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STATE POLICY IN DOMESTIC COMPUTING TECHNOLOGY DEVELOPMENT AT THE XX-XXI CENTURIES

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Abstract

Purpose: The aim of the study is to investigate the state policy in domestic computing technology development at the turn of the XX-XXI centuries.

Methodology: The methodological basis of the study was the principles of historicism, objectivity and reliability.

Main Findings: In a number of industry organizations, with the direct participation and under the guidance of the department members, unique automated systems are developed. Hence, the country needs to restructure and modernize its industrial potential, the dialogue between authorities and leading scientists, the training of highly qualified specialists in the field of engineering, etc.

Applications: The research findings can be used by universities, cultural organizations, technology-media institutes and by graduate students in social sciences.

Novelty/Originality: This paper studied Russia's participation in the international division of labor. Russia's entry into the global information community required the consideration of international standards during the creation of systems, which needed academic science support.

Keywords: *State Policy, Technology Development, Centuries.*

INTRODUCTION

In the current geopolitical and economic situation, the only alternative for our country is to determine an accurate, science-based strategy for further development. In the May Decree of 2018, the President of Russian Federation named the acceleration of introduction of digital technology and its social sphere among the goals of national importance. It is possible to use the powerful potential of the Russian fundamental science more actively due to the excellent schools in the field of mathematics and theoretical physics. Of course, currently the Russian IT companies are globally competitive. Domestic specialists offer the best unique software solutions, and a new sphere is being created. Relying on the digital economy, the leaders of the country hope to establish a separate industry, and to qualitatively form the basis for new business, trade, logistics, production model development, changing the format of health care, education, communication between people, public administration; thereby, set up a new paradigm for the state and its economic development.

In order to develop a clearly phased strategy for digital economy creation, search for the best mechanisms for the set task and overcome previous mistakes, it seems very relevant to study the experience of computer technology introduction in our country. In this regard, the problem of information technology role determination in the transformation process observed across the world at the turn of the century, and the problem of state policy evolution in this area require a separate and a more detailed study.

LITERATURE REVIEW

Digital economy is a relatively new concept that is expanding with the development of information technology in developing societies. The digital economy, which is sometimes called the Internet economy, the new economy, or the network economy, is an economy based on digital technologies, including digital communication networks (the Internet and other value-added networks), computers, software and other information technologies. The digital economy is a global network of economics and social activities that can be accessed through information and communication technologies such as the Internet, mobile, and other networks. In this new economy, digitalization and communication infrastructure provide a global context in which individuals and organizations interact with each other by communicating, collaborating and searching information. This platform includes the following: a wide range of digital convertible products, databases, news and information, books and magazines, radio and television programs, movies, electronic games, music CDs and software's. Digital platform is available and delivered at anytime and anywhere around the world, consumers and companies pay for digital financial transactions. Financial transactions are carried out through digital money, either through networked computers or mobile devices, and physical goods such as home appliances and cars equipped with microprocessors and network facilities (Velikhov et al., 2009).

Symbols of the digital economy utilize media such as computers, mobile phones, communication equipment and tools such as console services in activities such as sending messages to friends and organizations, searching for a service in the city, using a router in the car for routing, purchasing and paying, exchanging goods or services, receiving services from organizations and so on. Organizations adopt digital economy for providing better services for their suppliers and customers and to work more efficiently in a collaborative manner. Also, the use of information technology in the value chain for change and innovation in processes, operations and administrative and executive activities can be a sign of the impact of digital economy. The impact of digital economy on education can be made possible through the use of information technology for providing content, teacher-student relationship, management in the line of education and, training (Bodrova & Kalinov, 2017).

It may hardly be possible to predict the future of digital economy, because it is based on information technology and its innovations and the influence of technology on business proceeds at a high speed. With the unpredictable pace of change and evolution of IT, it is difficult to predict the future. The digital economy needs an infrastructure that is during the first stage the responsibility of the state and later extends through various organizations and sectors of the society. Information and communication technologies have not only transformed an individual's relationship, but has also changed the relationships of business with each other, customer relationship with businesses, customers with the government, government with the government, and dozens of other communication patterns. The way things work, buy and sell, vote, invest, study, play, entertain, finance, interact and live our lives are all changing. Electronic commerce, electronic services, electronic city, e-citizen, e-government, virtual world, and dozens of other terms all see this change in a space wherein information and communications technology is its main actor (Krasnov, 2018; Bagherpour & Shamshiri, 2018).

