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pages

MARKING THE 120TH ANNIVERSARY
OF THE PETER THE GREAT ST. PETERSBURG POLYTECHNIC UNIVERSITY

12+



Rector Andrey Rudskoy with the participants of the North-West Industrial Forum.

*Fair Government
Strong Business
Prosperous Citizens*

12+

RUSSIAN  MAECENAS

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Cover image:

Young specialist Galina CHEREVATENKO at a laser installation in the
Nanobiotechnology Research Centre.
Photo: Timur Turgunov.

Welcome!

Called to be Great

The leadership genes of this university were created 120 years ago by its founders Witte, Mendeleev and other great minds and were absorbed by the first generation of graduates and staff. Whole areas of research and industry were set up: metallurgy, hydraulic engineering, electricity transmission, the tank industry, nuclear physics (this is no joke: five three-time Heroes of Socialist Labour who worked on the Soviet nuclear project had direct links with the Polytechnic). After the war came the space industry, new materials, cybernetics... the list is endless!

It is no surprise, therefore, that today the university is at the cutting edge in fields such as computer engineering, artificial intelligence systems, additive technologies and nanobiotechnologies. It is one of the leaders of the National Technological Initiative, has set up a consortium with fifty of the country's leading companies, scientific organizations and higher education establishments, and is involved in the design chains of a number of Western companies.

The university's focus on specific technological tasks is by no means an imposed service: it finds a response from system-forming industrial companies such as *Rostec*, *Rosatom*, *United Engine*, *Ship* and *Aircraft Building*



Corporations, the *Kurchatov Institute*... The logical consolidation of these links will be the next step, approved by the President of the Russian Federation — the creation of the federal technopolis *Advanced Production Technologies*.

No, not for nothing is the official anniversary slogan 'To Be Great'. The university produces specialists of international standard — with that ambition it could hardly be otherwise. And they are not simply advanced 'techies' but, following the traditions laid down by the founding fathers — engineer-intellectuals who are active in the sociocultural field. This is particularly important to Russian Maecenas, which has the honour to be a permanent partner of the Polytechnic University.

To mark the 120th anniversary of the university that bears the name of Peter the Great, we have assembled materials from our publications of various years concerning various spheres of its activities. They clearly show how the university is growing and developing, still faithful to its calling to be Great.

*Arkady Sosnov,
Editor-in-Chief
of Russian Maecenas*



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by the atom / p. 48



— We are training engineering shock troops for our country. And, of course, we are participating in every global project... To-day our university is the undisputed leader in digital technologies and in the introduction of computer engineering into manufacturing industry.

We have defined for ourselves a totally new vision of how we need to work — higher education, the Academy of Sciences with industry, so as to actually get away from words, from flamboyant trumpeting of our achievements and move on to the specific, fully comprehensible interaction of science, education and production.

In the last five years we have carried out a whole range of very important projects for industry.

*Academician of the Russian Academy of Sciences
Andrey RUDSKOY, Rector of the St. Petersburg Peter
the Great Polytechnic University, at a meeting
with Russian President Vladimir PUTIN.
6 February 2019*

A Polytechnic Planet

GRADUATES ARE THE PRIDE OF THE COUNTRY'S LEADING TECHNICAL UNIVERSITY

Alexander KOBYSHEV, Head of Corporate PR of the Peter the Great Polytechnic University. Photos: the St. Petersburg Polytechnic University Media Centre



The student Pyotr Kapitsa.

In 2019, my alma mater, Peter the Great St. Petersburg Polytechnic University, will turn 120. These years have been full of turbulent and complex events that changed the world's history and people's fates. The biggest technical school in Russia, the Polytechnic University has changed as well. What, however, has never changed is the supreme quality of its education and research and the University's leading role as one of the main Russian engineering schools. The word *Polytechnician* has become a mark of professionalism for students, graduates, teachers, and researchers.

Look at the photo from the personal record of the student Pyotr Kapitsa who enrolled in the Electromechanical Department in 1912. He is still wearing his secondary school uniform. Then there were WW1, work at Rutherford's laboratory in England, establishment of the Institute of Physical Problems of the USSR Academy of Sciences, the Hero of Socialist Labor award, disfavor and unemployment,

teaching at the Moscow Institute of Physics and Technology, and global fame... In the 1920s, Kapitsa did research together with Nikolay Semyonov who was then an assistant at the University. It is no accident that the future Nobel Prize winners are pictured together at the painting by Boris Kustodiev.

Our graduates have made an invaluable contribution in the country's development, be it the implementation of the GOELRO plan, the design and construction of Dneproges and the Sayano-Shushenskaya HPP, the development of metallurgic and engineering plants, the first man-made satellite of the Earth, the first lunar rover or the first nuclear icebreaker.

The Polytechnicians have played an exceptional role in the development of the Russian science. In 1918, the famous Physics and Technical Institute was opened in Petrograd. It developed from seminars and the Physics and Mechanics Department, a creation of

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Left:
This is how Boris Kustodiev saw
the young physicists Pyotr Kapitsa
and Nikolay Semyonov.



The monument to the Polytechnic Institute
student and the fountain *Us* at the first
academic building were made with the
Polytechnicians' funds.

Abram Ioffe who started his scientific career in 1906 as a laboratory assistant at the Polytechnic Institute. Later on, numerous physical institutes and departments nationwide span off from the Ioffe Institute.

There is no need to introduce Yuli Khariton, Igor Kurchatov, Yakov Zeldovich, Anatoly Alexandrov (President of the USSR Academy of Science in 1975–1986), and Georgy Flyorov (the 114th element of the periodic table is named after him) who created the nuclear shield of our country. Alexander Baykov developed the scientific foundations of metallurgy, and high voltage electricity transmission would not exist without Mikhail Shatelen's studies.

A special group of Polytechnicians are artists and writers who developed in the humanistic aura of the University. These include the theater director and teacher Leonid Vivyen (a reinforced concrete structure engineer by education), the writers Yevgeny

Zamyatin, Boris Zhitkov (shipbuilding engineers), Daniil Granin (electromechanical engineer), and Alexander Zhitinsky (electrophysical engineer), and the legendary World Chess Champion Mikhail Botvinnik (electrical engineer).

Our graduates have carried the Polytechnic spirit through their lives. As early as in 1910, they organized a Society of the Peter the Great St. Petersburg Polytechnic Institute Alumni. This alliance survived the revolution and had branches working in Europe, Asia, and North and Latin America. The memoirs of its members were published for the 25th and 50th anniversaries of the University and republished for the 105th anniversary of the Society.

In the 1990s, many young scientists found jobs abroad. One of them was our former Lenin scholarship holder Ilya Bezprozvanny who became a Professor at the University of Texas Southwestern Medical Center. This did not, however, stop him from creating a



The University's historic main building looks beautiful at any time of year.



The best WW2 tank is the famous T-34 designed by Mikhail Koshkin. The renowned U-2 by Nikolay Polikarpov were in the air service, and the world's biggest cargo aircraft, Antei, was designed by Oleg Antonov. All these people are graduates of the Polytechnic University.



Neuromolecular Degeneration Laboratory at his home Polytechnic University where he spends several months every year with his young colleagues studying Alzheimer's and Huntington's diseases and methods to fight these lethal illnesses. Several more laboratories headed by Russian scientists are part of the RASA center (Russian-Speaking Academic Science Association), which opened in 2016.

Thousands of foreign graduates of the Polytechnic University are the engineering, scientific, and teaching elite of their countries. For example, Gao Jingde, a postgraduate student from China, defended a candidate's thesis here that was recognized as a doctor's thesis. In 1983, he became the head of Tsinghua University in Beijing and made it the biggest technical university in China. In 1987, Tsinghua became the first Chinese university to sign a partnership agreement with the Polytechnic University. Another center of cooperation is the SPbPU office in Shanghai, which is the first headquarters of a Russian university in China.

Our graduates at Tsinghua and universities of other countries are united through foreign associations of the Polytechnicians.

They are supported by the University's Graduate Liaisons Center, which has been publishing the Unity magazine since 2015. In a February 2016 letter to the University Rector, RAS Academician Andrey Rudskoy (a Polytechnic graduate, of course), Hungarian Polytechnicians wrote about the celebration of the 60th anniversary of their class. The forms of cooperation between the University and its alumni are diverse. It is logical that an association entitled *Graduates and Friends of the Polytechnic Institute* was created on the Rector's initiative. This is not just a sign of 'high relations' or nostalgia about the good young days, but a part of a resource mobilization project for bringing the university into the global educational elite. Integration of professionals who have accumulated the best achievements of the Polytechnic school and hold commanding positions in the science and economy of various countries is one of such resources.

And indeed, our graduates are working successfully in every Russian region, running the biggest companies including *Silovye Mashiny*, *Atomproekt*, *Aerospace Equipment*, *Izhora Pipe Mill*,

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Zvezda, and many more. Vitaly Savelyev, *CEO of Aeroflot*, the best airline in Eastern Europe, is a graduate of our Mechanics Engineering Department. A complete list of the Polytechnicians would be too long, but the University is in contact with each and every one, and that contact is bilateral. 'Never in my post-university life have I been ashamed to answer the question, What school did you go to' are the words written in the SPbPU Book of Guests of Honor by Alexander Lapshin, First Deputy General Director of *Rosatom*.

In the fall of the 2016, the Graduate Liaisons Center initiated a new educational project entitled *Knowledge from the First Person*. The speakers are renowned Polytechnicians, and the audience are students, postgraduate students, and staff. The lecture schedule is full for six months ahead, and there are usually not enough seats in the classroom.



From the top:

Rector of the University Andrey Rudskoy and his predecessors, Mikhail Fyodorov and Yuri Vasilyev, at the University Graduates and Friends Forum in 2014.

Eduard Tiktinsky, President of the RBI Group and a graduate of the Polytechnic University. He founded the company, which is now the leading player on St. Petersburg's exclusive and business-class residence market, while still in his second year at the university

The 105th anniversary of the first graduates' association. Nils Knigge, an intern from Germany, is testing a bolide made by students.

Alexander Kobyshev and Issa Togo, a Mali graduate who defended his thesis at SPbPU and now runs a chair.

Russian Maecenas No.25, April 2017.

For a Special Purpose

THE POLYTECHNIC UNIVERSITY AND GAZPROM ARE TO SET UP A PERSONNEL TRAINING CHAIN

Arkady SOSNOV. Photos: Evgeny Shcherbakov (*Gazprom Transgaz St. Petersburg*)



THE STUDENT

Since 2010 *Gazprom* has been conducting a programme to train specialists for specific jobs. Its first bachelor degree-holders were accepted for employment in 2014. Their number increases each year, as does the number of senior pupils competing for the special course. There are also master's degree-holders in the pipeline. Most of the targeted students (77) are at the *Gazprom's* anchor partner, the Peter the Great Polytechnic University: 48 of them are at in the Institute of Energy and Transport Systems — 40 are studying for a bachelor's degree and eight, like Alexey Vinogradov, have completed the first year of their master's degree.

Alexey comes from the village of Kholm-Zhirkovsky in the Smolensk Region. After finishing school he applied for the targeted

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course at the St. Petersburg Polytechnic University (his father had instilled him a love for machinery), though he did not harbour any particular hopes of success: Kholm-Zhirkovsky and St. Petersburg seemed to be worlds apart!

The first three years were the hardest — descriptive geometry, which he had not studied at school, and a very great deal of maths and physics. He then got so fired up that after graduating with a bachelor's degree in the department of Turbines, Hydraulic Machines and Aircraft Engines, he enrolled on a full-time master's degree. He wanted to obtain a full higher education.

By that time he was already married with a child, so he found a job in parallel with his studies — as a technological compressor engineer at one of the company's branches — the Severnoye line management of gas mains. Neither the university nor Severnoye had any objections: why not combine theory (17 disciplines!) with practice in his chosen speciality?

— Not all the basic knowledge we pass on to students will be of use to them in practice, but it is a way of exercising the mind, — says Professor Nikolay Zabelin, Director of the Institute and Head of Department, who knows Alexey and the other targeted students personally.

Although his workload has doubled, Vinogradov sees this way of getting into the engineer's profession — by grasping the basics of production — as the correct one. Last summer was particularly difficult for Alexey. In his fifth year, when he had been promised that life would become easier, his workload was greater than ever, including weekends... He had to combine his exams and his shift work with the preparation of a paper to be read at an open scientific-practical conference for *Gazprom's* young employees. He chose the subject, concerning the modernization of equipment and the increased reliability of the heating system on the industrial site of a compressor station, on the advice of his





Professor Nikolay ZABELIN demonstrates a gas turbine engine which had outlived its usefulness at the Pikalevo compressor station and has now become a visual aid — the company has given it to the Institute. In order to get the 3.5 ton machine into the Polytechnic University's engineering block it was necessary to build a mini-railway and a viaduct. By looking into the model future specialists can get a full idea of the engine's structure, the purpose of most of its mechanisms, assemblies and components.

fellow production workers. He passed his exams with flying colours and received a grant. And at the conference he was not fazed by speaking to an unknown audience and answered twelve questions. He explains the lively interest in his paper by the fact that he produced an animated presentation. Once again the 'exercising of the mind' at the Polytechnic University had helped. Passing tests and exams, presenting papers at the annual Science Week and defending a bachelor's diploma — all this is in the university background of the targeted students.

For Vinogradov his master's dissertation will be a new challenge. He will probably be entrusted with part of the large amount of work the department is undertaking as part of a national target programme for making expansion turbine installations.

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A specialist who carries out this type of research is no longer considered a 'mid-level engineer' but a 'special mission engineer' in the terminology of Andrey Rudskoy, Rector of the University and a Corresponding Member of the Russian Academy of Sciences.

Alexey hopes that his master's degree will help him up the career ladder — to be a shift engineer for a start, and after that... it will all depend on him. He is pursuing a career based on knowledge and is very pleased that his professional life is linked with a steadily developing company like *Gazprom Transgaz St. Petersburg*.

The list of competencies of a master, as opposed to a bachelor in the same department, includes research, planning, design and teaching, so in a year or two Alexey Vinogradov may well be giving optional lessons to pupils of the St. Petersburg's first '*Gazprom Class*' at Secondary School No.330 in the Nevsky District.

THE YOUNG SPECIALIST

Gazprom takes on between 50 and 60 people each year, 70% of them with higher education, but not many of them have two degrees like Ekaterina Yanchenko: she has a bachelor degree in IT and computer technology and is an interpreter of professional communication. Quite simply she studied for two degrees at the Polytechnic University at the same time!

