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ESTABLISHMENT OF NOVOSIBIRSK AKADEMGORODOK – CENTRE OF THE SIBERIAN BRANCH OF THE RUSSIAN ACADEMY OF SCIENCES: ACHIEVEMENTS AND OMISSIONS

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Abstract. This paper, written to commemorate the anniversary of the Russian Academy of Sciences, offers a detailed account of the establishment of Novosibirsk Akademgorodok. The author, Academician Abel Gezevich Aganbegyan, played an active role in this process. He regards Akademgorodok as a major contributor to the advancement of science and education. Akademgorodok was initially created to accomplish three primary objectives: to foster the development of fundamental sciences and facilitate their mutual interaction, with a focus on breakthrough directions; to integrate science with higher and pre-university education; and to promote innovation based on scientific achievements. These goals demanded significant efforts from both the research community and the state. Despite significant challenges and risks, Akademgorodok has become one of the leading scientific centres both in Russia and globally. However, this process was associated with some omissions, including insufficient attention to the commercialisation of scientific findings and innovation transfer in industry.

Keywords: interdisciplinary scientific development, integration of science and education, applied research

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ИСТОРИЯ НАУКИ

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О ФОРМИРОВАНИИ НОВОСИБИРСКОГО АКАДЕМГОРОДКА – ЦЕНТРА СИБИРСКОГО ОТДЕЛЕНИЯ РОССИЙСКОЙ АКАДЕМИИ НАУК: ДОСТИЖЕНИЯ И УПУЩЕНИЯ

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Аннотация. В статье, посвященной юбилею Российской академии наук, академик РАН Абел Гезевич Аганбегян подробно описывает историю создания Новосибирского Академгородка. Он был активным участником этого процесса и считает, что Академгородок сыграл важную роль в развитии науки и образования. Академгородок создавался для достижения трех основных целей: комплексного развития и взаимодействия различных направлений фундаментальных наук с концентрацией на прорывных направлениях, интеграции науки с высшим и довузовским образованием, инновационного развития на основе достижений науки. Автор отмечает, что достижение поставленных целей было непростым и потребовало много усилий как со стороны ученых, так и со стороны государства. Однако, несмотря на все трудности, Академгородок смог стать одним из ведущих научных центров России и мира. Автор подчеркивает, что, несмотря на успехи в развитии науки, были и упущения. Например, недостаточное внимание уделялось коммерциализации научных достижений и внедрению инноваций в производство. Это привело к тому, что многие научные разработки так и не нашли практического применения.

Ключевые слова: комплексное развитие отраслей науки, интеграция науки и образования, внедренческая деятельность

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INTRODUCTION

This year marks the 300th anniversary of Peter the Great's founding of the Academy of Sciences in Saint Petersburg and the 65th anniversary of the establishment of Novosibirsk Akademgorodok.

I spent the most productive and fulfilling 25 years of my life, from 1961 to 1985, in Akademgorodok. For nearly 20 of those years, starting in 1966, I served as the Director of the Institute of Economics and Industrial Production Organisation, being also a member of the Presidium of the Siberian Branch of the USSR Academy of Sciences. Although I was elected a corresponding member in 1964 and an academician in 1974, I have maintained strong ties with the Siberian Branch. On average, I visit my home institute two or three times a year. Like many others from Akademgorodok, I observe its developments with great interest, regularly reading its publications and staying updated on research in my field.

In recent years, I have extensively studied innovative development, not only in Russia but also by examining the experience of other countries, particularly the United States, China, and Israel. This perspective has given me a new understanding of Novosibirsk Akademgorodok, which I am eager to share. To begin with, let me consider the interplay between science and education.

According to the vision of its chief founder, Academician Mikhail Alekseyevich Lavrentyev, who was Vice-President of the USSR Academy of Sciences at the time, Novosibirsk Akademgorodok was established as the centre of the Siberian Branch with a view to achieve the following interconnected goals:

1. *Comprehensive development of fundamental sciences:* To promote diverse fundamental sciences, with a particular emphasis on interdisciplinary interaction and pioneering research in emerging fields.
2. *Integration of science and education:* To establish Novosibirsk State University and a physics and mathematics school at the heart of Akademgorodok. This required tight collaboration between research institutes to identify talented youth and train highly-qualified specialists.
3. *Practical application of scientific achievements:* To foster innovation by facilitating knowledge transfer in practice.

This triad of objectives has become known as the 'Lavrentyev Triangle'. It was thoroughly described in the book by Ibragimova and Pritvits (1989), which bears the same title. The book draws extensively on the reflections of distinguished scientists who brought this vision to life.

1. Novosibirsk Akademgorodok – The Largest Integrated Centre for the Development of Fundamental Sciences

Today, Novosibirsk Akademgorodok is home to 49 academic institutes and affiliated scientific and technical organizations spanning all natural science disciplines – including mathematics, mechanics, physics, chemistry, geology, biology, medicine, and agriculture – as well as five institutes in the fields of the humanities. These institutes are situated on a compact site, with researchers residing in a newly built town of approximately 20,000 inhabitants. Among the most renowned institutes, both in terms of their composition and international significance, are the Institute of Mathematics, the Institute of Nuclear Physics, the Institute of Catalysis, the Institute of Cytology and Genetics, and the Institute of Geology.

The interaction between various sciences was embedded precisely in the structure of the Siberian Branch, reflecting the focus of its institutes. Mathematical methods permeated the research of most institutes, not only in mechanics and physics but also in chemistry, geology, biology, and, of course, economics.

At the Institute of Mathematics, Academician L.V. Kantorovich headed the mathematical economics department, while the Institute of Economics established a separate complex to house a computer with a dedicated mathematics department for applied economic and mathematical research. Physical and chemical ideas and methods deeply influenced biology, fundamental medicine, and geological studies.

During the formation of the Siberian Branch, efforts concentrated on establishing around 10 institutes. However, over the next 60 years, new institutes gradually emerged, including five in mathematics and computing, seven in physics, five in biology and agriculture, seven in chemistry, seven in geology, and five in the social sciences, encompassing economics, law, philosophy, archaeology, ethnography, history, and philology. Today, the institutes of Akademgorodok employ approximately 30,000 specialists, including about 50 academicians of RAS, 60 corresponding members, and around 1000 doctors of science.

The Siberian Branch is globally renowned for its outstanding scientific achievements. For instance, the Institute of Physics was among the first, alongside Stanford University, to launch a large collider, a feat that had eluded dozens of leading scientific teams worldwide. Siberian geologists have gained fame for discovering oil and gas fields not only in Western Siberia but also in Eastern Siberia and the Far East. They predicted the existence of a major diamond province in Western Yakutia, where geological expeditions later confirmed the presence of diamond pipes.

