methods and devices for synthesizing carbon nanomaterials and carbon nanomaterials-based nanocatalysts have been developed and protected with patents.

Advanced methods of investigating and characterizing carbon nanomaterials using Fourier Transform Infrared technique and Raman spectroscopy, thermogravimetry and electronic microscopy have been implemented and a process for pilot production of carbon nanomaterials using CVD techniques which allows new functional materials on substrates and in the free state to be produced has been developed. Over the recent years, 7 postgraduate students have been trained, the senior students of the Belarusian State University (BSU) have been encouraged to perform research, and a course of lectures in computer simulation of heat-transfer processes has been prepared and delivered at the BSU Physics Department.



Scientific and innovative activities in the hydrogen energy field are being streamlined, the international scientific and technical cooperation (Egypt, Sweden, PRC and Korea) is developing and research within the framework of the Belarusian-Bulgarian project is being efficiently conducted. The Belarusian-Chinese laboratory was established in 2007 to produce new types of catalysts and electrode materials for advanced fuel cells. An extensive framework agreement on cooperation with Kurchatov Hydrogen Energy and Plasma Technologies Institute was signed in 2008 to perform joint research into development of scientific foundation and innovative activity in using hydrogen energy technologies.

Prospects for Development of Chemistry and Earth Sciences

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Department of Chemistry and
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Corresponding Member

Belarus has a highly developed modern chemical, oil-refining and petrochemical industry. The NASB Department of Chemistry and Earth Sciences (DCES) is responsible for scientific support of these sectors.

The DCES affiliates a Research Council for integrated exploration into the Earth crust and upper mantle of the territory of Belarus and adjacent regions and the *Belarusian Chemical Society*, issues the journal *Lithosphere* and publishes transactions in the journal *Vesty Natsiyanalnai Akademii Navuk Belarusi*. Seriya Khimichnykh Navuk (News of the National Academy of Sciences of Belarus. Chemical Sciences Series). The DCES employs 788 persons, including 592 researchers, 14 Academicians and 14 Corresponding Members, 52 Doctors of Science and 211 PhD. After the 2007-2008 restructuring, it comprises two state research and production associations: SSPA *Chemical Products and Processes* (NASB Institute of General and Inorganic Chemistry (IGIC) and Institute of Physical and Organic Chemistry (IPOC)) and SRPA *Chemical Synthesis and Biotechnologies* (NASB Institute of Bioorganic Chemistry (IBOC), Institute of Microbiology (IM) and self-financing pilot production unit of the NASB IBOC). The Institute for Nature Management (INM) is involved in the Earth science research.

The sphere of activity of the SSPA *Chemical Products and Processes* includes research in physical and chemical fundamentals of action and use of surfactants, polymers and polymer complexes in various processes and development of innovative reactants, polymer and composite materials and valuable small-tonnage chemicals.

They are introduced into the processes at the enterprises of *Belneftekhim* Concern, *Belbiopharm* Concern, Ministry of Architecture and Construction, Ministry of Agriculture and Food, Ministry of Industry and also Departments of *Belavtodor*, Ministry of Transport and Communications and *Goznak* of the Ministry of Finance.

The DCES provides a scientific support for production of new products under 29 orders of the government scientific and technical programs within the framework of the State Program of Innovative Development of the Republic of Belarus for 2007—2010. Large basic projects in the sphere of mineral fertilizer production being of strategic importance for the Belarusian economy are to be implemented and include as follows:

- production of granulated potash fertilizers with improved physicomechanical and agrochemical properties;
- improvement of the concentration process of potash ores containing high quantity of insoluble residue and sylvinite ore from

Krasnoslobodsky and other new zones of the Starobinskoe deposit;

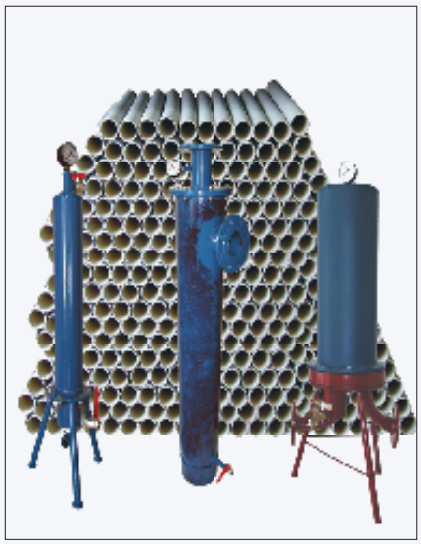
- development of methods of deep dehydration of clay-salt sludge to substantially reduce loss of potassium chloride and solve the problem of liquid waste storage and to reduce allocation of arable land for sludge depositaries and their maintenance costs.

The Production Association *Belaruskaly* implemented the NASB IGIC-developed innovative reactant regimes of conditioning fine-grained and granulated potassium chloride using locally manufactured products as water-repellent agents, anti-clodding agents and dust-depressing agents which resulted in a stable quality of potash fertilizers and increased export. The Belarusian currency earnings increased from USD 400 million in 2001 to USD 1.3 billion in 2007, while the total economic effect from implementing these developments exceeded BYR 20 billion over the last 3 years.

The DCES is testing a modular integrated water treatment plant with a capacity of 500 m^3/h within the framework of scientific support of the *Belneftekhim* Concern's sectoral programs to replace high-rate filters in the reverse water supply system of the *Belshina* Company that would allow not only substantial reduction in overall dimensions of existing systems, but also improvement of the water quality and equipment maintainability. Currently, modified porous filtering elements and water treatment plants manufactured at the NASB IGIC experimental department operate at the S.I. Vavilov Minsk Mechanical Plant, enterprises of *Atlant*, *Belekotekhstroi, Chaika, Kristall, Peleng, Zhilteploservis* and at Mogilev waste water treatment facilities.

In the course of implementation of the *Chemistry and Construction* Sub-Program, the SSTE *Construction Materials and Technologies* developed foaming agent compositions using small-tonnage waste and byproducts generated in the process of mineral fertilizer production which are currently being successfully introduced at the Mogilev Integrated Silicate Goods Plant to produce lightweight concrete blocks. The DCES's achievements comprise as follows: innovative technologies of construction of a road surfacing protection layer using a bitumen/resin composite emulsion, Biokom anticorrosion composition with bioprotective properties for structural steel and structures, fire-bioprotective agents for wood treatment and production of *BAN* non-combustible gypsum plasterboards and *BOPOD* coloring fire retardants to develop hard flammable materials. As a result of the program implementation, in 2006—2007, the amount from sales of manufactured products exceeded BYR 2 843.5 million.

The IPOC operates an ion-exchange/sorption agents pilot production unit. A fibrous ionite plant with a production capacity of 10 tons/year was installed and commissioned to optimize and scale up production of various types of chemisorbents and produce ion-exchange agents. In 2006—2008, the export of ion-exchange fibers to Germany, Austria, South Korea and RSA amounted to USD 500 thousand. The IPOC launched a pilot plant production of semi-permeable polymer membranes and semi-permeable polymer membrane based on membrane elements and produces complete filtering equipment ordered by the Belarusian and CIS countries' enterprises. It is noteworthy that supply of membranes and membrane equipment amounted to USD 250 thousand in 2006—2008. Implementation of the contract (*Water Treatment Technology Using Hollow-Fiber Membrane Modules*, prepayment amount — USD 252 thousand) with the King Abdulaziz City for Science and Technology (Kingdom of Saudi Arabia) commenced. A pilot-production unit of the Medical Substances Department launched the production of biologically active additives and food additives and sold 51.7 tons of them to consumers for an amount of BYR 450 million.



Materials and devices developed and produced in NASB IGOC

In implementing the State Integrated Targeted Scientific and Technical Program *Zdorovie* (Health), the IPOC developed innovative methods of synthesizing heterocycles and natural biomolecules — analogues of antimicrobial, antileukemic, antituberculous and antiviral agents. Efficient methods were devised to isolate and clean thrombin, albumin, amino acids and antibiotics. Active agents were synthesized for substances of new antitumor preparations, for prevention and treatment of diseases of a gastrointestinal tract and a skeletal system, immunocorrectors and disinfecting agents. Synthesized carborans for cancer neutron capture therapy and radio diagnostics are under trial.

The SSPA *Chemical Synthesis and Biotechnologies* performs strategic research in synthesis and production of substances of new medicines and develops crop protecting agents and various bacterial drugs for the RB Ministry of Healthcare, Ministry of Agriculture and Food and *Belbiopharm* Concern.

The NASB IBOC developed processes for manufacturing herbicides (*Shkval*, *Taifun*

and Propolon), insecticides (*Vitan, Kerber and Biunik*) and fungicides (*Ekhion and Fungicide-P*). Using these processes, *Frandesa Ltd.* manufactured and sold in 2007—2008 over 1.5 million liters of herbicide *Shkval* and 96 thousand liters of fungicide *Ekhion* for an amount of BYR 35.84 billion. 95 new jobs were created. In 2008, import substitution amounted to USD 16 million.

Chemists' research resulted in emergence of an extensive range of diagnostic and treatment drugs of high social significance. Development of medical diagnostic agents is underway using methods of immunochemistry and molecular biotechnology. The IGOC pilot production unit commercialized production of 40 diagnostic sets and reagents for early detection and control of oncologic, infectious and endocrine diseases, with the output being sufficient to fully meet the domestic and export demand.

Pharmaceutical substances of local modern anti-tumor and anti-viral drugs are commercially produced. Pharmaceutical substances of *Leikladin*, *Frudarabel* and *Cytosorbin* for an amount of BYR 885 million were produced using processes developed by the SSPA *Chemical Synthesis and Biotechnologies*. In 2006—2007, import substitution amounted to BYR 2.145 million.

The Institute of Microbiology developed environmental biotechnologies for bioremediating soils, removing toxic volatile organic compounds from ventilation air at metallurgical plants; ecologizing the agricultural and industrial sectors; devised an action plan of mycological protection of dwellings and preservation of historical and cultural values of Belarus — book stock, archives, icons, etc. The IM's Biotechnological Center and *AktivBioTekh Ltd.* produced 15 360 ha/portions of microbial fertilizers, 60 l of biopesticide *Frutin*, 1 230 liters of biopesticide *Phytoprotectin* and 120 liters of bioinsecticide Baciturin for a total amount of BYR 22.01 million. Bacterial agent Laksil is being produced and sold. The cost of silage treatment using this agent is 1.5—10-fold lower compared to imported biological agents, with efficiency of both agents being actually equal. The import substitution due to sale of Laksil biological product to the Belarusian agricultural producers amounted to USD 1.5 million in 2006—2007.

A sustainable development implies not only innovative activity and scientific and technical revolution: last but not the least important for Belarus is scientifically grounded nature management and introduction of resources and energy-saving technologies for using natural raw materials.

The NASB Institute for Nature Management (INM) performs an extensive research in the sphere of geochemistry, ecology and sustainable use of natural resources. The INM investigates a subsurface structure on the territory of Belarus, various types of mineral water, provides scientific support for exploration and development of mineral resources and geothermal power engineering. It develops theoretical basis for performing geologic-geophysical, seismotectonic, hydro-geological and ecological explorations being of critical importance for substantiation of selection of optimal zones for constructing specifically important engineering structures, including nuclear power plants, and planning civil and industrial engineering facilities.

To enhance fuel and energy potential of Belarus, the INM established a large laboratory experimental plant for conducting high-rate hydrolysis of solid fuels in a moving bed to produce gaseous and high-calorific energy. It demonstrated potential of using brown coal in Belarus as a fuel source for generating electric energy by power plants or as a raw material to be converted into motor fuel. The Beltopgaz's enterprises and District Selkhozservis divisions produce fuel peat tablets at the abandoned peat fields.

Utilization of peat and brown coal derivatives not in a form of fuel is also efficient. Using the INM-developed processes, the enterprise *Mostovskaya Selkhoztekhnika* and associations *Zhitkovichsky Agrokhimenergoservis, Lyubansky Raiagroservis and Ushachskaya Selkhozkhimiya* produce organogenic composite materials for eliminating technogenic contamination of soils, meliorants for recultivation of disturbed and degraded soils, fertilizing mixtures and nutrient soils and sapropel substrates for ecological rehabilitation of such land which are to be used by glasshouse-cropping, horticultural and gardening farms. The Borisovsky combine state farm, Dzerzhinsk broiler poultry farm and Polotsk meat-processing plant efficiently use peat-based sorption agents to clean polluted air and water. The Research and Production Association Inzhenertsentr Supplementary Liability Society launched manufacturing peat potassium and ammonium humates and produced an experimental batch to be tested abroad (Poland, Bahrain). A process for manufacturing and utilizing the Ekotorf sorption agent (trademark is registered, RB Specifications 02999284.291-98, Patents of the Republic of Belarus Nos. 2551 and 5613) intended to eliminate accidental oil/petroleum product spills on water and on soil was introduced at the enterprise Tatarka (Beltopgaz Concern) which produced 30 tons of sorbent.

The scientists proved a specific role of Belarusian bogs in biosphere processes and environmental protection of the entire European continent and convinced the world community that there was an urgent need to co-finance research and actions to restore and protect them. 26 thousand ha of wetland were restored with financial assistance of the Global Environmental Facility, that is several-fold higher than in any other country, and restoration of additional 42 thousand ha is underway. A positive experience of Belarus is to be disseminated in Russia, Ukraine, Poland and Baltic States and for this purpose it has been resolved to commence preparation of a new international East-European project.

THE STATE SCIENTIFIC-PRODUCTION AMALGAMATIONS

CHEMICAL PRODUCTS AND TECHNOLOGIES

A multi-functional plant for the study of processes and development of technologies for water treatment.

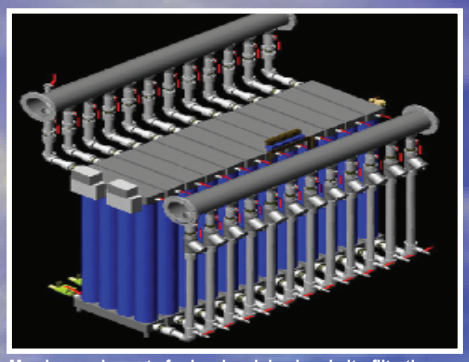
The development of new materials and technologies in the field of water treatment is equally urgent for Belarus and for the entire world. Its importance is due to that traditional water treatment methods have become obsolete while water treatment requirements have been constantly growing and water quality in sources has been permanently deteriorating. Using modern approaches permits more effective removal of microorganisms, viruses, bacteria, colloidal particles, iron, manganese, arsenic from water, reduces the content of natural organic substances, which ensures independence of qualitative characteristics from seasonal influence and decreases capital and maintenance costs.

SSPA *Chemical Products and Technologies* is carrying out active research into the following subjects:

- porous ceramic materials and polymer capillary membranes for water treatment;
- flocculants for intensifying sewage water treatment and dewatering industrial waste;
- simulation of dewatering processes on laboratory facilities;
- reagents for complex protection of water circulation cycles of enterprises;
- preventing water sources pollution by technogenic waste.

For example, to solve the problem of obtaining strong macroporous ceramic materials based on crystalline silicon dioxide, there was investigated the effect of different factors of granulometric composition of frame-forming particles, compression pressure on the forming process, structural and strength characteristics of produced ceramics; there were manufactured samples of ultramacroporous (>50 μm in size) substances meeting the basic criteria imposed on substances used for filtration purposes. It was revealed that the optimal combination of porosity and mechanical strength is exhibited by materials based on polydisperse powder of crystalline silicon dioxide having granulometric composition of 100—315 μm, formed under 30 MPa. The high mechanical strength, well-developed porosity, permeability, productivity and low cost of articles make them attractive for use in treatment processes.

The Association has organized its own production of water purification systems characterized by a high purification efficiency and reliability, lower cost compared to analogs, low maintenance cost, use of inorganic filtering materials and ultrafiltration membrane modules based on polymer fibers.



Membrane elements for low-head dead-end ultrafiltration

Decanter centrifuge

Chamber filter press

Band filter press

Advanced Medical Diagnostics

The field of functional biochemistry, in particular, its physiological aspect, which historically formed in Belarus, currently is developing at the level of exploration into mechanisms of specific chemical reactions. To address this target at the molecular level, there is a need to isolate multiple compounds from cells and determine their structure and functions. A modern level of research requires an experimenter to identify what changes in the structure of chemical compounds evolved impairment of some or other function in order to correct it.

Diagnostic agents for immunochemical microanalysis

In the middle of the last century, a new science — bioorganic chemistry — emerged at the intersection of chemistry of natural compounds and biochemistry chemistry, which set as its main objective to determine the relationship between a structure of natural organic substances and a function they perform in a living organism. That was a principal approach which the scientists of the NASB Institute of the Bioorganic Chemistry (NASB IBOC) made use of Results of investigating a "structure-function" interaction in the series of biopolymers (proteins, glycoproteins, DNA and RNA) and low-molecular weight bioregulators (components of nucleic acids, hormones and lipid derivatives) laid a foundation for developing new diagnostic methods in formulating pharmaceuticals and conducting research of diverse profile.

With specific hereditary metabolism diseases, biochemical manifestations of mutant genes precede emergence of clinical symptoms. Specifically due to this, an approach of research from a molecular level to formation of first signs of disease remains a key one in analyzing a mechanism of pathogenesis, its diagnostics and subsequent treatment. Appropriate biochemical methods are used if hereditary pathology is suspected.

One of the modern approaches is based on multiple doubling of a specific DNA section in the process of polymerase chain reaction. As a result, sufficient DNA quantities are produced for visual determination (PCR diagnostics). This method of chemical investigation of biological macromolecules allows detection of new hereditary abnormalities or predisposition to their development, quantitative assessment of the gene expression profile in samples of tumor and other tissues, thereby providing diagnosis accuracy and influencing the choice of a treatment regimen of patients.

The NASB IBOC developed the molecular diagnostic agents based on the PCR diagnostics to be used in the agricultural, sports and healthcare sectors. In 2007—2008, the PCR diagnostics method was used to develop efficient techniques of determining gene polymorphism, angiotensin converting enzyme, bradikin and endothelial nitric oxide synthase which allow for predicting stamina of a sportsman and his/her ability to endure substantial physical loads, determining predisposition of a person to risk of development of cardiovascular diseases, such as arterial

hypertension and left ventricular hypertrophy at the early stage to timely take preventive actions (V.A. Sinelev, A.S. Babenko, I.E. Maiorov and S.A. Usanov).

A PCR-based method of determining the level of *Her~2* oncogene expression in tumor tissues of human mammary gland was developed and it is characterized by a high degree of results reproducibility and also a reliable system of positive and negative controls. The *Her~2* oncogene hyperexpression helps diagnose development of human mammary gland carcinoma. The procedure comprises the stages of isolating highly purified agent of a total RNA preparation from the tumor tissue homogenate, obtaining RNA-DNA duplex followed by amplification of specific kDNA fragment in real time (A.S. Babenko, V.A. Sinelev, I.E. Maiorov and S.A. Usanov).

The PCR diagnostics was used in the method of TB rapid diagnosis since conventional TB detection methods (conventional and luminescent microscopy and culture technique) are characterized by low sensitivity and require lengthy time to obtain a result. As is known, TB is a chronic bacterial infection. Annually, nearly 8 million people contract TB and out of them, nearly 3 million die from TB-induced complications (out of this figure, 100 thousand are children). The *Mycobacterium* genus comprises several tens of types. However, *M.tuberculosis*, *M.bovis* and *M.africanum* comprised in the *M.tuberculosis* complex affect TB in humans. Sequencing genomes of mycobacterium representatives allowed for selecting specific oligonucleotide primers, conducting PCR analysis to identify the *Mycobacterium tuberculosis* complex with high specificity and differentiating it from other mycobacterium representatives (A.V. Vasilevskaya, G.V. Sergeev, A.A. Gilep and S.A. Usanov).

