Holland, Editor

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EDITED BY WADE B. HOLLAND

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A REPORT PREPARED FOR UNITED STATES AIR FORCE PROJECT RAND

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SOVIET CYBERNETICS REVIEW is published by The RAND Corporation as part of a program of research in the computer and system sciences. Its purpose is to disseminate to a wide range of specialists information about Soviet publications, activities, and new developments in computing technology, cybernetics, and scientific policy. *SCR* is issued monthly by RAND's Computer Sciences and System Sciences Departments.

New SCR Dating System

This issue of *Soviet Cybernetics Review* begins Volume 4. Because of a change in the dating and issue numbering system, it follows the issue of November 1969, Vol. 3, No. 11. So that there will not appear to be a break in the holdings, the forthcoming 1969 Annual Index issue will be called Vol. 3, No. 12.

Our new typographical format, introduced in the present issue, permits a significant reduction in the number of pages without any decrease in the volume of material contained in each issue. The same phototypesetting process that has been used for the past year in the Press Review section is now being applied to the full contents.

Issues prior to June 1969 (through Vol. 3, No. 5) were published under the name *Soviet Cybernetics: Recent News Items*. Text references to past issues are made in the form "*SCR*/69/6" (or "*SC:RNI*/69/5"), where the first set of numerals refers to the year and the final set to the issue number.

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HIGHLIGHTS

The Ukrainian Institute of Cybernetics has announced the **Mir-2 computer,** the follow-on to Viktor Glushkov's successful Mir-1. The Mir-2 is the **first Soviet computer** known to have a **CRT terminal and light pen** input device as part of the standard configuration (p. 3). A CRT input-/output unit, also with a light pen attachment, has been announced by the **Kiev Institute of Automation** (pictured, p. 4).

The **special feature** of this issue of *SCR* is a **historical survey** of Soviet computers, including **photographs** of nearly all known computers in operation today (p. 6). Each machine is described in the context of its place of design. Two charts summarize operational characteristics of major machines and depict the various development streams on a time-line.

The awarding of **State Prizes** in Science and Technology saw three groups of computer designers and manufacturers honored (p. 46). The Institute of Precise Mechanics and Computer Engineering, under S. A. Lebedev, and the Moscow Calculating Machines Plant received a State Prize for the design and manufacture of the **BESM-6 computer.**

State Prizes were also awarded for the design of the **UM-1-NKh** small process control computer, and for the development of **automation systems** for use in the **petroleum industry** of Azerbaijan.

Automation and mechanization at the **State Bank** of the USSR are detailed in an article that covers the development of mechanized procedures for handling banking transactions, the current status of automation, and plans for **increased use of computers** (p. 50).

Articles on computer hardware concern a study of the **reliability of the BESM-2** computer (p. 48); and the new **STEM** special-purpose computer for solving production engineering problems (p. 55).

Production automation is considered from the Party viewpoint (p. 59), while K. Rudnev, the USSR Minister of Instrument Construction, Means of Automation, and Control Systems, comments on the need for a **scientific basis of management** and the achievements of his ministry in this direction (p. 61). Along the same lines, a specialist at an economic-mathematics research institute briefly identifies problems of automating **design evaluation** procedures (p. 62).

An **automated system for plan evaluation** (ASPR) has received considerable attention lately in the Soviet literature. A report from a meeting of the Academy of Sciences' Scientific Council on the development of ASPR reveals the progress made and the assignment of **responsibilities** for further work (p. 63).

Two articles in the "software" category briefly describe the **VASSAL language** (p. 57), and the **Emik program** for research in **artificial intelligence** areas (p. 64). The first of these two articles is of special interest because of the possibility that it is authored by William H. Martin, the NSA employee who **defected** to the Soviet Union in 1960.

A. Dorodnitsyn, Director of the Computer Center of the USSR Academy of Sciences, addresses the issue of **man vs. machine,** supplying a **negative answer** to the question of whether machines will become man's enemy (p. 67).

The future of industrial production in an era of **large-scale automation** is predicted by two scientists, who direct their comments at the **year 2000.** They foresee an important role for computers (p. 68).