Governments play an important role in developing a digital economy. Governments facilitate the penetration and expansion of the digital economy through policy-making, by providing the necessary infrastructure, by reducing the gap or inequality in the use of information technology and by designing incentive mechanisms for its development and deployment. So, the main driver of this economy is the Government. With the changing governments, various sectors of the economy, organizations and businesses can take advantage of the measures introduced by the government to recognize their business needs and rely on their own capabilities to provide for their specific needs. The economy will benefit and ultimately, individuals and groups of society will also be able to upgrade their living standards and enjoy life in this social and economic environment through the use of this platform and services (Zhatkin, 2018).

MATERIALS AND METHODS

The study was carried out based on the principles of historicism, objectivity and reliability. The basic theory is the theory of modernization. The features of the Russian model are represented traditionally by borrowing, and catching up, due to external challenges, initiated from above and its fragmented nature. The features of multi-line modernization model include: the recognition of its implementation possibility on its own path, taking into account and on the basis of national peculiarities; the exceptional importance of sociocultural, external, subjective factors and the factor of historical randomness. The authors of this study attempted to consider one of the most important, and still few meaningful, reasons for the inhibition of modernization in the USSR, and then in the Russian Federation. We were able to significantly expand the source base of the study, primarily due to the introduction of unpublished documents of the Russian State Archive of Economics (RSAE), the State Archives of the Russian Federation (SARF), the Archives of the Russian Academy of Sciences (ARAS), the Archives of the State Duma of RF Federal Assembly of the Russian Federation (SD RF FA Archive) in the scientific circulation (Parrot & Leong, 2018).

RESULTS

The study suggests that during the period from 1950 to 1960, the advanced developments made in the field of computer technologies are far ahead of the Western counterparts in terms of performance and fault tolerance. We can be proud of the achievements of the Soviet scientists like S.A. Lebedev - the creator of the first Soviet computer BESM-6; Bazilevsky - the ideological inspirer for the development of the computer Strela - the first industrial computer; I.S. Brooke - the developer of M-1 Automatic digital computer; and many others.

The cold war and the need to implement their own projects in the field of information technology and hardware platforms were the factors that influenced the emergence of a large number of different computers in the early 1950s. Government support, the implementation of national projects and social optimism were the most important factors for the implementation of such developments. This is confirmed by the memories of the academician Moiseev (1917) who stated that “the late 1950s and the early 1960s were a very bright time for our scientific and technical intelligentsia: its energy, its abilities, and skills — all this was needed by the people, the country and the state ... On the contrary, we felt our involvement in the development of the Great State. What can be compared with the feeling of demand and need? Are there any other equivalent incentives for optimism and willingness to work? We had complete freedom and even more - we were fascinated by the competition with the West, and we were not going to lose at all ... In those years, I traveled a lot to foreign countries, read lectures, delivered reports and read them in Russian everywhere - except France, since I spoke French. The audience has always been big and interested. I saw that in the field of science where I worked, we are on par with America at least.” In his memoirs, the academician reminded that a computer, some amazing lamp assembly, was born in the Soviet Union almost simultaneously with its birth in the USA and independently. The need for computing was facilitated, above all, by the needs of the military industry at the brink of the 40s and 50s and when military parity was not achieved with the United States, we have been on par with the West in this area. Moiseev (1917) recalled that at the end of the 50s, when he was touring the computing centers of Western Europe, he did not see anything new. Moreover, he saw that the domestic experts were able to do something more cunning, the algorithms were more advanced and the Soviet experts were more talented. He wrote that in the field of computer mathematics, we competed with the second team of mathematicians and obviously won it.