During her study, on her own initiative, she spent each summer working in the IT department at *Gazprom Transgaz St. Petersburg* and planned to work there or in one of the company's branches after graduation. That was how she ended up in the Severnoye line management of gas mains, in the automated control systems section. According to Ekaterina the section is small but is responsible for everything:

— We are concerned with the full maintenance and control of programmes safeguarding the technological processes, production management and IT security.

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Katya has been working for the company for just over a year and has never regretted her choice of specialization. Her university education was wide-ranging and it helps her to fulfil the tasks of an engineer in the automated systems section, even though they are of a more applied character. The novelty of the tasks is merely an excuse for her to continue to study and broaden her horizons. The company supports her — it sent her to take part in the St. Petersburg International Gas Forum, which greatly helped her to understand how the gas industry is constructed and how automated it has become.

Again on her own initiative Katya is refreshing her basic knowledge of programming with the aid of the *Coursera* educational Internet resource and is learning new subjects — for example, administration, which was not included in her university



course. She recognizes that even two bachelor degrees are insufficient for self-fulfilment, so she is in the process of choosing a specialized master's course in IT. Ekaterina is grateful for her 'double' degree from the Polytechnic University that enables her to look to the future with confidence.

— *Gazprom Transgaz St. Petersburg* concentrates on developing its employees' potential, — emphasized Georgy Fokin, the company's General Director. — Our personnel policy is based on a system of continuous education. We collaborate with *Gazprom's* principal higher education establishments; this enables us not only to make adjustments to the programmes by which students learn and our staff increase their qualifications, but also to introduce new courses and even new departments to meet the company's requirements.

Georgy Fokin and Andrey Rudskoy, Rector of the Peter the Great Polytechnic University and Corresponding Member of the Russian Academy of Sciences, after signing an agreement concerning the establishment of the basic department Gas Turbine Units for Gas Pumping Stations. May 2015.

Russian Maecenas No.24,
September 2016.

Knowing Who Your Friends Are

A UNIVERSITY IS CHOOSING INDUSTRIAL PARTNERS

Arkady SOSNOV. Photos: the St. Petersburg Polytechnic University Media Centre



Experienced marketing specialists say: 'If your products are not at an exhibition, you can consider that they are not on the market'. In this sense, the exhibition of innovative developments of companies in the *Rostec* state corporation at the North-West Industrial Forum fully came up to market expectations. The exhibits included the very latest developments in medicine, residential-communal management, urban environmental safety... A helicopter with electronic optical equipment from the *Svabe* company even landed in the grounds of St. Petersburg Polytechnic University, which hosted the exhibition.

The forum was timed to coincide with the tenth anniversary of *Rostec's* representative office in St. Petersburg — a bridge linking the country's largest corporation (15 holding companies, 80 direct subsidiary organizations) with the university. It was quite logical for the university to provide space in its scientific research block to its stra-

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tegic partners, knowing full well what this alliance meant for higher education, especially in the sciences.

Today, as I was told by the university's rector, Academician of the Russian Academy of Sciences Andrey Rudskoy, collaboration with the corporation encompasses the whole of Russia. Its orbit includes the *Kalashnikov* concern in Izhevsk, the *Arkady Shipunov Instrument Design Bureau* in Tula and a number of companies in St. Petersburg. A programme for the manufacture of medical appliances is under way in Novosibirsk (one of the appliances, for the detection and treatment of neoplasms in their early stages, has passed approbation and has been forwarded to partners from *Svabe* for production). The collaboration with *KamAZ* in Naberezhnye Chelny has progressed from local design and expert support to joint solutions to complex engineering problems. This is no joke: the university has become the main developer of technical documentation of a unified base platform for all types of passenger transport!

This example clearly shows how the Polytechnic University is now being included in the operational plans of powerful, self-sufficient companies. The giant vehicle manufacturer possibly underestimated the university's creative potential: at one point the collaboration wilted. Meanwhile, the university has continued to put down roots in the car industry, winning international tenders and becoming part of the technical processes of world brands such as *BMW*, *Mercedes*, *Skoda* and *Volkswagen* — in competences, in the price of developments and in the ability to find important solutions. It is just as active in aircraft building and other industries. And the contacts with *KamAZ* were revived — what a coincidence! — in parallel with the university's participation in the *Cortège* project for a production line of premium-class executive cars. The Polytechnic University's contributions to the project are now becoming more distinct and are comparable with that of the principal organization (*NAMI*). The most important of these contributions is the first digital double to be made in Russia — a visual image of a real object that describes its behaviour in any situ-



ation with up to 98% accuracy. This means that actual experiments can be replaced by virtual ones within various parameters.

Of course, not only cars can be tested in this way, but also aircraft, ships and drilling rigs under the *Arctic* state programme. Having mastered an instrument for digital planning and design, the Polytechnic University has set up Russia's only *Advanced Production Technologies* centre. It might be said that time itself was the university's ally: the time from the concept to the end product was reduced to two or three years, thus meeting the demands of the global market, on which the university is orientated.

The collaboration with *Rostec* is apposite for a university that trains specialists in fields such as energy, mechanical engineering, control of technical systems, computer engineering... It has led to close contacts with companies in the defence industry — in particular, as the rector said, friendly relations have been established be-

The Japanese *Kawasaki* company also became one of the university's partners after opening an industrial robotics centre on its premises.

Page 12:
Andrey Rudskoy (in the centre)
with forum delegates.



Danil Korepanov, graduate of the Polytechnic University and employee of the Klimov plant.



tween the university and the *Klimov* plant, part of the *Rostec United Engine-Building Corporation*. *Klimov* has become a testing ground not only for their joint scientific-technical production, but also for trials of relevant educational programmes. The result has been an entirely unconventional, multidisciplinary base department that trains students for master's degrees in various subjects at the behest of the plant: economists, computer specialists, electrical engineers, designers and experts on materials.

'It is a community of like-minded people formed on the student bench' Andrey Rudskoy explained. 'We are parachuting young engineers into a company that is conceptually and thematically related to us.'

The plant's executive director, Hero of the Soviet Union Alexander Vatagin, expressed it succinctly in military style: 'If it were not for the Polytechnic University, there would be no *Klimov*'. He probably meant that the nucleus of his staff (including General Designer

Alexey Grigoriev) consists of Polytechnic University graduates and that the science taught there can guarantee the steady progress of its partner company. Indeed, when *Klimov* was faced with the task of building a new modification of a helicopter engine in an incredibly short time, the university provided technical support on all fronts: from the calculation of critical frequencies of revolutions of the rotor to the development of wireless sensors (instead of the usual sensors) and turbine blades with the use of additive technologies and functional materials.

When setting up the base department, a selection procedure was carried out among master's degree students in various disciplines, not only from the Polytechnic University, and it was successful. The small group assembled by this means was transferred to an individual form of study, mostly at the *Klimov* plant. At the university they had a free schedule, but the accent was on training in additive technologies — fortunately, the university has a study centre in that very subject. In this way, through personnel and technology there was a flow of competences from the university to the plant. And when their own competences were insufficient, they invited lecturers from other institutes, who opened the students' eyes to the engine turbine as the subject of their future careers. Another good point was that in the course of the development of a new-generation engine, the university signed several service contracts with the plant. These are being fulfilled, partly by students who are paid for their work, so they are doubly motivated.

The helicopter and aircraft engines made at *Klimov* under import substitution programmes were presented at the exhibition by Danil Korepanov, the plant's leading technological engineer. He is also a product of collaboration with the Polytechnic University — he is a graduate of the base department and has experienced for himself the advantages of being immersed in manufacture from the student bench: two years before graduating he was already working as a technologist in the testing section. According to him, the teach-

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ers in the base department are the most knowledgeable of the plant's employees: if someone has been working all his life with, for instance, combustion chambers or automatic control systems, 'you won't catch him up.' These employees may be lacking in oratorical skills, but you have to listen to them: they will tell you things that nobody could tell you anywhere else.

How does the university choose the algorithm of collaboration with a particular company: sign a service contract with it, set up a joint laboratory or open a base department on its premises? Andrey Rudskoy gave two answers to this question of mine — one short, one more detailed. The short answer was: 'you can't go into a different monastery with your own rules.' The detailed answer was that the fan principle for a *poly-technic* university is used in work placements for graduates: with this aim they hold a 'labour exchange' and other forms of dialogue with representatives of leading companies of many different profiles. As far as the search for partners in the fields of science and high technology is concerned, the approach has to be more scrupulous.

'The first step is to find our range', explained Andrey Rudskoy. 'If a company is pursuing promising work with our scientists' input, we make every effort to develop those contacts. As a second step, we evaluate a potential industrial partner and, depending on its mission, the standard of its management, technical level and technological resources, and then we consider the possibility of collaborating with that company in fields where we are indisputable leaders — digital design, computer engineering, additive technologies, robotics... And only after weighing up the pluses and minuses do we determine the format of our collaboration.'

As the rector stressed, this is not pushiness on the university's part, but healthy practicality. The depth and extent of collaboration depends on the degree to which the potential and aims of the company and the university coincide. Sometimes they reach a maximum, as with the *Klimov* plant.



The Polytechnic University is not only making an effort for its own scientists and graduates. It is the co-founder of the *I am a Professional* All-Russian Competition, which enables it to select promising personnel for key sections of Russian industry, a social step forward for them. The first winners of the competition have been on work experience at leading Russian companies and are included in a database accessible by major employers.

The exhibition mentioned at the beginning of this article was also intended to reduce the distance between higher education establishments and employers, and to demonstrate that university science is participating in the modernization of the Russian economy, helping *Rostec's* companies and organizations to increase the share of hi-tech production for civil and combined purposes. Vladimir Putin spoke about this at a recent session of the Presidential Council on Science and Education: the result of applied research should not be reports or the number of developments, but the practical contribution made by its introduction.

A base department of the Polytechnic University has also been set up at the private *Baltic Industrial Company*. Students spend several days a week there in close collaboration with the company's design office and after graduation become fully qualified machine tool builders.

Poisk, Scientific Community
Newspaper, No.49, December 2018.
Russian Maecenas No.30, July 2019.

Beyond Intuition

ALEXEY BOROVKOV, PRO-RECTOR FOR LONG-TERM PROJECTS OF THE PETER THE GREAT POLYTECHNIC UNIVERSITY,
DESCRIBES HOW *FACTORIES OF THE FUTURE* ARE NOW BEING SHAPED

Arkady SOSNOV. Photos: Timur Turgunov, the archive of the CompMechLab® Engineering Centre at the St. Petersburg Polytechnic University



— Alexey Ivanovich, you are Co-Director of the Technet Working Group (a cross-branch project of the National Technological Initiative — NTI), one of those people who not only look to the future of our economy but are bringing that future closer. In these uncertain times for the economy how realistic is it to be planning factories for 2035?

— The first thing I would say is that the National Technological Initiative was launched by the President of Russia in December 2014 and is now one of the priorities of government policy. It is a long-term all-embracing programme to guarantee the global competitiveness of our economy until 2035. How can it be guaranteed? Besides the gradual development of enterprises and companies, we have to direct our energies towards future markets — mainly the so-called *nets* (network-based markets): *Aeronet*, for example — distributors for pilotless aircraft, *Avtonet* — the driverless car market, *Marinet* — the market for marine intellectual systems on and under the water.

The most extensive of them is *Technet*, aimed at the development and use of advanced production technologies. This is, above all, digital planning and design, the creation and use of new materials (I would particularly mention metamaterials and composition materials), additive technologies (that market is growing at approximately 30% per year, at a time when the standard market is growing by only 5–7%), total automation and robotization of manufacturing.

Then, of course, there are *Big Data*: industrial robots will report on themselves and interact with one another, there is now an *Internet of Things*, or an industrial Internet — streams of data which have to be collated, structured, analyzed and used, i.e. controlled. For example, a supermodern gas turbine generates 500 terabytes of informative data every twenty-four hours and that information has to be used both for controlling the operation of the turbine and for making new

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generations of turbines. The *Internet of Things* is developing in almost everything around us, in all the gadgets we use. Smart homes and smart cities will come whether we want them or not.

The necessity of *Big Data* analysis is to stimulate the development of predictive analysis and digital design, and for that high-performance capacities are needed. The Polytechnic University has one of the most powerful supercomputers in the country, aimed specifically at use in industry.

Factories of the Future are bringing together everything I have mentioned and generating new-generation specialists with the necessary competences. In *Factories of the Future* it will all come as a package: planning, design, analysis and distribution in a digital format. Digital transformation is no longer a fashionable trend but an urgent necessity and the current reality of modern hi-tech production.

Some people think *Factories of the Future* is an attractive image, a meme, but in actual fact they are an integral element of the 4th Industrial Revolution that is now happening — a structural link and, I would say, the quintessence of the digital transformation of the economy.

— **A key project of the Polytechnic University and its Engineering Centre is *Cortege* — the development of a range of presidential-class cars. To what extent have you used digital technologies in this project?**

— This project has actually served as an example of the ‘solution of insoluble problems’ on the basis of digital technologies, not only in the motor industry. In 2014 the task of making four cars on a single modular platform was announced: the Russian motor industry replied that it was impossible to make them within the allotted time. We, in conjunction with the Central Scientific Research Automobile and Automotive Engine Institute, managed to do it and the result was confirmed in June 2016 on an independent testing area in Berlin: at the very first attempt the sedan was given the highest mark in passive safety. What led to this success? A unique ecosystem of technologies,



a digital platform and a team of engineers with world-class competences who are ready to use them at any moment, to work with any company interested in change.

The question arose as to whether this approach could be extended to other branches of industry. And shortly afterwards, at the Forum for Strategic Initiatives attended by the President of Russia, we were offered the megaproject *Factories of the Future*. It was confirmed and is undoubtedly serving as a spur to the development of all sectors of the economy.

Russia is one great design bureau: we know how to design, but we do not know how to be really competitive in mass production. The Fourth Industrial Revolution will enable us to add value in areas where we are strong and offset our weaknesses: by using advanced production technologies and the business model of *Factories of the Future* we will be able partly to exclude the human factor in produc-

According to European statistics only six per cent of the innovations proposed by technological entrepreneurs actually reach industry. It is more logical to take specific tasks-challenges from the hi-tech market and resolve them as our engineering centre does. That is the only way of compensating for the gap between the complexity of the task and the level of competences of the companies' personnel. And for us it is important that these tasks develop us and enable us to move forward, capitalizing on the experience.

