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Information Technology Policy in the USSR and Ukraine: Achievements and Failures

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After the end of the Second World War, the government of the USSR started to create a computer industry. This became one of the main tasks of the national economy and computer manufacturers began serial production of electronic tube computers starting in 1953 (the "Strela" computer series, then the M20, BESM2, Ural 1, and Minsk 1). Later, in the early 1960s, semiconductor universal computers (M220. Ural 11, 14, Minsk 22, 32, Razdan 3, Setun, and others) were developed and produced. At the same time, computers for engineering calculations were developed (Promin, MIR1 and MIR2, Nairi), as well as control computers (Dnepr, Dnepr 2, VNIIEM, MPPI, and others). In the 1950s and 1960s, in Moscow, Kyiv, Minsk, and other large cities of the USSR scientific research institutes, plants, and engineering and design companies were founded, and thus began the development and manufacture of first and second generation computers. As a result, all important projects of that time in the field of atomic energy, cosmic investigations, rocketry, and so on, gained the necessary computer support.

In 1967, the Soviet government adopted a decree regarding the future development of the computer industry. The decree covered all problems, from the research and development (R&D) of essential semiconductors and microelectronic circuitry to manufacture of the new generation computers for civil and military applications. According to this decree, computer industry facilities were to be doubled. Thus began the industrial production of the supercomputer BESM6, computers for anti-rocket systems, computers for cosmic space observation systems, rocket-attack warning systems, and onboard military computers for myriad purposes. In the early 1970s, cooperation with the computer industries of Bulgaria, Hungary, Czechoslovakia, and Poland was widened. More than 100 enterprises were involved in computer development and production, with a staff of more than 200,000 scientists, engineers, and 300,000 workers.

Given these advances, by the late 1950s and early 1960s, the Soviet Union had become one of the world leaders of computer industry. The development of computer science and technology in the USSR at that time was going on independently and in parallel with the West. However, at the end of the 1960s, the possibility suddenly loomed for merging the USSR's scientific and industrial potential with that of Western European countries, toward the development and production of fourth generation computers. This was actually a proposal by ICL, the British computer company, and it was supposed that this mutual effort would help Europe outstrip the United States in the field of fourth generation computers. Prominent USSR computer scientists approved this idea, but in 1970, the government of the USSR decided to stop contacts with ICL and to take the American IBM-360 system (without USA permission) as an industry model. It was huge mistake with dramatic consequences. The idea of trans-European cooperation failed. Instead, enormous amounts of money were spent on a computer system based on the IBM-360. This system soon became obsolete and the Soviet Union moved from being a computer leader in the 1950s and 1960s, to being an outsider in the field of computer industry.

The Main Achievements of the First Decades of Soviet Computer Development

One of the authors (Lev Malinovski) had the good fortune to be a witness and a participant in the establishment and development of digital computers in the USSR. He worked together with distinguished scientists in this field, such as S. Lebedev, A. Dorodnitsyn, I. Brook, Y. Bazilevsky, V. Glushkov, B. Rameyev, N. Matuhin, M. Kartsev, I. Akushsky, G. Lopato, M. Sulim, N. Brusentsov, V. Melnikov, V. Burtsev, A. Lyapunov, A. Berg, and others. In the difficult postwar years, the efforts of these people and the scientific teams they supervised catapulted the USSR into a leading position in computer manufacture. This extremely rapid development of computer technology was an extraordinary feat, as were the great achievements in the fields of satellite technology, rocketry, and nuclear fission, of which much already has been spoken and written. Though the computer played an enormous role in carrying out this work, this fact has not received great attention.

Despite terrible human and material losses caused by the Great Patriotic War (the Second World War), the first decades after the war were characterized by enormous energy and great enthusiasm by the Soviet people. In those years, the rate of economic growth in the Soviet Union was more rapid than in any other country, except Japan. It must be noted that the establishment and development of computer technology in the USSR advanced in the postwar years without any contact with scientists from the West. Computer technology in the USSR during this period developed in its own way, due to the outstanding achievements of the top Soviet scientists. Most of them were connected with the creation of the digital electronic computers:

The design of the first computer project, in the USSR. (I.S. Brook, B.I. Rameyev, August, 1948);

Substantiation of the concepts of computer construction, with a stored memory program, independent of the work of John Von Neumann (S.A. Lebedev, October—December, 1948);

Registration of the first patent of a digital computer in the USSR (I. S. Brook and B.I. Rameyev, December, 1948);

First test launching of a prototype of the small electronic computer (MESM) (S.A. Lebedev, November, 1950);

Approval by the State Committee of the MESM—the first computer in the USSR and continental Europe, put into regular operation. (S.A. Lebedev, December, 1951);

Launch into operation of the M-1, the first computer in the Russian Federation (I.S. Brook and N.Y. Matuhin, January, 1952);