However, the implementation of the project in several independent areas, focusing on the solution for specific production problems and taking into account the characteristics of a particular industry, led to the use of a sufficiently large number of non-unified computers, the development of software for a specific computer and the impossibility of integrating them. Therefore, during the late 1960s, the leaders of the country made a decision to use IBM 360, an obsolete sample at that time, as the standard for the American counterpart of Soviet computers. The Row Directive did not stimulate its own innovative technologies, but focused only on the adaptation of already existing developments for specific production goals. The production of certain types of domestic computers, such as the Elbrus, lasted until the late 1980s. However, these were single projects. By the mid-1980s several generations of computers changed, but they did not correspond to the Western characteristics, as they were, in fact, the copies of outdated foreign samples. When perestroika was introduced, there was practically no production of personal computers in the USSR. This led to the increase of electronic computer imports (the main component of the modernization), but less than a percentage of total imports was used for these purposes in terms of rubles. On the other hand, 50 to 90% of the petrodollars received by the country were spent on the import purchases of meat, grain, clothing and shoes. Besides, there was a shortage of specialists in such important branches as computer technology, computer science, microprocessor, laser technology, etc. The number of reporting indicators of regional scientific and technical societies (STS) almost never included such an indicator as the production organization improvement and the introduction of computing technology.

Analyzing the effectiveness of Soviet science during the late Soviet period as a whole, Khanin (2010) rated it even lower than the efficiency of an unproductive agricultural industry. There was a very significant lag behind the USA in terms of labor productivity, and investments in R&D (1985: 106.6 billion dollars in the USA and 28.6 billion dollars in the USSR). In fundamental science, this gap was even larger - 7.5 times. During 1981-1985 only 251 licenses were sold annually, and many thousands of licenses were sold in capitalist countries. The number of created machine and equipment types was steadily declining, and the number of ones, which were developed for the first time, grew slightly. However, the researcher believed that during the mid-80s, the country had real opportunities to overcome the stagnation and impending economic crisis.

During the years of perestroika, the Resolution of the Central Committee of the CPSU and the USSR Council of Ministers No. 361 on the improvement of work coordination in the field of computer technology and on its use efficiency increase dated on March 20, 1986 inspired some hopes. It defined the task of computer software creation and improvement, and the introduction of industrial methods for the development, production and supply of these tools as industrial-technical products as the most important tasks of the national economy. However, the production of computing equipment did not become a priority, although the USSR State Committee on Computing Machinery and Informatics were established on the basis of the USSR State Committee on Science and Technology, the USSR State Planning Committee, USSR Gossnab, the ministries and the departments of the USSR. The tasks of this institution were the following: the radical increase of computer equipment technical level; the coordination of work and control over the implementation of decisions of the Party and the Government on the development, production and use of these funds in order to meet the needs of the national economy fully; and the creation of the Department of Informatics, Computers and Automation in the system of the USSR Academy of Sciences to overcome the backlog in this sphere.

In August 1986, a decision was made to create in Odessa, a branch of GKVTI on software issues - the All-Union Intersectoral Research and Development Center for organizing the development, production and use of software (AUISC State Org. Program) with the responsibility of the leading research units concerning the quality and the reliability of computer software. It was also planned to entrust the branch with the production tasks associated with the maintaining of a specialized fund of algorithms and programs (FAP), software evaluation and testing, including the software for mathematical statistics method implementation, which could be followed by industry-specific FAP and software production enterprises. Even before the perestroika, the Decree of the Central Committee of CPSU and the Council of Ministers of the USSR No. 730-232 issued on 29.07.1983 provided for the construction of an enterprise in Brest to aggregate compute ES with a cumulative base. But only in 1987, the object was included in the design plan.

In an interview, Gorshkov, the Chairman of the USSR State Committee on Computer Science and Informatics, established in 1986, tried to explain the reasons for our lag in this area rather accurately. In his opinion, "... Many problems were not solved, but only identified. They did not overcome departmental barriers. They required the organization of powerful experimental production, often interdisciplinary ones, and the creation of entire software industry. Finally, taking into account the widespread use of computers, it was necessary to take care of their users — to open a service center. Gradually it became clear that the task of computerization is comparable with such national task solution, as the creation of the atomic or space industry. And this requires not only the increase of investments in this area of scientific and technological progress, but also new forms of force concentration and cooperation, the creation of a new infrastructure. Besides, the course on IBM was an error; the production and the use of computers has not become massive and effective from an organizational and technical point of view. We believe that if it were not for the obvious miscalculations in the state science and technology policy, if the USSR did not follow the path of copying and would invest more funds in the development and production of the element base, the history of computing technology would be completely different." The attempts made to use the tested way of borrowing and managerial reorganizations to catch up with the United States in the development of computers failed. A number of experts believed that the reason was the economic and the ideological crisis in the USSR, and the emergence of the personal computer concept. The Union's cybernetics was not ready either technically or ideologically for the transition to individual computers.