In my own field, I would highlight the achievements of Academician L.V. Kantorovich in optimisation, which earned him the Lenin Prize in 1965 and the Nobel Prize in Economics in 1975. Another notable contribution is the development of economic sociology by Academician T. Zaslavskaya, a new direction recognised in sociological science. The system of models for interregional and interindustry linkages by Academician A.G. Granberg provided a scientific foundation for spatial research and regional planning. The discovery of the 'ancient' Denisovan hominin by our archaeologists is regarded as a global milestone in this field.

A key feature of Novosibirsk Akademgorodok consists in the agglomeration of academic institutes across various scientific disciplines, making it an integrated scientific town, unlike specialised science cities such as Dubna (focused on physics), Chernogolovka (primarily chemistry), Pushchino (biology), Zelenograd (semiconductor industry), and Korolyov (space research).

The creation of an integrated city of Akademgorodok offers undeniable advantages, enabling new breakthroughs through interdisciplinary collaboration. For example, high-precision diagnostic and treatment methods in medicine rely on nuclear physics (radiation therapy, isotopes, etc.) and genetics, the foundation of biological science. While a scientific medical institute may not have top-tier physicists on staff, such expertise is abundant in physics-focused institutes. Thus, collaboration between, say, the Institute of Nuclear Physics and a major medical centre is irreplaceable.

In advanced countries, scientific development primarily relies on universities. Consequently, the scientific-educational campuses of major universities are inherently integrated. While the size of any university is limited, the potential of a scientific town expands significantly when it interacts closely with nearby universities and academic institutes. In this way, Akademgorodok is becoming larger and more comprehensive.

Novosibirsk Akademgorodok was the first of its kind not only in Russia but also globally, with major research institutes in all key scientific fields clustered around one university.

Inspired by the example of Novosibirsk Akademgorodok during a Japanese delegation visit, Japan established Tsukuba, an integrated scientific centre 35 km from Tokyo. Tsukuba evolved into a unified science city in 1987 (Bloom, 1981). During the 1970s and 1980s, around 50 research institutes and the University of Tsukuba were established on a single site. This science city consolidated previously independent settlements across an area of approximately 250 square kilometres, creating a hub of science and advanced technology with a population of 220,000, engaged not only in science but also in private enterprises and innovative organisations that emerged as a result. Prior to the creation of this integrated science city, the area was home to about 100,000 people.

Several university campuses worldwide have grown into large innovation zones, often referred to as 'Silicon Valleys,' densely populated with innovative companies. The first of these emerged from Stanford University's research park in the 1970s, expanding into the vast Silicon Valley between San Francisco and Los Angeles, encompassing numerous cities and towns, including the million-strong city of San Jose. Similarly, based on academic institutes and two major universities – Peking University and Tsinghua University (with a polytechnic focus) – a multi-million-strong innovation zone has formed, encompassing parts of Beijing and surrounding areas.

The same pattern is evident in the development of Silicon Wadi in Tel Aviv and adjacent areas along Israel's coastline. Such 'Silicon Valleys' are home to hundreds of thousands, or even millions, of people, many of whom are engaged in innovation, science, and education.

Russia currently lacks such large innovation zones. Innovations, as is well known, are based on R&D and university education, driven by the generation of new knowledge. While Russia performs well in generating new knowledge within its integrated and specialised scientific-technical towns, it has not, for various reasons, developed similar innovation zones, unlike leading countries. In my view, Russia's lag in innovation development is catastrophic, and I will attempt to demonstrate this below.

Akademgorodok is yet to reach the level of innovation activity seen in Silicon Valley. Will this be achieved in the foreseeable future? This may largely depend on the success of the proposed Akademgorodok 2.0 project, which has not been officially approved yet. Under this project, as envisioned by the leadership of the Siberian Branch of the Russian Academy of Sciences (SB RAS), the number of employees in academic institutes and organisations will increase from 30,000 to over 80,000, while the student population at Novosibirsk State University is expected to grow from 8000 to 12,000. In my opinion, this expansion is insufficient (Zaikov, 2018).

If a Russian 'Silicon Valley' can be established on this scientific-educational foundation, it will require the development of large areas around Akademgorodok, including not only Koltsovo and Pravye Chely but also nearby Berdsk and other adjacent settlements, potentially increasing the population by hundreds of thousands, and possibly reaching a million within 15–20 years.

While I am not qualified to discuss the specifics of this development, I should mention one area close to my expertise: healthcare. A significant oversight in the Novosibirsk Scientific Centre is the exclusion of a scientific-practical medical centre, such as the nearby National Medical Centre named after Academician E.N. Meshalkin.

When the Siberian Branch was established, one of its goals was to integrate modern medicine with the highest achievements of physical, chemical, and biological sciences. This aimed to correct what we consider a profound mistake: the exclusion of medicine from the USSR Academy of Sciences and the creation of a separate Academy of Medical Sciences. While some leading scientists in this field were elected to both academies, all medical research organisations were concentrated within the Academy of Medical Sciences, which has gradually distanced itself from the general Academy of Sciences.

This separation may explain why Russia lagged behind other countries by decades in adopting advanced diagnostic and therapeutic methods, such as radiation diagnostics and therapy, high-precision nuclear medicine, and genetics. Until 2005, high-tech medical treatments had been inaccessible to many patients in Russia, while such care was already available abroad, where medical technologies developed in close collaboration with the natural sciences.

National programs such as 'Demography' and 'Healthcare' were launched in 2006, with significant additional funding, to improve treatment quality and, after 50 years of stagnation, increase life expectancy in Russia, albeit temporarily.

Unfortunately, the noble vision of Siberian scientists to integrate medical science as an organic part of the academic centre has not been implemented. Without delving into unnecessary details, the Meshalkin Institute was effectively expelled from Akademgorodok. Only through the energy of its leadership and the efforts of its team did it become a first-class cardiology and oncology centre, arguably the best in Siberia and the Far East. However, it falls short of being a world-class centre because it does not fully utilise modern nuclear medicine methods, including in oncology and cardiovascular disease treatment. It lacks even a positron emission tomography (PET) facility.

Specialised proton therapy centres for cancer treatment, which appeared decades earlier in the US and a few other countries, were established in Russia only a few years ago, in St. Petersburg (at a private biotech firm) and Dimitrovgrad (a site for nuclear research). Why not in Novosibirsk, where the Institute of Nuclear Physics, with its associated plant, could have implemented these technologies more quickly and effectively? It is not too late to do so now. A first step in this direction has been taken by St. Petersburg entrepreneur A. Stolpner, who established a PET centre in Novosibirsk, with radiation therapy departments in Barnaul and Tomsk.