The research on clinical polymorphism of hereditary pathology is still a pressing problem. Owing to discoveries in the field of biochemical genetics and cytogenetics, new hereditary abnormalities were detected. As a rule, some or other previously known hereditary disease represents a group of clinically similar, but genetically different conditions (genetic heterogenicity phenomenon).

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From the genetic point of view, genetic heterogenicity and change in manifestation of the major gene under the influence of other genes and environmental factors are main causes of clinical polymorphism of hereditary diseases.

Research on monooxygenase polymorphism plays an important role in detecting the risk of occurrence of and in diagnosing chemically induced cancer. This is associated with the problem of pathologic effects produced by low-molecular compounds of endogenic and exogenic origin and the need to establish defense mechanisms of an organism from adverse chemical exposure. Under specific conditions, oxidation of low-molecular weight compounds in the organism by specific cytochorome P-450 (P-450 1A1, P-450 1B1) isoenzymes leads not to their detoxication, but to metabolic activation, formation of carcinogens, promoting initiation and development of cancer. It is well known that the genes coding both types of P-450 cytochrome are polymorphic. Jointly with German scientists, baculovirus plasmids comprising a wild-type gene SUR1A1*1 and its most commonly occurring mutated variants — SUR1A1*2 and SUR1A1*4 — were designed, expression of respective proteins in insect cell line of *Spodoptera frugiperda* and also physical and chemical characteristic of produced hemoproteids were determined and their catalytic activity with respect to substrates potentially metabolizing into carcinogens was studied. This allowed clarifying the functional significance of point substitutions of amino acids in the human cytochrome structure which is extremely important for identifying the mechanism of development of oncologic diseases and their early diagnostics (P.A. Kiselev, N.A. Bovdei, V.Kh. Schunk, D. Schwarz).

A new technique characterized by high specificity for diagnosing inflammatory processes in an organism was developed to detect lipolytic activity in

a biological material. Content of inflammation-associated phospholipolysis metabolites in cells of alveolar macrophages and in blood serum of healthy donors and acute pancreatitis patients was determined for the first time with involvement of meth-hemoglobin by using difference spectroscopy (N.M. Litvinko, L.A. Skorostetskaya, S.V. Kuchuro and G.N. Rakhuba). The method was adapted to capacities of the Belarus-made device SF *SOLAR* which is used in clinical practice (N.M. Litvinko and L.A. Skorostetskaya).

The level of activity of pancreatic phospholipase A_2 (PLA_2) hydrolyzing phospholipids is considered to be a highly specific diagnostic marker of acute necrotic pancreatitis. Therefore, a lipolytic reaction with involvement of pancreatic PLA_2 served as a basis to develop a method of finding an antipancreatic-action agents among physiologically active compounds (N.M. Litvinko, T.A. Zheldokova, S.V. Kuchuro, E.R. Filich, Patent of the Republic of Belarus No. 5752 dated 07.08.2003), including thiotetronic acid derivatives (D.B. Rubinov, T.A. Zheldakova, N.M. Litvinko, S.V. Kuchuro, G.N. Rakhuba, Patent of the Republic of Belarus No. 10191 dated 24.10.2007). To use PLA_2 for diagnostic purposes, a unique method of isolating it from a pancreas based on extraction of the enzyme using a substrate dissolved in an organic solvent in the absence of cofactor was developed (N.M. Litvinko, Patent of the Republic of Belarus No.8416 dated 29.05.2006).

Therapeutic and diagnostic agents of high social significance form a group of products associated with the pharmaceutical industry. The NASB IBOC developed diagnostic kits and their production was launched at the IBOC self-financing pilot production facility in the quantity meeting the demand of the country. The immunochemical microanalysis methods and devices found a wide application in a healthcare sector. They allowed mass prophylaxis of various diseases, conditions for medical examination of the population in Belarus and also establishment of a modern diagnostic service using an extensive range of RIA and IEA reagent kits (over 30 items) produced by the NASB IBOC self-financing pilot production facility. A team of the IBOC scientists (A.A. Akhrem, O.A. Strelchonok, N.V. Piven and V.L. Chashchin) was awarded the BSSR State Prize in 1988 in the sphere of science and technology for development, practical application and production of radioimmunological microassay means. This branch of science is progressing.

5-aminolevulinic acid used for photodynamic diagnosis and therapy of malignant tumors was synthesized by applying a unique method (F.A. Lakhvich, M.A. Kisel, I.V. Trostyanko, V.I. Dolgopalets, Patent of the Republic of Belarus No. 10019 dated 27.08.2007).

In 2005—2007, software for the computerized information system used for integrated evaluation of the thyroid function was developed and implemented at the specialized outpatient hospital of the Republican Unitary Enterprise (RUE) *Production Association Belaruskali* (N.V. Piven).

The possibilities for future use of glutamic acid decarboxylase autoantibodies (GAD) — a highly informative pathogenetic marker of type 1 diabetes mellitus — come under review as a quantitative criterion for diagnosing and studying pathogenesis of the insulin-dependent diabetes mellitus, evaluating the rate of manifestation and predicting development of the autoimmune pancreatitis lesion during type 1 diabetes mellitus in children and adults (N.V. Piven, E.E. Orlova and L.N. Lukhverchik).

According to the World Health Organization, the incidence of thyroid disorders is nearing that of cardiovascular pathologies and diabetes. The most widely spread non-oncologic diseases of thyroid profile are of autoimmune nature and their diagnostic markers are autoantibodies (AAB) to thyroantigenes — thyroglobulin (TG), thyroperoxidase (TPO) and thyreotropic hormone receptor. Modern recognition of the autoimmune process defines efficiency of use of therapeutic agents, therefore, development of rapid, sensitive and inexpensive assay methods assumes an ever increasing significance. To determine AAB, TG and APO, the principle of immunometric assay based on direct interaction of dissolved AAB with immobilized antigene was used (K.I. Mikhailopulo, O.V. Tsyganova, E.P. Kiseleva and I.A. Kemezhuk).

A conjugate containing residues of vitamin H (biotin — Bt) and thyroid hormone 3,3', 5-triiodine-L-thyronin (T_3) was synthesized by analogy with biotinylated thyroxine. A conjugate Bt-T_3 was tested as a bifunctional ligand in several laboratory test systems used for determining T_3 concentrations in human blood serum. It was found that compared to hormone-protein conjugates conventionally used for that purpose Bt-T_3 had a number of advantages. The main of them resides in more expressed and understandable stehiometry and predictability of specific binding reactions in which it is involved. In addition, Bt-T_3 demonstrated high stability in the process of application and lengthy storage than thyrohormones conjugated with proteins.

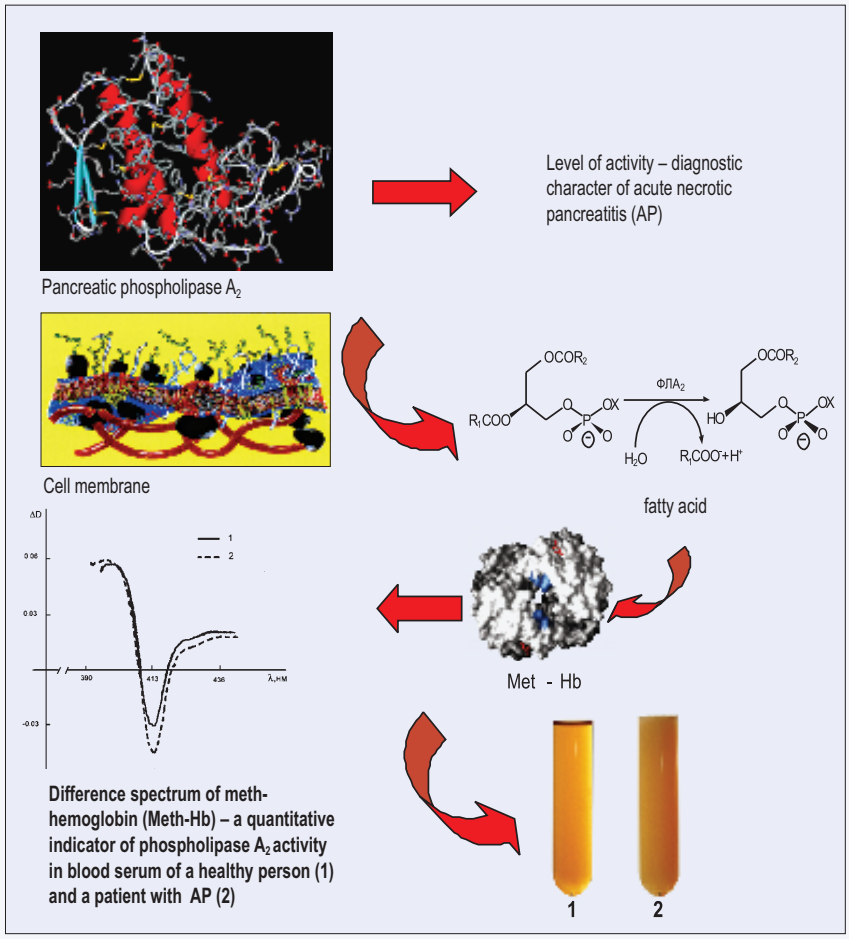
Given the results of the computer-simulated interaction between Bt-T_3 and biotin-binding avidin glycoprotein, it was proposed to modify an immunoenzyme test system in which T_3 test interacts with the anti- T_3-Ph at the first stage followed by introduction of Bt-T_3 into the reaction medium to react with remaining unoccupied T_3 — binding sites of T_3-Ph. The pro-

posed system is unrivaled and its advantages were determined in the experiment (M.E. Novakovsky, O.V. Zhorov, N.V. Kuzub, I.I. Vashkevich and O.V. Sviridov).

The pancreas-specific antigene (PSA) is the most accurate marker of the pancreas malignant tumors. The main molecular form of the total immunoreactive PSA in human blood serum is the PSA complex with protease inhibitor α_1-antichimotripsin, with the free PSA making up 5—30% of the immunoreactive PSA. The free-total PSA ratio serves as a criterion for differential diagnostics between cancer and pancreas benign hyperplasia. Under optimal conditions of immunochemical reactions, the required level of sensitivity of immunoenzymometric systems to determine total and free PSA is also reached during a single-stage assay.

Using the WHO international standards of total and free PSA comprising 90% of α_1-antichimotripsin-bonded PSA and 10% of free PSA, accuracy of assays using the developed immunoenzymometric test systems of both PSA molecular forms was demonstrated (A.I. Shcherban, O.V. Zhorov and N.V. Kuzub).

Caspases — a family of serine proteinases catalyzing hydrolysis of peptide bonds formed by carboxylic groups of aspargenic acid — play a key role in initiating programmed cell death (apoptosis). Apoptosis is responsible both for removal of unnecessary cell structures and defective non-functioning cells in the processes of ontogenesis and homeostasis and for development of pathologic conditions, in particular, cardiovascular, autoimmune and oncologic diseases. A set of caspase substrates of a peptide nature was synthesized. The developed schemes are promising for synthesizing fluorogenic substrates in which the aminocumarin derivatives are an eliminated fragment, thereby making it possible to quantitatively determine the caspase activity, characterize the manifestation rate of apoptosis processes and diagnose a functional condition of tissue and plasmatic cells (V.P. Golubovich, O.V. Gribovskaya, V.P. Martinovich).



Use of lipolytic reaction for diagnosing inflammatory processes

Therefore, chemist-scientists are on the leading edge: innovative human disease diagnostic methods are being developed, state-of-the-art agents are being produced and high-purity markers are being isolated to this end.

Diagnostic agents have already passed laboratory trials and are widely used by consumers. Just not long ago, tests for diagnosing pregnancy and determining glucose level in blood, urine, etc. were not available in drugstores. Currently, they are accessible for the population.

The rate of progress in this field of knowledge is the highest and it may be stated with confidence that development of new agents and quality of patient treatment will be closely associated with the degree of readiness of the Belarusian pharmaceutical industry and healthcare sector to accept innovative diagnostic technologies.

Modern Life Sciences: Problems and Prospects

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The modern science is characterized by search for priority research spheres, comprehensive analysis of activities of scientific institutions, determination of their potential and perspectiveness of developed projects. The objective of the strategy of biology development in Belarus is to gain the lead in the world advanced research, extend the arsenal of methodological tools, upgrade the level of fundamental and applied research and introduce the development results into practice.

The National Academy of Sciences of Belarus (NASB), the Department of Biological Sciences (DBS) implemented a number of measures aimed at addressing urgent scientific tasks in the field of Biotehnology, the following tasks need to be highlighted: the State Programmes *Biotechnology*, development of the National Program *Innovative Biotechnologies* and joint R&D Program of the Union State Stem Cells. The goals set in them comply with the world trends and are aimed at of improving scientific and methodological level of research being conducted in this sphere.

The DBS comprises the Institute of Biophysics and Cell Engineering (IBCE) and Bioresources Scientific Practical Center (BSPC), NASB.

The IBCE — a leading organization responsible for implementation of the State Integrated Research Program *Biological Engineering and Biosafety* — conducts research in the field of biophysics, genomics, genetic engineering, proteomics, nanobiology and cell engineering. The IBCE was the first institute in Belarus to commence research into the proteome of a plant and animal cell. There were found the main regularities of stress factors acting on the intracellular calcium content and expression of phospholipase C genes in transgenic plant cells. To increase crop resistance to phytopatogenes, a method of treating tomato plants grown in a hydroponic system with ethylene was developed. Unique data on differences in intramolecular dynamics of various proteins were obtained which may be used in the express methods to get unique data revealing the role of intracellular active forms of oxygen in regulation of activity of multidrug resistance proteins were also obtained. A membranothropic action of toxic and potentially toxic microelements on blood cells was demonstrated. The method of growing mouse feeder-independent embryonic stem cells line allowing for maintaining such cell properties as high activity of alkaline phosphatase, proliferative activity and non-differentiation was developed. The IBCE began development of a novel drug form of an efficient

liposome-incorporated antiviral agent — Butaminophen.

A three-dimensional Bid protein structure was refined and the change in its conformation when it interacts with the Bcl-2 antipoptosis protein was demonstrated providing a new explanation of the molecular mechanisms of apoptosis.

The Bioresources Scientific Practical Center, NASB was established by reorganizing the Institute of Zoology and integrating the V.F. Kuprevich Institute of Experimental Botany (IEB), Central Botanical Garden (CBG), Institute of Forest (IF) and Dvinskaya, Zhornovskaya and Korenevskaya Experimental Forest Facilities into the BSPC. The BSPC's researchers achieved a number of important scientific and practical results related to protection and sound management of the fauna biological diversity, including drawing up regulatory and procedural documents for the administrative authorities and providing ecosafety and biosafety, scientific support for establishment, functioning and development of a system of natural areas of preferential protection (NAPP) and national ecological network for implementation of environmental international conventions.

For example, 5 new aurochs keeping and breeding centers were established within the framework of the National Program for Dispersal, Conservation and Use of Aurochs in Belarus, thereby allowing their number to be increased over 2-fold in Belarus.

There were identified main causes of progressing depression of the population of the most dominant species of hunting fauna associated with an impaired mechanism of controlling and limiting the number of predators and irrational character of some traditional regimes of utilization of the hunting fauna resources. A package of recommendations was prepared to increase efficiency of managing game husbandry and fish industry, namely, to create new populations of hunting hoofed species, rehabilitate problem commercial fish spawning grounds, reduce exposure of people to adverse effect of undesirable animals and commercially use some species in hunting and ecological tourism.

To develop preventive measures aimed at reducing negative consequences of invasion of alien species into the Belarusian fauna, the main corridors of their invasion into the country and invasive hazard degree were identified.

Inventory of the Belarusian fauna biological diversity helped identify 2 new fish species and 2 species of caddis worms and 2 species of rotifers in Belarus, a taxonomic composition of 3 classes of invertebrates inhabiting dead wood was determined for the first time, 26 species and 5 genera of spiders, 2 species of mud dauber wasps and 2 species of lepidopterans, 1 species of road beetles were registered, over 70 species of mollusks were identified subject to the modern specification and fauna specific elements of the most environmentally critical areas were specified and described.

During implementation of an integrated action plan for preventing bird flu spreading in Belarus, a map of main sites of waterfowl migrating clusters being potential carrier birds was compiled and a package of actions to control spring and fall flows of their migration along two largest continental migration routes in the Pripyat and Dnieper valleys was implemented.

A scheme and ways of complementary interaction between the national ecological network in the Polesie region and Ukrainian ecological network were developed as a step toward integration into the European space.

Planting of new feed crop — eastern galega

View of biotechnical complex for commercial production of virus-free mini-tubers

Guidelines and schemes were prepared within the framework of the State Program of Ecological Rehabilitation of the Lake Naroch to eliminate pollution resources and optimize condition of natural territorial complexes of the Naroch region and also to develop a recreational zone of the *Narochansky* National Park. The actions taken resulted in stabilization of main indicators of water quality and 3.5-fold reduced cercariosis morbidity rate compared to 2007.

The main sphere of activity of the oldest Belarusian biological research institution — V.F. Kuprevich Institute of Experimental Botany (IEB), NASB — comprises as follows: protecting and efficiently using flora resources, monitoring and forecasting condition of the environment, developing adaptive methods of arable farming and investigating mechanisms responsible for plant productivity and stability.

The IEB is a head organization responsible for implementation of the State Program of Oriented Fundamental Research *Fauna and Flora Resources* one of the major objectives of which is to compile the National Fauna Cadastre and also monitor fauna within the framework of the State Program of Development of the National Environmental Monitoring System for 2006—2010, establish local forest monitoring networks *(Minsk, Novopolotsk* and *Mogilev)*, develop methods of monitoring forest wetland, establish a network for monitoring the condition of grassland and bog vegetation, establish a network for integrated monitoring the ecosystems in the key natural areas of preferential protection and apply the remote diagnostics method to assess the vegetation cover condition.

The IEB is actively involved in the work aimed at increasing efficiency of functioning of sites of the Belarusian nature-reserved fund. Schemes of efficient distribution of over 50 largest sites of the nature-reserved fund were developed. The researchers of the Flora and Plant Taxonomy Laboratory prepared text and cartographic data for the 3rd issue of the Red Book of the Republic of Belarus and they maintain the largest herbarium in the country recognized as a scientific object and being a National Endowment. The results of the IEB-conducted research find a wide application in the agricultural and forestry sectors. For example, it developed the technology of cropping eastern galega — a new high-protein feed crop, crop acreage for which in Gomel Region alone reached 3 thousand ha in 2007. The IEB prepared and the Ministry of Agriculture and Food adopted sectoral schedules of new processes to be introduced for growing fall rye and winter tare as silage, haylage and green fodder and also barley-pea mixtures for obtaining a balanced grain forage in terms of digested protein. 2 types of bioengineering complexes were established to yearly commercially produce virus-free potato mini-tubers using aeroponic and ionitoponic technologies and also environmentally safe biostimulators and crop-protecting agents using starch industry waste. The laboratory of mycology developed a biopreparation *Mycolin* using *Bacillus mycoides* strain of antagonist bacteria to be used as a crop disease-protecting agent.

Over 50 varieties of medicinal, decorative and spice-aromatic plants were selected and processes to grow them commercially were developed by the Central Botanic Garden (CBG), NASB, using an accumulated genetic material. The total plantation area for these crops exceeds 1 200 ha in the Belarusian farms and an average annual yield of berries is about 500 tons and that of medicinal and spice-aromatic raw materials — 600 tons.

The fundamental research into the biochemistry of plant cell nuclei and plastids is successfully progressing. Investigation of biochemical, molecular and biological aspects of the genetic diversity of botanical collections is underway. Integrated biochemical certification of lilac/bog bilberry/rhododedrons collections was initiated. Methods of microclonal reproduction of commercially valuable introducents were developed and a unique collection of genotypes of medicinal and woody plants and *in vitro* culture was formed.