The American historian of science L. Graham recalls that during the mid and late 1980s there was the most heated debate about computers among the members of the Soviet leadership. One of the leading Soviet scientists in this field, A. Ershov, agreed with him that the desire of the Communist Party to have control over information hampered the development of the computer industry. At the same time, he was convinced that the state would have to allow its citizens to own personal computers, since a time will come soon when any person anywhere in the world will be able to communicate with any other person in the world: "This will be a real revolution - not only for the Soviet Union, but for you too. But here its consequences will be the most significant" (Velikhov et al., 2009). It is hard to disagree with N. N. Moiseyev, who saw the reason for the inhibition and technological lag not in the fact that the country missed the new rise of scientific and technical progress, but in the fundamental inability of the system to accept it. A scientist and an academician, Lavrentiev, along with many others insisted on the need to restore and develop the industry on a new technological basis in the mid 50s. But it was beneficial only to drive the shaft for the departments. Thus, the fate of computer technology use has particularly clearly demonstrated the features and the flaws of the sectoral monopoly system.

On June 28, 1994, S. V. Emelyanov, reporting on the work of the Computer Science, Computer Engineering and Automation Department of the Russian Academy of Sciences, summarized the history of computer technology development in the USSR and cited the decision to transfer a large group of academic institutes to the industry as one of the main reasons of development lag. Thus, the country in which computers were created, at one time not inferior but even superior to the Western ones in some parameters, began to lose its position rapidly. The academician explained that the motivation of scientists who have switched to industry has changed dramatically. Unsupported by in-depth studies, the departments made poor decisions on the development of computer equipment. It became more profitable and easier to deal with unlicensed copying of foreign samples. The visibility of progress was maintained until the reproduction of integrated circuits developed by the Western firms became impossible. A significant step towards the revival of basic research in the field of computer science was made by the leaders of the USSR Academy of Sciences. Due to the efforts of academicians like Velikhov et al. (2009) the first Commission on Computing Engineering, and then the Department of

Informatics, Computing and Automation were established in 1983, which became the center of basic science crystallization in this area as part of the Academy of Sciences.

The documents we studied indicate that a slowdown in the seemingly started modernization processes was marked out quite clearly in 1987. Along with the sharp political discussions of the time, the obvious problems in the field of computer science, computer technology and automation became a subject of wide discussion. It seemed that certain steps were taken: in 1990, the Concept of Informatization of Society was approved by the Commission of the Supreme Soviet of the USSR on problems of transport, communication and informatics; the total volume of domestic computing facility production has grown, reaching 10 billion rubles this year; the park structure and technical and economic characteristics of computer equipment were improved; the nomenclature was expanded; and the parameters of peripheral equipment were improved significantly. However, the lag at the global level was not reduced. This was especially evident in the production and the use of domestic personal computers (PC). According to the estimates of the Institute of Informatics Problems of the USSR Academy of Sciences, the number of imported PCs in the USSR was 380-410 thousand in 1990 alone. The domestic production, underperformed the five-year plans by almost 13% and produced a little over 900 thousand PCs for the entire five-year period. At the same time, domestic production yielded its position to imported PCs in many respects. The rate of lag increased with each month. The development of a super-computer achieved new heights. However, on this occasion the speeches of leading experts from academic and sectoral institutions were filled with an alarm for the fate of domestic developments. The pace of development in this area of computing technology and the size of capital investments were inadequate to the processes occurring in the world.

On the eve of the final collapse of the USSR, scientists tried to save the country's scientific and technological complex in vain, suggesting, among other things, the Chairman of the Interstate Economic Committee (IEC) I. S. Silaev to establish a Committee for Expert Evaluation and Control as an interim measure, which could have the following functions: the coordination and the control of technology spread and scientific and technical product commercialization, according to the type of similar intergovernmental organizations established in the West; the expert evaluation and the preparation of proposals for the observance of sovereign state interests with the participation in international scientific and technical projects; the use of scientific and technological achievements of the West to create their own industries in order to abandon imports; the organization of relevant research; and development protection from their premature disclosure. The academicians like Yu A. Ryzhov and N. P. Laverov thus attempted, first of all, to prevent the export of new technologies from the country, since at that time intermediary commercial structures appeared that claimed exclusive ownership of often the same technologies and developments with a shortage of information about inventions. Scientists were worried about the facilitated access to domestic high technologies, and the desire of intermediary structures to commercialize them.