After years of research and development, the Institute of Nuclear Physics created boron neutron capture therapy for cancer treatment. China was the first to adopt this technology, using it to establish a new treatment centre. However, the Meshalkin Centre could have been the first in the world to implement this breakthrough.

There is currently no organic connection between the vast Meshalkin Clinic and the nearby academic centre. Yet, it might become a world-class hub. For example, A. Stolpner's proton centre has become the global leader in treating previously incurable forms of childhood cancer. Patients from abroad come here for treatment. The centre is widely recognised today, since proton therapy facilities are rare. The UK only recently built its first centre, and Israel has yet to establish a major one. Only a handful of countries possess such an advanced and effective medical technology.

The Meshalkin Centre operates as a first-class medical facility but not as an integrated research and treatment centre for cardiology and oncology. It is not part of the Siberian Branch of the Russian Academy of Sciences. In my view, it is essential to integrate medical science, particularly with nuclear physics technologies, especially since the eastern part of Russia lacks access to these advanced diagnostic and treatment methods.

2. Integration of Science and Education in Novosibirsk Akademgorodok

Historically, since the time of Tsarist Russia, academic institutions and universities in this country have developed in relative isolation from one another. The Academy of Sciences, as is well known, was established by Peter the Great in 1724, while the country's leading university was founded in 1755 in Moscow. However, there was no organic connection between these institutions.

In contrast to Russia, universities in many other countries have become not only educational centres but also major hubs for scientific research. In these countries, fundamental science has typically been developed by scientists working in universities, who are often engaged in both research and teaching. As a result, the integration of science and education in many other nations, including developed ones, has been a feature from the very beginning.

The scale of scientific research in Russian universities is incomparable to the volume of research and development conducted by the Academy of Sciences. The Russian Academy of Sciences comprises over 600 institutes and other scientific and technical organisations, while Moscow State University (MSU), the largest university with 42,000 students, has only 15 institutes employing around 2500 people.

This separation between the Academy of Sciences and higher education not only persisted during the Soviet era but was further exacerbated by the establishment of the Ministry of Higher Education of the Russian Federation. The two systems had different funding channels, and the ministry made efforts to develop a distinct scientific base within universities and other higher education institutions. However, no significant funds were allocated for scientific development at universities at that time. As a result, university-based science has historically been less well-equipped. The availability of scientific instruments and specialised facilities has been limited; the primary focus of higher education institutions has been on training rather than research. Additionally, the Ministry of Higher Education imposed restrictions on part-time work at universities, which also affected academic staff. While prominent scientists could, at their discretion, teach at universities and deliver lectures, there was no organic connection between academic institutions and universities. The Academy of Sciences did not establish its departments within universities, nor did it involve students in internships or research using advanced equipment at its institutes. This situation persisted until the creation of the Moscow Institute of Physics and Technology (MIPT), which was established to train specialists for the priority task of developing nuclear technology.

The need for integration became particularly evident when Russia faced the challenge of ensuring national security, which required the rapid development of an atomic bomb. Solving this problem demanded personnel with new qualifications. It became clear that even the faculties of Moscow State University were unable to train specialists with the necessary knowledge and skills. This was not only acknowledged by its rector, the eminent mathematician Academician I.G. Petrovsky, but he also became one of the initiators of a new type of institute integrated with atomic science – the Moscow Institute of Physics and Technology.

This was the first educational centre in Russia to integrate fundamental and applied science. Students at this institute not only gained knowledge within its walls but also spent a significant amount of time working as staff members in scientific and industrial complexes of the nuclear industry, using the most advanced nuclear installations. Academician S.A. Khristianovich, one of the founders of the Siberian Branch of the Academy of Sciences, was the first rector of MIPT and a key initiator of its creation. M.A. Lavrentyev, who later moved to the Siberian Branch, worked at MIPT, and Academician V.V. Voevodsky, who also relocated to Siberia, served as the dean of the chemistry faculty. Many leading staff members of the Institute of Nuclear Physics and other institutes were graduates of MIPT.

Unfortunately, even in post-Soviet Russia, no effective measures have been taken to further integrate science and education. Over time, a few universities and higher education institutions have emerged with connections to specific institutes of the Academy of Sciences. However, this has not been part of a systematic effort, let alone a strategic direction in science and technology policy. Graduates of universities, even the best ones, often lack the skills to conduct research, particularly collaborative research with other scientists, and have no experience of working with modern scientific equipment. It takes them years to become fully-fledged researchers.

Novosibirsk State University (NSU) has become the first university to adopt the MIPT model. Students typically studied in university classrooms for five to six semesters (2.5–3 years), gaining foundational knowledge, and were then assigned to institutes according to their specialisation. There, they were supervised by leading researchers and received specialised training, often in dedicated facilities within the institutes. Working with state-of-the-art equipment, they not only acquired knowledge but also developed research skills and experience.

M.A. Lavrentyev was a strong advocate of this integration. He famously declared, "There is no scientist without students." During elections for academicians and corresponding members, he would meticulously question candidates about the subjects they taught, whether they led seminars, who their students were, and how deeply they were involved in training the next generation. This was one of the key criteria for academic elections.

Leading scientists used university classrooms to conduct their seminars. Notable examples include seminars on logic by the outstanding mathematician Academician A.N. Malcev and on economic-mathematical models and methods by L.V. Kantorovich.

During my time at the Siberian Branch, the university was led by its founder, Academician I.N. Vekua, a renowned mathematician. He established the university's academic council, primarily composed of institute directors who were considered leaders in their respective fields within the university. I was tasked with creating the economics faculty at the university. Naturally, I recommended a dean in consultation with the university leadership, selected department heads, and encouraged leading institute staff to teach, although some initially resisted due to the lack of teaching experience. This was the case, for example, with Academician T.I. Zaslavskaya, who led the sociology department at our institute. Previously, she had worked at the Institute of Economics in Moscow and had no teaching experience, but she eventually established the sociology department at our faculty, trained many students, and founded a school of sociology. She even co-taught social studies with me at the senior level of the physics and mathematics school affiliated with NSU, aiming to persuade some of the winners of regional Olympiads, who formed the core of the school's students, to enrol in the economics faculty. We managed to attract around 10 of these highly talented students to our faculty each year, sparking their interest in economics and sociology.

It seems to me that the strong position of institute directors as the primary leaders of specialised education in their fields has weakened. Novosibirsk University now has many full-time professors who do not work in institutes. Moreover, the university aims to establish its own research institutes and laboratories, parallel to those of the Academy, something that was never even discussed during my time.