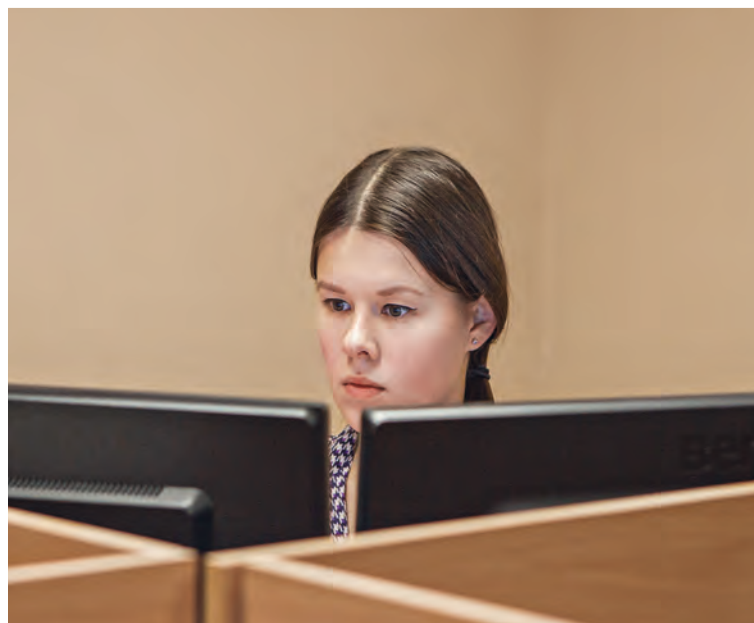
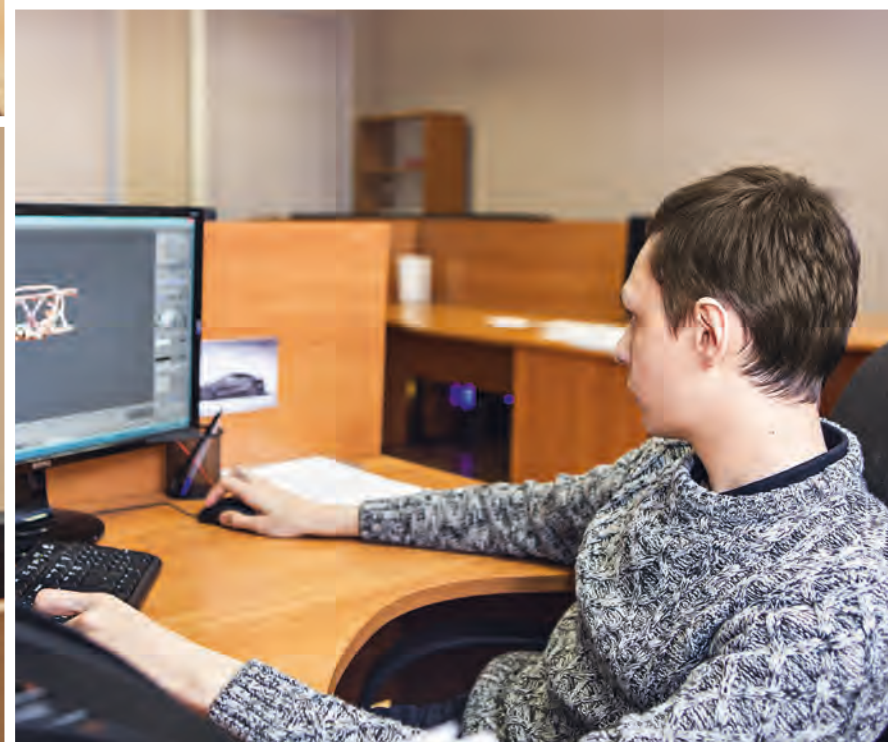
I remember when we began our collaboration with a well-known American corporation: we worked on the task for four months, they then took three months to accept it and only after that were we paid. That was in 2000 — very strict conditions with daily monitoring and weekly reports. At that time we were still thinking in the Soviet way: if we can't finish it in time, we'll just extend the deadline for a day or two. We had to be re-educated.

As early as 2004 the U.S. Competitiveness Council launched a national programme for the manufacture of supercomputers and proclaimed that the winner in the competitive struggle would be the one who came out on top in calculations. And today the slides in presentations by world leaders feature endless, abundant calculations which guarantee the exponential growth of the economy. And what we are promised by artificial intellect is linked to the endlessly growing potential of calculations.

Global trends develop regardless of our wishes and readiness for change. There is only one criterion for evaluating a result: the competitiveness of the product on the world market.

Man has to get wiser more quickly than intellectual technical systems — that is one of the main challenges of the 21st century.

Thinking Aloud. Alexey BOROVKOV.



The principle of educating students in the Institute of Advanced Production Technologies is gradual immersion in real projects. In other words, studying by means of actual Scientific Research and Experimental Design projects.

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tion, draw up distribution networks of certified suppliers, reserving the right to expertise in digital planning and design, i.e. key competencies. It will be a fundamentally different economy.

— What is the role of universities in building the economy of the future?

— Going over to a digital economy will require a different class of specialists — that is a challenge for universities, as the traditional cycle for the training of specialists is 5 or 6 years. It is obviously necessary to solve a whole range of problems in education, research and development: to set up applied graduate studies by carrying out actual Scientific Research and Experimental Design projects, to run topical problem-orientated projects, to develop key competencies in universities' engineering centres, centres of competency and engineering companies. It is important to set up a digital ecosystem as an infrastructure — to create virtual experimental testing-grounds as centres for the assembly, testing and efficient use of advanced multidisciplinary and cross-branch computer technologies. And, of course, the main task is the formation of world-class competencies. The slogan 'Competent personnel decide everything' has never been as relevant as it is now.

At the Polytechnic University we are already running a training programme for new-generation specialists via the Institute of Advanced Production Technologies. These *engineering special forces*, as our Rector Andrey Rudskoy calls them, will create knowledge-intensive products adapted as closely as possible to the demands of the market and specific consumers. A university-type experimental testing-ground is being created on the basis of the Polytechnic University's Institute of Advanced Production Technologies — as a prototype and generator of digital factories for various branches of the hi-tech industry.

Our *5-100* programme is aimed at the integration of Russian higher education establishments into the international education-

al arena and guaranteeing their competitiveness. In autumn 2016 the priority project *The Contemporary Digital Education Environment in the Russian Federation* was approved with the aim of creating the infrastructure, standards and legislative basis for high-quality and accessible online education. The colleges and universities in this project integrate into the international scientific education arena, act as centres of innovation and should operate in close contact with business in the concept of continuous education.

— It is now 2017, but when the Internet markets take over the world economy, which is what the National Technological Initiative is aimed at, it will be 2035. So the people who will be at the most mature age then are now 18–20, but you have to make the choice here and now. How do you pick out the creators of the digital economy before sending them to the frontier of technology?

— It is a long and painstaking process. We do not strive for mass inclusion but for the minimization of random choice — the search for motivated students who realize that learning will not be easy. As before we start the process almost while they are still at school, but in earnest when they are in the third year at university. The technologies of the world's leading companies become more knowledge-intensive and multidisciplinary year by year, and the specialist of the future will need engineering, aerodynamics, heat and mass transfer, materials science and electromagnetism, all underpinned by maths and physics. Of course many of them want to design the best cars in the world, but experience has shown that only one in ten is suitable, and only one in twenty has the necessary knowledge, mentality, competencies and the ability to work without mistakes. Incidentally, thanks to the Unified National Exam youngsters from all regions of Russia now have the chance to join the new economy — over 60% of our students are from other cities.

So, from the third year onwards we select the best, follow their progress and appoint them a tutor (a qualified working engineer, not

The Polytechnic University and the Engineering Centre signed a collaboration agreement with the group of companies for the creation of a *Factory of the Future* for space technology. The university's engineers have been involved in rocket and aircraft building for quite a long time. Under the *Factories of the Future* megaproject, in conjunction with leading specialists from this industry, they have succeeded in selecting urgent industrial and corporate problems-challenges which can be solved with the aid of digital twins.

The CompMechLab® Engineering Centre at the St. Petersburg Polytechnic University receives around 250 delegations a year. Some come for familiarization, some to discuss ways of collaboration, others to sign contracts.



The customized electric CML-CAR, being developed in the Engineering Centre.



a professor) to whom they can apply at virtually any time. This very quickly helps to remove barriers of misunderstanding and save unnecessary stress, and the young person gradually becomes involved in real projects and finds a job. The structure of education is changing fundamentally. It is now 50% formalized knowledge (lectures and seminars) and 50% informal knowledge obtained in the course of a real project working alongside experts.

The main stimulus for the development of *engineering special forces* is interesting tasks — very interesting ones. Sometimes, even when he joins a global oil and gas company, a specialist after a while begins to realize that he has reached the limit of his development and will not develop further in the next 15–20 years. And so he comes



back to us — for a salary comparable with the international level for employees, but also for the most interesting tasks and various Scientific Research and Experimental Design projects.

— **And are there plenty of tasks? After all, we are not all living in 2035 as you are...**

— There certainly are: the number of complex tasks is increasing, as is the queue of customers — not only Russian customers, but Russia too is expanding with the NTI and the *Factories of the Future*. Industry is manufacturing new products and cannot do without advanced technologies as it is faced with complex problems that are already beyond the bounds of intuition. A developer does not

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understand how to take into account the mutual influence of different components in the operating process. Previously expensive field studies came to the rescue. Today there is not the finance or infrastructure for such experiments, but any design can now be calculated to a high degree of accuracy and tested virtually.

— Calculated beyond the bounds of intuition?

— We obtain solutions that cannot be generated by intuition. In one of my lectures there is an illustration of this boundary: there is a solution within the limits of a head designer's intuition and there is a solution obtained by us beyond the bounds of intuition — essentially the digital twin of an actual object. Moreover, the world will learn of this solution within one, two or three years. The world's leading companies do not release such solutions on to the market immediately, since they are leaders even without them. These solutions will be released whenever there is a threat to their leadership. This is a different business model characteristic of the new digital economy.

— We are cutting corners, in the literal words of one of the experts, in striving towards 2035, but foreign corporations are also not marking time. How can we avoid being left standing by their leap forward?

— I noticed that just this August the key term in the Fourth Industrial Revolution — a digital twin — appeared on the curve of advanced technologies drawn by the Gartner analytic company. There is a sense that in the last ten years the world's leading companies have been employing diversionary tactics: they have launched fashionable trends like the industrial Internet, robotics, cyber-physical systems (all these are useful but auxiliary initiatives) and have 'forgotten' to say that for ten years they have been intensifying the creation of digital twins — both of actual objects and of actual production. Imagine a field of competition in which half the business of one of the players is 'concealed' in digital twins, which 'lie in ambush' and can 'spring



out' into actual production at any moment. An invisible fundamental change is taking place in industry. Whoever generates digital twins that are relevant to real objects in the whole life cycle will dominate in tomorrow's world.

— And are there digital twins in the Polytechnic University's Engineering Centre?

— We are creating them in conjunction with companies — the world leaders in recent years. They are actually *21st century super-weapons* which have to be used sensibly. A twin can be complete, i.e. almost fully adequate for an actual object and/or actual production, and then it can travel along the life cycle at the leader's pace.

Oleg Bocharov, Deputy Minister of Trade and Industry, holding a bracket for the aerospace industry, optimized in accordance with the principles of bionic design.

*Russian Maecenas No.26,
November 2017.*

Transmitting Health

SCIENTISTS AT THE PETER THE GREAT POLYTECHNIC UNIVERSITY ARE CREATING THE FUTURE OF BIOMEDICINE

Natalya MAKHOVA. Photos: the St. Petersburg Polytechnic University Media Centre, site scardio.ru



A handmade hi-tech bio-prosthesis.

‘Into whatsoever houses I enter, I will enter to help the sick.’ That line from the Hippocratic Oath is becoming exceptionally relevant today with the proliferation of translational medicine and the diminishing distance between promising developments and their practical use. This is largely on account of a new paradigm in medical science and innovative technologies which give researchers the possibility of looking into the hidden depths of the human organism. The characteristics of biomedicine are the interpenetration of life sciences (biomechanics, biophysics, biochemistry, bioinformatics, neurobiology, psychophysiology, genetics...), the modelling of pathologies in laboratory conditions with the aim of identifying the mechanisms of diseases and the search for new treatments for those diseases. Only universities can provide this interdisciplinary approach.

A graphic example of this — the Peter the Great Polytechnic University in St. Petersburg — is one of the leaders in this field

in Russia, striving to develop according to Model 4.0, where a combination of material resources, competences and high technologies makes it possible not only to solve problems that are not within the compass of separate branches of industry but also to make an invaluable contribution in the public health domain. An innovative ecosystem is forming around the university, generating hi-tech biomedical designs.

In 2015, in conjunction with the Almazov National Medical Research Centre and several other educational institutions in St. Petersburg, the Polytechnic University set up the Translational Medicine science-education cluster. One of the cluster’s main purposes is to carry out a full cycle of scientific research and experimental design work, including making preparations and industrial prototypes of appliances which can actually be used in doctors’ daily practice. In 2016 the Polytechnic University and

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the Shanghai Biotechnology Corporation signed a collaboration agreement and in October 2017, following a decision by the university's Academic Council, a new structural subdivision was founded — the Institute of Biomedical Systems and Technologies. This is by no means a spontaneous step or a nod to fashion — the Institute's programmes have already been running for two years as part of the 5-100 project. It will train specialists capable of meeting the most difficult challenges that face medicine and threaten public health in conditions of heightened stress, technogenic dangers, mutations of viruses and the deteriorating ecological situation on the planet. This important scientific-educational project is being implemented in conjunction with the Almazov Centre.

The modern world is rapidly changing perceptions of professions, making urgent demands of them. Doctors in the 21st century not only have to be up to date with advanced methods of diagnosis and treatment but also to actively introduce them into clinical practice and approach each patient individually, relying on

the data of molecular-genetic and epigenetic examinations. This has prompted the Polytechnic University to solve a number of important problems at once in the field of hi-tech biomedicine. The university is contributing to the formation of multidisciplinary teams in which specialists in biomedicine and mathematics, mechanical engineers, chemists and even economists will work on an equal footing with clinicians. These specialists are also being trained at the university. Students of the Institute of Biomedical Systems and Technologies will learn truly innovative specialties: molecular design and bioinformatics, biomedical machinery and materials, nuclear and quantum medicine, cellular and regeneration medicine, neurobionics and medical robotics. Training of new-formation medical personnel on a master's programme will begin as early as autumn 2018. It is planned to take 10–15 students with basic medical education who will receive superscientific hi-tech education at the Polytechnic University and its partner institutions.