However, the academicians along with the head of Economic and Legal Regulation Department in respect of Scientific and Technological Progress of the Ministry of Science of Russia, B. D. Yurlov, received a response on March 24, 1992, which contained the refusal to create such a Committee, motivated by the fact that its creation in the Russian Federation would duplicate the functions of existing state bodies, in particular, the Ministry of RF Security, the State Technical Commission under RF President and some other ministries and departments that have already been entrusted with the task of information protection in political, economic, scientific, technical, military and other spheres. The collapse of the USSR led to the interruption of the relationship between computer manufacturers, trapped in different states, and their effective production became impossible. Many developers of domestic computers were forced to work beyond their field of experience, losing their skills and time. The only copy of Elbrus-3 computer developed in Soviet times was twice faster than the Cray Y-MP, the most productive American super machine of that time. In 1994, Elbrus-3 was disassembled and put under a press.

In 1992, listing the achievements of RAS, Osipov (1993) paid a special attention to the fact that in the field of computer technology, based on the ideas of parallel institutions, the use of traditional architectures and new physical principles for the element base development, a large amount of work was carried out to create new generations of domestic supercomputers. The Academy of Sciences experienced an acute need for such machines. But this major problem, he said, turned out to be abandoned, and ownerless, because those ministries that traditionally supported the creation of these systems were destroyed. The Academy of Sciences, of course, was not able to support these works financially. At the same time, they implemented the project of an alternative semiconductor metal nanoelectronics creation in the field of new high technologies, the formation of a new database of computing equipment. In the course of the project, various model nanoelectronics device structures were fabricated, including one-electron, quantum, and interference structures. An electron phase memory effect was found, leading to the superconductivity of normal metals. However, the commissioning of the supercomputer Electronics SS BIS at the Institute of Problems of Cybernetics and the launch of the Elbrus-2 supercomputer at the Collective Computing Center were also delayed.

The crisis of liberal reforms has increased the backlog of Russia in the development of computing technology. In May 1994, the academician Velikhov et al. (2009) named its reasons and recalled that a state program for the development of computer equipment was developed in 1984, but it collapsed because of the crisis and because the concept underlying it was the concept of full budget financing, a complete lack of competition and a decision making based on the struggle of interested groups. Besides, in 1987, imported computers made a break-through in the domestic market. The state and our industry were left behind, which led to huge losses for the economy and the intellectual potential of the industry. The scientists noted that the computer technology market became one of the first markets in our country, but there were no domestic products of this industry. The concept of computing technology development, developed in the mid-80s, was based on the priority solution of defense tasks, and, therefore, it was necessary to rely only on their developments, starting from the element base. But Velikhov et al. (2009) believed that under these conditions, it was necessary to rely on the development of the world element base and components, and focus on the experiences of Japan and Europe, which did not develop their own microprocessors. Therefore, the academician considered it expedient not to develop his own production, but, above all, to support the development and research, and then - and to carry out the preparation for the production of mass technology. The research and development of the scientific and technical program in computer engineering and computer science were to be supported, and the experts were to be trained. Concerning the question about joint venture creation, Velikhov et al. (2009) was forced to answer that foreign firms which were working in Russia at that time mostly thought about their equipment sale, and not about cooperation.

They further added that during the summer of 1994, their country received the equipment, not always the best one, the value of which made 4-5 billion dollars. More than 300 firms selling information services and information products with an extensive dealer and distribution network were represented in the Russian market. The experts in the field of automatic control, the academician of RAS, Saltykov, warned in this regard:

Informational intervention, which was announced by the West in relation to Eastern Europe, and, first of all, Russia, makes us worry that we are not late, do not allow Western firms to start the provision of those services that must be implemented traditionally by the native organizations and individuals (1997: 14).