Production of the Strela, the first industrial computers in the USSR (U.Y. Bazilevsky and B.I. Rameyev, 1953);

Creation of the most efficient, high-performance computers on the European continent (at the time of their operation), the BESM (S.A. Lebedev. April, 1953), the M20 (M.K. Sulim and V.A. Melnikov, 1958), and the BESM6 (S.A. Lebedev, 1967);

Launch of the SESM into operation — the first matrix-vector processor in the Soviet Union (S.A. Lebedev and Z.L. Rabinovich, January, 1955);

Creation of Ural 11, Ural 14 and Ural 16 — the first family of Soviet hardware and software compatible general-purpose computers (B.I. Rameyev, V.I. Burkov, and A.S. Gorshkov, 1960's);

Development and mass-production of the M3 and Minsk 1 — the first small universal computers made in the USSR (I.S. Brook, N.Y. Matuhin, and G.P. Lopato, 1956—1960);

The creation and industry production of Setun — the first and only trinary computer in the world (N.P. Brusentsov, 1958);

Creation of the first (and possibly the only one in the world) high-performance, specialized computer, using a system of calculation in remainders (I.Y. Akushsky, 1958);

Development of the theory of digital automatons (V.M. Glushkov, 1961);

Implementation of a proposal of the concept of high-level hardware language (V.M. Glushkov and Z.L. Rabinovich, 1966);

Development of the "Promin and MIR" computers—the first computers in the USSR for engineering calculations, forerunners of future personal computers (PC) (V.M. Glushkov and S.B. Pogrebmsky, 1959-1965);

Creation of the first soviet semiconductor control computer, widely known as the "Dnepr" (V.M. Glushkov and B.N. Malinovsky, 1960);

First proposal in the USSR of the idea of a multiprocessor system (S.A. Lebedev, 1956);

Proposal of the concept of brain-like computers (V.M. Glushkov, 1961);

Proposal of the principle of a recursive (non-Neumannian) computer (V.M. Glushkov, V.A. Myasnikov and I.B. Ignatiev, 1974);

Creation of the M10 — the world's first multi-format vector structure computer (M.A. Kartsev, 1974);

Creation of the world's first fully parallel computer system — with paralleling on all four levels: Program, control, data, and transfer units, on an M10 base (M.A. Kartsev, 1970s);

The 5E26 computer — first mobile control multiprocessor complex on integrated circuits, with a performance of 1,5 million operations per second, (S.A. Lebedev and V.C. Burtsev, 1978);

Development of the first Soviet vector-pipeline computet M13 (M.A. Kartsev, 1978).

These are only the main results of the principal scientific schools, supervised by S.A. Lebedev, B.I. Rameyev, I.S. Brook. And V.M. Glushkov, which emerged in the years of the formation of digital computer technology and which fulfilled the development of the basic classes of computers at that time. Simultaneous with the development of computers for computing centers, systems were also designed and developed for defense systems. The Cold War made it necessary to create an effective rocket-attack warning system (SPRN), a system of cosmic space observation and anti-aircraft, anti-rocket systems (the PRO and the PVO). The SPRN computer were developed under the supervision of M.A. Kartsev, the PRO system, under the supervision of S.A. Lebedev and the PVO system by teams supervised by N.A. Matuhin. The inherent secrecy of this work brought a great disconnection among scientists and caused parallelism in research. This tended to blur the objectivity and completeness of Soviet computer history. It is still full of "blank spaces." Quite a number of outstanding scientists and their achievements still have not received their true recognition in the world of computer history and development. We do, however, have profiles of a number of key figures.

S.A. Lebedev was born on November 2, 1902 in the town Nizhniy Novgorod. By the time he was 45 years of age, he was a well-known expert in energy systems. In parallel with American and English scientists at the end of 1940s, he developed the main principles of construction and structure of electronic digital computers. Under his management in 1948—1950, the first stored program computer in Ukraine, Soviet Union, and continental Europe was created. In 1951-1953, this computer (MESM) solved very important problems in thermonuclear engineering, rocketry, space flights, long-distance electrical transmission, and so on. In the next 20 years, (after his move from Kiev to Moscow), he developed fifteen high-performance types of computers, each more productive, reliable, and convenient in operation (BESM, BESM2, BESM4, BESM6, M20, M40, M50, and others). From the early stages of creative activity, Lebedev put forward and subsequently realized the basic ideas for supercomputer construction, that is, parallel computing processes. In the first computers, he used parallel arithmetic units for this purpose, then mainframes and later on, pipeline algorithmic structures, multiprocessing, etc.