The CBG researchers-developed technologies were used to produce functional biologically active additives and food products (soft drinks of *Phytolinia* series, flavored syrups, dressings, candied fruits, etc.) to diversify the range of locally produced food, upgrade its biological value, reduce and substitute the import of products.

Scientific research of the NASB Institute of Forest is aimed at addressing major problems of the Belarusian forest industry: a regulatory and procedural framework for reafforestation and aforestation, harvesting, forest conservation and protection and its cadastral valuation was developed and reafforestation and aforestation were converted to genetic selection basis. The condition of genetic resources of tree species in Belarus was integrally evaluated. The forest planting stock is grown by using resource-saving technologies and novel compositions and biopreparations. Methods of microclonal propagation of forest woody plants and phytopathological monitoring of forest tree nurseries using DNA markers were developed.

Over 40 governmental, national and sectoral standards and guideline documents were prepared and put into effect with involvement of the IF, NASB researchers. More than 100 scientific and technical developments of economic, environmental and social significance are annually implemented in the forestry and other sectors of the Belarusian national economy.

Woody Plants Introduction Division

The priority directions of the Section activities are rational environment conservation, ecological safety, effective use and renewal of natural resources. Research into the basics of reproduction and protection of plants is carried out.

Applied investigations are dedicated to the possibility of using moderate zone trees in phytodesign, development of planting stock reproduction and growing technologies, creation of tree nurseries and green building objects.

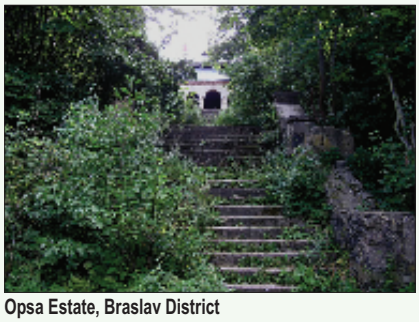
The research theme *Biological Peculiarities of Cultivated Dendroflora of Large Industrial Centers and Historical Parks of Belarus and Its Enrichment by Means of Introduction* is currently under study within the framework of the state program of oriented fundamental research *Vegetable and Animal World Resources*.

There were developed scientific criteria and methods for the assessment of cultural-historical and landscape-decorative significance of over 300 old estate parks and their current state was evaluated. The taxonomic composition of the cultivated dendroflora as a gene pool of wood introducents was studied. There was collected over a thousand of landscape photographs, identified the most significant landscape-decorative, architectural, dendrologic and touristic objects. These data will serve as a scientific justification for prospects of use and assessment of the degree of parks significance in the country's cultural heritage.

Seventeen promising hybrids of Kuril tea, weigela and butterflybush were selected as applied products. The weigela varieties *Vodoley* and *Feierverk* and the buddleja variety *Lesnoye Ozero* have been submitted for the state variety test (SVT). The weigela variety *Vecherniy Zvon*, Kuril tea varieties *Fonarik, Rumyanets* and *Morena* as well as over 30 kinds of wood introducents have been included in the list of zoned varieties. The *Aromatny* variety of Chaenomeles was submitted for test in 2008. Annual realization of nurslings for the total sum of about BYR 150 million, agreements on scientific and technical cooperation with forest farms and housing and communal services of some towns and cities are the evidences of the demand for the scientific and technical products of the Section.

In recent years, there has been worked out a forward scheme of development of botanical gardens and tree nurseries on the territory of Belarus up to 2030. There have been realized projects of planting and reconstruction of green plantations in many localities. Tree nurseries have been created or extended; many forest farms have laid down nurseries of decorative woody plants and have been provided with technologies and a large number of nurslings. The *Republican Forest Breeding and Seed Center* has introduced recommendations on the use of new technologies of presowing seed treatment and nursling growing. An assortment of tree introducents has been developed and planting material has been passed to the tree nursery of the Naroch National Park.


Restored Part of Nesvizh Palace


Opsa Estate, Braslav District


Kraski Estate, Volkovysk District

Biological Diversity — Renewable Resource of Biosphere

Efficient commercialization of biological resources is the most important task which Belarus faces. It is to be addressed using principles and commitments arising from the program of management natural resources and environmental protection and also the National Strategy and Plan of Actions for Conservation and Sustainable Use of Biological Diversity adopted in Belarus as a part of governmental actions to implement the UN Convention of Biological Diversity.

Biodiversity as an Object of Scientific Knowledge

Significance of biodiversity for conservation of the biosphere is extremely multifaceted. The Earth's biota, a remarkably diverse assemblage of organisms inhabiting it — is the major factor of a sustainable functioning of the biosphere and forms its basic renewable resource without which neither the progress of civilization, nor the very existence of the mankind is possible. Among the major functions of this biosphere critical component is maintaining the amount of oxygen in the atmosphere and assimilating and accumulating solar energy (converting it into accessible forms of chemical bonds, synthesis of organic substances from inorganic compounds). The soil forms and its fertility are maintained through activity of plants, soil animals, fungi and microorganisms. Vegetation performs the most important water-regulating and anti-erosion functions and controls interaction of exogenic and endogenic factors responsible for the Earth's relief formation.

Biological diversity and its components such as taxonomic, structural-functional and environmental diversity of organisms, their communities and ecosystems and also diversity of regional combinations of plant and animal species are responsible for stability and sustainability of ecosystems and biosphere under conditions of continuously changing climate and other environmental components. It is the essential condition of the balanced processes in the biosphere. It is noteworthy that multiplicity of species provides continuous functioning of the ecosystems against the background of evolutionary smooth or abrupt changes of the environment — up to extreme stress situations.

The diversity of natural communities finely adapted to local conditions performs its most important functions actually "free of charge"; there is only one condition allowing them to continue their useful work — to maintain them and not to squeeze them out from the Earth. Efficient and inexhaustible use of renewable nature resources, primarily biological resources, is one of the most cost-efficient and harmonious ways of the national economy development.

Diversity of living organisms and, in particular, genetic diversity of each species and the gene pool as a whole is invaluable and only minorly developed natural resource to improve the existing and breed new plants of useful varieties and species of animals for the gene engineering. Each species, moreover, a large group of organisms is a product of a long evolution and as such they are of unique planetary value, i.e. principally irreplaceable and their loss is irrecoverable.

Diversity of territorial combinations of organisms may be evaluated in general

subject to systematic and typological diversity of taxons or subject to diversity of subordinated territorial biota units. The concept "biological diversity" includes living organisms which are distributed among 5 kingdoms: Monera, Protista, Plantae, Fungi and Animal. They are classified according to the two principles: level of organization and type of nutrition (plants — photosynthetic, fungi — absorptive and animals — holozoic).

Flora Biodiversity

It is the major component of a stable functioning of the biosphere. Nearly 12 thousand plant and fungi species are known in Belarus. The biodiversity of vascular plants is represented by 1 467 indigenous species (out of the total number of 1 933), bryophytes — 442, lichens — 477, algae — nearly 2 300 and fungi — nearly 7 000.

Dominating, many of them form plant communities and are comprised in various types of natural vegetation — forest, bog, meadow and shrub vegetation. In other words, they form renewable biological (fauna and flora) resources making up a sizeable share in consumption and playing a critical role in the national economy of Belarus and in a day-to-day life of its population. The major components of these resources are as follows:

- forest resources — wood, non-wood and recreational. Forests cover 37.8% of the area of Belarus; timber volume is estimated to be 1.34 billion m^3. Out of non-wood resources, of the most critical importance are edible mushrooms, wild berrying grounds and ancillary cropping. In addition, forests are the most critical component of natural landscapes and therefore, they are indispensable as a recreational resource, aesthetic and habitat-forming qualities of which are commonly known;
- forage resources — natural meadow land covering about 16% of land reserves — inundated (flow) and noninundated (dry) meadows;

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- medicinal resources — nearly 300 plant species which are used as one of the major components in formulating dosage forms in the medical industry;
- other types of resources (berry/fruit/nut-bearing and industrial resources) widely used both for direct consumption and as a raw material for various purposes.

The vegetation cover and its taxonomic components — flora (combination of plant species) and vegetation (assemblage of plant communities) — are continuously in a dynamic condition. Human intensive activities in various production spheres inevitably affect the natural vegetation cover of some or other country. Deforestation (even planned deforestation followed by afforestation) impairs its natural structure, changes the course of development and formation. Land tilling to expand the arable land area, reclamation of wetland areas and vice-versa overmoistening (swamp formation) as a result of construction of various hydraulic structures also leads to the change in and even extinction of historically formed plant communities. In all cases, acting on them explicitly or implicitly also changes phytocoenotic structure of forests, bogs and meadows and leads to extinction of entire plant complexes, specific plant associations and populations of rare plant species.

Fauna of Belarus

467 species of vertebrate and over 300 thousand species of invertebrate animals of various groups (protozoans, bryozoans, molluscs, worms, insects, arachnids, crustaceans and myriapods) of weel in Belarus. The vertebrate mammals are represented by 76 species, including 5 most important resource species of hoofed animals, 15 species of carnivores, a number of species of rodents, chiropterans, insectivores, etc., and also American mink, common raccoon, musk beaver and Ussuri raccoon dog acclimatized in the XX century.

Currently, 310 bird species occur in Belarus, 227 of themnest regularly in the country, 42 belong, to occasionally vagrant, 28 make a stop during annual migrations and 9 overwinter. 13 amphibian species inhabit Belarus: 2 — water lizards and 11 — acaudate (toads, frogs, fire-bellied toads, peepers, spade-footed toads). The reptile fauna comprises 7 species: 1 — turtles, 3 — lizards and 3 — snakes. Fish fauna comprises 62 species, from which, 3 species — lampreys and 59 — fish. The indigenous fish fauna is represented by 46 species; the water reservoirs were populated with 13 species for fish breeding. The insects making up not less than 70% of all wildlife species are most diverse among the invertebrate animals. The resource animal species directly used in the economy and for consumption include 19 mammal species, 24 bird species, 33 fish species, 1 reptile species (European northern viper) and 2 invertebrate species (Astacus leptodactylus and grapevine snail). Large mammals are of the highest value as hunting resource: hoofed animals (a Eu-

ropean elk, European wild hog, roe deer and potentially auroch); carnivore (wolves and a number of fur-bearing animals); 2 species of hares, musk beaver and beaver. The hunting bird fauna comprises mass species of waterfowl, wood grouse and grouse; among the fish species, the most valuable are related to a group of commercial species inhabiting natural water reservoirs (29 species).

Currently, the above flora and fauna biological diversity is still not fully used for commercial purposes and is resource-significant. The major share of flora and fauna species belongs to noncommercial biological resources. Nevertheless, specifically this component plays a major habitat-forming and functional-biocenotic role in sustaining the environment and ecological status of the biosphere as a whole. Dominating, many of them form renewable biological resources which should make up a substantial share in the resource consumption and take a lead in the Belarusian economy.

Given significant implicit and explicit anthropogenic influence, irreversible destructive processes take place in natural ecosystems, while intervention into functioning of the biosphere is assuming unprecedented scale. These negative processes need to be counteracted by focusing on conservation of the natural complex the indicator of which is biodiversity. This leads to awareness of the need not only to conserve, but also renaturalize the nature and balance ecological development.

Conservation of Biodiversity

This process includes multiple levels: organismic, population-species and biogeocenotic levels which combine in specific landscape structures to which respective approaches are formulated. In general, the biota protection is viewed as a conceptual system comprising a scientific cognition, legislative acts and institutional actions. At the organismic level, it is provided under cultivation; at the population-species level, it is embodied in compiling the Red Data Book of rare and endangered species of animals and plants. While being oriented at conserving the rarities, it as if pushes dominants to sidelines with their form and intraspecies diversity, but specifically they are the major biocenotic components in structural and functional terms and leading habitat-forming factors. Specifically biogeocenotic principle of conservation demonstrates its territorial feature and models the biosphere as a single planetary formation. 284 plant species and 189 animal species are included into the Red Data Book of Belarus.

Under conditions of ever-increasing influence of technogenesis, in contrast to the process of destruction and degradation of natural ecosystems, the landscape and ecological approach based on an integrated ecosystem principle implies establishment of a system of natural areas of preferential protection which is to become an efficient biodiversity management tool and maintain an unhindered process of the biota microevolution and migration. The natural-reserved fund making up 7.3% of the Belarusian territory comprises 2 wildlife reserves, 4 national parks and 787 various wildlife sanctuaries and also 661 monuments of nature.

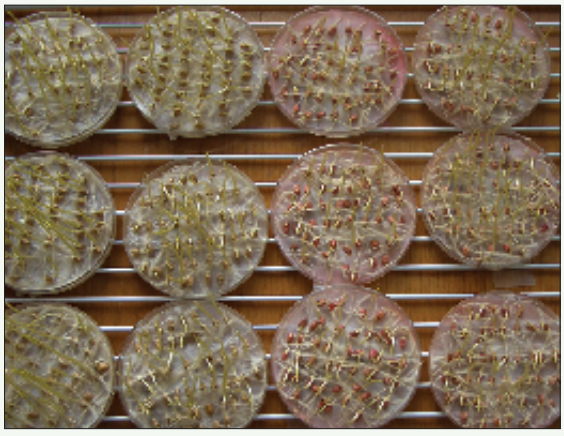
Studying and conserving biodiversity of specific species of plants and animals and also flora and fauna as a whole focus on the following key interdisciplinary spheres:

- inventory and classification — assessing the current condition of the biodiversity; analyzing and synthesizing obtained data to forecast further surveys and train taxonomist specialists;
- functioning of ecosystems and maintaining biodiversity — obtaining the information about ability of the ecosystems to restore depending on diversity of species, about influence of global climate changes, land use and technogenesis on their functioning and about the role of biodiversity (from genetic and species to landscape levels) in ecosystem processes (change in productivity, decomposition and nutrients cycle, etc.);
- biodiversity evolution, origin and conservation — studying response of species and commercial groups of plants and animals to the change in habitat using various scientific approaches, including genetic, physiological-biochemical and molecular-biological features of species, relationships between them and population levels in the evolution process; exploring physiological and genetic processes responsible for mechanisms of intermutation and speciation or species degradation leading respectively to the increase in or loss of the regional, continental and global biotic wealth;
- biodiversity monitoring — developing efficient and standard methods of monitoring the species condition, populations and ecosystems to formulate the criteria to prepare and take substantial decisions at any administration level aimed at mitigating consequences of the changes that may occur;
- protection, restoration and sustainable (efficient) use of biodiversity — studying the factors (natural and anthropogenic) influencing it, dynamics, protection system, formulating strategies to restore disturbed ecosystems and genetic changes of populations in this process.

Despite that each of the above spheres is specifically oriented, in the majority of studies they are viewed comprehensively supplementing each other. Scientific and practical solutions of the above problems are stipulated in the integrated state program of the purpose-oriented fundamental research "*Problems of Sustainable Functioning of Natural Ecosystems, Management and Conservation of Biological Resources of Flora and Fauna*".

Belarus also prioritizes studying and protection of the biodiversity as a critical task of modern biology and ecology. To address this task, dedicated involvement of research institutions and scientists of various specialities is required.

Plant Growth and Development Laboratory



One of the field in which laboratory workers are doing research is physiological and biochemical mechanisms defining quality of the crops' seed grain. Currently, this problem is very pressing for Belarus due to the reduced field germination and high percentage of seed infestation with pathogenes. While many specialists in Belarus doing research in the seed science, their developments are predominantly of a practical character. This includes assessing the parent material for breeding new varieties, obtaining stock seeds and treating them with protective agents. However, the fundamental research should serve as a basis for emergence of efficient developments. Such international societies as International Seed Science Society and International Seed Testing Association are mainly involved in studying fundamental aspects of seed germination and in developing innovative methods for seed quality assessment. Unfortunately, these problems are not in the focus of attention in the CIS countries. Due to this reason, high discrepancy between laboratory germination indices assigned to the seed grain by the control-seed inspection and field germination is observed. A team of scientists was set up in the Plant Growth and Development Laboratory which is actively involved in research on the quality of seeds at different levels — from the field research when development of technologies of their treatment with protective and growth-promoting agents are underway to laboratory research when biochemical changes occurring in seeds of various quality are investigated. The method of accelerated ageing has been introduced and is efficiently applied to reduce the quality of seeds in a controlled conditions by a short-term incubation at high air humidity and temperature followed by biochemical assessment of obtained lots in terms of membrane integrity, content of antioxidants, specifically carotenoids and tocopherols, and DNA integrity. The focus of research is to find biochemical markers allowing more accurate prediction of resistance of germinating seeds to frequently unfavorable field conditions. Development of compositions for pretreatment of seeds with protective and growth-promoting chemicals is also of a practical value. They are based on a film-forming compound comprising polyvinyl acetate and ethyl alcohol by-products. The development is the know-how of the Laboratory and is patent-protected. A low-cost and high-quality film comprises a large quantity of components and efficiently holds them on the seed surface, thereby opening up prospects for reducing doses of expensive and environmentally hazardous chemicals.

Infected barley seedling

Healthy barley seedling

Medical Science for Human Safety

Evgeny KONOPLYA
Acting Academician-Secretary
Department of Medical Sciences, NASB
Academician

The Department of Medical Sciences of the National Academy of Sciences of Belarus comprises Institutes of Radiobiology and Physiology and the Scientific-Production Center *Institute of Pharmacology and Biochemistry*. It carries out and coordinates scientific research in the field of biomedical and medical sciences, including the problem of overcoming the after-effects of the Chernobyl disaster and the demographical safety problem. The Department's personnel includes 196 employees, 14 Doctors and 68 Candidates of Science. There are 9 Academicians and 12 Corresponding Members on staff. The main research trends are the study of the functioning and development mechanisms of pathological conditions of an organism and experimental and scientific justification of new treatment, prophylaxis and rehabilitation technologies; development of new principles and methods of disease treatment, optimization and interference of physical factors; biopreparations for health care and veterinary based on new biotechnologies; research into the mechanisms of action of ionizing radiation on an organism with a view of creating methods for improving its radioresistance; fundamental and applied research into the biosystem functioning, biotechnologies, chemioprophylaxis, immunoprophylaxis and therapy of infectious and noninfectious diseases, immunology, molecular biology, biochemistry; toxicological and hygienic evaluation of new chemical substances, compositions and formulations introduced in various branches of national economy and health care system.

The Department participates in a number of governmental programs such as:

- the state complex purpose-oriented scientific-technical program *Health* which includes the State Complex Program of Scientific Research *Modern Technologies in Medicine*, the State Program of Oriented Fundamental Research (SPOFR) *Physiologically Active Substances*, the State Scientific-Research Program *Therapeutic and Diagnostic Technologies* (including the subprograms *Therapy, Surgical Technologies, Oncology, Heart and Vessels)* and *New Medicinal Agents* (including subprograms *Amino Acids* and *Medicinal Agents*);
- the National Demographic Safety Program;
- the State Program on Overcoming the After-Effects of Chernobyl Nuclear Power Station disaster; SPOFR *Radiation and Ecosystem;*
- the state program of the development of physical training and sport;
- the state program of national activities aimed at the prevention and elimination of drunkenness and alcoholism.

The research resulted in new data about the formation regularities of defense reflexes and system mechanisms of regulating adaptation processes under stresses of different origin and brain hypoxia; revealing of high antibacterial properties of titanium implants coated with a diamond-type silver-containing film; creation of an original nanotechnology-based high-sensitivity test system for diagnosing tuberculosis and other infectious diseases; revealing of new mechanisms of biological action of magnetic fields, development of apparatuses and technologies for their application in medicine and sport; determining of diagnostic ultrastructural peculiarities of cardiomyocytes in cardiomyopathy patients; conducting of biomedical research which resulted in the appearance of innovative medicinal agents.