The academician, A. M. Prokhorov, recalled in this regard that at one time the military industrial complex allocated significant funds to produce fiber for communication. Also, in the mid-80s, fiber communication was created for the missile system and for television. But in the 90s it was decided that they should focus on foreign countries, so a turnkey plant was purchased to produce fiber, although the domestic production of fiber was no worse than abroad. The attempts to establish communications from St. Petersburg to Gatchina using their own forces ended up with nothing — everything sank in the ministries. The first Deputy Chairman of the Committee on Informatization, V. V. Korchagin, pointed to another very important inhibitor: the departure of system programmers who were pulled out through various projects. During a discussion on these problems at a meeting held at the Russian Academy of Sciences Presidium, the academician, Zh. I. Alferov, did not remain indifferent. According to Alferov, who warned, unlike Velikhov et al. (2009), against the dangerous thesis about the uselessness of domestic microelectronics? To a large extent, he paid attention that domestic microelectronics appeared due to scientific research and the research of academic institutions. Agreeing with the allegations that these developments turned out to be in an extremely difficult situation not only because of a lack of funding, but also because of the lack of demand for their domestic industry, at the same time the academician proposed not to rely on numerous Western firms. From his point of view, the whole progress of the 20th century was largely associated with the success of microelectronics. The scientist spoke about a very significant scientific and technological reserve in our country, so he was confident that with the purchase of ready-made schemes, we had to develop domestic microelectronics simultaneously. Without this, the country could not develop high-tech industries. Zh. I. Alferov offered to use the experience of cooperation with South Korean electronics firms in this regard, since domestic developments could receive technological development there and then return to our country. The academician noted that the basis for the development of domestic microelectronics was the work of the Physics Institutes of the Russian Academy of Sciences (Bodrova & Kalinov, 2017; Shirvani et al., 2015).

It seemed that the country had a powerful intellectual potential for the implementation of these tasks. By January 1994, the Department of Informatics, Computer Engineering and Automation of the Russian Academy of Sciences had 30 full members and 56 corresponding members of the Russian Academy of Sciences, and included 24 institutes that employed about 7.0 thousand employees, including 3.8 thousand scientific employees. But just like all the teams of the RAS, the

Department existed in survival mode during the 1990s. We have to admit that the analysis of documents of that time allows us to say that such a definition of the general state of science in the 1990s - the survival - became a universal one and reflected the essence of the ongoing processes very accurately. So, from 1991 to 1993, the financing has decreased several times in absolute terms at the institutes of this department, the amount of financing under the contracts with industry has plummeted. If in 1991 the share of contracts for the institutions of the Branch was 40%, then in 1993 it was reduced to 8%. Young people left and in 1993, the number of institute employees of the Branch Office reduced by about 25%. The costs for the rental increased sharply and the maintenance of buildings led to an inevitable curtailment of programs for institution technical base update, and, consequently, to a decrease in the conducted research effectiveness. Nevertheless, these institutes released 12 scientific journals, including international ones. Significant results were obtained during basic research performance on all the components of mathematical modeling concept: model, algorithm, and program. Within this area, mathematical models and computational algorithms have been developed that allow to perform a computational experiment in areas of most complex technologies that were previously unavailable for modeling. In particular, a set of mathematical models was created to study the new self-regulating neutron-nuclear operation mode of a fast reactor, which significantly increases the safety of the entire cycle of energy production; the models of metal burning in HS furnaces; and the simulation of operating conditions in propulsion systems.

They performed a simulation of the aerodynamic flow around the aircraft and the aerospace vehicle Buran, taking into account the possibility of a major damage to the heat-shielding tile layer. There were also the following achievements: the development of the model for a super-pure single crystal growing in terrestrial industrial plants, the model calculations of target compression and burning processes for laser or ion controlled thermonuclear fusion, the model of an ultra-strong magnetic field and current generators that convert the energy of an explosion, etc. The mass use of mathematical methods by the experts in all the fields of science made the relevant problem of information technology creation for problem solution that do not require computer knowledge and programming skills from the user. For a number of years, works were carried out to create methods for the so-called intellectual task solution. Typical examples of which are decision-making and forecasting problems arising, in particular, in technical diagnostics, non-destructive testing, remote sensing, environmental monitoring, forecasting and diagnostics in medicine, planning, searching, in geology, the forecasting in chemistry and scientific research automation. They performed the development of basic hardware and software complex for data networks with packet switching on a promising element base. They prepared a system project of an inter-regional data transfer network with packet switching. Interested in the regions of Russia, they developed and implemented standard projects of integrated information and telecommunication systems. Similar works were carried out in Pskov, Novgorod and Yaroslavl regions. The institutes of the department obtained significant fundamental and applied results in the field of theoretical foundations and new technologies of the computer element base. According to experts, these results sometimes surpassed the results obtained across the world (Krasnov, 2018; Lobão & Pereira, 2016).