All the computers created under Lebedev's supervision (from early models based on electronic tubes to those based on integrated circuits) were manufactured and used in computer centers of large scientific research institutions, as well as antimissile systems of the Soviet Union. Hundreds of highly skilled specialists and engineers gained valuable experience in Lebedev's institute and became famous scientists, chiefs of scientific research centers, and designers of more advanced computers (Academicians Melnikov, Burtsev, Rjabov, Ivannikov, Doctors Sokolov, Tjapkin, and many others). The institute established by Lebedev continued the work of creating modern supercomputers.

Other prominent computer scientists of the same period include Academician Isaak Brook and his famous pupils N. Matuhin and M. Kartsev. Isaak Brook was born in Minsk on the November 8, 1902 (the same year as Lebedev). Like Lebedev, Brook began his career working on problems of energy systems. In 1948, together with B. Rameev, Brook designed the first computer project in the Soviet Union and received the first patent for a computer with a unibus. Under Brook's supervision, the

Ml, the first stored program computer in the Russian Federation was created. The M1 was put into operation in 1952, 2 or 3 months after the launching of the MESM in Kiev. For the first time, it used semiconductor diodes instead of electronic tubes, a two-level address command system and teletype for data output.

Under the direction of Brook and the active participation of Kartsev and Matuhin the M2 (1953) and M3 (1956) were created. The latter became the initial model for a popular family of computers, MINSK (G. Lopato and V. Prjyalkovsky). The first prototype of the M2 computer with comparable performance was manufactured and put into operation a little bit later than BESM. It was under operation at the Institute of Energy for more than 15 years. Matuhin, who was the chief designer of the M3, later became the chief designer of the family of computers and anti-aircraft systems. Under his leadership, ten types of computers for such systems were developed. The first ones used semiconductors, the later ones, integrated circuitry.

The powerful computers M4, M10, and M13, created under Kartsev's supervision, were responsible for multi-computer complexes for outer-space control and for missile-attack warning systems. Although the Mio was slightly slower than the American supercomputer Cray 1, it surpassed the Cray 1 in versatility, by virtue of its architecture: The number of cycles for one operation for Mio was from 0.9 up to 5.3 (for the whole spectrum of operations) while for the Cray 1 it was from 0.7 to 27.6. On the basis of computers developed by Kartsev's Institute, the largest multi-computer complex in the USSR was created. This complex consisted of seventy-six computers which were connected with 10,000 km of information channels, working at uniform algorithm. In the M13 multi-processor system of the fourth generation, an equivalent speed of special purpose system processors was more than 2 billion operations per second.

Kartsev realized the conception of multi-format vector structure and absolutely parallel computing structure that enabled the project to solve complicated tasks requiring super-performance computers. M. Kartsev was also the author of fundamental theoretical works. He wrote four monographs on the fundamentals of computer arithmetic and computer architecture.

It should also be noted that while Lebedev and his Moscow group ensured the development of supercomputers, computer technology of common usage was designed by B.I. Rameev in provincial Penza. Rameev had no possibility to get a higher education because his father was punished by Stalin's regime (later on, he was absolved). Nevertheless, due to his outstanding abilities, Rameev became chief designer of the "Ural" computer family. These computers were inexpensive and widely used at the former Soviet Union's computer centers. Under Rameev's management, a whole family of special purpose computers was developed, as well as about loo peripheral devices. Another key Soviet computer pioneer was U.Y. Basilevsky, the chief designer of the Strela, the first industrial computer, that appeared simultaneously with the IBM 701. Basilevsky worked under the supervision of Rameev at this time. Rameev was also the first in the USSR to formulate the principle of software and hardware compatibility and realized it in the Ural 11, 14, and 16 computers. He formulated this important idea one and a half years before the production of the IBM 360 software and hardware compatible computers.

V.M. Glushkov, of course, deserves to be included in this group of Soviet computer pioneers. He was born on August 24, 1923 in the south of Russia. The name of Glushkov in the history of computer technology was connected first of all with the development of the theory of computer design in his well-known books, *The Theory of Digital Automatons, Introduction to Cybernetics,* and so on. The next very important part of his work in this field during the 1950s and 1960s was his investigation in the field of control computers and computers with "high inner intellect". Under his guidance, a series of specialized computers for engineering calculations, the MIR1. MIR2, and MIR3 were designed and became the forerunners of PCs.

The Kiev Cybernetics Institute was founded and guided by Glushkov. It was at that time one of the most well-known computer institutes of the Soviet Union and very quickly gained international recognition. The top achievement of Glushkov's work was undoubtedly the creation of the ES-1766, a micropipeline supercomputer, which had no analog in the world at the time. In the 1960s and 1970s, the computer industry in the Soviet Union manufactured more than fifteen types of computers, designed at the Institute of Cybernetics (Promin, MIR1, MIR2, MIR3, Dnieper, Dnieper 2, Neva, Iskra 125, Pirs, and others). "The scientific works of Glushkov and the practical results of his research for many years will have an influence on the development of computer science all over the world," H. Zemanek, an eminent computer design scientist from Austria, was quoted as saying.