Taking into account the complexity of the problems caused by the Chernobyl disaster and those related to the development of nuclear power engineering, large-scale use of nuclear materials in various

branches of industry, the necessity to evaluate the state of the natural ionizing radiation background and its effects on an organism, a special attention is given to the study of biomedical after-effects of ionizing radiation and scientific monitoring of anthropogenic environmental pollution.

To solve these problems, an overall evaluation was made of the dynamics of content and forms of occurrence of radionuclides 137Cs, 90Sr and transuranium elements (TUE) in water, air and soil, the main affecting factors were identified, a radiation situation forecast was made and the initial after-disaster territory contamination conditions in the Republic of Belarus were reconstructed. Under the established general tendency toward the reduction of the radionuclide activity in the atmosphere and surface waters, there are observed sporadic fluctuations of activity increase caused by many factors. For example, an increase of radioactivity in water systems may be seasonal or depend on the degree of annual water content and flooding, the high contamination level of sediment beds remaining high (2 to 4 orders of magnitude higher than that of surface waters).

Analyzing the dynamics of the annual average concentrations of radionuclides in the atmosphere of different Belarusian towns and cities and within the 30-kilometer zone around the Chernobyl Nuclear Power Station shows a tendency toward a slow reduction of radioactive contamination. However, agricultural and other activities on the contaminated territories as well as forest fires locally increase the radioactivity in surface air by hundreds and thousands times, which, in its turn, increases the inhalation radiation dose of the contamination.

Special attention is given to the study of the radionuclide behavior in the "soil — plant — farm livestock — man" food chain. It was established that the pollution of plants with radionuclides is affected not only by the soil contamination level but also by such factors as the soil type, physico-chemical properties of nuclides and their content in the fulvic acids or humic matter fraction. It is shown that the decay of fuel particles and increase of free forms of radionuclides have recently caused a considerable growth of the bioavailability of 90Sr, plutonium isotopes, and high-toxic americium-241, which enhances their getting into a human organism together with food.

Examining the condition of a cardiovascular system revealed a reduction in the maximum speeds of intraventricular pressure buildup and drop, cardiac contraction and relaxation rates. Vascular disorders are one of the leading factors of the radiation sickness pathogenesis. It was revealed that the action of low-intensity ionization intensifies the contractile reactions of vessels and reduces their dilatation reactions, which underlies the increase of cardiovascular disease incidence in people exposed to ionizing radiation.

There was also revealed a pronounced effect of ionizing radiation on the condition of closed glands, formation of germ cells and synthesis of reproductive hormones. It was determined that antenatal irradiation causes damages to the most important systems of an organism and metabolic processes as well as the occurrence of genetic damages in a fetus and progeny. From generation to generation, the negative after-effects of chronic exposure build up. A number of methods and means were developed and proposed for reducing postradiational disorders — calcium-containing preparation dopinat, metheonine-selenium-metheonine, the enterosorbent Calfosorb, featuring a unique ability to reduce the accumulation of 90Sr in bone tissue, as well as other biologically active substances.

It should be noted that the obtained results are important not only for eliminating the Chernobyl disaster consequences. They are also of great importance for the world community in case of any nuclear incidents. In view of the expanding use of electromagnetic wave-emitting means and intensive development of mobile communication, research has been started into the effect produced by electromagnetic radiation on the endocrine, hematopoietic, reproductive and other systems of an organism.

The permanent interest on the part of foreign organizations is the evidence of the research importance. Only within recent years, with UNESCO support, there has been prepared a research project on the study of remote effects of chronic exposure on biota and the man, works have been conducted within the framework of the NATO *Security through Science* program, a joint Russian-Belarusian laboratory of electromagnetic and ionizing radiation has been created, other international projects and agreements have been realized.

Promising Trends in Physiotherapy Development

In recent years, nonmedicinal treatment of patients has been gaining ground. The task of the modern physiotherapy consists in optimizing and increasing the use effectiveness of physical factors in therapy. In this aspect, complex, primarily, combined use of physiotherapeutic means is considered the most promising method which is not only theoretically justified today but is also acquiring experimental validation and being practically realized.

The obtained experimental data point to the most characteristic advantages of the proposed trend. Experiments on rabbits were carried out to study the action of different combinations of permanent magnetic field (PMF) (30 mT) and high-frequency ultrasound on the hormone status of animals. According to the obtained data, the combined (simultaneous) action of ultrasound and PMF was accompanied by the most pronounced changes in the content of all hormones of interest in blood, which is the evidence of a synergistic effect. At a sequential use of the same factors, the cortisol and insulin levels grew less notably and the amount of thyroxin was below check figures. This allowed a conclusion that in case of closed gland hypofunction, it is expedient to use not a sequential but a combined action of magnetic field and ultrasound.

The most pronounced inactivation of yeast cells was observed under simultaneous use of ultrasound and hyperthermia (Lyudmila Komarova and co-authors, Medical Institute for Postgraduate Education of Physicians, Saint-Petersburg). It is shown that the synergistic effect depends on their intensity. The study of the effect produced by a simultaneous use of galvanization and ultrasound on drug (heparin, atropine, ascorbic acid, analgin) penetration into an organism through skin proved that a much greater amount of substance is administered than in case of their sequential or separate use. Similar regularities were also revealed during the study of the effect of a sequential use of galvanization and ultrasound on the drug action (anesthetic effect for analgin and hypocoagulation effect for heparin); the most significant and lasting shifts of sensory thresholds and blood coagulability were observed with a simultaneous use of the physical factors under investigation. Experiments with radioactive iodine proved that exactly in this case the depth of drug penetration into the skin and subjacent tissues was higher. The research data served as experimental validation for the development of the new method — medicine electrophoresis and a special device for the realization and study of this method (Patents of the Republic of Belarus No 4037, No 3523, No 6698).

The prolongation and reinforcement of the action of combined procedures were illustrated by the study of acupuncture and franklinization which proved that a simultaneous use of these factors causes a prolonged (120 to 150 min) and significant (by 1.5 to 2 times) reduction of skin sensitivity to electric current. At a separate or sequential use of these methods, skin sensitivity changes insignificantly and only during 30—60 min. The nerve potential action amplitude, microcirculation (research with radioactive iodine) and anesthetic effect of acupuncture also underwent the most significant changes when used in combination with franklinization. With a sequential use of these physical actions, the above shifts were expressed more weakly. These data served as a basis for introducing the new method, which was given the name of acupuncture franklinization, into clinical practice.

Similar conclusions were also drawn while studying the influence of different use conditions of inductothermy on electrophoretic drug administration. According to the obtained experimental data, inductothermy significantly increases the amount of electrophoretically administered medicinals as well as their depth and rate of penetration from the skin into the blood

and pharmacological activity. Just like in the research with other physical factors, the most significant changes of all the methods under study were observed at their simultaneous use (inductothermo-electrophoresis), which became the ground for a wider introduction of the latter into clinical practice.

Without other proofs, the results of which are basically similar to those previously described, it can be stated that they comply with the theoretical assumptions and confirm the advantages of simultaneous use of therapeutic physical factors. Hence, it may become a real trend in optimizing and increasing the therapeutic effectiveness of physiotherapy.

Practical Implementation

Despite the decided advantages offered by a simultaneous use of physiotherapeutic methods over their sequential use, the latter variant still enjoys more popularity in medicine. This is caused by technical and methodical difficulties which are quite surmountable as is proved by the below materials. The experimentally developed acupuncture franklinization method was evaluated on patients with neurological manifestations of lumbar ostechondrosis. Using a course of 8 to 10 procedures increases the active range of motion, causes disappearance of pain syndrome, tonic contraction of muscles and stretch symptoms, restores cutaneous sensitivity and normalizes blood flow and microcirculation in lower limbs. This method can also be used in the treatment of diseases where an important role belongs to hemodynamic disturbances and pain syndrome.

A number of methods based on a combination of vacuum therapy and other therapeutic agents such as d'arsonvalization, medicinal substances, ultraviolet and laser radiation were clinically tested and Russian Federation and Eurasian Patents were issued on them. These methods are successfully used in treatment of patients suffering from diseases of periodont and

Vladimir ULASHCHIK
Head of the Laboratory of Medical Physics and Physical Medicine Institute of Physiology, NASB Corresponding Member

mucous membrane of mouth as well as from teeth and jaw anomalies.

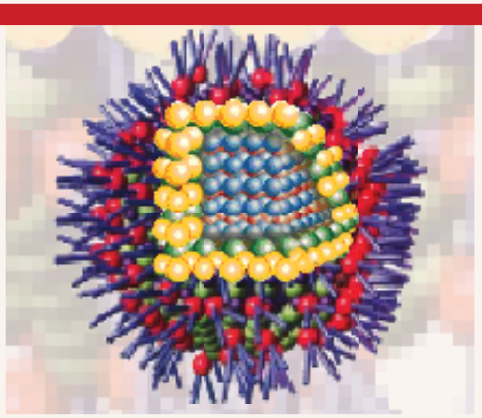
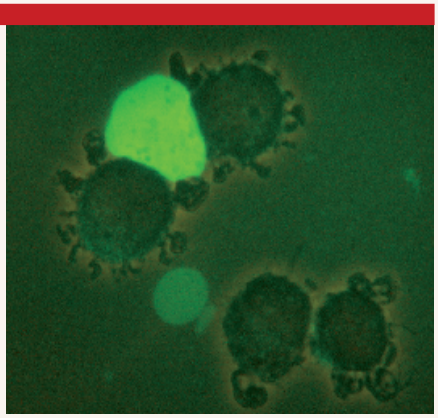
The researchers of the Institute of Physiology jointly with stomatologists from the Belarusian State Medical University Ivan Gunko and Sergey Ivashenko suggested a number of physico-pharmacological methods based on a combined use of medicinal substances and physical factors (galvanic current, ultrasound, magnetic fields, inductothermy), which reduce considerably the treatment period of tooth and jaw anomalies (the methods have been patented in the Republic of Belarus).

To introduce electrophoresis into medical practice, a special device was created. It allows effective use of the method with many diseases such as peptic ulcer of stomach and duodenum, osteochondrosis vertebralis, deforming arthritis, epicondylitis, chronic cholecystitis, etc.

The Institute of Physics jointly with the Institute of Physiology and the Physiotherapy and Balneology Department of the Belarusian Medical Academy of Post-Graduate Education have developed a series of equipment for multicolor magnetic-laser therapy which found applications in treatment of a number of diseases including dyscirculatory encephalopathy, trophic ulcers and wounds, ischemia. These treatment methods were granted Patents of the Republic of Belarus.

Theoretical justification and experimental evaluation was given to a new method — thermomagnetotherapy which provides a combined and separate use of low-frequency magnetic field of different parameters and heat according to general and local methods; there were also suggested equipment for the practical application of this method. The development is protected by Patents of the Republic of Belarus. It was proved that thermomagnetotherapy features a pronounced hypotensive, anesthetic, anti-inflammatory, immunomodulatory, trophic-regenerating and antiedematous action. According to the experimental data and state clinical test results, thermomagnetotherapy may be recommended for use in sport and treatment of many diseases: arterial hypertension, ischemia, obliterating diseases of peripheral blood vessels, osteochondrosis vertebralis with neurological manifestations, transient ischemic attacks, etc. To apply this method, ATMT-1M apparatus was created and patented in the Republic of Belarus (Patents No 2593, No 2651, and No 2796).

The above facts prove that the development and use of the methods of combined physiotherapy are promising not only for medicine, but also for sport. These methods are more effective, offer less load on patients and are less labor-intensive for medical personnel. Using these methods not only improves the results and reduces the patient treatment periods, but also reduces considerably the pharmacological load on patients, which proves not only medical, but also socioeconomic effectiveness of this physiotherapy development trend.

Laboratory of Psychoneurophysiology and Oncogenesis

The Laboratory of Psychoneurophysiology and Oncogenesis (LPO) was established on the basis of the Brain Stem Physiology Laboratory in the NASB Institute of Physiology in the early 2008 to provide deeper insights into the brain functions and oncogenesis processes, specifically in cases of cancer emergence.

It is difficult to make explorations into intricate regularities of a controlling function of the brain in health and disease by a single lab, therefore, the LPO researchers seek an integrated study and a wide cooperation with researchers and physicians of Belarus, the CIS and other countries. For example, an innovative process for manufacturing titanium dioxide and oxynitride films to locally produce biochips was developed jointly with scientists of the BSU Physics Department — Corresponding Member Sergei Cherenkevich and Doctor of Physics and Mathematics, Professor, Nikolai Poklonsky — and engineers of the *Integral* Association. This effective technique for applying coatings on the surface of a planar sensor would further promote the import substitution. This process is protected by the Patent of the Republic of Belarus, while the fundamental research of the LPO team in this sphere was prized as the best 2007 European Innovator Design by the Cypress University Alliance (San Jose, USA).

The research into magnetic properties of spleen cells of healthy animals and animals ill with Ehrlich's carcinoma has revealed that the share of paramagnetic cells in tumor carriers is twice as low as that in healthy animals. This result is applicable for magnetophoretic measurements for diagnosing cancerogenesis process.

The specialists of the NASB Physical and Technical Institute led by the Corresponding Member Eduard Tochitsky have developed a novel titanium-based material for implants characterized in that silver nanoparticles are introduced into the composition of a diamond-like film used to coat titanium alloys and handed it over to the LPO for testing. It has been found that such samples are characterized by high antibacterial activity and may be used for production of transplants for surgery, traumatology, orthopedics and stomatology. The studies aimed at determining the blood circulation disturbance mechanisms in cosmonauts after landing are being jointly conducted with French and Russian scientists within the framework of the European Space Exploration Program. It has been found that when cells are cultured in a three-dimensional space in ceramic samples manufactured by the NASB Institute of Powder Metallurgy, the cell development is impaired under microgravitational conditions that may be used to correct tumor development.

The results achieved by the LPO in the recent years are an evidence for a critical role of integration in the scientific work.

Figures above:
computerized electrophysiological unit;
structure of a semiconductor nanoparticle;
cells of Ehrlich's ascites carcinoma

NASB INTSTITUTE OF RADIOBIOLOGY

Laboratory of Radioecology

The research covers a wide spectrum of studies of natural and artificial radionuclides' behavior in the environment. Peculiarities of migration of radionuclides of various origins in all ecosystems' natural components are analyzed; forecasts of the radiation situation after the Chernobyl accident and its reconstruction are developed. Few scientific institutions in the world perform research of such level. Our researchers provide scientific support for the construction of the APS in the country.

Over a short period of existence, the researchers of the laboratory have published more than 150 scientific papers and developed 15 measurement techniques listed in the State Register of the Republic of Belarus.

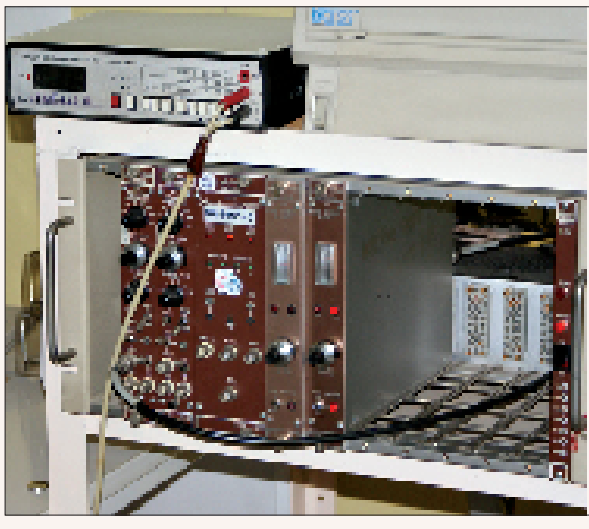
The laboratory is certified in the Quality Control System of State Standard of Belarus for technical competence in compliance with STB ISO/IEC 17025. It is licensed for these works and is contracted for numerous water, food and agricultural products tests. The laboratory is equipped with modern instrumentation — ICP mass-spectrometer ELAN DRC-II, semi-conducting gamma-spectrometer GEM-40200-P, Alpha Analyst alpha-spectrometer, Berthold LB 770 gas-discharge radiometer for measuring alpha and beta activity, low-background radiometer PKC-01AB, beta and gamma field meters.

Patents protect scientific developments; our researchers received seven patents of the Republic of Belarus, and filed four applications.

Within the framework of State Programs of Targeted Fundamental Research, the laboratory of radioecology participates in the "Radiation and Ecosystems" part of the State Program on Mitigating Chernobyl Consequences for 2006—2010. The laboratory contributes to a range of international projects — joint activities of the Union State in mitigating consequences of the Chernobyl accident 2006—2010; development of extraction chromatographic methods of radionuclide detection in the environment jointly with "Forschungsburo Dr. Langrock".

Within the NATO project "Partnership for piece" SFP 983057, section "Nuclear topics", jointly with the University of South Carolina, the laboratory analyzes migration of radionuclides in the food chain "soil — plants — insects — birds".

Sampling in the Polesse Radiation Ecological Reserve



Gamma-spectrometer GEM-40200-P

Humanities as a Key Factor for Innovation Development

Peter NIKITENKO
Academician-Secretary of the Department of Humanitarian Sciences and Arts, NASB
Academician

It would be the mistaken belief that the contemporary innovation process is merely a mechanical renewal of production processes and management schemes. For the Belarusian society, this is in some sense a unique, many-sided problem which includes both preservation of traditional social forms and linkages and introduction of new technological and organizational schemes, re-direction of the entire system of knowledge generation and reproduction toward the most urgent problems of national development and state-building.

Nowadays we must have the interconnections between science, education, training, authorities, and institutions of civic society in this country tuned so that any task of state importance could be appropriately estimated by national mentality and timely resolved.

Innovative formation of the Belarusian social medium calls for solid international, cultural, mental and personal grounds. Many thinkers of the XX c. predicted that no technical progress is possible without specific and carefully maintained atmosphere of respect for scientific knowledge, great skill, accuracy and responsibility and at the same time for the spirit of creativity which implies bold innovation, openness to the new and unexplored, and preparedness to take any risk.

To this end any citizen would have to actively form personal qualities such as logic, consistency and global thinking, patriotism, ideological consciousness, wideness of world outlook and ability to orient himself to aims above momentary interests and needs. As follows from the studies of humanitarian scientists, the historical experience of our people suggests that the periods of economic, social and intellectual upsurge are accompanied with an increase in versatility of cultural forms that seem to be unnecessary from the point of view of pure economic sense and profit gaining. On the contrary, the ages which guiding principle was the well-known “bread and circuses” motto ended up on the decline of all spheres of culture.

Innovation development presumes the availability of a certain people of “cultural type” that are not only inclined to creative thinking, but to maintaining intellectual, mental, and moral atmosphere which is vital for appearance, maintenance and realization of social and scientific innovation. The said “cultural type” is a kind of “creative professional” that is always more than an ordinary professional rather than merely a qualified worker or a narrow specialist.

In the XXIst century, the content of scientific activity is to be determined not only by the nature of actuality under study, but the socio-cultural context of acquisition of scientific knowledge. Science is essentially gaining human dimension. This characteristic is applicable to any branch of science from mathematics and physics to the humanities.

The human dimension of science appears not only as an integral feature of scientific activity, but as its orientation to acting in the interests of people’s development and higher spirituality. In Belarus which is becoming a state of all people, each component part of science focuses on the man.

The modern society makes stringent demands to its members, both as citizens and workers. Many fields of practical activity have actually established a requirement for their meeting a definite set of criteria that may be collectively referred to as "functional noospheric literacy". What we mean here is human capability to think globally and act locally, answer challenges thrown down by rapidly changing international and domestic situations and conditions of life, as well as circumstances that might occur. This causes a question on whether an individual is capable of the fastest adaptation to the environment and efficiently functionate therein to be repeatedly asked and request a new answer each time. One cannot integrate into modern society without having a fixed minimum of knowledge, skills, practices, procedures and know-how. Thus one shall know a foreign language to the extent sufficient for mastering the volume of planetary information, find one's bearings in the relevant legal and financial matters, make use of equipment, etc.