Almost a quarter of the department members were from various industries. Therefore, studies that aimed at the most important problems of national economy and defense were widely represented in their works. In a number of industry organizations, with the direct participation and under the guidance of the department members, unique automated systems were developed and created: the Moscow air defense system; the world-famous mobile anti-aircraft missile system S-300; the global data exchange network of RF armed forces for ensuring the functioning of national strategic systems; the system of operational monitoring and forecasting of motion in the descent area within the atmosphere of the Buran orbital ship; the computer-aided design system of military aircraft (in particular, SU-27 fighter), a unique installation for controlled drilling in any selected direction, and many others. With the direct participation of the leading scientists of the department, a number of state programs were organized in the field of informatics, telecommunications and microelectronics, the purpose of which was to overcome the lag in this strategic direction of science and technology development and the entry of the country into the international system of labor division. However, according to Yemelyanova, if the content of the programs met the requirements of computer science main trend development, their funding was so low that it was simply impossible to talk about any breakthroughs in information technology. So, for the whole program, The Informatization of Russia, in which organizations of the Ministry of Science, the Ministry of Industry, and the State Committee for Information and higher educational institutions took part, 350 million rubles were allocated in 1993, and 127 million rubles were invested during the first quarter of 1994. These funds were not only not enough for the organization of any production, but also did not allow the academic institutions to exist properly (Bodrova et al., 2013; Ardakani et al., 2015).

Meanwhile, one of the claims by the high state officials to Russian science during these years was its redundancy. Saltykov (1997), the former minister of science and technology, recalled the following in an interview with Nezavisimaya Gazeta in 1997: "When we came to power in 1991, we understood very clearly that with all the visible advantages of Soviet science (and they certainly were), its era is over ... We chose a soft version of reform... We made it clear to our scientific community, very indirectly and cautiously, that our scientific field will shrunk inevitably by two or three times... Today, the number of people employed in science has fallen by half and continues to decrease... On the one hand, our science has fallen under the engine of economic reform, but on the other hand, it is very labor-intensive." The Minister of Science and Technology of that period, Bulgak (1997), inclined to see the cause of collapse of science in itself: Indeed, today the number of scientists has decreased as compared to the number before the reformation of the economic structure in the country. But this was not due to someone else's order, but due to the fact that many scientific institutions have ceased to be such, and their employees applied their strengths and abilities in other fields.

DISCUSSION

The analysis of scientific literature suggests that some of the authors, denying the technological lag in the USSR, believed that the Soviet industrial potential and the military industrial complex are so powerful and demonstrate high efficiency in market conditions, which are enough to restore it. On the contrary, a group of authors headed by Velikhov et al. (2009) pointed out the innovation recession observed in the USSR during the mid-80s, and called the underestimation of the strategic role of mass information technologies as one of its main reasons. Information technologies can become an innovation catalyst for science, education and industry, since its structural adjustment was ensured by the leading countries of the world. In the USSR, similar processes were very far from completion.

According to a leading researcher at the Institute of Sociology at RAS, D. D. Raikova, the key idea of the government strategy, i.e. the development of a mobile, dynamically developing scientific and technical potential that meets modern requirements and resource capabilities of the country, was an antinomy: the country's resource capabilities were brought to such a level that the development of scientific and technical potential that meets modern requirements became impossible and all attempts to adjust science to the state financial deficit turned out to be deadly for science, and for the society. At the same time, the researcher wrote in 1998 that the objections to the destructive actions of reformers were interpreted by the authorities as the unwillingness of the scientists to change the state of affairs and as a desire to preserve the outdated forms of scientific community functioning. D. D. Raikova referred to the opinion of authoritative scientists and insisted on the conviction of the majority of the scientific community that reforms are necessary as science could be saved only through a reform carefully developed by specialists. The officials, aiming at the reduction and the elimination of scientific trends, would like to imagine that their ideas looked like the own choice of scientific institutions at the same time. Inconsistent as well as unsystematic actions taken by the governments in the field of state science and technology policy and also in the development of computing technology, led to an unprecedented decline of the authority in the eyes of scientists, destroyed their own production base, slowed down the development, and sometimes led to the elimination of entire scientific fields.