In terms of the level and quality of education, Russia ranks highly among the world's countries. According to the 2022 UNDP international ranking, Russia is 29th out of 192 countries in education, ahead of France (44th) and Italy (52nd), not to mention Brazil (92nd) or China (114th), all BRICS countries, all developing nations, and most post-socialist European countries (Ranking of countries of the world ..., 2023). All these countries are significantly behind Russia in education. The level of education is determined by the average number of years of schooling among the working-age population, which in Russia is around 13 years. In the coming years, a large cohort with relatively low levels of education will reach retirement age, while the working-age population will increasingly consist of people with higher education. Therefore, the expected average years of schooling in Russia is projected to exceed 15 years. In 2023, Russia ranked 6th in the world in the proportion of residents with completed secondary specialised and higher education – 62.09%, trailing only South Korea, Canada, and Japan among major countries, which have rates of 65–69%[1]. Other leading countries, including the USA, UK, and Germany, have lower figures.

However, in terms of educational outcomes and efficiency, Russia falls below 60th place, which is its ranking in terms of economic development (GDP per capita). In the Social Progress Index, Russia is in the 70s, and in terms of life expectancy and population health, it ranks in the 100s in international rankings (2024 Social Progress Index, 2024).

Our educational institutions provide relatively good knowledge, although Russia's position in international rankings is declining due to insufficient funding. Recall that when the first Earth satellite was launched, an American commission led by the US Vice President identified the superior education system of the USSR as the main reason for its technological edge. At that time, our country spent a third more of its GDP on education than did the USA. Now, it spends only 4% of GDP, ranking 120th in the world (also according to the UNDP ranking), a far cry from its leading position 60 years ago.

Yes, Russia still provides good knowledge to university graduates, although not requiring them to apply this knowledge, nor does it provide the skills and experience needed to work effectively and independently. In the USA and several other countries, a diploma alone often does not qualify someone for a permanent position. For example, to become a high school foreign language teacher there, a bachelor's or master's degree is not enough; 300 hours of supervised teaching practice are required. Only then can the graduate become a fully paid teacher, and even then, only in a private school. To teach in a state school, where salaries are higher, they must also pass a licensing exam.

This applies not only to teachers but to many other professions. The highest requirements are for medical training. In some countries, to enter a medical school, one must first complete a four-year bachelor's degree in physiology, biology, or psychology. This is followed by four years of medical school, after which several years of work as a medical assistant are required, along with additional exams to gain skills and experience. In total, it takes from 11 to 15 years of study, depending on the specialty – the longest being for surgeons. Unfortunately, nothing like this exists in Russia.

In certain cases, such as with the Moscow Institute of Physics and Technology and some similar institutions, as well as Novosibirsk University, the issue of integrating science with higher education can be relatively easily resolved. To formalise this administratively, Novosibirsk University should be transferred to the Siberian Branch of the Russian Academy of Sciences. But what about other universities in the country?

[1] URL: https://www.statista.com/topics/7785/education-worldwide/#dossier-chapter3 (date of access 20.02.2024).

The Academy of Sciences has three regional branches – Ural, Siberian, and Far Eastern – and 15 scientific centres, each comprising a group of research institutes working collaboratively. The largest of these centres is in St. Petersburg, which could incorporate St. Petersburg University and possibly other universities where integration with science is particularly important. The same applies to Ural University, which has the Ural Branch of the Academy of Sciences, Irkutsk University with its scientific centre, and others, including Tomsk, Krasnoyarsk, and Yakutsk universities. Far Eastern University in Vladivostok should naturally be included in the Far Eastern Branch of the Academy of Sciences.

Perhaps Moscow State University could remain as an independent institution, possibly with a special status, given that it is developing a large scientific and industrial complex.

It should be noted that the proposed integration of the Academy of Sciences and leading universities could only be fully implemented after the institutes are returned to the Academy's control, as was the case before the controversial reorganisation of the Academy in 2012, which many scientists continue to view as detrimental.

3. Practical Application of Scientific and Educational Achievements for Innovative Development

The early years of the Siberian Branch of the Russian Academy of Sciences (SB RAS) were spent forming scientific teams, creating the material and technical base for scientific development, and defining effective research themes. The idea of the founders of the Siberian Branch – to focus on using research results for the socio-economic development of the country – began to materialise when the first outcomes of the institutes' research work emerged.

The Siberian Branch proposed a comprehensive program for the development of the productive forces of Siberia and the Far East as a priority project for the next five-year plan and beyond. The government approved this initiative, and the Presidium of the SB RAS appointed three leaders to oversee the program: Vice-President of the SB RAS Academician G.I. Marchuk, who later became president of the SB RAS after M.A. Lavrentyev's resignation; Academician A.A. Trofimuk, Director of the Geological Institute; and myself as the director of an economics-focused institute.

Dozens of institutes, not only from Akademgorodok but also from other centres in Siberia, participated in this work. We collaborated with the Council for the Study of Productive Forces in Moscow and the Regional Development Department of the USSR State Planning Committee. Regional leaders in Siberia and the Far East also actively supported this initiative, on the condition that the SB RAS would assist them in developing individual regional development programs and organising conferences on these issues with the participation of scientists, for which they were willing to allocate funding. This comprehensive work continued for 20 years and involved numerous scientists from the SB RAS in practical projects aimed at the development of the eastern regions.

For example, our geologists not only actively participated in the development of the West Siberian oil and gas province, which became the primary source of oil and gas in the USSR, but also proactively studied the oil and gas resources of Eastern Siberia, where new deposits were discovered with the help of science. Today, a significant portion of oil and gas supplied to China comes from these deposits. Academician A.A. Trofimuk, a leading expert in the geology of oil and gas fields, played a key role in this process. Academician V.S. Sobolev, who first predicted the existence of a vast diamond province in western Yakutia, also contributed significantly to the discovery of new diamond deposits and the establishment of a new industry in the country.

Scientists in geography, economics, geology, and other fields conducted extensive work to create new territorial production complexes in the Angara-Yenisei region, such as the Sayan, Bratsk-Ust-Ilim, and Lower Angara complexes. In subsequent five-year plans, starting in 1975, the development of the Baikal-Amur Mainline (BAM) zone began in connection with the construction of this new railway. From 1980 onwards, the idea of organising year-round navigation along the Northern Sea Route and exploiting the natural resources of the Arctic zone attracted widespread attention. Much was done to further develop the Kuzbass, Irkutsk-Cheremkhovo region, and the growth of Krasnoyarsk and Angarsk. Together with the leadership of the Yakut ASSR, a program for the development of the South Yakutia complex was developed, and the construction of a railway to Yakutsk was initiated, which is now nearing completion with the construction of a bridge over the Lena River near Yakutsk.