We mean here both the set of requirements to an individual and requirements expected to be met by other people. Compliance of knowledge, skills, and practices of any individual to challenges of modern society cannot be ensured by only the accumulated experience (since the response shall be immediate), it is not possible to advance by a rule of thumb (since the price of decisions made is too high and their consequences are long-lasting and affecting many people). In that case one should have specific knowledge in various fields of science and be capable of applying one's knowledge whenever necessary.

In the majority of cases we mean not only natural-scientific and technical knowledge, but social and humanitarian knowledge as well. Then the said knowledge and technologies shall be generated, stored, translated, accumulated and updated in sufficient volume by the society itself. Market relations being developed in the modern world make a tough claim on an individual — he has a slim chance of getting one or another job, it is difficult for him to compete with other individuals. Thus we should refer now not to direct investments into production, equipment, or etc., but to investment into human capital, to accumulation of noospheric (planetary) intellectual resources, which is most crucial for going ahead without "eating up" the national stocks of raw materials. It is pertinent to note the importance of innovative development of scientific knowledge in general and socio-humanitarian knowledge in particular, which penetrates every pore of social life not only via engineering and technological novations and their implementation, but via a set of requirements to the man and his mind that is sufficient for successful functioning of the social medium.

Successful innovation growth calls for something more than a mere estimation of an industrial product, project, or program, it calls for comprehensive socio-humanitarian and econological examination of decisions that are crucial for the existence and development of the society and its segments; the preparedness and capability of the population and its individual groups to accept the decisions; analysis of their consequences (including far-reaching effects); their linkages with other decisions made, etc. Herefrom stems a modern social medium's need for

- scientific (including socio-humanitarian) support of adopted managerial decisions from the level of specific organization or institution to supreme government bodies;
- feedback to be aware of opinions and sentiments of the population in general and its individual social groups and sections so as to eventually be aware of the society we are living in.

The latter is impossible without comprehensive reproduction of both purely humanitarian branches of science (history, linguistics, literary criticism, and ethnography) that ensure the integral conception of culture, and the subjects of synergetic social course (economics, sociology, law, and philosophy) that make it possible to understand what really happens in the social medium.

The reverse of the medal is awareness of the scientists of their place and responsibility in the contemporary world. But the society itself shall strictly and unambiguously define its position toward science, scientific activity in general and socio-humanitarian knowledge in particular. This should be a component part of official ideology that is responsible for not only prosperity of the country, but for well-being of its population. It is amply clear that both the conditions of production and use of scientific knowledge have radically changed nowadays. Science and scientific activity turned out to be a planetary, noospheric, and resource-intensive enterprise. Their implementation is based on the premise that there is a well-thought and long-term government strategy which determines priorities, provides resources, raises the benefits from science (bearing in mind the need for solving not only momentary, but long-term problems), enhances the prestige of science both in the opinion of government and population, and eventually the rise and development of noospheric economy as a thoroughfare for modern society.

The Belarusian model of socio-economic development relies on the particularities, traditions, and mentality of the Belarusian people, its psychology and national character with its keen sense of global solidarity of people, team spirit and mutual assistance.

Research into spiritual and ethical, cultural and historical basics of the national identity of the Belarusians in the age of globalization, specific features of their spiritual traditions in the context of modern culture, the role of language and literature in the development of our society

Museum of Ancient Belarusian Culture. Ethnographic. Showcase with traditional folk costumes

Museum of Ancient Belarusian Culture. Painting Hall

is of prime practical importance for forming a politically and spiritually stable social environment.

Here we are dealing primarily with social and moral values, with the fact that restoration of the historical spiritual and cultural ties in their entirety is crucial for molding of the contemporary man. Traditions should be involved in the building of the new. The cultural heritage plays a decisive role in the socio-economic development and spiritual life of any individual. It is precisely this idea that dominates in the works of scholars — literary men, art critics, culturologists, historians, linguists, economists and philosophers.

Fundamental works such as "The History of Belarusian Literature of XI — XIX cc." in 2 volumes and "The History of Belarusian Literature of XX c." in 4 volumes have revised the centuries-old spiritual experience of our nation and the cultural traditions of the past which is prerequisite for linking the epochs, securing continuity and promoting cultural progress.

Research into the history of evolution of the Belarusian language, its contemporary state, and folk dialects contributes to the growth of the national awareness, formation of the national and cultural originality of our country in the contemporary world community. Scholarly works in the Belarusian language have enabled the Belarusian language to occupy an undiminished place among other Slavonic languages and on the linguistic map of Europe.

In the age of globalization, the national culture shall become a major factor of the national and state awareness. According to the recent interviews conducted, there is a 10-point raise in the index of significance of identification of our people as citizens of the Republic of Belarus from 0.33 to 0.43 over the last 4 years which can be largely attributed to the purposive study and popularization of the historical and cultural inheritance, achievements of the modern culture and arts of Belarus, fundamental multi-volume publications such as "The Belarusian Folk Arts", "The Collection of the Monuments of History and Culture of Belarus", "The History of Belarusian Arts", "The History of Belarusian Theater", "The History of Belarusian Musical Theater" and "The History of Belarusian Cinema". It is noteworthy to add hereto a number of research and practice events aimed at preservation and popularization of historical and cultural inheritance of small towns such as Nesvizh, Zaslavl, Kletsk, Mir, Kamenets, Novogrudok, Orsha, Polotsk, Postavy, Shklov and Smorgon.

Archeological research and analysis of the historical records have made it possible to form a notion of the role and place of the Belarusian people in the European and world history.

Ethnological science has made it possible to identify the peculiarities of ethnic environment and self-consciousness of urban and rural dwellers, demographic, confessional, language and social processes in the territory of modern Belarus which is of prime importance for preservation of the national identity of our people.

To summarize, we can state with assurance that the Belarusian model of development is a socially-oriented innovative sustainable and predominantly market-based social reproduction under which the man, perfection of the personality, and preservation of nature for future generations are becoming top values.

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- department of macroeconomic regulation and institutionalization;
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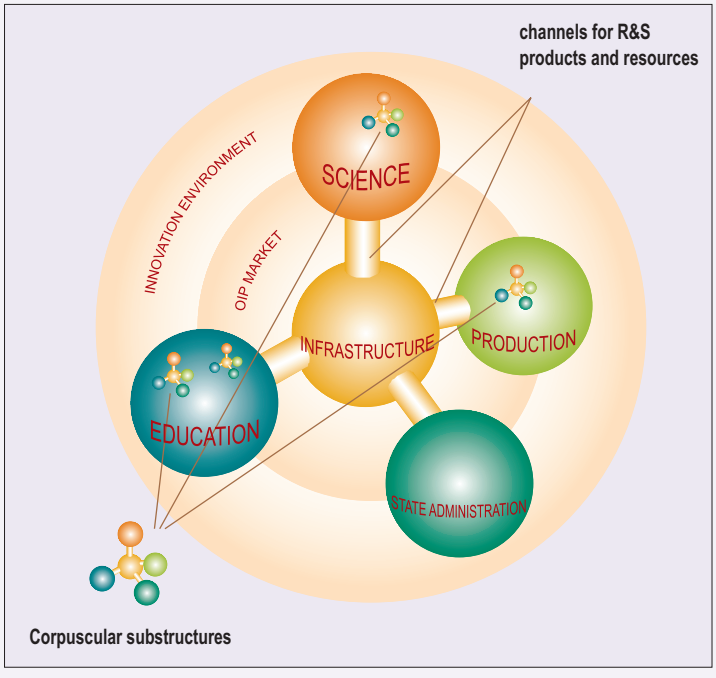
Upcoming Trends of Scientific Progress and Innovation

The period of economic upturn which our country has just entered will be probably called an era of innovation by historians not in a too distant future. The existing uncertainty can be attributed not only to natural alternatives to the course for innovation, but to the necessity of real steps toward translation of the well thought concept of the Belarusian economy, social structure and statehood into life.

There is no need of proving that adoption of any specialized programs does not guarantee their execution.

For example, the very existence of programs for innovation development or modernization of the economy expects something more than scrupulous implementation of the steps "from and to" from their participants (actors). It is of utmost importance to create an integrated system of mutual coordination of actions aimed at obtaining the maximum integral effect rather than deriving momentary benefit in the interests of any producer, state body or region.

Scientists are growing more aware of the necessity of selecting long-term priorities in the development of society that rely on the appropriate production basis. The latter, in turn, must rely on the practical use of achievements delivered and adapted by the scientific sphere for specific needs of producers of products and services. Interaction between science and production as well as their very existence are unthinkable without education system offering a solution to the staff problem. Government acts as intermediary between the three components by providing the legal framework for their operation and regulating their development.



Optimum NIS model

Thus the components forming the basis of any national innovation system (NIS) appear in the foreground. Alternatively, their objective presence (let in their infancy only) in each country cannot be a sufficient condition for successful economic growth. Transition from a latent NIS model to a truly innovative model consists just in the necessity of shaping scientific, educational and industrial spheres that would be optimum in size and interconnected in the area of managerial solutions. An indispensable attribute of any NIS is the innovation infrastructure which items interact in the market of R&D products (intellectual property market). And finally, it is essential to shape innovation culture which is a key component of long-term success in such activity and which produces a nutrient medium and the only substrate for fully fledged participation of society in whole and each member in particular in the implementation of a prosperous state model.

The theoretic foundations for national innovation systems were laid by European scientists more that two decades ago. Nevertheless the world experience evidences that each country despite of having a unique set of starting conditions selects its own way of their use. At the same time, implementation of a unique set of NIS components and their development mechanisms does not preclude from successful use of the already time-tested tools of innovation policy for answering the challenges of the modern time.

An optimum NIS model can be schematically represented as shown (Fig.).

Since science is, by definition, a sphere responsible for purpose-oriented and systematic generation and adaptation of innovations, it should play a dominant role in any true NIS. On the other hand, this would imply certain responsibilities of science to other structural units of the national innovation system. Most important is not only meeting the industrial requirements for competitive scientific products, but also working ahead of time to shape future demand. Moreover, the said requirement comes to the foreground in the post-industrial economy as science shall substantiate the directions and prospects of the development of society by timely delivering its proposals on adjustment or "tuning" government policy. Note that the innovation infrastructure is in the center of the model discussed. This is attributed to its basically intermediary role in the process of circulation of scientific and technological achievements.

A special feature of an optimum NIS model is its "corpuscular" nature. Each NIS element shall include particles comprising scientific, educational, production and infrastructure components that will represent the innovation system in miniature. In the contemporary world, some large universities that include research and development institutes, production laboratories, and units of innovation infrastructure such as technology transfer centers and technoparks may serve as prototype of such "corpuscles".

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What steps shall be taken then to create a Model NIS for Belarus that would have met the key optimality criteria?

First of all, facilities shall be provided for restoration of a logical sequence of innovation cycle in the material sphere. Unlike the existing model where the production specialization that have established over decades dominates as the only true leaving the service role to science and education, innovation shall become the primary source and foundation for the development of production.

Scientific knowledge shall be treated as a source for shaping of new production and scientific specialization of the Belarusian economy aiming at integration into the international flows of competitive products and services on the basis of equality. The change of paradigm will ensure a new quality of economic growth stipulated by intensive production factors that naturally emerge from scientific and technological progress. To this end, the output of high tech and science intensive products shall be increased by a factor of 10 at least. This will serve as a basis for further increase of exports.

With the new arrangement of accents in the material sphere, it will be possible to secure sustainable trend in GDP growth, high value-added rate in the output of products (works, services) and, hence, a long-term innovation rent. Of fundamental importance is that such an approach basically offers the reduction of the so called intermediate consumption. In other words, there would be no need of prepaid investment and current outlays on mate-

rial and energy intensive industries for deriving benefit from sale of product.

These steps will make it possible to implement the core feature of innovation economy which implies that neither the man nor his labor will be thought of as elements in a series of production factors or as one of the arguments in a production function equation. Development of the man, his mental and creative faculties will become Alpha and Omega in the vital activity of the society.

Nowadays, the prospects for successful rise and development of innovative economy are beyond the capacities of individual states. This supports the validity of statement that there may be no national science as there may be no national multiplication table. The recent achievements in the world of "large science" provide ample evidence of the primary importance of the international cooperation in science and technology.

On the other hand, the opportunities of cooperation with scientists in other countries depend on the development of science within the country. That is why the level of internal motivation of research workers and incentives applied are largely responsible for prospects of the national economy: whether it will join the group of technological leaders or stay far away from the world processes. In pursuing these aims, the widely known approaches to making GDP more science-intensive shall be supplemented with a reform of relationships in the field of intellectual property so as to include the objects of intellectual property into trade turnover (i.e. commercialize them) after having previously secured the rights of authorship.

Note that the importance of patent and license trade is not questioned by anyone at present. However, the performance of any research institution is still assessed by the number of patent applications filed and protection documents obtained whereas demands for objects of intellectual property (OIPs) are neglected. As a result, the number licenses sold by the Belarusian licensors is extremely low as compared with the number of patents held. The amounts of royalties are an order of magnitude less than the average international royalty with the license terms being many times shorter.

The severity of problem of OIPs circulation can be significantly reduced by building up a market of scientific and technological products. The market will handle an agency in the exchange of R&D products by relying on the combination of its virtual institutional basis with physical units of innovation infrastructure to be built up, although its member organizations may currently number in the tens. Unfortunately, they are aimed primarily at solving local problems and are demonstrative in nature to a greater extent.

It is but evident that the units of innovation infrastructure shall be implemented under patronage of the government, which presumes functional interrelation of the entire system that includes financial, production process, information, recruitment and advisory activities. This would make it possible to build up a civilized market of OIPs, optimize demand and supply, and balance the interrelations between individual scientists, teams, research institutions and the state.

Generally, the innovation policy of any state shall be based on a reasonable combination of direct and indirect promotional methods. Significance of the latter will increase with the innovation sphere development. Under instability of world economy, good forecast is gaining in importance. To this end, it is necessary to continuously improve the methodology of all-round forecasting of progress in science and technology. Taking account of the experience of leading countries, it would be vital to provide for extensive use of foresight approaches.

Their distinguishing feature will be interaction of the parties interested in the implementation of the Belarusian model of development as well as thoroughly elaborated solution. Forecast will include not only probability estimates of the future, but the reasons for selection of a desired version and the system of measures for its implementation. This would lay the foundation for selection of national priorities in scientific and technical activity, and for identifying the country's specialization in the system of international division of labor and cooperation.

It would be necessary to raise innovation activity and receptivity of domestic enterprises to an international level. Improvement of the production sphere shall be intimately associated with clustering, connecting the economic entities to networks of transnational corporations, the use of "flat" organizational structures of networking, participation of banks in innovation financing. These actions would lead to higher competitiveness of Belarusian enterprises and their output both in the domestic and foreign markets, upsurge in their scientific and technological potential, favorable conditions for extensive attraction of domestic and foreign investments.

The gaining momentum of noospherization of global development serves as an important incentive for our state to realize the lasting value of social and functional innovation for efficient economy. That is why further progressive development of Belarus to parry the challenges of the emerging era may only be guaranteed by cultivation and careful nurturing of innovation culture shoots.

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Institute of History in a New Time Dimension

In the present-day conditions both the management and the personnel of the Institute of History, NASB, are striving to intensify their efforts in innovating their activity: introduce their scientific findings into study of history and historical education, popularization of historic-cultural experience and traditions of the Belarusian people.

Incense-burner with image of St.George from Turov. Late XII — early XIII century

Historians are aiming their work at social innovation, connecting fundamental investigation and practice, as well as connecting it with life of society.

An impressive evidence of the above-said is implementation of the Comprehensive State Program of Scientific Investigation for the Period 2006—2010 "The History of the Belarusian Nation, Statehood, and Culture" by scientific workers of the institute. The Program includes 17 tasks with the Institute being responsible for coordination and control over organization of investigation. The progress obtained to-date appears to be very important and prominent.

Thus the institute has successfully completed a work on a unique archeological scientific-museum exposition that was opened in November 2007 at the time of the Fist Congress of Scientists of the Republic of Belarus. On the basis of in-deep systematization of archeological sources, the exhibition displays a reconstructed historical process in the territory of this country in primordial time and the Middle Ages, and illustrates all the most important lines of investigation from the emergence of the domestic archaeological science up to now.

The archaeological scientific-museum exposition of the Institute of History acts as an educational center as well. At present the exposition has been attended by pupils and students, museum professionals and employees in the cultural department of regional executive committees, members of the Parliament of the Republic of Belarus, officers of the ministries of culture, education, internal affairs, representatives of various ministries and departments of Russia, Ukraine, Lithuania, Poland, Sweden and Vietnam. It should be noted that the opening of the exposition is a first step toward the creation of a multibranch humanitarian practical-scientific center of nation-wide importance. The center will be responsible for investigation and conservation of historic-cultural items to be museumized and restored; their preparation for inclusion in tourist routes; training personnel on the basis of joint scientific, educational and methodological programs that are currently being developed by the National Academy of Science and the Ministry of Education and Culture.

Archeological monuments form a considerable layer of antique historic and cultural heritage of Belarus. The workers of our institute elaborated normative documents on carrying out archeological investigations in 2006. They include a Regulation on the Field Committee of the Institute of History, NASB; an instruction on issue of permits for archeological prospect and excavation, their conduct, and reporting on the completed work; an instruction on registration, safe keeping and use of items and collections in scientific archeological stocks; guidelines on execution of documents and

price calculation for economic agreements for archeological investigation in case of earth and construction work.

it is safe to say that over the recent 2 years the Institute of History has succeeded to gain control over architectural supervision on sites, on restoration of monuments and other. In the said work on sites and restoration, a representative of the Institute is assisted by representatives of the universities and students' brigades. Archeologists from our institute take part in restoration of mediaeval castles, palaces, country estates, and channels in Belarus. Some of them have been entered in UNESCO lists. Last year we have presented research documents based on the archival and stock materials from long-term investigations (from 1945 to 1991) for drafting a project on museumizing the historical core of Minsk — a citadel on the river of Nyamiga.

By Decree of the President of the Republic of Belarus Alexander Lukashenko, the Institute has been appointed a head organization responsible for the work of integral archeological expedition to be conducted in 2008—2012 for investigation of the Polatsk land which is timed to the 1150th anniversary of Polatsk — the earliest town in this country.

At present the Institute of History has been implementing 3 innovation projects. One of them concerns with the study of the historical and cultural heritage of the National Park "Belavezhskaya Pushcha" (The Belavezha Forest) and drawing up specific recommendations on its practical use. Within the framework of the said project, a large-scale study of local lore has been conducted: there have been revealed and processed more than 800 records on the history of the Forest and the system of its conservation and use in XVI — XX cc. in 50 stocks and archives of Belarus, Russia, Ukraine and Lithuania. As a result of the work, the following has been compiled for the first time in the historical science: a collection of records on the history of the Belavezha Forest with presentation of their reproductions and transcripts, a summary index of acts that includes an index of names, an index of geographic names and an index of subjects; records available on 14 archeological monuments in the territory of the National Park have been studied.

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Due to implementation of another project on historical and archeological investigation of the Nyasvizh monuments, entered in the UNESCO List of World Culture and Natural Heritage, compilation of a collection of documentary witnesses to be used for conducting all-up restoration and supervision of the nomination enabled us to study design features of the profile of moat surrounding the Nyasvizh castle and details of its fortification, on the basis of which the project has been drawn up to restore the castle in its appearance back in the XVI — XVII cc.; we have conducted architectural and archeological study of structural members of one of the bastions of the castle which is currently under restoration; we have identified the location of the castle of Mikhail Radziwil Chorny that existed before the construction of a new stone building constructed by Mikhail Radziwil Sirotka.