Besides "classical" computer facilities developed by the scientific schools of Lebedev, Brook, Rameev, and Glushkov, significant contributions were made by N. Brusentsov in 1958, with the "Setun", a computer using a trinary notation system and by I. Akushsky who also in 1958 developed the first and probably the world's only special computer using notation in remainders. There are a number of other designers in the field of universal, onboard computers including V. Polin, Y. Hetagurov, V. Levin, S. Majorov, V. Smolov, A. Larionov, V. Priyalkovsky, B. Kagan, and others, but their description is beyond the scope of this chapter.

Wrong Decisions

The Soviet government allotted significant means for the development of the computer industry. Dozens of plants existed (some of them new and ready to start manufacturing) and several big scientific technical institutes in Moscow, Minsk, Kiev, Leningrad, Penza, and Yerevan already had experience in developing second generation computers. The SR Center of Electronic Computer Technology, SRCECT was established — one of the most powerful scientific organizations in the country. One important detail should also be noted—the official negation of cybernetics (as well as computer technology as a whole) had become a thing of the past. The computerization of the economy, science, and technology was now considered a high-priority task. At the governmental level, a decision was made to create a Unified Computer System (Russian abbreviation — EC), a new generation of computers using integrated circuits.

The creation of a family of computers in the West first took place in the United

States. The American company IBM led the way when it developed the IBM 360 computer systems in 1963—1964. The family consisted of models of various productivity, which were supported by wide array of software. For small models, the operating system DOS 360 was proposed, for large models — the OS 360 operational system was used. The latter operating system was designed because the DOS 360 turned out to be insufficient for large computers. The experience of developing these complex and extensive operating systems (software) showed that they required even more labor consumption (thousands of man-years) than creation of the hardware itself.

Some time later, the British company ICL developed the SYSTEM-4, a family of third generation computers (from the software point of view). Almost simultaneously in West Germany, there appeared an analogous computer family made by the Siemens Company. The first country in Eastern Europe, which started development of a series of compatible computers was the German Democratic Republic, GDR (East Germany) where they managed to copy one of the models of the American IBM 360. The discussion concerning third generation computers, their architecture, and structure started in the USSR in the late 1960s. In that period, the strength of electronic technology specialists of the Academy of Sciences of the USSR (AS USSR) was weakened, if not to say more harshly—undermined. By government decree, initiated by Nikita Khruschev, a series of institutes of the AS USSR were transferred to the industrial ministries. So, the Institute of Precision Mechanics and Computer Technology was transferred to the Ministry of Radio Industry and only nominally belonged to the AS USSR.

The Ural computer designers, together with Glushkov, offered a new development based more completely on Soviet experience, with less consideration of foreign achievements. In October 1967, they wrote to the Ministry of Radio Industry (which had been appointed to manage the EC project).

"The decision to copy models of IBM-360 computers which was proposed by the Commission on Computer Technology on October 26, 1967 should he seriously disputed. The proposal to copy the IBM-360 system is equivalent to planning the manufacturing of 1970's computers using the technical level of the early 1960's. Considering the existing trends of science and technology", it can surely be affirmed that the architecture of the IBM-360 will be obsolete in 1970's. It will not be capable of satisfying requirements and challenges in computer technology... The design teams of Soviet computers have sufficient experience for the development of a series of computers which would correspond to the level of requirements expected in the near future, and thus, it would be a more correct decision to develop the architecture of a unified series of Soviet computers on the basis of experience already accumulated in the country, considering the latest foreign achievements."

The "Ural" designers had solid grounds for such a conclusion. They already had implemented a series of program-compatible computers using semiconductors (Ural 11, Ural 14, and Ural 16). A comparison of the architectural and functional possibilities of the "Urals" with the same parameters of the foreign systems (IBM-360 and SYSTEM-4) showed that the Urals were fully competitive with the foreign models and in some parameters and features, even overtook them (multi-computer systems, communication channels work, etc.). Moreover, in the Penza Scientific-Research Institute development of the multiprocessor computer Ural-25 had just been completed. This system integrated the best features of the Ural 11-Ural 16 series (and its designers were all followers of Rameyev: V. Burkov, A. Gorshkov, and A. Nevsky). Meanwhile, the Ural 21, a computer design project using integrated microchips, was proceeding successfully.

The system possibilities of the Ural family (11—25 series) provided for the creation of a powerful, multi-computer, automated system in which computers were connected with each other through communication channels. Urals from Penza had already been in operation in numerous computer centers, plants, banks, and systems designated for military purposes. Using the semiconductor Urals the multi-computer systems "Bank," and "Builder," special systems for satellite data processing, were created. It was impossible to construct such systems using IBM 360 cluster computers manufactured in that period! Their purpose was mainly batch-information processing in computing centers.