Over the past 65 years, a major leap forward has been made in the development of the productive forces of Siberia and the Far East. There is no doubt about the outstanding role played by scientists from the Siberian and Far Eastern Branches, with the participation of research institutes from Moscow, St. Petersburg, and other regions of Russia. In the vast, sparsely populated territory of the West Siberian Lowland, which previously had no roads or significant settlements, the world's largest oil and gas complex began to take shape in 1965. Today, it produces two-thirds of the country's hydrocarbon resources and ranks first in the world in hydrocarbon exports. Extensive railways and roads have been built, a dozen cities have been established, and massive oil refining and petrochemical plants have been constructed. The Arctic coast has been developed, attracting three million people to the region and enabling the construction of hundreds of thousands of facilities. Such a large-scale development of the vast and challenging territory, characterised by swampy terrain, harsh climate, and a lack of building materials, is unprecedented in the world.

During the same period, the world's largest hydroelectric power stations were built – Krasnoyarsk, Sayano-Shushenskaya, Bratsk, Ust-Ilim, and Lower Angara. The largest aluminium industry and massive timber processing complexes producing millions of tons of pulp and cardboard were established. These complexes are connected by railways and highways, and large industrial cities and centres, such as Bratsk, Ust-Ilimsk, Zheleznogorsk, and Ust-Kut, emerged. The population of Angarsk, Irkutsk, and Krasnoyarsk grew significantly. The Bratsk-Ust-Ilimsk complex alone required the relocation of 600,000 people. The construction of the railway to Ust-Kut enabled the intensive development of the world's most significant diamond province in Western Yakutia, leading to the formation of new cities and the relocation of hundreds of thousands of people.

On the other hand, the railway to Ust-Kut allowed the construction of the Baikal-Amur Mainline (BAM), a 3000 km railway to the Pacific Ocean, starting in 1976. This railway, one of the most challenging due to its geological and seismic conditions, facilitated the development of a vast zone with significant coal, oil, and gas deposits, which now supply China. Large gas-chemical complexes, copper deposits, and a powerful timber industry have also been developed. Much more could be said about the exciting prospects made possible by the achievements of previous decades. We can undoubtedly take pride in all of this.

The urgency of applied research and development was heightened by insufficient funding for Siberian science, as it was financed not by the powerful federal budget of the USSR but by the republican budget of the RSFSR. This was a deliberate choice by the SB RAS leadership to maintain close interaction with Moscow-based science, which would have been difficult if funding had to be divided from a single source. To successfully develop science in Siberia, where regional wage coefficients apply and infrastructure, construction, and transport costs are higher, the branch needed significantly more self-financing than Moscow or Leningrad institutes. It was necessary to learn how to earn money and obtain permission to use it for scientific research and other additional expenses.

As the only economist on the Presidium of the SB RAS, I was tasked with addressing this issue. I had to involve experts in various scientific fields who identified research projects in individual institutes that could be applied in practice and commercialised. The directors of individual institutes assigned deputy directors to liaise with me, with whom I had to work closely.

For example, I became closely acquainted with Corresponding Member V.A. Sidorov from the Institute of Nuclear Physics. To create scientific installations at the Institute of Nuclear Physics, a machine-building plant was organised, producing various devices primarily for accelerator installations. It was decided to start producing industrial accelerators at this plant, which could find applications in many industries, such as irradiating grain to eliminate unwanted microorganisms or treating surfaces coated with dyes or other substances to make them more resistant to high temperatures or toxic substances.

Additionally, the Institute of Nuclear Physics developed a more advanced X-ray machine with fundamentally new software that allowed for a brief, multi-directional X-ray scan of a patient, enabling the examination of the resulting image without further exposure. Such devices could even be used in maternity hospitals for diagnosing a child in the womb, as the X-ray exposure lasts fractions of a second and has no impact on the health of the mother or child. Based on this technology, devices were developed for installation in airports and other locations where security screening is necessary.

Agreements were also quickly reached with the Institute of Catalysis, which developed fundamentally new catalysts to accelerate chemical reactions in various industrial installations. A small production facility for these catalysts was established, and chemical plants could purchase them to mutual benefit. There were many such examples.

In particular, our Institute of Economics, together with the Computing Centre of the SB RAS, developed an automated control system for individual plants, the first of which was the Khimapparat plant, producing mechanical engineering products for the nuclear industry. Its director, who defended his candidate and doctoral dissertations under my supervision, actively supported this work.

At the initial stage of implementing automated systems, independent implementation organisations were established at individual institutes in the form of enterprises, design bureaus, and applied institutes with pilot production. For this purpose, an area bordering the Ob Reservoir, several kilometres from Akademgorodok, named Pravye Chems, was allocated. This is where the Institute of Nuclear Physics' plant and the NII Systems, a developer of automated control systems created by our institute, were located. This was the period of *sovnarkhozy* (regional economic councils), which lasted until the end of 1965. After that, sectoral ministries were re-established, which attempted to take over the applied organisations they needed. Despite efforts to keep NII Systems under the SB RAS, the Ministry of Instrumentation succeeded in transferring this organisation under its jurisdiction, where it began to focus on the commercialisation of relatively primitive automated control systems. As a result, this zone did not develop further.

In another satellite town, about 10 km from Akademgorodok, in the village of Koltsovo, the Vector Biotechnology Centre was established on the initiative of Academician L.S. Sandakhchiev. In post-Soviet Russia, this centre focused on combating infectious diseases not only in Russia but also in Africa and other countries. This centre played a significant role in the fight against the coronavirus pandemic, developing the second most important vaccine after Sputnik V.

This large biological centre facilitated the creation of several new companies: Vector-Best, Vector-Pro, and Vector-Pharm.

In post-Soviet Russia, the new leadership of the SB RAS began creating centres for technological commercialisation, drawing on the scientific and technical ideas of Akademgorodok's institutes. These centres include various applied laboratories and firms, employing around 10,000 people.

The new leadership of the SB RAS, headed by President Academician V.N. Parmon, Director of the Institute of Catalysis, developed the Akademgorodok 2.0 project, which envisages the further development of Akademgorodok's technological belt.

A major component of this complex is the unique SKIF accelerator – a true megascience facility where researchers from various fields can conduct applied research using synchrotron radiation to study the structure of new materials, biological objects, and apply nanoparticles, among other things. This will create numerous jobs not only for SB RAS employees but also for representatives of other organisations, including foreign ones. It will be a unique centre of global significance. Plans also include the creation of a genetic engineering biotechnology centre to address various challenges, primarily in the interests of medicine.

From personal communication with the project's initiators, it is known that the potential costs for the entire Akademgorodok 2.0 project could amount to 170 billion rubles.

The complex socio-economic situation in recent years, marked by stagnation and crises related to the coronavirus pandemic and the Special Military Operation in Ukraine, has delayed the implementation of these projects. However, work is ongoing, and the first stage of the SKIF accelerator will soon be operational.

As can be seen, much has been accomplished on the previously empty forested area near the Ob Reservoir, where a world-class centre for fundamental science has emerged, striving not only to train highly qualified personnel but also to create a zone for implementation and contribute to the further development of the vast territories of Western and Eastern Siberia.