Within the framework of the third innovation project on the elaboration and creation of a breadboard model of a system for information support of the work on the historical map of the republic, software adaptation and setup have already been completed, a basic information resource of the Internet site of the Institute of History, NASB, has been produced.

In the period between 2006 and 2008 our research workers have made considerable progress in the study of domestic history. There were published 42 monographs, 8 collections of scientific papers and transactions of conferences, 11 manuals and textbooks, 7 brochures, 4 archeological publications and 2 reference books, 27 historical maps, 597 scientific papers and abstracts of conferences, 406 encyclopedic and popular scientific papers. The research findings were made public in the form of more than 640 reports presented to more than 240 international, republican, and regional conferences, congresses, round tables, workshops, innovation sites and other events. The collection of papers named "The Traces of Centuries on the Map of Native Land" is dedicated to the 70th anniversary of Mikhail Spirydonav, a well-known Belarusian historian and a founder of the Belarusian cartography.

There were published 5 books of the Metrics of Grand Duchy of Lithuania that make a bulk of new materials available for studies and serve as an important source for research into legislative activity of supreme power, economy, social, political, ecclesiastical and religious processes in the historical geography of Belarus, Lithuania and certain areas of Ukraine and Poland. A high appraisal of the public received the publication of a teaching and methodological package "The Great Patriotic War of the Soviet People (in the Context of World War Two)" that includes a syllabus, a textbook, a reference book, a writing book, a reading book, and a teacher book. The new reading book for pupils of the 11th form includes documents and materials (including earlier unpublished ones) that make it possible to form a systematic and unbiased notion about World War Two and

the Great Patriotic War. “Anthropology” manual has been reprinted.

Over the three recent years, the Institute has arranged for and run 44 republican and international scientific conferences and round tables (mostly in various regions of the Republic of Belarus) at high level in collaboration with educational institutions and local administrations. The events had a wide public response.

Generally, workers of our institute take an active part in the popularization of scientific achievements in the field of archeology and history, and dissemination of new knowledge. For the purpose they are making use of any mass information media — lectures, conferences, printing (publication of research scientific brochures, articles for magazines and newspapers), television and radio. Director of the Institute of History Alyaksandr Kavalenya and research workers such as Andrei Vaitsyahovich, Syargei Dzyarnovich, Alyaksandr Dounar, Marat Zhylinski, Vadzim Koshman, Vadzim Lakiza, Alyaksei Litvin, Volga Lyako, Alyaksandr Myadzvedzeu, Mikhalai Smyakhovich, Lubou Sobaleva (who is an author and presenter of “One minute with historian” weekly with the inter-state TV and radio broadcasting company “Mir”), Syargei Tratyak, Lidziya Tegaka, Dzmitry Shavyaleu, and Igar Yazapenka have been taking an active part in the arrangement for and conduct of the said work.

We have been intensively developing international scientific cooperation. Grants allocated by the Belarusian Republican Fund for Fundamental Research have enabled us to successfully complete work on the Belarusian-German, Belarusian-Ukrainian, and three Belarusian-Russian projects. We have made agreements on cooperation with the Institute of Slavonic Studies of the Russian Academy of Sciences, the Institute of World History of RAS, the Institute of History, State and Law of the Academy of Sciences of Moldova, the Institute of History of the Bulgarian Academy of Sciences, the D.N. Anuchin Scientific Research Institute and Museum of Anthropology under the M.V. Lomonosov Moscow State University,

Icon of St.Matthew. Site of ancient settlement Kaplantsy. Late X — XI cc.

Icons from Turov. XIII c.

Cross-encolpion from Brest. XIV c.

Women’s decorations — metal bracelets from Brest. XII — XIV cc.

the Institute of History of the Polish Academy of Sciences, and the Institute of the History of Material Culture of RAS. They provide for support of joint scientific research projects; exchange of research workers; conferences, symposia, seminars and summer schools in the problems of interest to both parties; keeping informed of and assistance in preparation for participation in international congresses, etc.; regular exchange of literature and bibliographical information; preparation for and publication of works, documents and materials; mutual reading and criticizing of author’s abstracts of dissertations for Master’s degree and doctorate.

Our research workers are involved in scientific and educational activities, delivery of basic and special courses of lectures, conducting classes and seminars, supervising graduation and term projects at the universities of the republic, and they more than once participated in juries of academic competitions in history at a level of the republic and the Union State of Belarus and Russia. The Institute of History and the Academy of Post-Graduate Training have conducted a series of guest innovation schools within the framework of the project “Introduction of an Author’s Model of Ideologically-Valuable Educational Space of an Educational Institution”, elaborated and implemented technologies aimed at the improvement of ideological and educational work in the teaching process at a new level of content and methodology. A concept of National Museum of History of the Republic of Belarus is currently worked out collectively by the Ministry of Culture and the National Museum of History and Culture.

Today we can state that the Institute of History, NASB, has been conducting intensive innovation activity. The latter is used as a basis for carrying out restoration work at the objects of historical and cultural heritage in our country, for a range of mass-organized research events that contribute to forming civic stand and patriotic feelings as well as consolidation of the Belarusian society. We are making efforts that our research findings were of practical use rather than remain on paper only.

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Specifics of Management of Agricultural Science

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Agricultural science is systemic. It includes a wide spectrum of activities — development of soil management and animal husbandry, machinery and required level of mechanization of agriculture, production of quality and safe products, adequate economic research and support, etc. Each of these areas has its own branch structure and spheres of application for scientists. Soil management and crop growing include grain husbandry, potato growing, vegetables, fruit growing, fodder, etc., which require profound knowledge of each technological operation and even separate technological steps to achieve the desired result. Animal husbandry needs scientific support of cattle breeding, hog breeding and poultry farming. Thus, scientists and specialists of the agricultural sector shall go into detailed research of specific technologies, types of machinery, soils, plants and animals as components of the integrated agricultural mechanism including the widest spectrum of problems. Agricultural science requires deep knowledge of most general-purpose fundamental sciences and targeted research in biophysics, biochemistry, microbiology, genetics, theory of mechanisms, production management, etc. Besides, in most cases borrowing foreign practices and research results is impossible (though in many areas the results are applicable). Each country has its own specific zonal characteristics proceeding from soil and climate conditions (which is indisputable), and specifics in organization of labor and production, mechanisms of state support of agriculture, methods of animal husbandry and labor stimulation. Therefore, agriculture might be Belarusian only to extent it is called Polish, German, French or Scandinavian in relevant cases.

These factors add to the complexity of tasks, and stimulate our scientists to seek competitive scientific and practical results. Traditionally, Belarusian agricultural science was one of the most efficient in the former USSR. It is noteworthy that it maintains its strong position to the present day. However, it has to compete with powerful structures, products and achievements of developed European countries.

At present, the developments and research of Belarusian scientists meet the demands of the nation in varieties and hybrids of agricultural crops, productive livestock and efficient machinery, resource-saving technologies and effective organization and management of agriculture. Annually, 100—120 innovative developments are put in operation with returns outscoring investments.

Practically all growth of agricultural production depends on science and scientific support; 90—95% of this growth are the developments of Belarusian scientists. The record grain crop of 2008 should be attributed to a considerable extent of the work of our scientists. They have provided varieties and hybrids of local selection, and agricultural workers were more careful with recommended agricultural technologies.

These developments are in good demand, and they have to cope with growing requirements of consumers who are dissatisfied with slow pace of agricultural scientists.

Development of new varieties, hybrids, machines, mechanisms, recommendations and other scientific products with better qualitative and quantitative parameters is not enough today. Best results in line with international achievements are needed, providing for efficient and competitive agricultural production.

A task has been put forward to build principally new national agriculture based on modern efficient technologies and machinery, adapted to specific conditions and management providing for maximum use of intrinsic agents to intensify the operation of the agricultural sector of economy. This puts the agricultural science on the forefront of the latest achievements in science management, theory and methodology of research requiring highly qualified personnel, modern instrumentation and laboratory equipment.

The National Academy of Sciences includes the department of agricultural sciences, hosting most of the agricultural scientists of the country. Five scientific and practical centers have been organized: arable farming, animal husbandry, agricultural mechanization, potato and vegetable growing, and food supplies. Each center solves specific tasks in fundamental and applied science, and innovative sphere. Modern selection and phytotronic complexes are being created in plant-growing, selection and hybrid kernels in animal husbandry, as well as technical and technological practice grounds for scientific research and examination procedures of scientific developments. These centers are used for training specialists and as extension facilities.

The achievement of agricultural science is quite impressive. Varieties and hybrids of Belarusian selection account for over 90% of arable land, 95—97% of productive livestock of agricultural enterprises are the result of long work of local stock-breeders, 95% of agricultural machinery are of local produce, 30% were designed with participation of the National Academy of Sciences.

All achievements in soil science, agro chemistry, land reclamation, economics and management of agriculture are the result of the efforts of our scientists and specialists.

Practically all major agricultural events in the country are held with participation of agricultural scientists. Jointly with practical workers they develop recommendations for the improvement of technological processes, organize workshops for promotion of new techniques and methods, and monitor the development and changes in production processes (especially, during periods of intensive work), and advise on improvement of structural and management approaches.

It is worth noting, the farms that are keen on scientific developments and

NASB Agricultural machinery and varieties of plants

new technological processes achieve best results. As a rule, they are leaders in their areas. Scientists provide support for the full cycle of research and development in organization and management of production.

Agricultural science can boast of priority and breakthrough developments effected by specific instructions of the Head of State, Administration of the President of the Republic of Belarus, the Council of Ministers and other government and economic entities. Thus, in 1990[s] there were no local rapeseed varieties and practically no technologies of its cultivation. The dilemma was either to purchase foreign seeds or to breed domestic varieties. Today, we have 15 varieties of spring and winter rape of local selection, 99% of cultivated rape are grown from Belarusian seeds. In 2008, rape was cultivated on 300 thousand hectares of land, the crop was 600 thousand tons of rapeseed processed for oil and used as feed protein. The problem was fully solved by the agricultural science.

Our scientists have also solved the problem of brewing barley seeds, corn (to lower imports) including sweet corn for human consumption, pea seeds and black-eyed peas (valuable protein product), onions, soybean and sunflower varieties. All these tasks were fulfilled successfully.

The change of natural climatic conditions in Belarus results in gradual shift to new production conditions, similar to Ukrainian. Accordingly, our scientists work on the improvement of soil cultivation and introduction of special agricultural varieties — millet, corn hybrids, and draught-resistant grasses. There are first results of growing grapes and vine crops.

The scale of work of our researchers is impressive. They are engaged in practically all areas of agricultural production. However, there are key areas of concentration for the forces of the agricultural science. In plant growing, they are as follows:

- breeding of varieties and hybrids of agricultural crops of highest productivity adapted to varying soil and climatic conditions, providing most efficient use of organic and inorganic fertilizers.
- innovative technologies of soil cultivation, crop growing and harvesting with proper focus on plant specifics and capabilities of agricultural machinery and due consideration of the ecological balance.
- development of new effective mineral and organic fertilizers and management mechanisms ensuring soil fertility balance and recovery and regeneration of soil quality.

In animal husbandry:

- selection of domestic varieties and hybrids of farm livestock with increased productivity and fodder conversion adapted to regional conditions and commercial husbandry;
- scientific support of the breed and animal stock in the country, deeper specialization of animal husbandry within each specific area (meat or diary farming);
- development of new technologies of livestock management and rations ensuring enhanced productivity with maximum use of local resources, builders, proteins, vitamins and microelements, high quality of products and its ecological safety.

In the area of agricultural mechanization:

- development of model lines of agricultural machinery and technical equipment with competitive qualities (efficiency, handiness, safety, reliability, and operational efficiency), better adapted to the climatic specifics of the country, human factor, and specifics of soil, plants and animals;
- active cooperation of Belarusian scientists with colleagues from leading foreign centers of machine building; development of advanced prototypes of machinery jointly with partners from foreign machine-building centers; targeted and purposeful assimilation of the best achievements in world engineering. Integration of the national machine building in to the world system of manufacturing and sales of quality and efficient equipment.

In the area of food supplies:

- production of high quality, safe and available foodstuffs (ranges of products) for various consumer (functional) applications;
- development and introduction of innovative technologies of agricultural products processing and production of valuable and competitive foodstuffs;
- organization of national system of food quality and nutritional value control to ensure its safety.

In economics of agriculture:

- development of effective economic mechanisms, models, methods, guidelines and recommendations for specific conditions of management for various types and groups of agricultural enterprises providing for higher competitive power and efficiency of operation on the home market, and to increase export potential of the nation.

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Plant Breeding and Seed Growing — Major Tools of Crop Husbandry

All the conditions being equal, new genetically enhanced varieties adapted to specific soil and climatic conditions provide for at least 50% of the increase in productivity.

Nikolai Vavilov, a prominent plant breeder, geneticist and immunologist, used to say that plant breeding is a science, art and craft. Like evolution, it resides on three "whales": heredity, variability and selection. As science, it needs integrity, as art it demands talented breeders, capable of intuition, and as craft — high level of organization and management of the field selection process — "conveyer". Optimum mix of these components permits to develop new genetically enhanced varieties practically every year with high stable productivity and better quality.

Strain renovation and changing made in time increase yields by 10—15%. These measures shall be taken at least once every four years to ensure stable crops, otherwise harvests may fail.

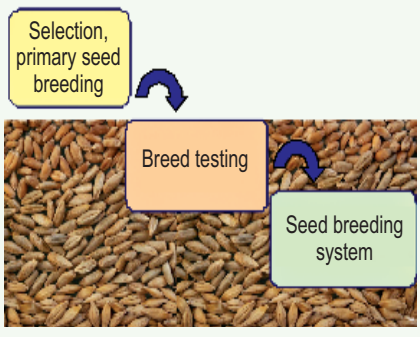

Fig. 1. Stages of breed introduction

The system of national plant breeding, crop variety testing and seed growing (Fig. 1) is common in the world. Its goal is to support seed resources, provide with quality seeds commercial producers. Today, 73.5% of arable land in Belarus planted with domestic varieties, 26.5% — foreign varieties (Table 1). The same ratio is observed in Western Europe.

Over 70 Belarusian varieties are included in the State Register and qualified in 37 oblast of Russia, Ukraine, Lithuania, Latvia, Kyrgyzstan and Germany (Table 2).

Selection of crops is successful for most cultures. However, certain problems requiring immediate attention do exist in plant breeding and seed growing.

Table 1. Domestic and foreign varieties in the State Register of the Republic of Belarus, 2007 r. (quantity and area)

Crop	Number of varieties in the Register, 2007			Cultivated area in 2007	
	Total	Including		Total, thousand hectares	Area under Belarusian- varieties, %
		Belarusian selection	foreign		
Winter rye	23	21	2	592.3	97.6
Winter wheat	28	18	10	229.1	72.6
Winter triticale	17	9	8	405.2	77.9
Spring wheat	16	5	11	128.6	43.1
Spring triticale	4	1	3	16.4	66.3
Barley	24	13	11	631.8	63.4
Oats	13	8	5	216.1	50.6
Buckwheat	13	10	3	9.4	82.9
Peas	28	16	12	45.2	42.2
Spring vetch	8	4	4	13.8	16.3
Lupine	16	16	—	39.4	97.3
Winter rape	16	8	8	162.2	97.0
Spring rape	19	10	9	63.9	99.9
Sugar beet	55	2	53	98.3	—
Corn	69	13	56	725.0	37.2

Historically, in 1965—1980 vast efforts were made to plant breeding and seed growing to a new methodological, instrumental and logistic level. Since 1965, genetics was no longer a mock science, it was actively promoted. Thirty new selection centers were created, including the Western Selection Center in Belarus, phytotron and greenhouse facilities were built and equipped with modern instruments and portable selection and breeding devices. Experimental seed-breeding farms were built, specialist traveled abroad to gain new experience, new training courses were introduced in high educational institutions, selection became a respectable profession. Two breeders were Heroes of Labor in our republic, vigorous and talented people came into profession.

For the last 20—25 years the achievement of Belorussian science have been based on this foundation. Local varieties are competitive with foreign and excel them in southern, eastern and central regions of the country in stability, yields and quality. In 1965 (Fig. 2) only two local varieties were cultivated (the rest were Russian and German), in 1980 — 19, 1990 — 53, and in 2006 — 189.

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Table 2. Varieties of the Agricultural R&D Center of NASB outside Belarus

Crop	EU: Germany, England	Russia	Ukraine	Lithuania	Latvia	Kyrgyzstan
Winter rye		3	4		1	
Triticale		4				
Winter wheat		1			3	
Spring wheat		1	1			
Barley		5	3	2	2	2
Oats		2	2	2		1
Buckwheat		2		3	1	2
Lupine	4		1	1	2	
Rape		3				
Perennial grasses		5	2			1
Common beet		3				2
Total	4	29	13	8	9	8

Efforts are needed to preserve all positive achievements of our plant breeding and seed-breeding, and to bring the branch to the level of modern biological science.

Objectively, foreign varieties cannot dominate in Belarusian fields. This results from the specifics of selection and commercial growing of crops: .

- predominance of light soils with sand bed (60% of arable land);
- vast areas of drained peat and marsh lands (10% in the Brest and Gomel oblast);
- varying economic performance of agricultural enterprises (yields vary from 15 to 90 hundredweight/hectare);
- increasing changes in plant environment (frequent draughts, frosts, floods, magnitude of temperature changes, heavier pollution);
- steep increase in technological costs: fuel, fertilizers, pesticides and equipment.

The following measures are being taken to enhance the efficiency of selection:

- Ecologization of selection — gradual transfer of separate stages to the oblast practice fields and agricultural educational institutions. In shall be noted, the number of selection per unit of arable land stations in Belarus is significantly smaller, than in Western Europe (for barley — by six times);
- wide introduction and use of modern genetic and biotechnological techniques in agricultural technologies (Fig. 3);
- accelerated breeding of new varieties

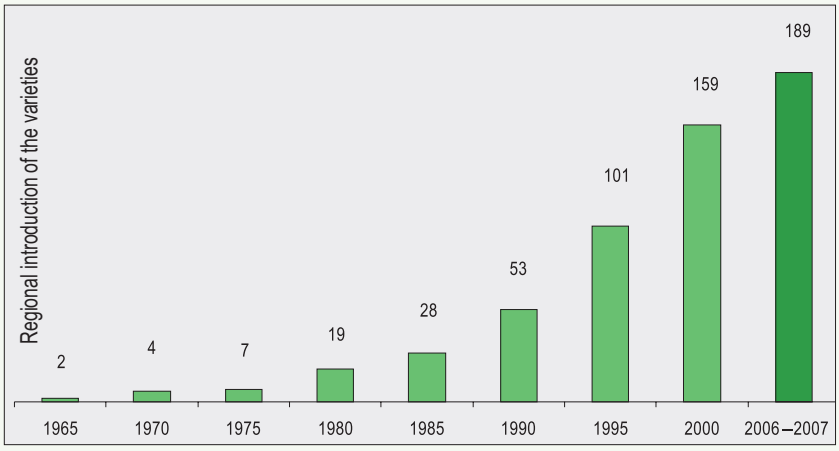

Fig. 2. Number of varieties of domestic selection of cereals, grain legumes, technical and groats crops in Belarus

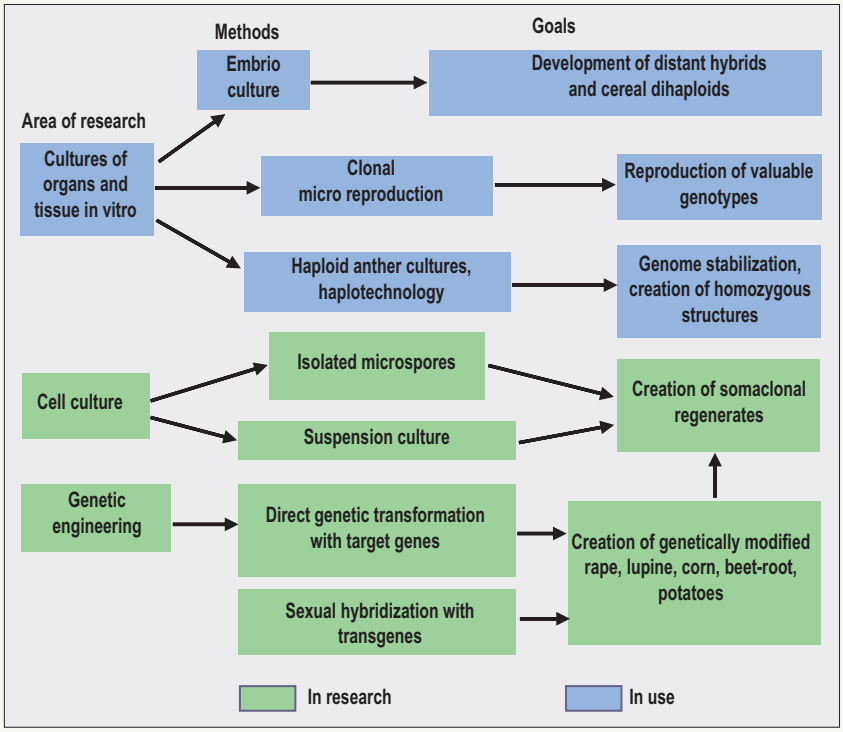

Fig. 3. Use of genetic-biotechnological methods in selection

(modernization of phytotron and greenhouse facilities);

- improved information support of selection processes (computer and information technologies);
- Creation of the National Bank of genetic resources of agricultural plants;
- technical and instrumentation renovation of all stages of plant breeding and seed growing.