The Polytechnic University is also training medical specialists in its foundation department, which works effectively with the Russian Ministry of Health's Influenza Research Institute. The Institute's staff gives the students courses and hold laboratory sessions which facilitate their immersion in the profession.

Scientists at the Polytechnic University have already created several original medicinal preparations and technologies and have passed them on to medical institutions. For example, the staff of the Medical Ultrasound Apparatus laboratory under Alexander Berkovich have developed Russia's first diagnostic scanner for the identification and ultrasound treatment of cancerous tumours at an early stage without surgery. The scanner is in demand when tumours appear in the mammary and thyroid glands, the kidneys, liver and other organs. And ultrasound can be used simultaneously for diagnostic, therapeutic and thermometric purposes. The non-invasive treatment avoids surgical scars and post-operative complications. The university, in conjunction with the Novosibirsk



With the help of our colleagues at the Polytechnic University we wish to introduce all the latest and best there is in science today into the doctor's surgery. I hope this lofty ideal — and we are looking beyond the horizon — will enable us to implement a pilot project for the training of specialists on the basis of new biomedical research

Evgeny SHLYAKHTO,

Academician of the Russian Academy of Sciences, Honoured Scientist of the Russian Federation, General Director of the Almazov Centre, President of the Russian Cardiology Society, Head Cardiologist of St. Petersburg and the Northwest Federal District

Left:

The Peter the Great Polytechnic University is working on the creation of new medicinal preparations and technologies.



At a session of the presidium of the Presidential Council on the Modernization of the Economy and Innovative Development of Russia held at the St. Petersburg Polytechnic University Prime Minister Dmitry MEDVEDEV was shown a bionic prosthetic arm made by students at the university in conjunction with specialists from the Turner Children's Orthopaedic Research Institute. June 2016.

An apparatus for the removal of cancerous tumours with the aid of ultrasound has been developed at the St. Petersburg Polytechnic University.

Instrument-Making Plant, is planning to start production of the scanner and put it on the market as early as 2019.

Ultrasound has also proved to be an effective treatment for varicose veins. The technology developed by the St. Petersburg Polytechnic University has no analogues in the world. According to World Health Organization statistics, tens of millions of people currently suffer from varicose veins. The disease attacks the veins of the lower limbs and the venous valves which help the circulation of blood from the legs to the heart. The essence of the new method, which requires no great financial expenditure or major surgery, is that the ultrasound seeks the affected part of the blood circulation system. Depending on its depth in the patient's body a computer program selects the course of action and focuses a $10\text{kW}/\text{cm}^2$ ray on the area to be treated, heating it to a temperature of 70–90 degrees Celsius. The procedure takes just a few minutes.



Another breakthrough in biomedicine achieved by the Polytechnic University's Nanobiotechnology Research Complex is the creation of a harmless peptide which prevents the adaptation of bacteria to antibiotics. This was a joint project with specialists from the St. Petersburg Nuclear Physics Institute (the National Research Center 'Kurchatov Institute'). It is known that bacteria constantly mutate and acquire the ability to nullify the effect of antibiotics. On a genetic level the peptide created by the scientists shuts down the systems of the accelerated evolution of bacteria. The method's effectiveness has already been proved and it has obtained a patent entitled Family of Peptides — Inhibitors of the Activity of RecA Protein Blocking Bacteria's SOS Response. This discovery should raise to a new level the effectiveness of preventive measures and the treatment of infectious and parasitic diseases, reducing their duration.

The Polytechnic University is also involved in the search for HIV vaccines and bio-agents for the treatment of Alzheimer's

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disease. The fight with this global disease, which is becoming more widespread with the aging of the world's population, has proved to be particularly attractive to young scientists, who regard it as a real challenge. A youth molecular neurodegeneration laboratory was established at the Polytechnic University thanks to a mega-grant from the Ministry of Education and Science and is functioning with the support of a grant from the Russian Science Foundation. Those working there are mainly master's degree students and postgraduates from the Department of Medical Physics (headed by Olga Vlasova, Doctor of Physics and Mathematics). And the laboratory preparing our biomedical response to Alzheimer, like the master's programme, is headed by the Polytechnic University graduate Ilya Bezprozvanny, now a professor at Texas University in the USA.

Another biomedical project is the development of high-precision technology for people with physical disabilities. It is put into action not mechanically but with the aid of the neural networks in the brain. For example, the Turner Children's Orthopaedic Research Institute made a working model of a prosthetic arm for a patient. As part of the collaboration with the Vreden Institute of Traumatology and Orthopaedics a titanium prosthetic coxofemoral joint was produced on a 3D printer with the aid of additive technologies. At that time, in 2015, it was the first project in Russia to use additive technologies in the manufacture of hi-tech articles for medicine. With the aid of digital technologies the joint of an actual patient was scanned and polystyrene models were produced, on the basis of which the metal prosthesis was made. The prosthesis, which has extremely complex geometry, is made of a bio-inert material that is absolutely safe for the organism.

One could mention other groundbreaking projects which are already at the output stage, such as the creation and development of nanovessels and nanofibres, transplanted during the replacement of blood vessels and internal organs. In the very near future a patient at



the St. Petersburg Clinical Scientific-Practical Centre of Specialized Types of Medical Assistance (Oncocentre) will have an operation to fit an artificial lower jaw. The prosthesis will be printed on a 3D printer at St. Petersburg Polytechnic University and modelled in accordance with the patient's anatomy.

It is no coincidence that the first biomedical centres appeared at leading world universities. The achievements of the St. Petersburg Polytechnic University again show the importance of a favourable innovative environment for the formation of an interdisciplinary biomedical cluster. The designs developed here are a genuine contribution both to science and to the improvement of the nation's health. The results of the research are confidently emerging beyond the bounds of laboratories, leading to groundbreaking technologies capable of changing approaches to treatment and health care as a whole and providing full-value lives for many of our fellow-citizens – better health for the nation.

Professor Anatoly Popovich, Doctor of Technology and Director of the Institute of Metallurgy, Mechanical Engineering and Transport at the St. Petersburg Polytechnic University (left), hands over a prosthesis developed at the university with the aid of additive technologies to Rashid Tikhilov, Director of the Vreden Institute of Traumatology and Orthopaedics.

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Our Answer to Alzheimer

THE POLYTECHNIC UNIVERSITY IS THROWING DOWN A CHALLENGE TO THIS PERNICIOUS DISEASE

Arkady SOSNOV. Photos: Alexander Krupnov



A MEGA-GRANT FOR A MEGA-PROBLEM

Late in 2012 the St. Petersburg Polytechnic University opened a Laboratory of Molecular Neurodegeneration (LMN) to study the nature of Alzheimer's disease and other neurodegenerative ailments which are a misfortune for elderly people and a worldwide problem for an aging population.

Why has the Polytechnic University in particular decided to tackle Alzheimer's? To find the answer to that question, one has to 'get personal'. This is not a figure of speech but a statement of fact: within the framework of Ministry of Science Education decree No.220 an unprecedented competition is under way to attract top scientists to Russian higher education establishments. The prize for each of the winners is up to 150 million roubles for research on pressing themes. The conditions of the competition stipulate that those who receive grants must spend at least four months of the year in Russia, raising

their science to international heights. In fact, the money is allocated to a specific outstanding individual, who spends it as he sees fit — though, of course, under the supervision of the educational establishment and the ministry.

One of these individuals is Ilya Bezprozvanny, who graduated from the Polytechnic University in 1988 and is now Professor of the Physiology Department at the South-West Medical Centre of the University of Texas at Dallas. He has returned to his *alma mater*, now in the capacity of *leading scientist*, to head the abovementioned laboratory. If this title jars on anyone, Ilya reacts calmly. He has over a hundred articles in prestigious publications to his credit and a high quotation index. He regularly reads papers at leading international conferences and is an Honorary Karl and Hortensia Thomsen Professor in research into Alzheimer's disease. All this was taken into account by the Russian Government's Grant Board and by foreign ex-

Investment in Intellect

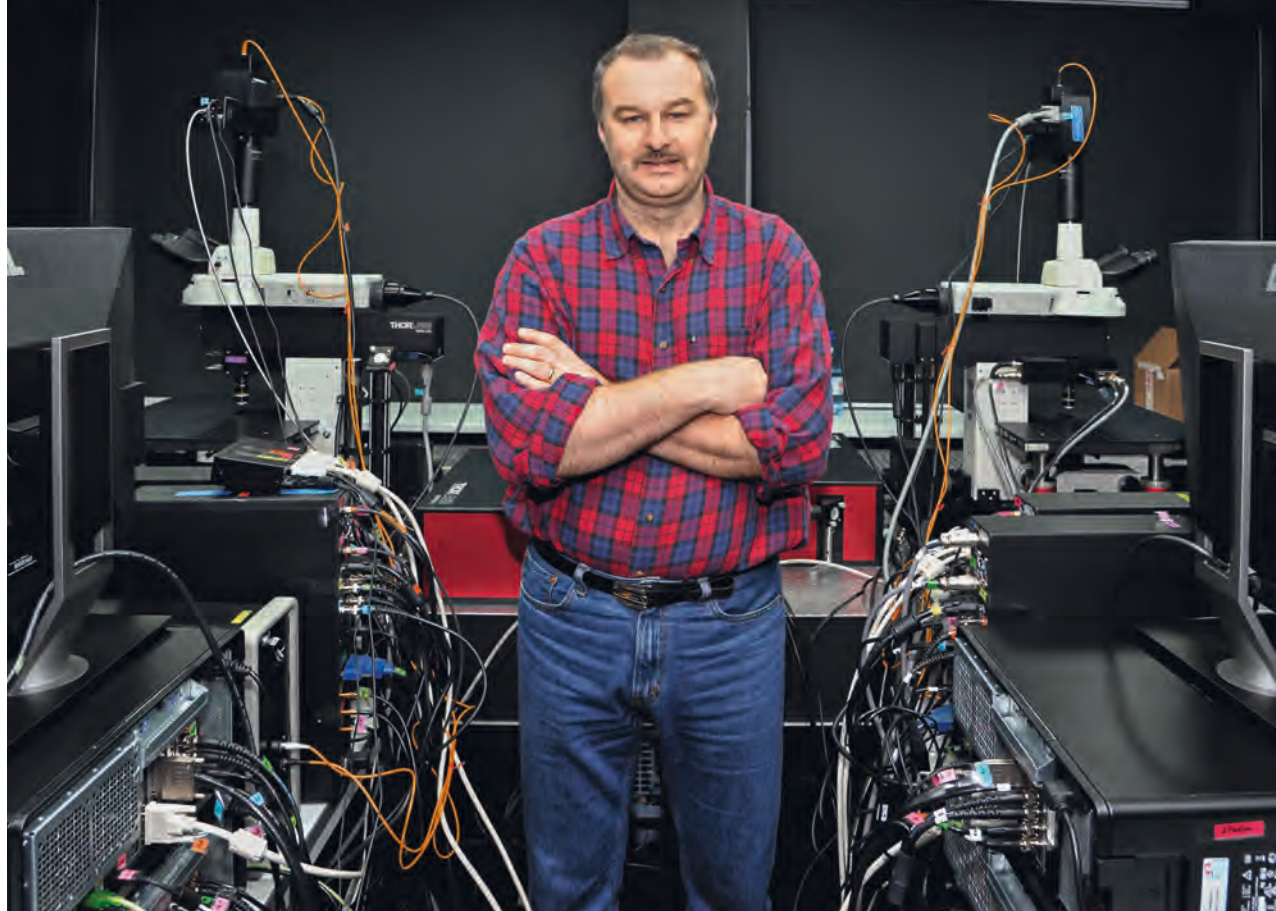
perts, as was the fact that Bezprozvanny had described how he would create a laboratory that no university had ever had, right down to its title — LMN. He considered that without the laboratory the Polytechnic would not be at the cutting edge of science and that it would enable promising young scientists to realize their potential.

The university received a mega-grant for its alumnus, who had worked in the USA for 22 years. He was given 'room to grow'. To avoid any false impressions, the university's rector Andrey Rudskoy, a Corresponding Member of the Russian Academy of Sciences, set out his position: 'Sceptics say that opening laboratories such as this in a technical university is a mistake — they think they should be in classic universities or in relevant academic institutes. They are absolutely wrong! Today, only at the meeting-point of biology with mathematics, physics, chemistry and technology can breakthrough results about humans be achieved in the natural sciences, including brain research. The problem that Professor Bezprozvanny is tackling is of a civilizing character. The fight against currently incurable diseases like Alzheimer's is a challenge for the whole of science, and we will make every effort to ensure that his laboratory develops, and we particularly want him to bring talented students to the fore.'

A YOUTHFUL TEAM

The staff of the LMN are predominantly young people: students intending to go on to postgraduate study, postgraduates and candidates of science who have already been successful in the West. Three groups of them spent three months in Bezprozvanny's Texas laboratory, also funded by the mega-grant. Not all of them survived the ordeal: Ilya's selection criterion is pragmatic — each probationer has to carry out a completed part of the project, however small it may be (a piece of research in the form of a graph, a diagram or a 'picture') — a brick that can be built into an article and into an application for a grant.

'I was lucky that in my first three months in the USA at the age of 24 I prepared material for an article in *Nature*. There only a re-



sult gets you through the test, but in Russia the usual process is: 'we think, we study and look through the microscope.' It is a different mentality, and I try to instil the Western approach in my staff straightaway' says Bezprozvanny. He invites to the laboratory mainly students with basic grounding in physics, maths and chemistry in order to teach them methods of biological research. There is no 'physicist's snobbery' in this, Ilya assured me.

'So many complex devices and methods are used in neurophysiology that biologists often cannot understand subtleties that are meat and drink to a physicist. And since the standard of physics and maths teaching in Russia is still high, finding suitable students for this work is easier here than in the USA.'

Of course, there was a temptation to take the easy route (Decree No.220 provides this loophole): to create the virtual shell of a laboratory at the university and study science — and entirely successfully —

Ilya Bezprozvanny, who left for the USA in the 1990s, at the height of the 'brain drain', has returned to set up a Laboratory of Molecular Neurodegeneration (LMN) in his alma mater, the Polytechnic University.