In the 65-year history of Akademgorodok, there have been both successes, which I have attempted to describe, and omissions. The primary reason for these omissions lies in the flaws of the socio-economic system and the policies of our state. During the period of over a third of a century, post-Soviet Russia has largely failed to demonstrate significant breakthroughs, increasing its GDP by only 20%. For comparison, the European Union grew by 1.5 times, the USA by 2 times, post-socialist European countries by 2.5 times, developing countries by 3–5 times, India by 8.5 times, and China by 12.7 times[2].

Regarding the shortcomings in scientific and technological development and our lag in innovation, the reorganisation of the Russian Academy of Sciences in 2012 had a negative impact. Thus, for objective reasons beyond the control of the scientific community, much has not been achieved. At the same time, as often happens, some things have not been accomplished due to short-sightedness or insufficient concentration of resources.

Let us now turn to the omissions and discuss them in a roughly chronological order – what was not achieved in the early years of the SB RAS and what has been missed in the past 10–20 years.

The first omission was the insufficient development of the Institute of Theoretical and Applied Mechanics and the departure from Akademgorodok of one of the founders of the SB RAS, the outstanding scientist and organiser S.A. Khristianovich, who was the director of this institute.

Without delving into the details of the conflict and incompatibility in the work of M.A. Lavrentyev and S.A. Khristianovich, I believe that the failure to fully realise the vision for this institute was a significant loss for the SB RAS. S.A. Khristianovich planned to focus the institute on researching combined-cycle power plants, for which the institute was specially equipped with experimental installations.

[2] URL: https://www.statista.com/statistics/270180/countries-with-the-largest-gross-domestic-product-gdp-per-capita/ (date of access 20.02.2024).

The absence of a significant share of combined-cycle power plants in Russia's energy system is a major drawback for the entire economy. The efficiency of the most advanced gas power plants for electricity generation is just over 30%, while combined-cycle plants are nearly twice as efficient. If gas power plants, which are both morally and physically obsolete, were replaced with combined-cycle plants, Russia could save about 70 billion cubic meters of gas. The cost of building such a power plant would be approximately half as much, as there would be no need to construct multi-story buildings to house large and expensive boilers with water tubes heated by gas burners, nor would bulky cooling towers be required to cool large volumes of superheated water.

Yes, we are not yet ready for the mass construction of combined-cycle plants because we have not mastered the production of powerful gas turbines with capacities of hundreds of thousands of kilowatts. These are much more expensive and complex than current water turbines, as the gas combustion inside the turbine creates much higher temperatures than superheated steam. Due to the high temperature of the exhaust gases, they can transfer their heat to water, which, after the gas turbine, will drive a steam turbine, thereby increasing efficiency.

However, Russia has all the necessary groundwork to start producing, for example, 300–500 megawatt gas turbines in a relatively short time, as we have mastered the production of aircraft engines, and many developments in this area can be applied. If such research had been conducted, it is highly likely that we would now have a more advanced and efficient energy system. By the way, we would not need such extensive power transmission lines, as combined-cycle plants are efficient even at relatively small capacities.

Given S.A. Khristianovich's high talent and organisational skills, there is little doubt about the enormous benefits he could have brought to the development of combined-cycle plants and their practical application. Research at the Institute of Theoretical and Applied Mechanics could also have significantly advanced the task of designing an economical and high-speed aircraft with laminar airflow. It is possible that domestic scientists could have been the first in the world to solve this problem, as the institute employed one of the world's leading specialists, Academician V.V. Struminsky, who developed fine tail surfaces for high-speed fighters with laminar airflow. A certain wariness towards the aerodynamic research of the Institute of Mechanics, as a continuation of S.A. Khristianovich's work, likely played a role, and V.V. Struminsky, who became the institute's director, was apparently not provided with favourable conditions. After a few years at the peak of his career, he left and continued his work in Moscow. Now, the lead in research and development for designing aircraft with laminar airflow has passed to the USA.

In 2022, Otto Aviation Group presented a small private aircraft, the Celera, with unique capabilities due to its egg-shaped design, long thin wings, specific tail surfaces, and a rear-mounted propeller powered by a powerful diesel engine. This all-plastic business jet can fly at an altitude of 14,000 meters, cover distances of up to 8,400 km with low fuel consumption, and has an operating cost of 326per hour, compared 2,100 for modern business jets. The experimental Celera 500L has completed about 40 flights, confirming the claimed performance. Larger models of this aircraft are being developed, and the Celera is being prepared for certification, with serial production expected to begin in 2025–2026, potentially significantly changing air transport.

Another omission concerns the development of economic science, for which no one is to blame, but it is worth remembering. The project for the development of economic science in the SB RAS was proposed by the head of the Economics Department of the USSR Academy of Sciences, an outstanding specialist, Academician V.S. Nemchinov. In the initial structure of Novosibirsk Akademgorodok, according to Vasily Sergeyevich's vision, an Institute of Economics and Statistics was to be established with three departments: an economic-mathematical department led by L.V. Kantorovich, elected a corresponding member of the USSR Academy of Sciences in the first cohort for the specialty of economics and statistics; a second department to be headed by N.N. Nekrasov, a specialist in the location of productive forces, elected a corresponding member of the SB RAS, who was to lead research on the development of Siberia and the Far East; and a third department on industrial organisation led by G.A. Prudensky, also was elected in the first cohort. V.S. Nemchinov himself agreed to be the director of this institute.

Vasily Sergeyevich was already advanced in age and, for health reasons, could not move to Siberia. Although some staff from his Moscow laboratory of Mathematical and Economic Methods came to the SB RAS and began working, upon learning that Nemchinov would not come, they returned to Moscow. Apparently, for the same reason, N.N. Nekrasov did not move to the SB RAS, becoming the chairman of the Council for the Study of Productive Forces under the USSR State Planning Committee. Therefore, G.A. Prudensky became the director and renamed the institute the Institute of Economics and Organisation of Industrial Production. L.V. Kantorovich, being a great mathematician, naturally did not want to be subordinate to G.A. Prudensky and chose to become the deputy director of the Institute of Mathematics under Academician S.L. Sobolev, where he established a mathematical and economic department.

Thus, the broad scientific economic cluster envisioned by V.S. Nemchinov was not created, and the institute could not take its rightful place in Akademgorodok from the outset. G.A. Prudensky believed that the institute should remain in the city to conduct research based on enterprises in Novosibirsk. He did not intend to cooperate with other SB RAS institutes and operated in isolation.