The idea of creating a unified system (EC) of computers received the full support of the Eastern Europe socialist countries. All of them (except the GDR) were against copying the IBM-360. After bilateral negotiations in August 1968, the multilateral document "General Technical Principles of the Creation of EC Computers" was signed (and approved by all delegations, except the GDR), in which the following opinion on all the major questions was formulated:

"The structure of the EC computer should be analogous to the structure of modern systems, like IBM-360, Siemens-4004, SYSTEM-4. During the development process, it should be possible to change the structure in order to take advantage of the latest achievements in computer technology or inventions defended by patents, on the condition of preserving the established project development periods and the guarantee of an accepted degree of software and technical economical features."

During further multilateral talks, an index of nonprivileged instructions for the EC computer that matched the instruction lists of the IBM 360, Siemens 4004, and SYSTEM-4 was unanimously adopted. The problem of privileged instructions was discussed several times, but no decision was made. The GDR specialists who insisted on duplicating the IBM 360 suggested using the IBM 360's list of official instructions. Other delegations did not agree with diem. When a special joint meeting in November 1968 dedicated to selection of logical structure of EC computer had not brought any positive solution, the problem was passed to a Council of Chief Constructors.

The Soviet approach of development of computer technology never denied wide international cooperation. On the contrary, its adherents, S. Lebedev, B. Rameyev, and M. Sulim, quite understood the advantage of cooperation with Western Europe companies. Western European firms, manufacturers of computer technology who wanted to compete with IBM, and who understood the huge scientific and industrial potential of the Soviet Union, and also the unquenchable demand for computers in the USSR and Eastern Europe countries, were the first to make concrete steps in the establishment of cooperation with Soviet Union in the field of computer creation and manufacturing. The initiator was ICL, the largest British firm which had at that time developed the SYSTEM-4 computer family, in no way inferior to the IBM 360.

Rameyev was an active supporter and participant of these negotiations. He signed a series of bilateral protocols on cooperation with ICL. He hoped that, in close cooperation with ICL (in accordance with the signed protocols), SYSTEM-4 could be copied by one or two engineering and construction bureaus, while the basic potential of the Scientific Research Institutes (SRIs) and construction bureaus could be directed towards creation of a more perfect series of machines using the already accumulated experience and the most recent foreign achievements. In a word, there was every reason to expect that the 1970s would bring great success.

But how did events actually unfold? In the selection of a prototype for a unified EC system computer, the leading specialists of the country, Lebedev, Rameyev, Glushkov, Dorodnitsyn, and Sulim were vanquished, and their opponents won out. Why? This problem was not given proper attention 111 the mass media, though up to the present day, it is under dispute. Archival material and the stories of participants in the discussion (Rameyev, Sulim, and Dorodnitsyn) allowed the author to reconstruct the events.

The efforts of designers to use foreign experience, software first of all, was certainly correct. It was quite natural at that time to get interested in the two systems that had already been created: The IBM 360 and ICL's SYSTEM-4. In order to duplicate the software successfully it was necessary to establish at least four conditions. First, to obtain the full software documentation of the prototype system, which should be enough for manufacturing, support, and operation of the software. Second, to establish contact with the firm who will provide maintenance of the transmitted information and rendering of assistance in the use of this information. Third, to ensure that the information for prototype system be sufficient for the guarantee of software compatibility and functioning of the EC computer and the prototype system. Finally, to ensure that prototype computers be fully equipped with reliable software to be reproduced and have the designers of software at their disposal.

The use of the IBM 360 as a prototype model did not match with the above conditions. The IBM company had no intentions of cooperating with Soviet Union in that period. There was an embargo on exports of US computers to our country. The documentation for the IBM 360 software, available in the Soviet Union, was not complete because it was not delivered to the country from IBM. The purchase of actual IBM-360 computers was possible only through intermediaries, which caused a lot of problems.

The contacts with the English firm ICL were quite different, thanks to the efforts of M. Sulim, Y. Gvishiani (Deputy Chairman of the State Committee of Science and Technology (SCST) in the Cabinet of Ministers of the USSR) and other supporters of cooperation with foreign companies. In accordance with a memorandum from April 26, 1968 signed by the manager of ICL and Chairman of the SCST, on the initiative of the firm the negotiations were organized for scientific—technical cooperation in the area of computer software.

The ICL company agreed with the Soviet side to share detailed information on SYSTEM-4's software and to allot their specialists for the rendering of assistance in the use of this information, under condition that the indicated information should be used for development, production, and accompanying software support of these third generation computers. During the negotiations, the participants, among whom were Sulim, Rameyev, and others from the USSR and representatives of ICL, emphasized that they were ready for mutual development of new generation computer technology. They proposed that, for the sake of creating competition with IBM from European countries, ICL and the Soviet Union could spend significant amounts of money for the development of mutual work.