The reform of the seed growing system includes the following measures:

- transfer of production of original seeds and super elite of all cereals, grain legumes, technical and fodder crops to the scientific research institutions of the National Academy of Sciences;
- introduction of new methods of seed quality control (DNA certification, electrophoresis);
- reduction of seed-breeding enterprises from 100 to 40 and their deeper specialization;
- building of seed plants for drying, cleaning and additional treatment of elite seeds at the seed-breeding enterprises;
- introduction of new motivational mechanisms and new system of seeds sales.

A method of young embryos, embryo culture in vitro, is used in the Scientific and Practical Center for Arable Farming for production of distant hybrids and monoploids. This method was used for the base line in selection of triticale, oats, cereal and legume grasses, for varieties of barley and oats. Antheral in vitro method was introduced for selection of cruciferous cultures, two dihaploid breeds of rape were produced, as well as clonal micro reproduction of broad-leaved clover, and a series of new varieties. Lupine and rape hypocotyls isolated embryo in vitro methods are introduced.

The implementation of the Program of development of plant breeding and seed growing of cereals, grain legumes and technical crops for 2008—2013, developed by the Scientific and Practical Center for Arable Farming of the National Academy of Sciences jointly with the Ministry of Agriculture and approved by the Presidium of the Council of Ministers, will ensure efficient operation of the branch for the nearest 20 years, increase and stabilize annual production of grain by 500 thousand tons. Provided robust financing, the economic effect will amount to BYR192 billion rubles, and the pay back period of 3 years.

This Program is of paramount importance for the Academy of Sciences, it will revitalize most areas of biological science. Development of new varieties, high quality seeds and improved technologies of crop cultivation is the real added value of all information, methods and skills, developed by plant scientists. This is the way how knowledge and scientific progress strengthen food security of the country. It is common knowledge, that transgenic varieties of agricultural crops have not brought about the "green revolution" so far, despite their perspectives and importance. Today, transgenic crops are cultivated in the world on 100 million hectares, 90% resistant to non-selective herbicides (mostly glyphosates).

99% of the cultivated land are used for growing of four crops: soy, rape, corn and cotton. One may suppose, that after the moratorium on genetically modified organisms will be lifted, European scientists will actively participate in their development and use.

For speedy development of transgenic varieties (when legally approved), we are prepared to "build in" target genes (transgenes) by traditional sexual hybridization from existing commercial transgenic varieties, resistant to non-selective herbicides, diseases and pests into the Belarusian and foreign varieties and hybrids of winter and spring rape, sugar and common beet, corn, and other crops. It is clear, this research should take into account all limitations and dangers of use of transgenic plants, high level of instrumental monitoring and marking of genetically modified products.

There are five approaches to the introduction of transgenic crops in the country:

- testing of the existing foreign varieties and recommendation of appropriate cultures for cultivation;
- ordering the development of transgenic strains of best varieties registered in Belarus from foreign biotechnological companies;
- purchasing required equipment and development of transgenic crops;
- transporting of the "transgene" from foreign crops into best newest varieties of local traditional selection;
- developing all technology independently.

For the coming 3—5 years, approaches 1 and 4 are the most probable. Foreign companies are reluctant, as a rule, to accept approaches 3 and 4. The fifth approach is time consuming and costly.

The potential of genetic engineering is used on a limited scale even in industrial microbiology. In the area of higher animal and plant organisms, its application is limited by genetics itself. Practically important facilities depend on numerous genes, and genetic engineering operates today with limited number of Mendelian facilities.

As a rule, valuable and adaptively significant facilities are polygenetic by their nature. Most of them are genetically non-identified and were not described biochemically. 200—300 genes have been studied in chromosomes for certain plants, of the genetic pool of over 50 thousand genes. DNA-methods have been developed for a limited number of crops and facilities.

During the 17th Congress on Genetics, held under the motto "Genetics and understanding of life", genetic resources and selection, genetics of development, evolutional, ecological, population genetics and genetics of quantitative facilities were among 11 major directions of research.

From the beginning to the end of the process of selection, the breeder faces the same obstacle: science today cannot offer reliable theory and methods of selection. The genotype is phenotypically multivariant, and selection is always threatened with failure to discriminate most valuable genotypes, generated in the course of long and costly work. Like others, we cannot reliably identify the genotype by phenotype, or by other means.

Some researchers prioritize further development of the ecological and genetic theory of polygenetic heredity and further study of the ontogenesis stages, development of methods genotype identification by phenotypes, final resulting and component facilities at different stages of ontogenesis, development of express field genotype identification techniques.

Selection is a complex systemic and random process, still far from optimal. Nikolai Vavilov put it very correctly: "Selection is evolution, guided by human will... Selection is an evolutionary process compressed in time and space".

Gomel Affiliate of the Academy of Sciences: Achievements, Problems and Prospects

The modern age decrees that the scientific activities should be reoriented to meet actual innovative needs of the economy, move cooperation between the science and science-intensive industry to a new level and seek more sophisticated institutional arrangements. Bearing in mind specifically these objectives, a decision was taken in 2006 to establish the Gomel Affiliate of the National Academy of Sciences of Belarus to promote scientific activities in the region.

It should be pointed out that all conditions are available in Gomel Region to improve the innovative activity, namely, sufficiently developed scientific workforce (over 140 Doctors of Science and over 1 100 Candidates of Science), an extensive network of scientific and science service institutions (3 academic institutions, nearly 20 sectoral research and designing institutes and special design bureaus), institutions of higher education and also large industrial enterprises. Many developments of Gomel scientists were recognized in Belarus and worldwide. The NASB V.A. Belyi Institute of Mechanics of Metallopolymer Systems is actively involved in implementing research programs, economic agreements and contracts of various levels. Among them, the following may be highlighted: implementation of the Union State's Program *Kosmos SU* aimed at solving the hardware-methodical problem of setting up an experiment at the international space station, regional scientific and technical program of Gomel Region in the field of polymer materials science and governmental programs of applied research to develop new polymer composites, friction materials and products. The priorities of the NASB Institute of Radiobiology is to eliminate long-term effects of the Chernobyl nuclear disaster in ecosystems and develop new methods of analyzing the environmental impact of the radiation factor. The NASB Institute of Forest developed proposals related to conservation of forest resources of Gomel Region, a valuable gene pool of forest woody plants and green planting sanitation in the city. The Regional institutions of higher education also make a sizeable contribution to promote entry to scientific products market.

In 2007, scientific and science service institutions, institutions of higher education and special design bureaus implemented 42 assignments of sectoral national economy programs, including those of high social significance, 57 assignments of governmental scientific and technical programs and intergovernmental projects, 14 assignments of regional scientific and technical program and innovative projects and 337 assignments of fundamental and applied research programs. Implementation of 935 economic agreements and contracts is eloquent of rather close cooperation between scientific institutions and the industry. According to the 2007 data, 127 units of innovative equipment were developed, 98 unique developments were implemented, 3 new production facilities were established and 197 titles of protection of subjects of industrial property were received.

The problem of searching for an effective arrangement of cooperation between all entities of innovative activities in the Region was given priority and was addressed immediately after establishment of the affiliate. To coordinate efforts, a scheme was

developed to define lines of cooperation between the bodies of state administration, research institutions and industrial enterprises in the region. The NASB Affiliate is responsible for the science sector. A Coordination Scientific and Technical Council of the Regional Executive Committee comprising managers of the sectoral services and representatives of the industrial and scientific community is in charge of the activities subject to the scheme. Therefore, a specific "platform" is established to allow a direct contact between the scientific community and industries.

Holding field theme meetings of the Presidium and Presidium Bureau of the Affiliate is a common practice to solve urgent problems. The first meeting was held at the Production Association *Gomselmash* and it is noteworthy that the most critical issue *On the Role of Science in Solving Problems of Agricultural Machinery Industry of the Republic of Belarus* was put on the agenda. The meeting resulted in conclusion of a number of economic contracts providing for manufacture of polymer buckets for a PKK-2-02 potato combine harvester, sight gages from a transparent temperature stabilized material, development of a material and structure of sliding supports of a shaker straw rack and so forth. Such a meeting is scheduled to be held at the Production Association *Belarusneft* in the near future to discuss urgent innovative demands of the enterprises incorporated into the *Belneftekhim* Concern.

To identify the scientific sector's potentialities to meet innovative challenges, meetings were held with the management of a number of economy entities such as Gomel Chemical Plant, Svetlogorsk Production Association *Khimvolokno*, Republican Unitary Enterprise *Gomelenergo* and Mozyr Agriculture Machinery Works. The meetings identified priorities which the scientists of the Region are capable of addressing within the frameworks of direct contracts. The problem enterprises are the focus of attention. The Regional Executive Committee's Scientific and Technical Council regularly organizes field meetings with involvement of the NASB Affiliate. The first meeting was held at the Gomel Measuring Instruments Plant to discuss an urgent problem, namely, capacity of the Regional science sector to address technological problems seriously hindering operation of that enterprise. The same meeting was held at the Administration of the Free Economic Zone (FEZ) *Raton* followed by visits to the divisions incorporated into the FEZ.

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The sphere of activity of scientists in the Region corresponds to the list of priority directions of fundamental and applied research in the Republic of Belarus for 2006—2010. 4 spheres of scientific research being of innovative significance for the region were identified based on systematization and analysis of scientific developments which emerge and are being commercialized:

- addressing post-Chernobyl problems;
- scientific and innovative activity in the sphere of agricultural machine-building and transport, petrochemical and synthetic materials industries and metallurgy;
- information support to scientific-technical and innovative development;
- specific scientific practical projects.

The NASB Affiliate created Working Groups comprising officials of the scientific and educational institutions and also of industrial enterprises. They are in charge for determining the scientific and innovative level of the current and future scientific developments within the framework of specific spheres and making specific recommendations to improve innovative processes.

In our opinion, the major barrier to innovations is insufficient activity of the majority of economic entities in promoting science-intensive technologies and lack of mechanisms of financial leverage on these processes. Most frequently, the scientific community is not so much responsible for the low level of introduction of scientific developments as inertia and unresponsiveness to them demonstrated by organization managers preferring to work in the old way. Availability of a strategy providing for approaches to creating the incentive system would help timely support innovative projects of critical significance for the Region and enhance cooperation between developers of scientific products and manufacturers.

That problem was discussed in detail at the workshop meeting held in April last year attended by the Gomel Region Administration and directors of enterprises and research institutions to gain a competitive edge by the Region's economy by strengthening science-industry cooperation. As a result, the Regional Executive Committee, NASB Affiliate and Regional Union of Employers signed a Protocol providing for implementation of a number of measures to more efficiently introduce scientific developments into production.

The scientific activity is not a thing in itself and is not intended to meet exclusively scientific ambitions. While these ambitions may exist and be implemented,

they should be based on technological requirements of the society. This is relevant, in particular, to those who have just embarked on a path of research in the world of science — young scientists, post-graduate students and students. Given the above, a number of joint actions are to be taken in close cooperation between the Regional Executive Committee, NASB Affiliate, institutions of higher education and Union of Employers:

- holding an annual tender of innovative projects and including high-priority projects into the regional scientific and technical program of Gomel Region and 100% funding of the winner-project research by the innovative fund of the Regional Executive Committee;
- increasing the prize for the winners of the Regional contest of talented young scientists and specialists up to 25 base values;
- nominating winners among the students for the best innovative proposals and developments;
- funding research conducted by the post-graduate students and doctoral students being of high innovative significance for the Region by the innovative fund of the Regional Executive Committee and also providing assistance in introducing developments and commercializing them;
- including the themes aimed at solving problems of socio-economic development of Gomel Region with consideration for the database of technological requirements of the region's organizations into the list of the students' term, diploma and master's theses;
- establishing temporary research teams to comprise specialists from various sectors of science and industry;
- training the teachers of institutions of higher education at the Regional enterprises;
- presenting topical lectures and holding workshops in the institutions of higher education by managers of economy entities to enhance awareness of the students about existing problems, prospects and innovation policy of organizations.

Regional authorities make substantial efforts to encourage innovative activity of small and medium enterprises and development of the "industrial science". To achieve this objective, it is reasonable to staff them with researchers of the highest scientific qualification which implies provision of stimulus for the economic entities to train and employ such personnel and create appropriate remuneration conditions, train specialists of enterprises in research institutions (some of them as post-graduates and candidates for a degree) and assigning graduates of post-graduate courses to the enterprises. Currently, the issue of staffing industrial enterprises with specialists in the field of innovative and patent and license activity who will be in charge of providing the required scientific and technical information is under consideration. Building a knowledge-based economy imposes new requirements to training the workforce capable of not only conducting the research, but also implementing its results. There is a need to train professional business administrators, managers of innovative infrastructure entities and marketing specialists who will be able not only to skillfully make the market study, but also properly identify the prospects of using innovative and advanced technologies.

Recently, a Scientific and Technological Park (STP) has been established in Gomel which prioritizes as follows: developing an enabling environment for organizations (primarily, small and medium-sized) operating in the scientific sphere and also promoting practical application of developments to produce innovative competitive products. Supporting innovation-oriented enterprises implies leasing premises on favorable terms, providing information, counseling, accounting, legal and other services and searching for domestic and foreign partners. The STP will be involved in promoting intellectual entrepreneurship. Cooperation with this critically important component of the Regional innovative infrastructure should be prioritized by the NASB Affiliate.

Our prospects are associated with available developments, formulated principles and practically confirmed institutional arrangements. The priorities include promotion of the field activity, which is also to include review of the technological problems of little towns and agricultural townships. We also viewed cooperation with the Belarusian Republican Foundation for Fundamental Research as one of the key directions of scientific and institutional work. The meeting of deputy managers of Foundations for Fundamental Research of Belarus, Russia and Ukraine recently held in the Gomel NASB Affiliate pointed out broad vistas of cross-border cooperation between scientists of these states. The Memorandum of Cooperation between the Foundations was approved. The first joint trilateral interregional tender for conducting fundamental research in the field of eliminating consequences of the Chernobyl nuclear disaster in 2009—2011 was announced.

Work is underway to improve the structure of the Regional Scientific and Technical Program *Scientific and Technical Support of Socio-Economic Development of Gomel Region* subject to which some functions of its organizational support are to be assigned to the NASB Affiliate. Proposals are being developed to provide the NASB Affiliate with the leverage to influence funding of regional R&D and formulation of research themes. The NASB Affiliate's Presidium Bureau meetings plan to randomly hear reports of research managers being in charge for assignments of governmental programs and specific projects to review the progress achieved. Subject to recommendations of the NASB Affiliate, the projects being of priority for Gomel Region may be included into scientific programs by using as a criterion of their assessment their compliance with the list of priority research spheres.

Neither science nor industries should develop separately in the country — currently, these two spheres of activity are interrelated. It is worth noting that organizational support for their cooperation is building up in our region serving as an example.

Expanding Science Frontiers

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The international research and development cooperation (IRDC) gains increasing importance in the activities of research institutions. This cooperation provides an opportunity for the institutions working in related fields to join efforts to scale up the research resulting in significant achievement. One of the forms of the IRDC is the exchange of information between scientists confirming relevance of the research being conducted by them, allowing adequacy of the techniques selected to be agreed and the progress of work to be promptly adjusted with consideration for emergence of innovative technologies or generations of scientific products. If today a scientific project or a program bears the mark of "provinciality", this automatically implies that it doe not comply with modern requirements. Being very instructive of the trends in the development of world science, international cooperation saves significant resources from inefficient investment. Finally, the IRDC plays an important role in identifying national priorities of the research and scientific and technical development as a strategic factor in the implementation of national policy.

Closer integration of Belarus with the international scientific and technological community, as envisaged by the Program of Social and Economic Development of the Republic of Belarus 2006—2010, is one of the major targets of improvement of scientific, research and development, and innovative activities of Belarusian scientists.. The concept of the development of science in the country for a period up to 2015 prioritizes involvement of the Belarusian researchers in the IRDC as one of the prerequisites to build up scientific potential, stabilize and improve the national economy. To meet these objectives, Belarus allocates substantial resources and their share is increasing from year to year. Participation of the NASB scientists in scientific or exhibition events abroad partially or fully paid by the budget has already become a common practice. A comprehensive government support results in increasing export revenues of Belarusian science-intensive products developed by the NASB institutions and also by attracting grants. In addition, the total value of contracts concluded at the international exhibitions is annually increasing.Estimates suggest their value will double in 2008 compared to 2007

Participation in foreign, international and domestic tenders, scientific and integrated programs initiated by the government, participation in specific programs, is an important component of increasing efficiency of budgetary investments in science. Joint scientific programs, with separate support of reaserch by each member-country ans shared use of the research are shared by all the parties involved, are being implemented subject to over 40 intergovernmental agreements on scientific-technical cooperation with other states concluded by the Republic of Belarus.

International cooperation of NASB is large-scale: at the level of the Academy there are 60 agreements of cooperation with research centers of 40 countries, our scientists work jointly on projects with researchers of over 50 countries. Belarus has arrangements with research institutions in 18 countries providing for direct equivalent exchange of scientists (when the receiving party covers the costs). Among the CIS countries, the NASB most actively cooperates with research centers of the Russian Federation, primarily, with the Russian Academy of Sciences. The Inter-Academic Council on Development of the Union State is functioning. Academic institutes and other institutions work on three R&D programs supported from the budget of the Union State, (*Cosmos-NT, Triada* and *SKIF-GRID*) and development and approval of 9 projects covering information, bio- and medical, nano- and laser technologies are underway. Since 2004, 16 interdisciplinary integration and 8 comprehensive projects were implemented jointly with the RAS Siberian Division in relevant disciplines of microbiology and biotechnology, machine-building, geochemistry and nanotechnologies research fields. The Belarusian Republican Foundation for Fundamental Research held 12 tenders jointly with the Russian Fundamental Research

NASB delegation at the jubilee meeting of the Council of International Association of Academies of Sciences (Kiev, December 2008)

Foundation and Russian Foundation for Humanities which resulted in implementation of over 400 projects.

Dealing with the subject of cooperation between the NASB and CIS countries, the projects being implemented jointly with the National Academy of Sciences of Azerbaijan and Academy of Sciences of Moldova should be also mentioned. Currently, each party finances its own project component, while the results are shared, and the parties seek ways and methods to commercialize project-related results.