The German doctor Alois Alzheimer, who in the early 20th century first described the symptoms of the disease that bears his name (progressive deterioration of memory, breakdown of speech, thought and motor skills), but was unable to establish its causes. Perhaps Russian researchers will be able to do this a hundred years later.

Investment in Intellect



At the entrance to great science. Laboratory employees on work experience in the USA.

Fifth-year student Polina Rybalchenko and postgraduate Polina Egorova, holder of a presidential stipend.



on the side, in already existing structures using subcontracting mechanisms. In a sense, this would even be a humane act, providing colleagues with material support. In Ilya's opinion, however, that would lead to too great a risk of dissipation of resources; there would be no actual laboratory in the university and the mega-grant would not be used for the purpose for which it was intended. In America he has all the conditions for conducting innovative research — purely scientific results can also be obtained there. But in Russia it interests him more to form a strong team of young people from scratch — he can ask what he wants from them, be responsible for them and get a charge from them.

The Polytechnic also did not want to take the easy route! Not without purpose did Bezprozvanny's team obtain a mega-reinforcement in the person of the energetic and charming Doctor of Physics and Mathematics Olga Vlasova, who combines administrative, teaching and scientific experience. She is a professor and Deputy Dean for Scientific Research in the same faculty as the laboratory.

She is also Director of the Scientific-Educational Centre *Fundamental Bases of Medical and Biomedical Technologies*, took an active part in drawing up the grant application and, quite logically, became Deputy Head of the LMN. She has never been to Dallas, but, unlike Ilya, she knows her way around the Polytechnic University very well. Naturally, this tandem observes with redoubled zeal the letter and spirit of Decree No.220, aimed at the creation of points of growth of university science.

Another question arises: what guarantee is there that the research facility they have created with the LMN will meet international standards? The answer is surprisingly simple: Bezprozvanny is creating a clone of his Texas laboratory at the Polytechnic University! They are like two halves of one whole — from the inside you cannot see the difference, as those who have worked there can confirm. Ilya selected equipment for the LMN on the American scientific-medical market; few of his Russian colleagues could have correlated price and quality better, especially as he assembled the equipment from various companies and obtained discounts from the sales assistants. Just as in Texas, the new laboratory has a two-photon fluorescent microscope with high definition, which means that two research workplaces can be created on the basis of one laser (the most expensive part of the apparatus). The value of this is not even that there are two, but that one of them is in reserve in case of breakdowns. This is not a mercenary view (let's have fun on the mega-grant!), but the calculation of a boss.

A SOLUTION — IN CALCIUM?

On his floor in the building in Khlopin Street Ilya is reproducing not only the working interior but also the structure of his American laboratory. It does not suit him that there are no administrators in Russian laboratories. Scientists should not have to be bothered with paperwork — in America the professor writes only the concept of an application and the rest is done by a 'specially trained person'. A great

Investment in Intellect

deal of time and effort was spent in the search for the right person, but it was worth it. Polina Plotnikova, the LMN administrator, is always ready to help with filling in forms and financial documents. Two employees with a managerial bent, Mikhail Khotin and Asya Bolshakova, have taken on themselves the trouble of the supply of reagents and the ordering and repair of equipment. As Bezprozvanny never tires of repeating, 'our undisputed advantage is the possibility of organizing our laboratory from scratch, not updating already existing ones, and recruiting young specialists who literally develop before our eyes and master modern equipment. In that scenario it would be stupid not to set ourselves high objectives.'

Even super-optimists who are experienced in the field of neurodegeneration are unlikely to find a panacea for the fatal aging of the brain and the pathologies that go with it, such as Alzheimer's, Parkinson's, Huntington's... Anyone who can explain why these diseases occur with inevitability will definitely win a Nobel Prize! At least it will then be easier to delay those diseases and slow down their development.

Bezprozvanny's idea is that they are caused largely by defects of neuronal calcium signalling. This requires clarification. Neurons, of which there are a hundred billion in the human brain, communicate with one another by means of electric impulses. Inside the neurons themselves signalling occurs with the aid of so-called secondary intermediaries. One of these is ions of calcium. When Ilya was working in America, he established that in the neurons of transgenic mice that showed symptoms of Alzheimer's disease the calcium signalling had been disturbed. A parallel verification of this hypothesis in Russia and the USA will surely help in an analysis of a number of paradoxes in this disease.

It is known that the probability of Alzheimer's disease increases with age, but while some people live to be a hundred with all their faculties intact, others begin to lose their memory well before old age. There is no rational explanation for this, only correlations, and



the most powerful of these — with the accumulation of toxic bodies in the human brain — are amyloid plaques. However, even that correlation is not ideal: often there are plaques but no disease is observed. Bezprozvanny assumes that the calcic and amyloid components supplement one another in various forms of neurodegenerative diseases.

Like the famous artist Paul Gauguin, who 'made a detour via Java and Sumatra to get to the Louvre from Montmartre', Polytechnic graduate Ilya Bezprozvanny 'made a detour' via America to return to his university. He has proved a great deal across the Atlantic but, as it turns out, by no means everything in Russia. At 47 he is mature enough to create a first-class laboratory at the Polytechnic. It may be organized along American lines, but it takes into account the specifics of Russia and is run by a new generation of students and post-graduates. The university, armed with Decree No.220, gave him this opportunity for self-realization that it would have been a sin to turn down. So you believe not in a happy ending, but in a happy continuation of the story.

Candidate of Biological Sciences Elena Popugaeva studies the influence of calcic signalling on the memory mechanisms in the brain as a result of Alzheimer's disease.

Russian Maecenas No.15,
April 2013.

Accurate to the Last Molecule

THE PETER THE GREAT POLYTECHNIC UNIVERSITY HAS CREATED A PEPTIDE
WITH FAR-REACHING CONSEQUENCES FOR THERAPEUTICS

Arkady SOSNOV. Photos: Timur Turgunov



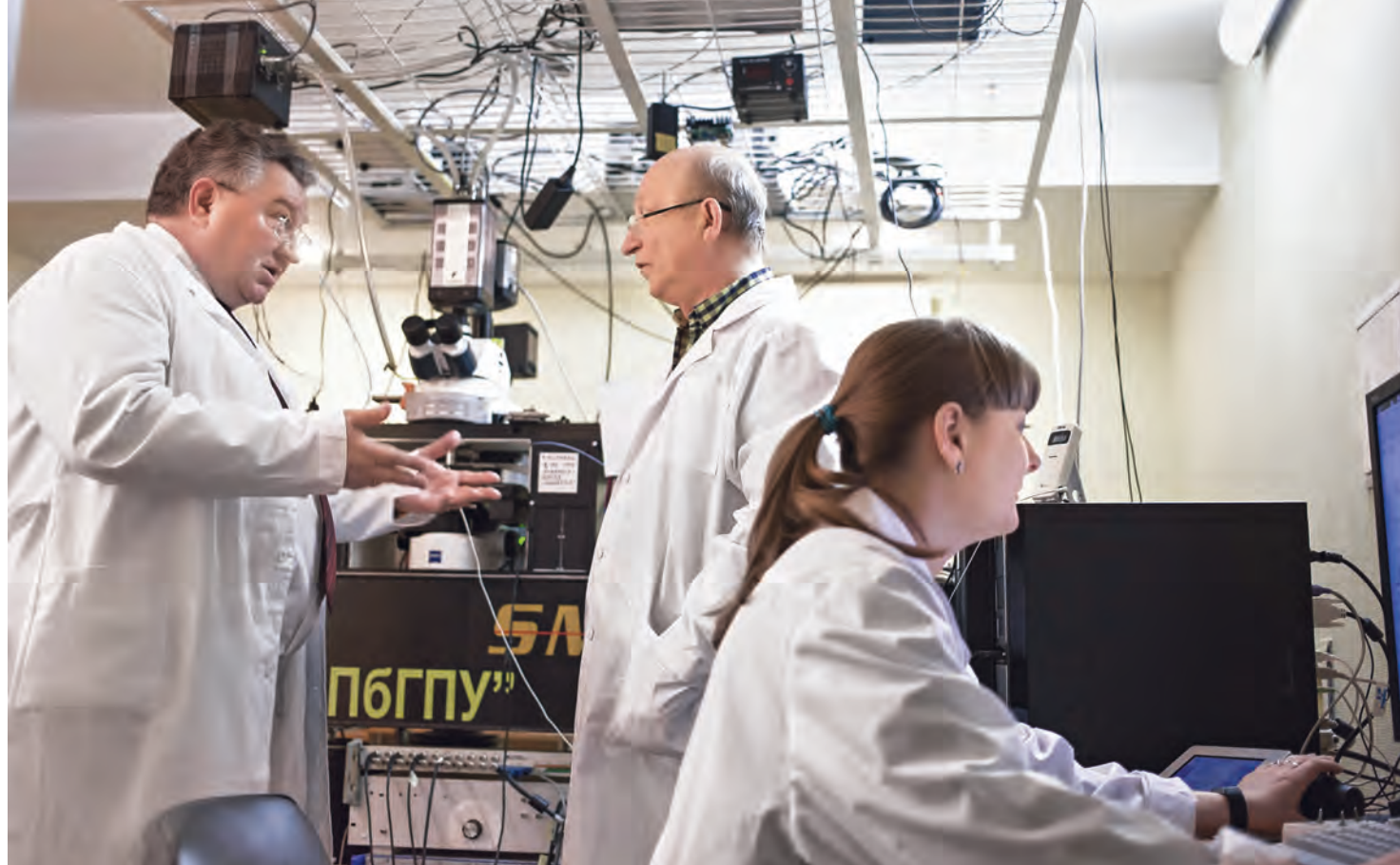
Alexey Vedyakin, a postgraduate at the Polytechnic University, studies the process of the division of bacterial cells.

I had heard a great deal about *laser tweezers*, a miraculous invention which makes it possible to study directly the behavioural mechanisms of individual molecules in living systems, but, as the saying goes, better to see it once than hear about it a hundred times...

I asked Mikhail Khodorkovsky, Director of the *Nanobiotechnology* Research Centre at the St. Petersburg Polytechnic University (*NanoBio* for short) to describe the creation and research with the aid of modern methods, including *laser tweezers*, of a peptide which is harmless to the human organism and is capable of preventing the adaptation of bacteria to antibiotics. He suggested: 'Let's first take a walk and have a look...', and as we went from floor to floor he began to show me the unique units at the disposal of the Centre of Collective Use — first and foremost, NMR (Nuclear Magnetic Resonance) — and high-resolution mass spectrometers

and those *tweezers* which record the movement of macromolecules with nanometric accuracy at the applied force of a thousandth of a nanonewton. These installations are for examining the composition and structure of biological objects and identifying their functions at cellular and subcellular levels by experimental biophysical and biochemical methods. This arsenal was assembled, in the figurative expression of my interlocutor, 'on the warm palm of the state'. The university has certainly made full use of the basic financing and grants available.

The first step in the construction of the new infrastructure was the creation in 2008 and 2009 of science education and analytical centres in nanobiotechnologies as part of national targeted programmes. In 2010 a Scientific Research Institute was formed on the basis of those centres, becoming the current *NanoBio* in 2013. In that year, at the third attempt (showing its persistence in



Andrey Rudskoy, Rector of the St. Petersburg Polytechnic University, discusses the results of the research with Mikhail Khodorkovsky.

achieving its aims) the Polytechnic won a megagrant to set up a laboratory of molecular microbiology in the centre, headed by the prominent scientist Konstantin Severinov. And in 2014 they won the Russian Scientific Foundation competition and were able to add a laboratory of the molecular biology of nucleotide-binding proteins.

Needless to say, each of these stages was accompanied by the purchase of equipment to tackle specific tasks in biology. Of no less importance was the fact that the launch of the scientific research centre led to an increase in the number of students from the university's biophysical and medicinal physics departments. As the director says, 'the children here pick up everything very quickly'. When they graduated, these 'children' stayed to work in the centre's subdivisions or went to related institutions, winning grants and continuing to work closely with their colleagues from

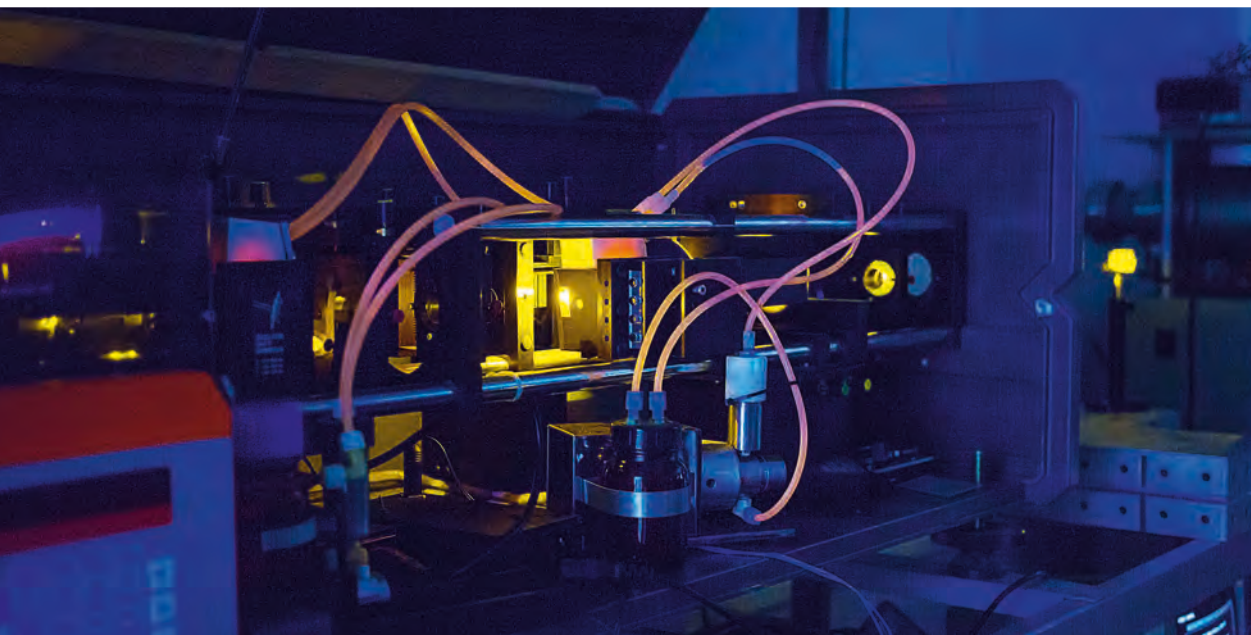
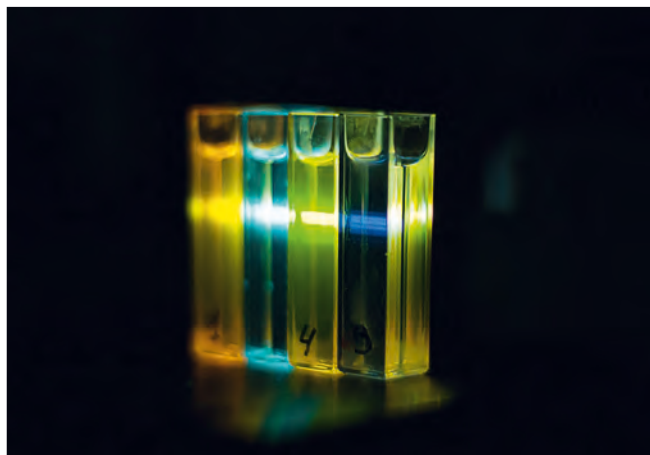
NanoBio. Of course, the centre has been successful in attracting scientific and industrial partners, such as the St. Petersburg Nuclear Physics Institute NRC *Kurchatov Institute*, the Skolkovo Institute of Science and Technology (Skoltech), the St. Petersburg State University, the *BIOCAD* company, the St. Petersburg Institute of Highly Pure Biopreparations and a number of other Russian and Western research centres.