In April 1969, the Council of Chief Designers, headed by the director of the SRCECT Krutovsky, in spite of the objections of country-participants—Bulgaria, Poland, Hungary, and Czechoslovakia—came to the following decision: For the design of the EC computer. They were to provide compatibility between the logic structures and instructions systems of the EC and IBM-360 computers. This decision was motivated by the work already begun between the SRCECT and its main partner—the GDR, which was already investigating the IBM-360 system and objected vehemently against any another orientation. The main argument was that the same position was supported by Minister Kalmikov and the President of AS USSR Academician Keldish.

So, it happened that the highest leaders had fallen under the hypnotic influence of the proposal to avoid software development. The supporters of the IBM approach said that IBM had the world's richest and most popular software library which could not be rejected by even fourth generation computers, and if we copied machines of this series, then we could use these programs, so as to gain time and money. A few months later, the Ministry Board finally approved the decision, in favor of the IBM-360 system. The scientifically substantiated solution to this important problem — of what was to be the basis of the EC computer — was nullified by the administration's order to copy the IBM 360 system. The management of Radio Industry Ministry, AS USSR, and managers of SRCECT did not take into account the opinion of leading scientists of the USSR and other socialists countries. The negative (or to be more exact—tragic) consequences of the adopted decision on Soviet computing technology would eventually be confirmed. Despite huge labor efforts, when it was eventually produced, the EC computer system appeared to be obsolete and noneffective.

In the 1970s, the government authorities made yet another unreasonable decision—the so-called "splitting" of the computer industry into three pieces: The microelectronic industry (Ministry of Electronic Industry, MEP), universal computers (Ministry of Radio Industry, MRP), and control computers (Ministry of Instrument Building, Automation and Control systems — the Ministry of PSA and SU). As a result, each of the ministries separately began development of a whole range of computers without coordination between the various projects. MRP and Ministry of

PSA and SU, where the best specialists were gathered, actually lost their access to an advanced microelectronic base, and therefore, their developments were destined to failure. Furthermore, MEP had no desire to cooperate with the other ministries. Having a huge microelectronic base, but lacking the trained personnel in computer construction, they simply decided to duplicate the designs of American computer firms, which caused many years lagging behind the world level. The last reason for the decline of Soviet computer technology was an underestimation of the value of the connection between academic science and the computer industry. This hindered the realization of advanced scientific results which, as a rule, come only from great efforts made over time.[1]

Post Soviet IT Policy: Developments in Ukraine

Following the break up of the Soviet Union the many newly formed ex-Soviet countries have had to organize their economic, scientific, and technological policies and strategies in a newly independent way. From the outset, many were optimistic that this would mean radical switch to more market-oriented activity, with consequent rapid advance. Ex-Soviet countries were, however, faced with a range of problems or opportunities, reflecting the legacy of the Soviet period and the assets available in terms of modernization. Ukraine, a very interesting case in this respect. The country was the site of dense IT industry activity throughout the Soviet years, much of which was linked to the military sector. Fundamental studies in the computer sciences were carried out in a number of Scientific Institutes of the Ukrainian Academy of Sciences, as well as in many educational institutions. Important fundamental research was also completed in special industrial scientific research institutions. In addition, a large-scale industry for serial computer production was established and the training of computer specialists was organized. So, the contribution of Ukraine in the establishment and development of the computer industry in the former USSR is hard to overestimate.

However, these Ukrainian achievements, as well as, a great deal of outstanding research by Ukrainian scientists was regarded as secret in the "cold war" years and thus, only some specialists were aware of it. Worth mentioning here is the outstanding achievement of the famous Ukrainian physicist. Academician Vadim E. Lashkarev, who in 1941 discovered the so called p-n junction in semiconductors, the physical phenomenon which became the basis for the further creation of the transistor — a basic computer element. Fifty years ago — in October 1948, under the supervision of Academician Lebedev the development of a Small Electronic Computer (MESM) was initiated. Independent of western scientists he worked out the basic principles of electronic computer design. For the next three decades the main contribution to computer science and technology was made by the world-known scientist Academician Victor M. Glushkov, founder of Cybernetics in Ukraine and the Institute of Cybernetics of the National Academy of Sciences of Ukraine. The Institute carried out a whole series of important applied R&D of new computers for control systems in technological processes — power generation, control of military installations,

[1] Materia] for the preceding section of this chapter is based on B.Malinovski, "The History of Soviet Computer Technology in Personalities" Kyiv 1995, currently available in Russian only.

automatic control of scientific experiments, etc.