Continued Soviet reticence to fully face the problem of technology-induced **unemployment** is revealed by a superficial article citing a particular example of how replaced workers were **absorbed** elsewhere in a small-car manufacturing plant. It comments on the situation in the West (p. 70).

An article on economic cybernetics in **Romania** reports on a conference held last year devoted to problems of **economic computations** (p. 71).

Other articles in this issue summarize achievements of the USSR Academy of Sciences in **the technical and mathematical sciences** in 1968 (p. 56); the use of computers in **criminology and police science** (p. 58); and the use of computers in the **fishing industry** (p. 65).

A new department introduced in this issue is the **"Who's Who"** section, containing photographs and thumbnail sketches of prominent Soviet cyberneticists (p. 73).

Erratum: A report in *SCR*/69/9, p. 43, stated that the "first Nairi was built with tubes and the second with semiconductor elements." Although an accurate translation of the original article, the statement is clearly in error with respect to Nairi-1. Both the Nairi-1 and Nairi-2 are transistorized, outgrowths of the Razdan design effort in Armenia; the Razdan was the first transistorized computer in the Soviet Union.—WH

BRIEF ITEMS

ROLE OF THE COMMAND-COMPUTING COMPLEX IN SPACE EXPLORATION. Although autonomous flight control of a spaceship is possible without the intervention of ground facilities, a more efficient method uses a combination of ground commands and on-board computing devices. The command-computing complex includes all facilities and services used to control spaceships. These facilities make up a general coordinated control system which is distributed among various regions of the country and the world. In addition, scientific research vessels and airplanes are often linked with command-computing stations. Along with other equipment, the stations use high-speed computers, instruments for automatic input of trajectory measurements, automatic data processing systems, and receiving, recording, and transmitting equipment. Further exploration of space will require optimal distribution of functions between on-board systems and ground facilities, as well as further development and automation of the complex.
(From the article "Navigation in Space," in the newspaper *Pravda*, November 3, 1969, p. 2 [File No. 2599].)

AUTOMATION IN SPACE. Several questions asked of Soviet cosmonauts during a recent press conference dealt with automation. One of the questions was whether the cosmonauts used an autonomous computer during manual operations of their ships. Cosmonaut G. S. Shonin answered in the negative. He noted that such computers are needed primarily for autonomous navigation and for calculating the craft's movement. The next question was directed to Academician M. V. Keldysh: "Automatic equipment occupies a large area of the spacecraft. Is not the active, conscious activity of man in space minimized by computers?" In his reply, Keldysh stressed that, as on earth, automation increases, not decreases, man's activity, freeing him from those duties which do not require creative intellect.
(From the article "Kosmonavty i uchenye otvechayut na voprosy," in the newspaper *Krasnaya zvezda*, November 6, 1969, p. 5 [File No. 2596].)

M-1000 USED IN PRODUCTION PROCESS CONTROL. The latest model of the M-1000 computer is designed for running and gauging one or several continuous production processes. As an integrated part of an aggregated computation system, the machine may be successfully applied to the production of sugar, ammonia, cement, and can be used in mechanical engineering. The machine has a specialized computing section—i.e., its CPU is not general-purpose in nature, but performs a certain range of operations (up to 16 commands). With the aid of peripheral devices, this model may carry out up to 90 commands for performing arithmetical, logical, and control operations. As many as 256 peripheral devices may be linked to the machine, increasing memory to 32,000 32-bit words. The M-1000 has an operating rate of 20,000 opns/sec, and is capable of receiving information directly, from transducers positioned on production lines, as well as from papertape and punchcards. The results of information processing can be seen on plotted diagrams and on tables, as well as in printed form. Although it is part of a modular, hierarchical system of computers, the M-1000 can serve as an independent channel, and is therefore also capable of computing and controlling any single given process.
(From the article "Electronic Operator," in the Novosti Press Agency's *Science and Engineering Newsletter*, No. 41, October 17, 1969 [File No. 2586].)