The default of 1998 became a certain milestone. The authorities demonstrated the significance of science awareness for crisis overcoming, further development of the country, and strengthening its national security. The process of computerization and information support for scientific research intensified significantly. High-performance information-computing systems and the network of supercomputer centers for collective use were created, including the Interdepartmental Supercomputer Center that was opened in December 1999. At the meeting 'The State and the Prospects for the Development of Semiconductor Electronics of Russia' (which included major Russian scientists), held on May 20, 2004 with the participation of the interfactional deputy association Science and High Technologies, the Committee on Education and Science and the Committee on Industry, Construction and High-Tech at RF State Duma, Zh. I. Alferov said: "As for the field of technology, we are at the level of the eighties in general nowadays... USA and Canada sell electronic equipment at the amount of $ 1260 per capita, and Russia sells such equipment at the amount of $ 14 per capita... Today, Russian electronics, even in terms of production, makes around 20 -25 percent." According to the scientist, the way out of the current situation is to acquire and build microelectronic enterprises with the most advanced technology on the territory of Russia and to create technology parks based on the existing scientific, technical, personnel and educational potential as the progress mechanism working perfectly in the world practice within the high-tech sector. However, according to the head of CJSC the Research Institute of Materials Science, Yu F. Kozlov, even in the case of turnkey procurement of high-tech enterprises, Russia would have to import almost everything for their functioning (gases, photoresistors, etc.). There was virtually no related production infrastructure for the electronics industry in

Russia, except of a few enterprises whose modern technological equipment required significant financial investments in the range of $ 25-35 million.

CONCLUSION

Thus, the technological lag resulting from, in particular, the obvious strategic miscalculations of the Soviet leaders related to the curtailing of the development and the production of domestic computing technology, can be put among the most significant factors that determined the collapse of the USSR. During the mid-90s, our country was seriously behind in terms of informatization. During that period, the volume of computer equipment production in Russia barely reached 10% when compared to that of the United States. The volume of replicated software continued to decline sharply. The reliability of domestic computing technology was 100-500 times less than the foreign models. In terms of technical and economic indicators, it turned out to be uncompetitive in the Russian market as compared to imports. There was a significant lag in the use of industrial databases and knowledge bases (Zhatkin, 2018). The development of communication networks and data transfer, which serve as the basis for the infrastructure of informatization of the country regions, was sharply behind the needs. During these years, the lag in the equipping of scientific institutions of RAS with computer equipment in comparison with similar institutions in the developed countries of the West only continued to increase. Meanwhile, a scientific support for the informatization process of Russia was a necessary condition for the development and implementation of a unified state scientific and technical policy during the creation of large-scale national and regional information systems, communication systems and data transfer (Laureano et al., 2018). Russia's participation in the international division of labor, and entry into the global information community require the consideration of international standards during the creation of the systems, which needed the academic science support.

Even during the favorable foreign economic conditions of 2000-2008, it was not possible to strengthen the technological base of the country significantly due to the prevailing ideology of systemic market reform. The leading positions in the sectoral structure of Russian exports and foreign investments were occupied by fuel and energy, metallurgy, chemical industry, timber industry, defense industry and nuclear complexes. Analyzing the current situation, experts are confident in one thing: it is impossible to build a long-term strategy for sustainable growth, and a competitive and innovative economic development model based only on the preferential use of natural resources. At present, the country requires the restructuring and the modernization of the industrial potential, the dialogue between the authorities and leading scientists, the training of highly qualified specialists in the field of engineering and technology, and the formation of an innovation-oriented society with spiritual, professional and ideological values, not alien to the Russian mentality. With all the difficulties of the starting conditions, the available resource and human capital gives hope for the possibility of implementation of such plans. Of course, it is impossible to imagine a technological breakthrough, and the overcoming of modernization recession without any phased implementation of digital economy development strategy.

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