The cooperation with the European Union is of critical importance for building up scientific and technical potential of Belarus. The NASB institutions and European partners submitted 28 project bids to participate in the first tender stage of the 7th EU Framework Program. Development of relations with the National Center for Scientific Research of France (CNRS) is progressing. Two standard tenders of joint projects were held which resulted in successful implementation of 25 research works and the tender of International Programs for Scientific Cooperation (PICS) was also held. Established research teams with proven joint publications have participated. The Scientific Center for Secondary Network of Central European Initiative established subject to the Agreement of Cooperation between the NASB and Abdus Salam International Center for Theoretical Physics is successfully functioning. Since 2005, the joint NASB-German Fraunhofer Society laboratory established in the B.I. Stepanov Institute of Physics has been functioning to make research into the field of optics, diagnostics and nondestructive testing. An agreement on cooperation with the German Max Planck Scientific Society is to be signed.

It is planned to significantly intensify cooperation between Belarusian scientists and their counterparts in the Asian Region's countries. Currently, the most extensive Belarus-China partnership contractual framework is available. It includes 10 agreements and protocols on cooperation to form an enabling environment for implementing scientific and R&D programs and projects and also for establishing Belarusian-Chinese Joint Research Centers and Technology Transfer Centers. The NASB set up a Special Council for Development of Cooperation with the PRC. In 2006, the Research Institute of Chemical Technologies (Heilungkiang Province, People's Republic of China) and the NASB Institute of Chemistry of New Materials established the Chemical-Engineering Center for Small-Tonnage Composite Materials in Harbin within the framework of which a number of contracts were signed. The International Research Laboratory was established at the facilities of the Academy of Sciences of Henan Province and NASB Institute of Physical Organic Chemistry. The NASB Joint Technology Transfer Centers with permanent expositions operate in two Chinese Provinces of Heilungkiang and Shandong. In 2008, participation of the NASB in the Shanghai International Fair resulted in signing a large contract by the NASB Scientific Practical Center for Materials Science (SPC) to supply the SPC's products to China which may turn into an extensive program of the SPC's developments commercialization in the Chinese market.

The cooperation between the NASB and Vietnam is dynamically developing. The SRPA Tsentr and SRPA of Powder Metallurgy are supplying large deliveries of equipment for the construction and repair sectors. In 2008, the Institute of History also started cooperating with the Vietnamese partners by concluding an Agreement on joint WWII research. It is planned to substantially increase export of the NASB-produced science-intensive products to Vietnam within the framework of existing arrangements.

The Korea-Eurasia Technology Cooperation Center, the Belarusian branch of which is based in the NASB, is functioning rather efficiently. Since 2004, Belarusian institutions concluded 30 contracts with Korean partners and the Korean party plans to increase funding of the joint activity within the framework of the medium-term project program. Signing the Protocol on Cooperation between the NASB and POSCO — the largest metallurgical works not only in Korea, but also in the entire South Asia — at the end of 2007 created good prerequisites for cooperation. Subject to the

Agreement on Cooperation between the NASB and the King Abdulaziz Center for Science and Technology (Kingdom of Saudi Arabia), 15 large contracts are being implemented by the NASB institutes. The Technological Supremacy Center in Riyadh was established to finalize and approve new contracts. It is planned to establish the NASB technology-based tire recycling and fuel plant on a contractual basis in the United Arab Emirates. The NASB intends to cooperate with companies of the Islamic Republic of Iran in the field of information technologies, innovative materials and agriculture.

Mutually beneficial contacts with Venezuela open up new vistas for the NASB. The NASB coordinates working-through and subsequent implementation of 11 projects included into the Executive Program of Scientific and Technical Cooperation of Two States for 2008—2010. An Affiliate of the NASB SPC for Agricultural Mechanization was opened within the framework of the Belarus-Venezuela Center established based on the Belarusian National Technical University. The implementation of projects is to be funded by a Special Fund for Cooperation Development between Two Countries.

The NASB also prioritizes involvement of Belarusian scientists into implementation of programs of such prestigious organizations as the International Scientific and Technical Center (ISTC), NATO Scientific Committee and IAEA. While the ISTC operated in Belarus, it financed over 90 projects worth over USD 33 million with participation of Belarusian scientists and specialists. 52 deliveries of scientific equipment costing over USD 400 thousand were performed within the framework of projects. Since 2008, Belarus is the member of the ISTC Governing Board which would help Belarus be involved in the ISTC's programs and projects at a larger scale.

As it was mentioned above, participation of the NASB in international expositions offers an opportunity to demonstrate advanced science-intensive products to potential partners with prospects of commercialization is of strategic importance. In 2008, the NASB participated in 23 expositions, including 16 expositions in which it participated as part of general expositions of the Belarusian scientific sector. In addition to conclusion of large contracts, the NASB organizations' developments were awarded diplomas and medals at those events.

Opening ceremony of Days of Science and Technology of the Republic of Belarus in China (Changchun, June 2005)

The NASB is continuously strengthening its position in the world scientific and technological market, thereby expanding opportunities for commercial use of the NASB science-intensive products and increasing performance of investment in the science. A contractual legal framework developed in Belarus at intergovernmental and interdepartmental levels, established effective mechanisms of cooperation between Belarusian organizations and their foreign partners and also a rapidly developing international infrastructure for supporting research and developmental cooperative activities, all this contributes to building up a substantial potential to consistently increase the number of and scale of mutually beneficial joint projects. To improve the ISTC efficiency, institutional and financial resources are likely to be focused on the following most promising areas:

- active involvementy of Belarusian scientists, primarily managers of institutions, in development and improvement of export-oriented international cooperation mechanisms, setting up special divisions for these purposes and continuously improving qualification of their staff;
- expanding a network of Belarusian technology transfer centers abroad which search for potential partners for implementing joint projects and contracts, providing legal support to commercial relations and promoting efficient intellectual property protection;
- increasing government funding of long-term and medium-term scientific and technical projects to be implemented subject to intergovernmental agreements of Belarus and optimizing the process of joint decision-making in evaluating the projects;
- continuous promotion of foreign contacts for scientists and supporting programs for their involvement in the international activities of the government;
- joining the international R&D consortiums, primarily within the framework of the EU programs, jointly with foreign partners; and
- further expanding the infrastructure of joint research and innovative divisions (Centers, laboratories and enterprises), also including those within the Technopark zones to be established both in Belarus and abroad.

Intellectual Property as a Factor of Sustainable Development

Subjects of industrial property (SIP) lay foundation for the majority of innovations in the scientific and technical sphere, while their creation and wide utilization is viewed as one of the key indicators of the innovative activity. The NASB pays special attention to intellectual property (IP) management and the IP is managed subject to the international practice.

The patent licensing policy is aimed at accelerating development of the scientific and technological potential in priority spheres of the scientific work and R&D activity in 2006—2010 approved by the President and the Government of the Republic of Belarus. It is a coherent system founded on integrity (SIP legal protection and assistance and the most extensive range of research and developments) and on building additional incentives for introduction and consistency — passing from scientific developments to industrial prototypes and further to their commercialization.

The performance of the NASB organizations in the recent years is confirmed by increased quantitative and qualitative indicators in terms of submitted and granted protective documents on subjects of industrial property.

According to the NASB, 619 applications for SIP were submitted to the patent authorities in 2007 (in 2005 — 582 and in 2006 — 601), including applications for inventions — 382, useful models — 184, industrial designs — 2, trademarks — 9 and plant varieties — 32. 580 protective documents were received (in 2005 — 326 and in 2006 — 503). Compared to 2006, their number increased by 15.4% which exceeds by 12.4% the target indicator (468) provided for by the Program of Socio-Economic and Scientific Innovative Development of the National Academy of Sciences of Belarus for 2006—2010 (Fig. 1).

Among the most significant developments of the NASB organizations on which the patents were registered in 2007, the following may be highlighted:

- Patent No. 9226 Suture Filament and Method for Producing It, which was applied in surgery for connecting soft biological tissues. Patent holder — V.A. Belyi Institute of Mechanics of Metal-Polymeric Systems, NASB, and Gomel State Medical University;
- Patent No. 10000 Method of Low-Temperature Removal of Hydrocarbon Volatile Fractions from Oil and Liquid Petroleum Products. It may be used in the petrochemical sector. Patent holder — V.A. Belyi Institute of Mechanics of Metal-Polymeric Systems, NASB;
- Patent No. 10010 Method for Producing Carbon Nanomaterial. Patent holder — A.V. Luikov Institute of Heat and Mass Transfer, NASB.

It is noteworthy that not only the inventive activity has been on upsurge over the recent years both in the NASB and throughout Belarus, but the structure of patents granted has also substantially improved subject to the International Patent Classification (IPC) (Fig. 2).

As it is seen from Figs. 2—3 (statistical data are preliminary and are subject to updating), the number of patents on proc-

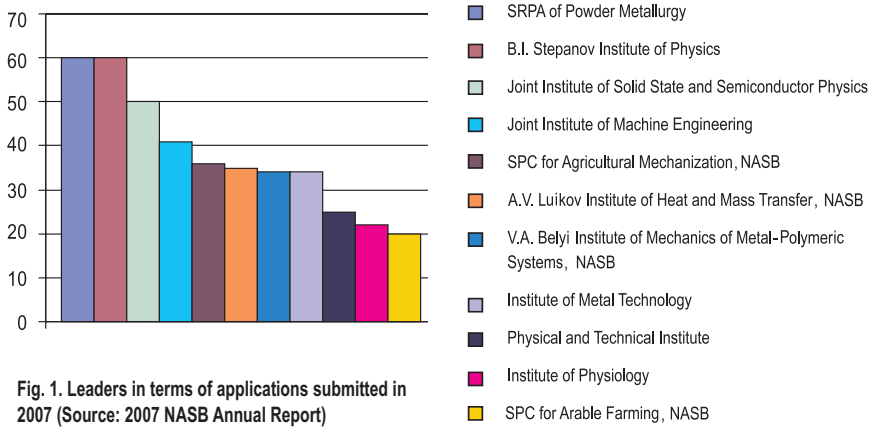

Fig. 1. Leaders in terms of applications submitted in 2007 (Source: 2007 NASB Annual Report)

esses, transportation and also on inventions in the field of electricity, chemistry, metallurgy, medicine, etc. received by the NASB institutions has increased.

The analysis of thematic directions of patenting subject to IPC sections and subdivisions shows that the highest activity in obtaining patents is observed in the field of inventing alimentary products and drinks (section A01) and in medicine (A61) followed by as follows: various processes (B01), foundry production and powder metallurgy (B22), nanotechnologies (B82), inorganic chemistry (C01), organic chemistry (C07), organic high-molecular weight compounds (C08), biochemistry and gene engineering (C12), physics (G01) and electricity (H01).

According to the results of the 2007 National Contest *Best Organization of Inventive Activity and Management in the Field of Intellectual Property* in which nearly 80 enterprises of scientific-technical and trading-industrial complexes participated, including 27 research institutions, the SRPA of Powder Metallurgy became a prize-winner in the nomination S*cientific Organization*.

The Institute of Bioorganic Chemistry, NASB became a leader in terms of the number of applications submitted to receive a Eurasian patent on inventions which were developed in the process of implementing the assignments of the State Program of Oriented Fundamental Research Physiologically Active Substances and Bio-Effective Pesticides.

Inventive Activity

The inventive and patent licensing activity of the NASB institutions and other Belarusian economy entities promoted competitiveness of the Belarusian products in external markets and, hence, the GDP growth with steadily high rates.

Nearly 20 indicators are used in the international practice to characterize inventive and patent activity. In our opinion, the most important indicators widely used by the UN, OECD, EU, WEF and other organizations are demonstrated in this article. They include as follows:

- number of patent applications of national applicants per 10 thousand people (Table 1);
- number of patents registered in the country per 10 thousand people (Table 2);
- number of patents received by national applicants per 1 million of residents (Table 3).

To conduct a comparative analysis, respective statistical data of East European countries similar to those of Belarus in terms of the population and area were taken. Despite the fact that merely 0.66% of employees of the total workforce are involved in research and development in the Belarusian economy, the ratio of patented inventions assigned through licensing to the patents legally effective in Belarus is 3.3% which is indicative of their relatively high demand in the Belarusian market. Not more than 5% of patented inventions are used on a license basis in the developed countries.

As it is seen from Tables 1—3, Belarus has a leading position in the inventive and patent activity compared to a number of

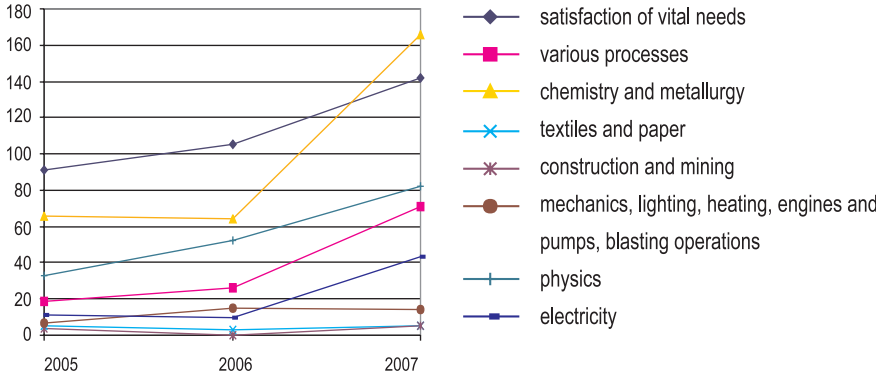

Fig. 2. Distribution of patents on inventions subject to sections of the International Patent Classification in 2005—2007 (Source: Official Bulletin of the National Center of Intellectual Property, State Science and Technology Committee, Republic of Belarus, 2005—2007)

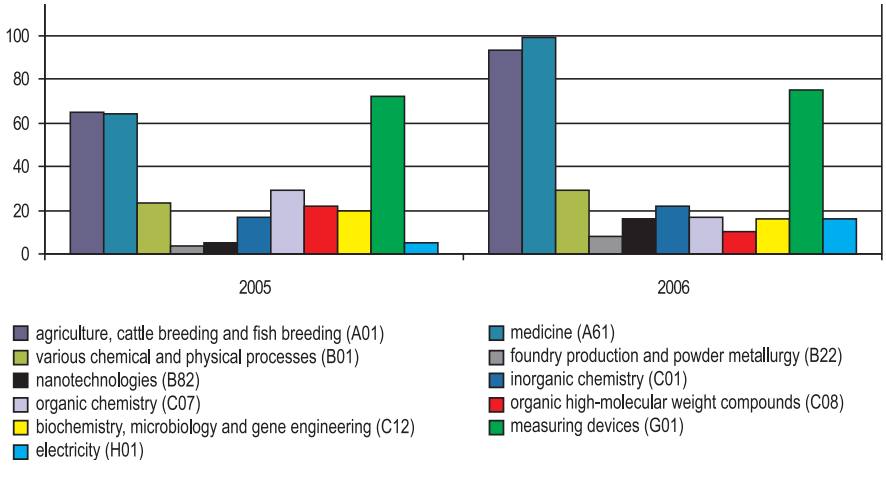

Fig. 3. Distribution of patents on inventions subject to IPC in 2005—2006 (Source: Official Bulletin of the National Center of Intellectual Property, State Science and Technology Committee, Republic of Belarus, 2005—2006)

Table 1. Inventive Activity Ratio, per 10 Thousand Persons

Country	Years				
	2001	2002	2003	2004	2005
Belarus	0.96	0.93	1.14	1.15	1.27
Hungary[1]	0.91	0.84	0.75	0.74	0.7
Romania[1]	0.5	0.66	0.39	0.42	0.41
Czech Republic[1]	0.56	0.51	0.61	0.6	0.57

[1] — exclusive applications submitted to the European Patent Office

Table 2. Number of Registered Patents, per 10 Thousand Persons

Country	Years				
	2001	2002	2003	2004	2005
Belarus	1.4	1.7	2.2	2.0	2.3
Hungary[1]	1.3	1.5	1.4	1.0	1.1
Romania[1]	0.4	0.5	0.7	0.6	0.7
Czech Republic[1]	1.7	1.8	1.8	1.6	2.2

[1] — inclusive European Patents

Table 3. Number of Patents Received by National Applicants per 1 Million People

Country	Years				
	2001	2002	2003	2004	2005
Belarus	39.2	54.8	89.7	79.6	85.8
Romania	21.3	22.1	19.3	19.5	18.9
Czech Republic	23.5	23.5	25.3	28.6	34.2

Source: Intellectual Property of Belarus, 2008, No.1

East European states. We also used these indicators to rank the CIS countries, with Belarus being second only to Russia.

It should be noted, however, that enterprises and NASB institutions register subjects of industrial property abroad at a rather limited scale, thereby impeding competitiveness of developments and indicating that patenting is not aimed at protecting the export and improving production processes to the full extent. Therefore, there is a need to more efficiently identify technologies which could be sold in the market as licenses to yield commercial profit.

Innovative and License Activity

As one of its priority goals, currently, Belarus sets the development of the National Innovation System to be founded on accelerated promotion of innovations. It is being implemented through a rather extensive network of channels. A commercial mechanism for transferring technologies comprising subjects of industrial property includes license agreements (exclusive and non-exclusive), assignment agreements, know-how transfer agreements, contracts for provision of engineering services, etc.

In 2007, the NASB institutions concluded 21 license agreements and assignment agreements on IP. The Sientific and Practical Center for Agricultural Mechanization, NASB, in particular, concluded 5 license agreements on as follows: application of useful models under Patent No. 2080 Roller Moist Grain Mill (with Kalinkovichy Repair and Engineering Works OJSC and Vitebsk Motor Repair Plant OJSC), under Patent No. 3177 Foam Generator (with Mekosan OJSC), under Patent No. 3290 Roller Moist Grain Mill (with a subsidiary enterprise of Shchuchin Repair Works of Grodno Unitary Enterprise Oblselkhoztekhnika) and application of a useful model under Patent No. 821 Sprinkler Device (with Republican Production Subsidiary Unitary Enterprise Experimental Plant). The V.A. Belyi Institute of Mechanics of Metal-Polymeric Systems registered 2 new agreements on sale of a non-exclusive license for application of the invention Method for Producing Compatibilizer under Patent No. 5382 (licensee — Tekma Supplementary Liability Society) and for know-how Composition for Producing a Friction Material (licensee — PF Polifest Ltd.), thereby increasing the number of effective license agreements the institute has to 6.

According to statistical data, the sphere of science and science service accounts for the largest share of advanced processes (56%) and this sphere is also a major supplier of these processes abroad (43.6%). However, they account for just 29.4% of all export agreements in terms of cost of exported processes.

The study of the intellectual property market allows a conclusion to be made that the NASB institutions, on the one hand, are characterized by a relatively high level of innovative activity and have adequate legal protection and assistance, and, on the other hand, technical innovations are in low demand by the real sector of economy, primarily due to the underdeveloped infrastructure for their commercialization.

A particular role is assigned to intellectual resource as a factor of a sustainable economy development and increased national security and to strengthening the export potential. The Government of the Republic of Belarus developed and approved the State Program of Intellectual Property Protection for 2008—2010. Its objective is to lay the foundation for making qualitative changes in the structure of the Belarusian economy, promote sustainable innovative growth, speed up the development of scientific and technical potential in the priority spheres of science, engineering and technologies and develop world-level competitive products. The NASB enterprises and institutions are actively involved in implementation of this Program aimed at establishing the priority of national technological achievements and stimulating production development.

The analysis of inventive and patent license activity in the NASB institutions allows a general conclusion to be made that key indicators have been increasing over the recent years. Short-term and long-term positive dynamics of these processes may be predicted with a high degree of probability in transition to the innovation-based development.

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