More than one-third of all serially produced computers in the Soviet Union were developed in the Institute of Cybernetics of Ukraine. Since the 1960s, the design and serial production of computers for control of technological processes and power generating plants have been implemented at the Severodonetsk '"Impulse" Scientific Production Complex. Most of the USSR's industrial control systems were developed with "Impulse" participation.

Much less well-known, or completely unknown, was the work on computer development for military applications, for example, a whole family of unique computer radioelectromc and hydro-acoustic systems providing a high technical level of navigation devices, the target designation, and control of ships and submarines, including nuclear vessels of the USSR Navy. This work was undertaken at the Kiev "KVANT" Scientific-Production Amalgamation and Kiev "Hydropribor" Scientific Research Institute. Close cooperation of the Kharkov "Hartron," Scientific-Production Complex, the "Kiev Radio Plant" Production Complex, and the Dnepropetrovsk "Uzhny Machine Building Plant," led to the serial production of four generations of complex rocket guidance systems with on-board computers, that strengthened the military might of the Soviet Union and guaranteed strategic parity with the United States.

During the 1960s and 1970s, the Kiev "Krystal" Scientific Production Complex developed and manufactured for the first time in Europe, large integrated circuits for calculators and other technical devices, using digital elements. Ukrainian plants produced about one half of all semiconductor products of the USSR. The Kiev "Electromnash" Production Complex, together with the Severodonetsk Plant, were the first enterprises to organize full-scale production of control computers for all of the Soviet Union. Ukraine fully satisfied its own needs in terms of computer and microelectronic specialists and even helped other republics of the Soviet Union, as well as many foreign countries, to train qualified specialist. Departments and faculties of cybernetics were founded at the Kiev Polytechnical University, Kiev State University, and others institutions.

After the collapse of the Soviet Union, the newly independent Ukraine inherited not only the Soviet's network of huge scientific and research institutions, for the most part connected with the Military—Industrial Complex, but a host of problems with their financing and conversion. At present, Ukraine faces a challenge: How to carry out the technological re-equipment in practically all branches of industry, while at the same time improving their productivity by means of efficient management systems. The scale of this task is comparable to the rebirth of the Ukrainian economy after the terrible devastation of the Second World War.

If one considers the rates of technical re-equipment of different branches of Ukrainian industry, real progress is evident in only one area. This is the sphere of information technology (IT), but this is based nowadays mostly on foreign hardware and software. Annually, Ukraine buys hundreds of thousands of PCs, work-stations, and network equipment. The Ukrainian computer market, according to data of the Institute of Cybernetics of the National Academy of Sciences, engages about 1500—1800 commercial companies, about half of which operate in Kiev. Practically, all of them are dealers, resellers, or distributors of various foreign companies.

About 300 companies deal with software. Seventy percent of these are concentrated in Kiev. Only one-third of these companies develop commercial software, the rest are engaged in distribution and system integration. About 133 companies, controlling over 80 percent of this sector of the economy, are included in the 1999 reference book "Who's Who in the Ukrainian Information Technology Market." In 1998, about 200,000 PCs were sold in Ukraine, 75 percent of which were assembled locally. However, domestic enterprises are involved only with final assembly and control of imported units and practically all modern IT is based on these computers. So, it is evident that Ukraine has the essential resources for the rebirth of the national computer industry. Yet, in 1998, only three enterprises were dealing with domestic computer production, namely: "Electronmash" (Kiev), "Impulse" (Severodonetsk), and "Magnit" (Kaniv), which produced only about 1000 computers.

The main economic and technical factors which have resulted in the present state of computer and IT in Ukraine, are as follows. First, isolation from the world labor market in the sphere of computer and IT. Second, weak inter-branch communication and overcentralization of the National Economy. Third, lack of interest among enterprises in working directly with customers. Fourth, disorganization of the computer industry forced by the disintegration of the Soviet Union. Finally, the uncontrolled influx of foreign computer companies into the domestic market.

To solve the problems of coordination in the IT sphere, and particularly, to establish analytic information systems for the state bodies, the President of Ukraine founded the National Agency on Informatization. World experience has already demonstrated the great potential in using IT for solving socioeconomic problems, which would suggest Ukraine undertake adequate steps on a nation-wide scale, to form and implement both unified state policy and strategy on information services for the establishment and usage of a national information infrastructure in the interests of every citizen, society, group, and company in Ukraine.

The main declared tasks of the state information policy are[2] to increase considerably the level of adequacy, efficiency, and accessibility of various information data for every Ukrainian citizen; to improve the provision of the state control system with informational data; to improve the information-marketing supply of economic entities of all forms of property; to use comprehensively the IT systems and networks for a full-scale solution of social and humanitarian problems, improvement of the educational system, healthcare, as well as the development of science, culture, and art; to intensify the international information exchange for the sake of development of political, economic, social, and humanitarian relations; and to provide an adequate level of information safety and information protection.