The link between them is not indirect, but as lively and human as it could be. Scientists from Skolkovo enthusiastically experiment in this compact building (a Skoltech Centre has been created in the complex), graduates of the St. Petersburg State University and the St. Petersburg State Chemical Pharmaceutical Academy, not to mention the specialists from the Nuclear Physics Institute, who share 'common genes' with the Polytechnic University, also come here. Semyon Bresler, Head of the Nuclear Physics Institute's

The strength of our university is in its quintessential polytechnic quality, which makes it possible to use all areas of knowledge not only to study biological substances but also to develop nonstandard products and technologies in the interest of human health. In the NanoBio complex they study living systems, drawing on the experience and knowledge of specialists in various areas of physics, chemistry, mechanics and biology.

As a material physicist I know only too well that our depth of knowledge of nature depends on the perfection of the research tools. As we move along the macro-meso-micro-nano path we are already discovering the secrets of the cell, the fundamental element of life. That is why it is so important to study all types of interaction that occur within a cell and among cells on the level of molecules, and that is what NanoBio is engaged in'.

Andrey RUDSKOY, Rector



Investment in Intellect

Radiobiological Department, once organized a Biophysics Department at the Polytechnic University, where staff from the Nuclear Physics Institute still lecture. Many of its graduates work at both the Nuclear Physics Institute and *NanoBio*. Incidentally, the idea of using the characteristics of the interaction of RecA and RecX proteins to create a future peptide was actually proposed by Dmitry Baytin, an employee of the St. Petersburg Nuclear Physics Institute. The best results are obtained, as a rule, in an informal creative atmosphere. It is formed by people of a similar mentality for whom, like Khodorkovsky, it is 'interesting, so that it is interesting and the wheels turn'.

Khodorkovsky's laboratory from a huge variety of proteins has chosen to study those that are able to interact with DNA, RNA and other nucleotides (nucleic acid units), and therefore are involved in the key processes of cell activity, ranging from bacteria to humans. In the field of view of scientists, in particular, the protein RecA, which performs the functions of a 'repairman' for damaged parts of bacterial DNA in the process of their recovery as a result of homologous recombination, was found. Due to this, some of the bacteria affected by external calls (it's not only antibiotics, but ultraviolet light, radiation, chemical agents), adapts, mutates, falls into the state of the SOS-response and eventually survives. But there is another protein — RecX, playing the role of an antagonist of this process, which parses the structure created by RecA, and forces the bacteria to exit the state of the SOS-response. Using this inhibitor to intentionally exclude the SOS-response in a pathogenic bacterium, then, by blocking the mechanisms of its adaptation, it is possible to fight it more effectively. There is now the prospect of creating a new generation of antibiotics to which bacteria cannot adapt.

The dynamics of the inter-protein regulation of this pair of molecules can easily be seen with the aid of *laser tweezers*. Why *tweezers*? Because they help to hold a biomolecule — DNA, for example — in place and observe how its mechanical properties al-

Investment in Intellect

ter on interaction with proteins, not in a test-tube but literally one to one. And the change in the length of DNA on which RecA is strung and whose thickness is a little more than two nanometres can be measured with an accuracy of less than ONE nanometre. Not for nothing is the unit, even though it is inside the building, equipped with its own foundation in order to exclude the smallest vibrations.

Needless to say, for the researcher such an opportunity to look into a living cell is a real buzz. Galina Cherevatenko, a young researcher, did not detach herself from the monitor and brought us a report from the scene: 'I am observing how two proteins participating in homological recombination with a single-stranded DNA molecule interact in the chamber of the device. The molecule is stretched between tiny polystyrene balls, you know, like a sheet on a clothesline. The main parameter that we register is the distance between the balls. And when the protein RecA is wrapped around a DNA molecule, it can be seen that it lengthens and the distance between the balls increases. Next, I look at whether this distance will be reduced in the presence of RecX, i.e. to break down the structure.'

That was how the idea of the investigation came about: the whole RecX protein takes part in the removal of the bacteria's adaptation system or one can take its central part, modify it to give it stability and be certain that it too can cope with this role. Then this short peptide can be created artificially! They took up molecular design — this was successfully undertaken by the tandem of Alexander Yakimov, a graduate of the Polytechnic University's Biophysics Department who now works in two places — the St. Petersburg Nuclear Physics Institute and *NanoBio* — and his scientific supervisor Mikhail Petukhov, who also works in both places. The hypothesis was then verified in practice with the aid of *laser tweezers* and other simpler methods, and was confirmed! On the order of the Polytechnic the peptide was synthesized initially in the USA, then in a much more effective modification in Russia,



and was tested many times by researchers Dmitry Baytin and Irina Bakhlanova from the Nuclear Physics Institute. The results were published in a prestigious international magazine and patented with the title *Family of Peptides — Inhibitors of the Activity of the RecA Protein Blocking the SOS-Response in Bacteria*.

Experts are of the opinion that this result could well be converted into a promising therapeutic agent for the prevention and treatment of infectious and parasitical diseases, but Khodorkovsky is clearly not a man who indulges in wishful thinking: 'We would be happy if such an agent were to appear today or tomorrow. The project has already taken five long years, but there are still about three years to go. We have to evaluate the effectiveness of other peptides in this family and construct an amino acid transporter which will ensure the easy passage of the peptide through a cell's membrane. We are already pleased that we are self-sufficient in terms of ideology and analysis: we have everything here and are not dependent on anybody'.

Alexander Yakimov, a graduate of the Polytechnic University, is an employee of the St. Petersburg Nuclear Physics Institute who works at *NanoBio*.

Page 32:
Galina Cherevatenko at a laser installation.

Lasers are used at *NanoBio* not only for manipulating individual macromolecules with *laser tweezers*, but also for studying the superfast processes running through them by up-to-date photo-physical methods.

Russian Maecenas No.27,
April 2018.

A Princely Undertaking

THE ST. PETERSBURG POLYTECHNIC UNIVERSITY HAS RESTORED THE ESTATE OF ITS FIRST DIRECTOR

Arkady SOSNOV. Photos: the St. Petersburg Polytechnic University Media Centre



Exactly a hundred years ago the first director of the St Petersburg Polytechnic University, Prince Andrey Grigorievich Gagarin (1855–1920) — an artillery engineer by profession, an inventor by nature — had the Kholomki estate built in Pskov Province. It was designed in the neoclassical style by the well-known architect Ivan Fomin, but the real architects were the prince himself, who lived in a neighbouring wing and scrupulously observed the construction process, and his sons. It is no coincidence that the estate building was reminiscent of the main building of the Polytechnic Institute, from which Gagarin had by that time been ‘dismissed without application’, accused by the authorities of encouraging democratically orientated students.

After the revolution, this scion of a famous family, which could trace its lineage back to Rurik’s descendants, received something like

a safe-conduct pass from Lenin: the engineer Gagarin was ‘not to be disturbed, not to be taken hostage and not to have his belongings requisitioned and to be given sufficient kerosene for his undertakings, which I consider to be beneficial to the republic’. He was not evicted but his estate was given over to a People’s House. From 1921 to 1923 it housed a colony of writers and artists: under the solicitous supervision of Princess Maria Dmitrievna Gagarina (nee Obolenskaya), those who gathered strength in the fresh air (there was sufficient flour, groats and tobacco, unlike in hungry Petrograd) included Korney Chukovsky, Evgeny Zamyatin, Mikhail Zoshchenko, Irina Odoevtseva, Mstislav Dobuzhinsky and Nikolay Radlov. Osip Mandelstam was also there for a time, and Kholomki left an indelible trace in the work of each of them. Inspired by the views of the Pskov countryside,





Prince Gagarin was a man chosen by God. He was born on 22 December 1855 and died on the same day in 1920.

Count Sergey Witte, who founded the Polytechnic Institute while he was Finance Minister, was looking for a man to head 'this splendid establishment'. As he wrote afterwards, Prince Gagarin was chosen for the following reasons: '...artillery officer, graduate of the Artillery Academy. He has been very inclined by nature to scholarly technical research and is still so inclined... Prince Gagarin is a man of ideal purity... He has indeed proved to be an excellent director of the Polytechnic Institute and is generally respected both by the professors, despite the fact that these professors have all kinds of academic qualifications and are much older than Prince Gagarin, and by the students'.

Vladislav Khodasevich wrote: 'Here the distance is visible in a spacious frame. Beyond the river a meadow, beyond the meadow a forest'. After the commune closed, Maria Gagarina was banished from what had been her own estate as a counterrevolutionary element and emigrated...

When the fascist occupants left the Pskov area, they took everything of value from Kholomki. After the war, the estate became a sanatorium for patients with pulmonary diseases. In recent years it had fallen into neglect and had been irreversibly destroyed — that is, until the Polytechnic University took the beloved family home of its first director, together with its park and surrounding forests (93 hectares), under its wing. The decision was more than responsible — after all, Kholomki is about 300 kilometres from St. Petersburg and 90 kilometres from Pskov, and the roads are not velvet, to put it mildly. The painstaking restoration process began in strict accordance with blueprints, drawings and descriptions that had survived in the archives.

Those who came to the official opening of *Prince A. G. Gagarin's Kholomki Estate* could not believe their eyes. It was as if the clock had been turned back a hundred years. A tall granite foundation, gleaming white mighty Ionic columns against a yellow façade and a semicircular domed rotunda facing the valley of the fast-flowing River Shelon. And it is true that 'here the distance is visible in a spacious frame'! The historic interiors had been recreated down to the last detail — it is a monument of national importance, after all — and modern apartments elegantly blended into them: a conference hall with an interactive screen, two classrooms, a staff room, 28 rooms with all modern comforts and a café-kitchen on the ground floor. True to its innovative approach, the Polytechnic has made a borehole at Kholomki for an uninterrupted supply of water from a depth of 75 metres and has installed an ecologically pure automated gas boiler that can operate autonomously. A hundred trees have been planted in the old apple orchard (students will now be able to eat Kholomki apples for free every autumn in the university canteen).

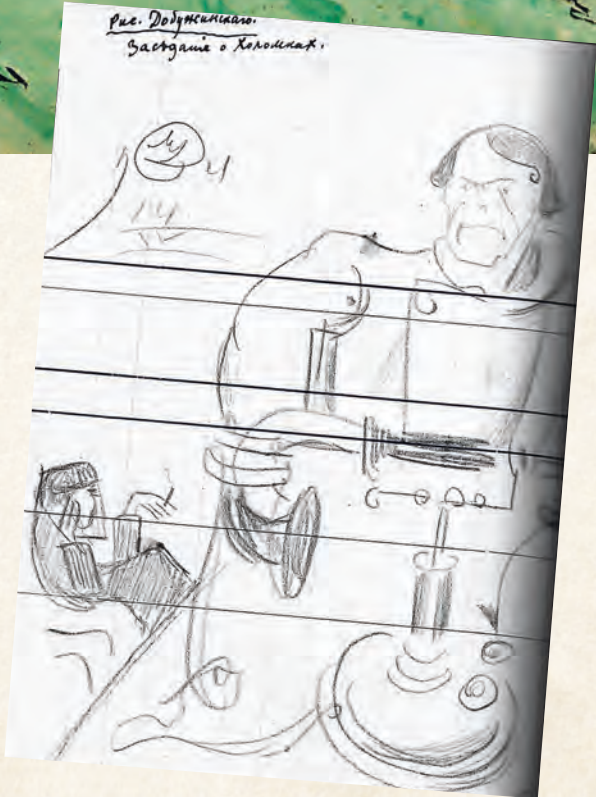


Everything has been done on honestly earned non-budgetary funds (around 200 million roubles have been spent), from which taxes have been paid to the state. 'Those tax deductions would have paid for Gagarin's collapsed wing to be restored, and more besides', complained Valery Silin, Prorector of the St. Petersburg Polytechnic University, who is the direct leader of the project. They applied on two occasions for Kholomki to be included in the federal cultural programme, since it qualifies in all respects, but without success.

In this situation the new owners were guided by the principle 'Do what has to be done...'. They tidied up the grave of their first director in the neighbouring village of Belskoye Ustye, next to the dilapidated Church of the Ascension built in 1797, installed a gravestone and, on the day of the estate's rebirth, unveiled a fine statue, at the foot of which flowers were placed.

There is no need to say how all this touched the prince's great-granddaughter Maria Gagarina, who attended the ceremony with her youngest daughter Sonya. It is a pity that her father Andrey Petrovich Gagarin, a professor at the Polytechnic University for whom the revival of Kholomki was a matter of personal concern, had died just two years before the event.

Heritage



In the early 1920s Kholomki inspired the poets and artists who lived in the People's House.



Left to right:
Andrey Rudskoy honours the memory of his predecessor.

Students at the Polytechnic have revived one of the traditions from the time of Gagarin's directorate — balls.

Roman PANOVA is Deputy Director of the St. Petersburg Polytechnic University's Historical-Technical Museum and a postgraduate student in the History Department of the Institute of Humanitarian Education. For him the key phrase in the prince's Address to Students is 'Conduct Yourself with Dignity'. Smart and stately, with restrained manners, he is clearly trying to adhere to that principle.