A high level of academic science, particularly in natural sciences, integrated with university education, is widely recognised to be the foundation for innovative development, especially in the technological sphere. Since the 1970s, first in the United States and subsequently in many other countries, large innovation zones, often referred to as 'Silicon Valleys,' have been established. These zones host numerous innovative companies dedicated to translating scientific and technological advancements into practical applications. While a typical scientific-educational centre might house from 10,000 to 30,000 residents, Silicon Valleys and their surrounding areas employ hundreds of thousands of people in innovative companies, with the total population often reaching several million. What innovative firms have been established around the Novosibirsk Scientific and Educational Centre in Akademgorodok?

A significant achievement in applying science to support human life was the creation of the 'Vector' Biotechnology Centre by Academician L.S. Sandakhchiev. This centre, mentioned earlier, focuses on combating dangerous viruses. It was established near Akademgorodok on a forested site, 10 kilometres away, and named 'Koltsovo' after the prominent Russian scientist and founder of molecular biology, Nikolai Koltsov. L.S. Sandakhchiev arrived in Akademgorodok as a young researcher at the Institute of Inorganic Chemistry, where, thanks to his talent, he earned his Candidate of Sciences and later his Doctor of Sciences degrees. He became a laboratory head and founded the Applied Institute of Molecular Biology, which he developed into a major scientific-production complex. As a skilled organiser, he effectively established an urban settlement, constructing the 'Vector' research and production buildings, acquiring advanced equipment, and initiating critical research into life-threatening viruses such as measles, which was thoroughly studied as a representative of a family of dangerous viruses.

To ensure the necessary level of safety, the work was conducted in a closed regime. Unfortunately, the founder of 'Vector' lived a relatively short life, passing away just a year before his 70th birthday. He died before fully realising his plans but left behind numerous students and a first-class team.

The most active years of Academician L.S. Sandakhchiev's career coincided with a transformational crisis, marked by sharp cuts in science funding, irregular salary payments to researchers, staff reductions, a lack of funds for essential equipment, and insufficient resources to establish the necessary pharmaceutical production in the country.

The negative consequences of this became evident during the COVID-19 pandemic when Russia developed the world's first vaccines against the virus but was unable to produce them in sufficient quantities even to vaccinate its own population. The European Union produced ten times more vaccines than Russia, fully meeting Europe's needs and selling 1.5 billion doses to other countries. The United States produced four times more vaccines than Russia, also exporting a significant portion to other nations.

Nevertheless, the creation of 'Vector' represents a fundamentally new direction, the most important and promising in terms of the effectiveness of fundamental science. This is how innovations are created, enabling humanity to advance not only quantitatively but, more importantly, qualitatively towards the heights of civilisation. It is worth noting that 'Vector' is perhaps the only major world-class innovative company established in the Novosibirsk Scientific Centre that continues to operate successfully.

The second-largest company, founded in 2010 based on the scientific developments of Academician M.R. Predtechensky, is OCSiAL. While working at the Institute of Thermal Physics of the Siberian Branch of the Russian Academy of Sciences, he developed a method that led to the creation of the world's first industrial installation for producing single-walled carbon nanotubes (graphene nanotubes), essential for modern batteries. Together with his colleagues, particularly Y. Koropachinsky, he established large-scale production in Russia and later in other countries, producing 80 million tonnes of these nanotubes, meeting 90% of global demand. This was the largest 'unicorn' company, with a capitalisation exceeding one billion. However, Russia lacked the necessary funding for mass production. A.B. Chubais, head of Rosnano, could allocate only 20 million, while Japan invested $2 billion in the company. As a result, the company became a global leader in this field, relocating to Luxembourg. Unfortunately, the majority of production now takes place outside Russia, funded by corporations in developed countries. Only a relatively small and decreasing portion of production remains in Russia, with the core team working successfully abroad.

Based on other scientific and technological achievements from the institutes of Novosibirsk Akademgorodok, we have not found other world-class companies. However, there are dozens of relatively large innovative companies by Russian standards, with production volumes exceeding two billion roubles, and a slightly larger number of medium-sized companies with production volumes ranging from 0.8 to 2 billion roubles. Hundreds of companies are small or even micro-sized. In 2021, according to research by Professor N. Kravchenko, innovative companies in the Siberian Federal District spent 167.9 billion roubles on developing innovative products, accounting for 2.4% of the gross regional product of the entire district. The share of revenue from high-tech products in the district's gross regional product was 0.28% (see the article by N. Kravchenko et al. in the journal *Region: Economics and Sociology*, No. 1 (121), 2024, in press).

All the world's 'Silicon Valleys,' the most significant and effective innovation zones, were created in this way – based on scientific achievements. Highly educated individuals with organisational talent dedicated themselves not only to scientific research but also to applying it to solve pressing practical problems, creating large scientific and technological complexes, and more recently, effective platforms. Hundreds and thousands of innovative companies have emerged worldwide, advancing science into practice, accelerating technological and socio-economic development, and improving people's lives.

For example, Silicon Valley in California began with graduates and faculty from Stanford University, who started creating innovative firms based on new knowledge. Among these are such outstanding examples as Apple, Intel, Google, Facebook, and many others. In 2011, a special study was conducted on the performance of all innovative companies created by Stanford University faculty and alumni throughout its history, predominantly over the last 40 years since the establishment of the technology park near the university. The total output of goods and services from these companies amounted to approximately 2.5trillion (about 60 billion annually). The total number of employees in these entities exceeded five million. Meanwhile, Stanford University scientists have won 91 Nobel Prizes throughout its history (Harvard – 131, Cambridge – 130).

The three largest innovation valleys in China are the Beijing Innovation Zone, which has extended beyond Beijing to include surrounding areas, based on natural science research from the Chinese Academy of Sciences and major universities such as Peking University and Tsinghua University. The second is the Shanghai Innovation Zone, and the third is Shenzhen, a southern zone near Hong Kong, an innovation city with 17 million residents and over 100 unicorn companies. Each of these zones is home to millions of people.

The Silicon Wadi zone covers a significant part of Tel Aviv and the coastal area near Israel's capital. In terms of scale, it is considered the second-largest in the world, trailing only Silicon Valley in the United States.

Qualitative growth in the economy, social sphere, and society as a whole is based on innovation. Innovative developments form high-tech production across all sectors. Leadership in innovation belongs to companies known as 'unicorns' due to their rarity, small numbers, and high significance. A unicorn is a company that has not yet commercialised its innovation but has already attracted hundreds of millions of dollars in investment to become a viable commercial entity. The capitalisation of unicorn companies exceeds $1 billion. The primary contributors to such companies are venture capital funds, which acquire a stake in the company in the hope that, once it begins commercial operations, the investment will yield substantial returns.

By early 2023, there were approximately 1,500 such unicorn companies worldwide, about half of which are American, over a third are Chinese, a quarter are from the European Union, and about a hundred are from India. Germany and the United Kingdom also rank highly, as do smaller countries like Israel and Switzerland (Aganbegyan, 2023a).