To implement these tasks the state policy on information based on the following principles. First, legal conformity of interests, rights, and obligations, and

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[2] A.Matov, "The Problems and Possibilities of Ukrainian Integration into the Global Information Community." Proceedings of The International Symposium "Computers in Europe. Past, Present and Future." Kiev. October 1998: 316-324.

observation of the constitutional rights and freedoms of each citizen in the information sphere. Second, the compliance of the National Legislation with International Regulations. When observing these principles, it is necessary that the normative and legal regulations on information infrastructure, technologies, means, and system development be directed to solve the following tasks. First to attract private investments in development of IT, equipment, systems, networks, etc. Second, to encourage competition in information services, as well as to ensure free access to the IT market, based on the principles of justice, mutual advantage, and parity in relations between economic entities of different forms of property. Finally, to ensure a permanent international exchange of opinions and information with the National Regulatory Body on development and introduction of proper regulations to support IT, equipment, systems networks, etc.

A great number of Legislative Acts have been adopted to regulate activity in the IT field. Under the leadership of the National Agency on Informatization, a National program of informatization was worked out and adopted by the Verkhovna Rada (high ruling body) of Ukraine. The concept "informatization" was considered m a wide sense as one of the directions of economic restructuring, with the goal of development, implementation, and wide-scale usage of ITs, systems and networks to solve state political and social-economic problems. Macro-effects of such innovations, on the basis of world experience, are very important, and include, in particular, the increase of the general technical level in the sphere of import-export, acceleration of innovative processes, changes of employment structure, etc. The National program is a unified multi-project, which unites ten basic directions in informatization on the basis of a common state policy. This program is intended to solve the following main tasks: To establish legal, organizational, scientific — technical, economic, financial, methodic, and humanitarian conditions for information development; to implement and develop modern IT in the various spheres of social life; to form a system of national information resources; to create a State information support network for science, education, culture, and health protection; to create State systems of information and analytic support for state, regional, and local bodies; to form and support the market for IT products and services; and to integrate Ukraine into the World Information Community.

Technological and communication structures are peculiar to any society and culture. But the level of its development is based on the community support of its own intellectual potential. It is not an abstract notion. It is derived from placing a high value on qualifications, skills, creative and intellectual work, as well as respecting a high moral character in a person, creating possibilities for personal self-improvement, as well as for enrichment of spiritual life, and establishment of conditions tor mutual professional and personal contacts. Hence one of the most important task of the state policy and the National program for informatization of Ukraine is to ensure the realization in practice of the constitutional right of every citizen to search, receive, transfer, create, and distribute information in any legal way.

It is impossible to solve this task without an adequate level of information and analytical supply in relation to the bodies of state control. At the same time, the existing IT infrastructure of the State control bodies does not fully meet these modern requirements. Information has achieved the status as the most important factor of state government, which ensures the formation and implementation of strategic decisions at the proper level. Persons, authorized to make important decisions, can nearly drown in the data flow, on one hand, and badly require informational data depicting adequate situations and development of social economic, and political processes in the country, on the other. There are several reasons explaining this state of affairs. Different information systems and networks have been developed in Ukraine independently, practically without any coordination between them. When developing these systems, the main attention was focused on information transfer, while questions of the rational organization of data flow, the development of informational support for the processes of decisionmaking, etc. were ignored. Data storage, formation, analysis, and output, show the effects of past periods. Insufficient attention was paid to the operative data processing and strategic forecasts, revealing drawbacks of the approved decisions, when implementing them. That is why the National program of informatization has formed a strategically important task to establish an information-analytic system for the bodies of state control.

In this period of social and economic development, the future of Ukraine greatly depends on the resoluteness of the people and all bodies of state control to implement the strategic target of introducing our country to the world economic community, as a developed country, contributing much of its intellectual labor to the national Gross Domestic Product. There is a great potential to achieve this task: Sufficient scientific potential, qualified personnel, great experience, and world-class level of design and production of numerous products in aviation, space, machine-building, military, and other technologies. However, it is necessary to maintain certain conditions to achieve such a strategic aim. One of the main tasks is to achieve a world level of informatization of society, mainly to increase the authenticity and effectiveness of decisions, which are made on different levels.

Modern IT has made countries more open, and the existence of global information systems allows for the provision of information services, practically independent of state borders. For many countries, including Ukraine, the real opportunity gradually appears to be reaching the updated levels of IT requirements. Taking into account the great know-how and potential of Ukrainian IT engineers and researchers, the most important directions for Ukrainian integration into the world IT community might be: Software design; the application of PC's into different technological projects; hardware design of data — signal processing and control systems; joint projects with IT specialists worldwide; and improvement of information flow in IT designs.

IT Policy in the USSR and Ukraine

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