Russian Maecenas No. 16,
November 2013.

'We will try to preserve the best traditions of a Russian estate', said Gagarin's successor at the university Andrey Rudskoy, the current Rector of the St. Petersburg Polytechnic University and a Corresponding Member of the Russian Academy of Sciences. It is planned to restore Gagarin's wing, which will become a museum (quite a few exhibits connected with the history of the Gagarin family, the Polytechnic and Kholmki have already been collected), the orangery, the stone buildings around the estate and the cascade of ponds — the Gagarins had an exemplary household.

But the life of the estate will now be filled with a new content. A scientific-educational centre will be based at Kholmki: lectures, seminars, national and international conferences. Local history readings have already been held at Kholmki for several years and the university publishes their materials. The huge recreational potential

of the place will be in demand — around the estate are mushroom forests, hunting grounds, rivers and lakes for fishing, paths for walking and horse riding. It is planned to open a zoo corner and a stud farm and to build a ski slope with a lift. There will be a student campsite not far from the estate house...

These plans are now firmly based: Kholmki has been saved. Gagarin is known to have been popular with his students, who called him 'our prince'. As Andrey Rudskoy said, he is also our prince. His deeds and his address to the first students that is still heard to this day at important events at the St. Petersburg Polytechnic University set the tone for the university's development. Gagarin's memory lives on in daily studies — a press he designed is still used in laboratory experiments on the strength of materials! The tradition of balls at the Polytechnic has been revived. In the prince's time, university balls



were important events in St. Petersburg life and were advertised in the city's newspapers. Orchestras were invited to take part, as were performers from the imperial theatres. At the opening ceremony of the educational-historical reserve one could see youngsters from the *Our Polytech* military history club whirling around in waltzes in the uniforms of Polytechnic students in the early 20th century (their recreation, right down to the gold buttons and epaulettes with the monogram MF (Ministry of Finance), fully corresponding to historical examples, is a story in itself).

Of course, Kholomki has been incredibly lucky — it has fallen into good hands, but there are many noble estates around that have been irrevocably destroyed. Here and there, ownerless remains of parks with fragments of avenues, buildings and manor-houses have survived. Each of these places preserves the memory of past events

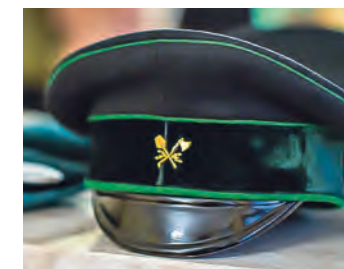
and their owners. Prince Gagarin's son Grigory hid around these estates in 1918 to avoid being shot. This is also the history of the country, recorded in the fates of long-departed citizens, in overgrown fortress walls, in family homes and paternal tombs. How can it not be preserved!

Viktor Stepanov, Head of the Porkhovsky District, is anxious about the fate of one of the area's most beautiful estates — the Stroganovs' home in Volyshovo — and asked that our almanac convey to the rectors of the Moscow University, the Timiryazevskaya Academy and other seats of learning to come, save it and take it over. But hurry, because in two or three years there will be nothing left to save. The Polytechnic University got there in time. The main estate house with its façade resembles an unstamped envelope and the whole project is like a letter to the future. Future generations will read and appreciate it.

Consecration of the main estate house at Kholomki.

The Church of the Ascension in the village of Belskoye Ustye.

Maria Gagarina and her daughter Sonya at the grave of their ancestor.



Semesters of the White Hall

THE NORTHERN PHILHARMONIA IS HELPING TO EDUCATE ENGINEER-INTELLECTUALS
Olga BARANOVA, Darya FILIPENKO. Photos: the St. Petersburg Polytechnic University Media Centre



A girl at the ball on 19 February to celebrate the university's anniversary.

The Polytechnic University's White Hall is, perhaps, the most unusual concert hall in St. Petersburg: classical masterpieces are played in Russia's leading technical university.

When elegantly dressed people are approaching the illuminated main building, an animated but austere atmosphere reigns in the university's park, in the enormous vestibules and on the grand staircase, just as it does before concerts in the Great and Chamber Halls of the Philharmonia in the city centre. Unlike them, however, this sumptuous hall with fine architecture and acoustics is in a huge dormitory district and is called, quite aptly, the *Northern Philharmonia*.

The hall, originally intended for university ceremonies and events, has become a venue where politics, art and science have held sway for over a century.

The first director of the Polytechnic Institute, Prince Andrey Gagarin — an outstanding scholar, engineer and specialist in mechanics, was a great lover of music. In 1902 he purchased instruments for the student symphony orchestra, which began rehearsing and, from 30 November 1908 onwards, performed twice a week in what was then the Assembly Hall. An organ was even commissioned in Stuttgart, but financial difficulties meant that it could not be paid for. Among those who appeared on the hall's stage were Fyodor Chaliapin and artists from the Imperial Mariinsky Theatre — the ballerina and singer Maria Kuznetsova (married name Benois) and Matilda Kshesinskaya.

Other fiery voices were also heard there: the *Manifesto*, the prototype of the first Russian constitution, was first promulgated in the hall on 17 October 1905. It was read out by Prince Gagarin.



rin, the text having been certified by the personal signature of Count Sergey Witte, the Finance Minister. In the same year Lev Trotsky spoke at a session of the St. Petersburg Council of Workers' Deputies.

On 10 November 1910 the first and last public session of the Institute's Council was held in the Assembly Hall. The reason was a mournful one: the death of Lev Tolstoy. It was decided to install a statue of the great Russian writer in the library.

During the First World War the hall was used as a field hospital under the patronage of Empress Maria Fyodorovna, who came to visit the wounded.

After the war, concerts resumed — Bunin and Mayakovsky were among those who appeared. Vladislav Khodasevich recalled that time: '...scientific, literary, theatrical and artistic life

proceeded with unprecedented clarity. Papers, lectures, debates, poetry and prose evenings attracted huge audiences.'

In 1922, in the gallery of the Assembly Hall, where the laboratory of the Physics-Technical Institute was located, its head Lev Termen (Leon Theremin) noticed in the course of an experiment that the pitch and strength of sound depended on the position of the hand between the plates of a condenser. Thus a new musical instrument was born — the termenvox (theremin or theremin-vox). The first concert featuring the instrument took place in the same year — not in the Assembly Hall, but in the Large Physics Laboratory.

In the 1950s the Polytechnic Assembly Hall was considered to be a 'second rate' cultural venue: a long way from the centre, in a working district... The performers included musicians and artists

The legendary White Hall.



Vladimir Spivakov and the Virtuosi of Moscow performing in the hall.



Igor Rogalev holds *Musical Semesters* at the Polytechnic.

The Pokrovsky Ball.

Page 43:
Pushkin Days at the Polytechnic.

Raisa Gundyayeva, conducting the St. Petersburg Religious Academy Chamber Choir.

Mikhail Morozov on the stage.

Olga Kondina by the piano presented to the White Hall by graduates of the university.

Russian Maecenas No.12, January 2012.
Russian Maecenas No.21, November 2015.

who were well known and recognized, but were not entirely approved by the authorities: for example, Alexander Vertinsky (his first concert after returning from emigration) and Wolf Messing with his mass hypnosis sessions.

The highlights in the history of the hall include a musical lecture hall for students run by Leonid Entelis from 1952 to 1965, meetings of the St. Petersburg Society of Bibliophiles (the invited guests were not only poets and writers but also popular actors from Leningrad theatres) and faculty festivals. Students' performances at these events ranged from minor genres (fables, sketches and couplets) to theatrical productions, sometimes of a high standard, and appearances by vocal-instrumental groups (each faculty had its own group).

The financial problems of the 1990s made it more difficult to invite cultural figures and to maintain the hall. The situation was helped greatly by the President of Turkmenistan Saparmurat Ni-



yazov, a graduate of the Physics-Mechanics Faculty and Honorary Doctor of the St. Petersburg Polytechnic University, who made his *alma mater* a generous gift: a cheque for \$100,000 from his personal funds. The money was used to restore the hall...

The new life of the hall began in 2005, when it was renamed the White Hall. Regular concerts, tickets for which can be bought in the city's theatre booking offices, have been held there for the last seven years. A prominent part in this is played by Boris Kondin, the founder and director of cultural programmes. The astounding beauty and superb acoustic of the hall with its vaulted ceilings is suitable for the classical repertoire and for the invitation of highly talented musicians from Russia and abroad. The concerts are non-commercial, so tickets cost much less than in other venues. And for many St. Petersburg residents it is sometimes the only chance to hear the Virtuosi of Moscow, the Terem Quartet, the Jazz Philharmonic Big Band, Vasily Gerello, Olga Kondina...

Heritage

In 2006 a Bechstein concert piano for the hall was donated by graduates of the university in memory of the lost Bechstein purchased in Prince Gagarin's time. It was selected at the company's factory in Berlin by People's Artist of Russia Pavel Egorov, who regularly performs in the hall.

The following year saw the launch of 'Musical Semesters at the Polytechnic', a special facultative cultural course for students in the form of lecture-concerts. The students are introduced to the world of classical music by composer Igor Rogalev, Assistant Professor at the St. Petersburg Conservatory, and... a symphony orchestra. At the lecturer's request, the musicians play excerpts from works, a single instrumental part or even a musical phrase, which helps students to understand the ideas of Mozart, Haydn, Schumann, Stravinsky, Rachmaninov...

'Musical Semesters' is the first step in bringing to fruition the concept of the university's rector, Corresponding Member of the Russian Academy of Sciences Andrey Rudskoy, for a blend of higher technical and humanitarian education. The rector's idea is that graduates of the Polytechnic, which was granted the status of the National Research University in 2010, should become the engineer-intellektuals of the 21st century. Programmes will be devised for the teaching of humanitarian disciplines (music, ethics and aesthetics, literature, painting) in technical and natural science faculties. There will be a new subject every semester. The White Hall, with its aura and traditions, is an ideal venue for putting these plans into practice.

With a view to preserving and entrusting to students the university's rich cultural scientific and historical legacy, it has been decided to open a museum of professional education. It is suggested that the first displays should be devoted to the St. Petersburg Polytechnic's close relatives — the Kiev and Warsaw Institutes, which were also founded at the turn of the 19th and 20th centuries at Witte's instigation to train 'educated people', the 'future of Russia'.



Our People in the Orient

THE PETER THE GREAT POLYTECHNIC UNIVERSITY IN ST. PETERSBURG HAS ESTABLISHED
FRIENDLY RELATIONS WITH THE PEOPLE'S REPUBLIC OF CHINA

Arkady SOSNOV. Photos: the St. Petersburg Polytechnic University Media Centre



Ivan Rey, a Polytechnic University graduate, already feels at home in Changxing.

I met Qingsheng Wang, head of the Chinese ENV company, in St. Petersburg during the celebrations for the 120th anniversary of the Peter the Great Polytechnic University. He was chatting informally over coffee with Professor Anatoly Popovich, Director of the university's Institute of Metallurgy, Mechanical Engineering and Transport. And how could there have been any formality when Wang had completed his master's degree under the professor's guidance at the Far East State Technical University in Russia developing materials for electrical batteries, including with the use of rice pods? The pods were necessary for the production of pure amorphous silicon powder, which was added to anode material in order to increase its capacity.

When he came to the Polytechnic University in 2011 Anatoly Popovich invited Qingsheng Wang to St. Petersburg to develop

the theme of lithium-ion energy storage. He could have chosen somebody closer at hand — from his own students, but Wang was valued not only as an expert in lithium-ion technology and a keen researcher, but also as an investor. In 2013 a Russian-Chinese laboratory of functional materials opened in the university's chemistry block and Wang invested his company's funds into research and development. In 2016 he defended his thesis on future materials for lithium-ion power sources.

'For Wang this subject is his whole life — a hobby, a science and a business', Professor Popovich told me. 'After completing his bachelor's degree at Harbin Polytechnic University, he even sold his flat in the city centre to set up a small company making batteries — nickel-cadmium batteries at that time. And now Wang is a prosperous and established businessman and scientist'.

Over the Barriers

Qingsheng Wang has an experimental-industrial production facility in the small Chinese town of Changxing and is also finishing construction of a large factory to produce lithium polymer batteries, a safer modification of lithium-ion batteries. The technology is based on his joint developments with the Polytechnic University in materials science. An Innovations Institute has also opened in Changxing, where Russian specialists, mainly from the Polytechnic University, work alongside their Chinese counterparts on year-long contracts, with an option to extend. With their arrival, on Professor Popovich's initiative, a line that is new for ENV is being developed: additive technologies, whose use in medicine will enable 'duplicates' of damaged human organs to be created by prototyping methods. A year ago, the St. Petersburg Polytechnic University and ENV jointly organized the scientific-educational centre *Additive Technologies and Functional Materials*, which is beginning to train specialists in key areas of collaboration. So now two sites are operating and developing: scientific at the Polytechnic University, scientific-practical in Changxing.

'The result is that we develop materials in St. Petersburg and specialists in China, mainly from our university, participate in their introduction,' I was told by Pavel Novikov, Deputy Director of the joint Scientific Institute. He is also a pupil of Professor Popovich and is involved, in particular, in 'casting' for Changxing. There are two criteria for the selection of personnel — an active interest in research and preparedness to immerse themselves in a specific environment, far away from family and friends.

Wang, who was wearing the diamond-shaped badge of the Polytechnic University graduate on his lapel, outlined the situation in his own way: in China there are far more specialists who have been educated in the USA and European countries than in Russia. Many companies are looking for good technologists, but he has already found them, collaborating with Russian specialists with a high standard of engineering and technological training. He intends



to defend his doctoral thesis in Russia, but first he has to get his factory up and running! 'Come and see it for yourself', he said in conclusion.

Changxing is a village by Chinese standards, with a population of 620,000. It is dotted with skyscrapers like a seamstress's pin cushion and is well cared-for and maintained to the envy of the average Russian regional centre: modern supermarkets, hotels, excellent roads. ENV occupies 7 of the 24 floors in one of the business centres: chemical and analytical laboratories, staff offices, administration, a BMS (Battery Management System) for electronic monitoring of the condition of the batteries and experimental production. And everywhere there are stickers with the St. Petersburg Polytechnic University logo and stands with information about the university.