In Russia, from 2014 to 2019, there was only one such a company – Avito. In subsequent years, there were none. The companies that were previously unicorns include Yandex, VKontakte, Mail.ru, and, to some extent, Telegram. In Siberia and the Far East, the only known example is inDrive, which originated in Yakutsk but became a unicorn after its founders moved to New York. They developed an algorithm for the driver–passenger dialogue to negotiate prices when not predetermined. This service is used by over 300 million people in dozens of countries worldwide, making the project worth several billion dollars.

Overall, in the 2022 list that I carefully examined, 28 companies have co-founders who came from Russia and received their education there. Notably, among them is the largest fintech company, Revolut, whose main founder is Nikolay Storonsky. Many of us are familiar with the founders of such companies through interviews conducted by the well-known Russian journalist Yelizaveta Osetinskaya.

Why do not these companies emerge in Russia? Because Russia lacks the volume of financial resources needed for a company to become commercially successful. The primary source of such funding is venture capital. However, all venture capital funds in Russia – state-owned, private, and foreign – had a combined capital of $2.3 billion in 2021. In comparison, the United States had 360 billion in venture capital, and China had 130 billion[3]. In 2023, all venture capital funds in Russia were reduced by the state, and their total volume decreased to approximately 150 million.

One of the largest venture investors is Yuri Milner (son of Boris Z. Milner, Corresponding Member of the USSR Academy of Sciences and Deputy Director of the Institute of Economics –my friend). After graduating from the Physics Department of Moscow State University, he worked in investments in Russia before moving to Silicon Valley and focusing on financing innovations. He has invested 19 billion, of which 7.8 billion is his own capital. There are several other Russian venture investors with billion-dollar investments, but all of them operate abroad. In Russia, it is extremely difficult to find such levels of investment in high-risk projects.

Could Akademgorodok have spawned a Silicon Valley, and can it do so in the future? It is important to understand that Silicon Valley is not a specialised technology hub; it encompasses various fields. An analysis of the main activities of unicorn companies shows that their majority operate in financial services, e-commerce, artificial intelligence, information technology, business services, data analysis, healthcare, and hardware. Every second company is involved in software development, and every sixth – in internet services, science, or engineering. Given the current funding system in Russia and the extremely low share of investments in GDP, it is unrealistic to expect a significant increase in the number of unicorn companies.

The share of investments in fixed capital in the gross domestic product needs to double from the current 18% to 30–35%, typical of advanced developing countries. Only then will dozens of such companies emerge. Therefore, this is possible in the future. However, it is essential to understand that such companies cannot be subordinate to scientific institutes. This is a different area of commerce – innovative commerce – which requires tens of times more funding than what is currently invested in fundamental science.

In order to gain a better understanding of what a large innovative company is, I refer to a detailed survey by the OSCE of 2500 large innovative companies in 43 countries worldwide. A large company was defined as one spending at least €35 million on R&D. Of these 2500 firms, 775 are in the United States, 536 in China, 421 in the EU, 309 in Japan, and just over 100 in Germany and the United Kingdom (cited by Aganbegyan, 2023b).

In Russia, only three such companies were identified, although several dozen of their founders and managers are of Russian origin. The most famous among them is Sergey Brin, the wealthiest Russian expatriate in the world, with a net worth of $107 billion.

The revenue of these 2500 companies amounted to one trillion, employing 564,000 people, and generating a profit of $3.2 trillion. If the revenue of these companies is compared to the GDP of their respective countries, it accounts for 27% in the United States, 16% in China, 43% in Germany, 67% in Japan, and 74% in Switzerland. On average, R&D expenditures account for 4.3% of revenue, with 7.1% in the United States and Switzerland, 3.6% in Japan, 4.8% in Germany, and 3.3% in China. Most companies operate in the digital sector, with computer technology leading, followed by IT services and electronics. The second-largest sector, less than half the size, is medicine and pharmaceuticals. The third is industrial engineering, accounting for roughly one-tenth of all firms.

To create innovative companies, Russia could draw on the experience of Belarus, which introduced incentives for such endeavours, exempting them from taxes and not requiring strict territorial affiliation. Over ten years of this system, their export revenue exceeded two billion, and their total activity

[3] URL: https://www.statista.com/statistics/277501/venture-capital-amount-invested-in-the-united-states-since-1995/ (date of access 20.02.2024).

reached seven billion. These companies are allowed to use cryptocurrency under preferential conditions. They are overseen by a high-tech centre established by a 2017 decree, which promotes their interests with the country's leadership, periodically improving their operating conditions. In the pre-crisis year of 2019, companies in the high-tech park, which were rapidly developing, accounted for half of Belarus's GDP growth. In 2021, the park included 1,054 companies.

The program for innovative development in Siberia should rely on the experience of other countries.

All these and similar proposals are naturally designed for a 10–15-year perspective. During this period, the primary task in the initial phase is to ensure economic and social growth of at least 3–4% annually, with corresponding improvements in the population's well-being and reduction in social inequality in income and housing distribution by at least half.

Once the majority of the population recognises positive changes in their lives, it will be necessary to transform the existing system of state-oligarchic capitalism, with its underdeveloped market and social sphere, into a developed market system with an efficient market for fixed and human capital and a social state developing based on strategic five-year planning.

By 2030–2035, R&D expenditures should be increased to the levels of advanced countries: R&D spending should triple, education spending should double, and healthcare spending should increase by 2.5 times, restoring the Soviet-era system of public health in sanatoriums, health resorts, and children's camps, with universal medical check-ups and developed primary healthcare. A goal could be set to increase life expectancy in Russia from 73.5 to 80 years.

Under such prospects, Russia could surpass Germany and Japan in GDP measured by purchasing power parity by 2030 and raise its technological, economic, and social levels to the average of developed countries by 2035.

CONCLUSIONS

The distinctive feature of Novosibirsk Akademgorodok consists in the presence of academic institutes across various scientific fields, enabling the Siberian Branch of the Russian Academy of Sciences to achieve outstanding scientific accomplishments. The establishment of independent implementation structures at individual institutes has facilitated participation in innovative activities and attraction of additional funding.

Novosibirsk University became the first university to adopt the experience of the Moscow Institute of Physics and Technology, allowing students to combine fundamental knowledge with applied research using state-of-the-art equipment. This approach not only provided them with knowledge but also equipped them with research skills and experience.

However, Akademgorodok is yet to transform into a significant innovation zone. Nevertheless, the scientific groundwork, the high level of education among young people, and, most importantly, the country's acute need for innovation demand the broadest possible application of scientific and technological advances to achieve a technological breakthrough and, consequently, an accelerated economic and social development.

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