We arrived on an important day: Wang had acquired a strategic investor. He signed a cooperation agreement with the Chinese GSR (Gold, Sand, River) Group, which incorporates around thirty hi-tech companies. The essence of the agreement is that GSR will invest in the development of the factory and the institute. Welcoming

Qingsheng Wang's mainstays are scientists and specialists from the Polytechnic University and he always stresses the insoluble link with his alma mater.





Qingsheng Wang in the factory building.
Soon production will be in full swing here.



Yu Yao from ENV with Vladimir Khizhnyak,
Head of the International office,
the St. Petersburg Polytechnic University.

speeches were made in the vestibule of the business centre and one of the managers of the GSR Group thanked the Polytechnic University for training such advanced personnel as Qingsheng Wang.

The ceremony made an impression on the young Polytechnic University graduates whom we managed to meet. Ivan Rey and Evgeny Maltsev were unanimous in declaring that substantial plans would follow this agreement: the scope for creativity would be greater. Ivan graduated from the Institute of Metallurgy, Mechanical Engineering and Transport only last year, in the *Theoretical Fundamentals of Welding* Department. Friends who had come here earlier called him and he followed them as soon as there was a vacancy. He was attracted by the opportunity of proving himself, plus the material factor. In less than a year he was heading the Additive Technologies Department, so his basic knowledge in metal science gained at the Polytechnic University came in very useful.

Evgeny's story was somewhat different: in 2016 he graduated from the Institute of Physics, Nanotechnologies and Telecommunications in the Department of Microelectronics and Nanotechnologies, but could not find employment in his specialization. He

worked in a bank and looked for vacancies on the Internet. Everything was decided by meetings with Pavel Novikov and Qingsheng Wang, who had come on a visit — Evgeny has been here since November 2018, developing materials for solid electrolytes.

After the signing of the agreement with the GSR Group, Wang invited us to look around the factory — the building has already been constructed and is just awaiting the installation of equipment. In the factory, which is 80,000 sq. m. in area, there will be a production chain of lithium polymer batteries with a solid electrolyte, enviable capacity and energy.

The principal merit of these batteries is that they are safe: they do not explode or burn under depressurization and overcharging (that has already happened and has led to accidents with electric cars and fatalities). The introduction of the solid electrolyte is a new twist in the development of lithium-ion systems. However, there is a problem which the designers have already run into: a reduction in the battery's capacity under rapid discharge. The solution to this problem will avoid losses when working with high-tension currents, and specialists in St. Petersburg and Changxing have already come up with various ideas for modifying the solid electrolyte.

Over the Barriers

Andrey RUDSKOY,

*Rector of the St. Petersburg Peter the Great Polytechnic University,
academician of the Russian Academy of Sciences:*

‘Our collaboration with the People’s Republic of China is the cornerstone of our international relations. Our university opened an official branch in China three years ago — in Pudong, a new district of Shanghai. It has been a very successful project, the first and, unfortunately, the only one among Russian universities. China is a great country with a rapidly developing economy, an ancient history and special traditions, philosophy and psychology. And we realized that we needed to set up a centre, which would be headed by a Chinese graduate of the Polytechnic University, as a platform for negotiations and the promotion of joint educational programmes, engineering design and fundamental research, in order to raise the university’s profile and competitiveness not only in China but in the whole Asia-Pacific Region. A great deal has been achieved in those three years. For example, we have opened a Joint Engineering Institute in the Pedagogical University in Jiangsu Province, where there are 562 students on bachelor’s degree courses and 36 studying for master’s degrees. Jiangsu has become the largest university in China in terms of the number of students learning Russian and training in technical specializations. Integrated study plans have been devised: for instance, after two years in the Joint Engineering Institute, the students spend the following two years at the Polytechnic University and receive our bachelor’s degree, then, after defending their theses in China, they are awarded a bachelor’s degree by the Joint Institute. There is a similar scheme for master’s degree students. The lectures are given by Russian and Chinese lecturers, and we help the latter to improve their qualifications.

We have also opened a joint Innovations Institute in the town of Changxing in Zhejiang Province for the production of lithium-ion batteries and the development of additive technologies, where our Polytechnic University graduates work alongside Chinese specialists headed by Qingsheng Wang, a pupil of Professor Anatoly Popovich. We have achieved a breakthrough in the Chinese car industry. The news recently hit the mass media: Russian engineers have taught their Chinese colleagues to design cars. That is not hyperbole: Polytechnic University graduates took part in the design of an off-road vehicle for BAIC, the largest state car corporation in China. Using tools of computer engineering (the creation of digital doubles of items in the production process, virtual proving grounds



and test facilities), they were able to reduce the weight of the vehicle by 7.5% — a huge achievement for mass production. The research and development were completed in 2.5 months — at least three times quicker than by traditional methods. What is more to the point for the market, including in Europe: with the aid of digital models we have regulated the testing of Chinese cars for safety.

With the active participation of our ‘plenipotentiary’ in the People’s Republic we are forming teams of Russian and Chinese engineers and scientists in a wide range of disciplines — from molecular biology and medicine to energy. The teams are winning BRICS grants and setting up joint laboratories, as, for example, in the East China Pedagogical University. The Polytechnic University’s branch is not an abstract concept: we keep our numerous partners in higher education, science and industry informed about its activities and they can count on our support. Academicians of the Russian Academy of Sciences Evgeny Shlyakhto, General Director of the Almazov National Medical Research Centre, and Mikhail Pogosyan, Rector of the Moscow Aviation Institute, and others have already had meetings and negotiations with Chinese colleagues in our branch. We are working for the whole of Russia. China has been and remains our most important strategic partner’.

Andrey Rudskoy opens
the St. Petersburg Peter the Great
Polytechnic University’s Chinese branch.
Shanghai, April 2016.

*The branch organizes cultural events, helps
to select undergraduates for our university
and holds video link-ups for them with
Chinese students and postgraduates from
the Polytechnic University — and there are
about two thousand of them here. On this
basis we plan to develop tourism for school-
leavers and university entrants, arrange for
groups of prospective Chinese students to
come on acquaintance visits to the Polytechnic
University and other higher education
establishments in the city.*

Russian Maecenas No.29,
April 2019.

For the Benefit of Turkey

THE ST. PETERSBURG PETER THE GREAT POLYTECHNIC UNIVERSITY IS TRAINING SPECIALISTS FASCINATED BY THE ATOM

Arkady SOSNOV. Photos: Natalia Dönmez, Timur Turgunov



‘Turkey has become closer’ — that is what they are now saying in the Peter the Great Polytechnic University in St. Petersburg. Its rector Andrey Rudskoy, Academician of the Russian Academy of Sciences, is President of the Society of Friendship with Turkey, and the university has been commissioned by the Turkish Ministry of Energy and Natural Resources to train specialists for the *Akkuyu Nükleer* nuclear power station, a major Russian-Turkish joint project. As part of the contract with Rosatom 24 Turkish students are receiving instruction in the university’s Institute of Energy and Transport Systems, specializing in *Nuclear Energy*.

The Polytechnic University was not handed this prestigious commission on a plate. It was carefully assessed: its experience in teaching foreign students and, in particular, its targeted training of specialists for energy installations under construction were closely

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examined. A delegation from Turkey which visited the university in June 2015 took an interest in everything: the auditoriums, laboratories, student hostels, sports facilities, the student canteen, the library and, most importantly, the curricula. Andrey Rudskoy showed the visitors the university's innovative infrastructure — the Engineering Centre, the new Scientific Research Centre and the Supercomputer. The delegation also visited the Institute of Energy and Transport Systems, which trains personnel for the design, installation and operation of nuclear power stations. The Turkish visitors were satisfied with what they had seen. They were especially impressed by the unique programme of specialization in Russian (after all, Russian will be the *lingua franca* at *Akkuyu Nukleer!*) with a course of study of 5.5 years, after which graduates are awarded diplomas as nuclear engineers. Two groups from Vietnam were already studying under this programme.

And on 1 September of that year (2015) a group of Turkish students who had been selected from approximately 5,000 contestants on the results of a two-stage competition commenced a course of study at the Polytechnic University.

They were very different people who had studied for a year or two at various universities in Turkey. Their level of training consequently varied: at first some of them had to do a bit of catching up and 'reduced to the common denominator' (the Russian educational standard), but none of them are here by chance. These students are absolutely convinced that Turkey should have its own nuclear power station (it is currently obliged to purchase electricity from neighbouring countries) and this motivates them in their studies. As the head of the group Emre Beki told us: 'Nuclear power is a tough but interesting specialization. I chose it because I am fascinated by physics and I reckon that energy will be man's most important requirement in the 21st century. Another factor which influenced my choice was that my father, who is now retired, was a technician in a state energy company and very much wants me to



Before studying nuclear energy, they had to learn Russian, which took a whole year at the Polytechnic University's Institute of International Educational Programmes. All the Turkish students were agreed: learning Russian from scratch is not easy, but it is possible! For example, Burak Pekşen was so successful that at the 15th All-Russian Olympiad in Russian as a Foreign Language he was placed third out of more than 80 competitors from 31 countries, and his fellow group member Cihan Açıkgöz came sixth!

Studying at Russia's leading technical university is no walk in the park. The first two years in the Department of Nuclear and Thermal Energy were the hardest — the students were bombarded with fundamental knowledge, mostly in maths and physics. Emre

Questions for the lecturer.
Assistant Professor Vladimir Polonsky
with Turkish students.

Page 48:
Turkish students by the model of
a nuclear power station.

Akkuyu Nukleer, the first nuclear power station in Turkey and Asia Minor on the shore of the Mediterranean in the province of Mersin, is being built to a Russian design which provides for four energy blocks with VVER-1200 reactors with a total capacity of 4,800 megawatts.



President of the Society of Friendship with Turkey Andrey Rudskoy and Turkish Ambassador Hüseyin Lazip Diriöz.

Mehmet Sariarslan solving the problem.

During the opening ceremony in Ankara in April 2018 by video link Russian President Vladimir Putin and Turkish President Recep Tayyip Erdoğan gave a start to the construction of the power station, the cost of which is \$22 billion. It is the first nuclear power station in the world to be constructed on the BOO (build-own-operate) principle. Russian contractors will be responsible for the design, construction, technical servicing and operation of the station. All the equipment (reactor, steam-powered and electrical) will also be Russian.

Beki admitted that he experienced difficulties in studying theoretical disciplines and taking oral exams: there are no such exams in Turkey — you write what you know and are given a mark, but here you have to talk to the teacher who exposes the depth of your knowledge. However, he added, they have very competent teachers who help them to master the subject.

The theory is reinforced in independent creativity. As part of the new *Basics of Design* discipline the students are split into small groups to design various things: the group headed by Emre Beki made a model of a nuclear power station, Şahin Can Tipi and his group studied the possibility of making a car that would run on nuclear fuel, Mehmet Sariarslan designed a model of a robotized tank...

After the general education disciplines come general technical subjects, which lead to specialized technical disciplines — a study of the equipment of a nuclear power station, which the current third-year students are now embarking upon. The teachers change, but the group's specially invited guest tutor remains: Natalia Dönmez lived in Turkey for several years, is fluent in Turkish and, also importantly, in English. With her alongside it is easier to fit into the university environment and enjoy the culture of St. Petersburg. The Turkish students regularly go on excursions with their tutor, visiting theatres, museums and, of course, organizations in their specialization. They have already visited the South-West Thermal Power Plant, the Leningrad Nuclear Power Plant, the Nevsky Plant and the Izhorsky Plant, where the core of the first reactor for *Akkuyu Nükleer* will be built. Their acquaintance with the fuel-energy complex is broadening: during the current academic year they will visit the Gazprom compressor station in Yukki and one of the Gazpromneft installations.

One senses that the role of excursion members does not now suit them. As a professional, Şahin Can Tipi appreciated the standard of production and safety at the Leningrad Nuclear Energy



Plant, which has four RBMK reactors and a new-generation VVER-1200 reactor at the initial operational stage — four similar reactors will be installed at *Akkuyu Nükleer*. This was just an acquaintance visit: next year the students will undergo practical tuition at the Leningrad Nuclear Energy Plant and will learn a great deal more about it. But even now they are gratified that Turkey will have its own similar nuclear power station. It should be noted the organization of practical tuition at enterprises in the industry, like the courses of study themselves, is undertaken by the Polytechnic University in close contact with Rosatom as one of its feeder establishments.

‘Turkish people know little about nuclear energy. Some think it is mortally dangerous and best avoided. The reliable information which I want to bring them will help to dispel those fears’, said Nurberk Sungur, the only girl in the group. She has written a series of popular articles about the structure of the atom, nuclear energy and nuclear medicine for the Turkish website kadinbilim.com (literally — science for women). Well,

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Nurberk's name obliges her to do this: in Turkish *nur* means light and *berk* — strong, confident.

'Turkey has become closer' also because the country is satisfied with the progress of its emissaries' studies and intends to send another group of students to the Polytechnic University for training — not only for the nuclear power station. As Professor Nikolay Zabelin explained, 'our partners are interested in a range of technologies and equipment connected with the conversion and use of nuclear energy — steam turbines, heat exchangers, electricity generators, right down to the supply of energy to the end consumer, and we provide them with a whole range of possibilities'. He then broke this range into its individual components.

Besides this speciality, the Polytechnic University may introduce a master's programme in nuclear energy taught in English — Rosatom shares this approach. There is the possibility of studying a master's programme in Russian on *Nuclear Energy and Thermal Physics* in the same department, but it has a fairly tough entry re-



quirement in the form of an interdisciplinary exam. It is also possible to study for a bachelor's degree in the same subject — that route is even preferable, as it provides fundamental preparation for future study for a master's degree. There is another form of study for foreign students — three-week masters' courses in summer and winter. At last year's summer school a new *Nuclear Energy* module was introduced. And this year saw the introduction of a *Gas and Oil* module: around 250 masters from 35 countries, including Turkey, came to the Polytechnic University, as well as 25 foreign lecturers from leading European higher educational establishments. Finally, a joint programme has been devised between the Polytechnic University and the Moscow Engineering Physics Institute, also to train personnel for *Akkuyu Nükleer* but aimed at the servicing of the reactor.

It is planned to install the reactor blocks at *Akkuyu Nükleer* gradually, at intervals of one year beginning in 2023, so by the time the first block comes into operation the advance guard of specialists educated at the Polytechnic University will be ready to work on it.

Turkish students get acquainted with Russian energy companies.



In addition to nuclear energy, Semih Uçar is keen on history and literature, now also of Russia.

Russian Maecenas No.28,
November 2018.