"COMPUTER OF THE FUTURE" STUDY COMMISSIONED. The State Committee on Science and Technology has commissioned the Institute on the Theory of Scientific Organization of the Ukrainian SSR Academy of Sciences (in collaboration with a group of cyberneticians) to make an elaborate study of computer development and forecast the computer of the future. According to the Institute's Director, Professor G. M. Dobrov, a truly scientific forecast of future computer generations must include probable estimates of the time when certain events and developments may be expected, as well as estimates of the kind and extent of resources which may be required. The forecast will also consider organizational factors involved in computer development (optimal distribution of the research effort; feasibility of skipping intermediary steps and avoiding duplication; attaining optimal hardware usage through modular design, use of computer systems, improvement of the computer center network, etc.). A strategy for reaching the highest possible state of the art in this field will be determined on the basis of all data gathered in the study.
(From the article "Science and the Tempo of the Century," Joint Publications Research Service, JPRS 48922, September 29, 1969, pp. 4-5; translated from the German-language journal *Horizont*, East Berlin, No. 33, August 1969, pp. 8-9 [File No. 2619].)

TsEMI CRITICIZED. A report at the Annual Conference of the Economics Department of the USSR Academy of Sciences mentioned that quantitative analysis with the aid of economic-mathematical methods is completely inadequate at the institutes of the Department. This is the fault of the economic institutes and also of the Central Economic-Mathematics Institute (TsEMI), according to the Department's Academic Secretary, T. S. Khachaturov. TsEMI should assist all institutes encountering problems in applying economic-mathematical methods, since these methods are not the monopoly of any one institute. The report urged more efficient use of ma-
(continued on page 83)

Glushkov Announces Mir-2 with Light Pen Terminal

State testing of the new Mir-2 computer has been successfully completed at the Institute of Cybernetics of the Ukrainian Academy of Sciences. Pravda correspondent, O. Gusev, met with Academician V. M. Glushkov, Hero of Socialist Labor and the director of the Mir-2 project, and asked several questions.

Gusev: What new cybernetic concepts have been realized in the Mir-2 computer?

Glushkov: The concepts which have been realized in the Mir-1 computer are further developed in this machine. Incidentally, these concepts (interpretation of complex algorithmic programming languages) are just beginning to appear in foreign technology. The "language" of the majority of computers is sufficiently simple, but in assigning a task to the computer, it is necessary to describe the problem in minutest detail, or, so to speak, to construct a large house from very small bricks. Therefore, it was necessary to accelerate the programming process by using a language closely resembling the natural language of the mathematician, engineer, or technologist.

In the Mir series, we have developed interpreter concepts in which the "external" algorithmic language almost completely corresponds to the "internal" language of the computer and the need for translation is eliminated. The computer is in command of a higher level of "intellect."

Another very interesting and important concept pertains to the step-by-step organization of microprogram control which has been realized in the Mir-2 computer. I will explain this by the following example. In storing complex systems in machine memory, we invariably repeat individual elements—specific letters, elementary mathematical operations. By arranging the "total space" of the program in levels (placing the simplest but most frequently encountered elements in the lowest level, and the more complex elements in the higher level), we obtain a so-called pyramid, whose vertex includes the larger blocks —i.e., those elements which are singularly encountered in program construction. This innovation introduces a higher level of "intellectuality" in the smaller memory of the Mir-2 computer.

Gusev: What new tasks can the computer perform?

Glushkov: The scientists of our institute were especially interested in the solution of mathematical problems using analytical, rather than numerical methods. This was due to the fact that, first, regular computers are poorly adapted for this purpose, and second, scientific workers and engineers have a great need for this type of automated computation. Our new machine, the unique "electronic engineer," will serve as an instrument to accelerate this work.

Programming on the Mir-2 computer is simpler for two reasons: (1) the machine language is simple to use in operations with formulas; (2) larger blocks, mentioned above, are introduced into the machine language. For example, the mathematical operation "open parenthesis" is preset in the machine in the form of a block and does not have to be programmed separately. It is possible to correct the computer at any given moment.

Gusev: The computer has a TV screen. What is the purpose of that?

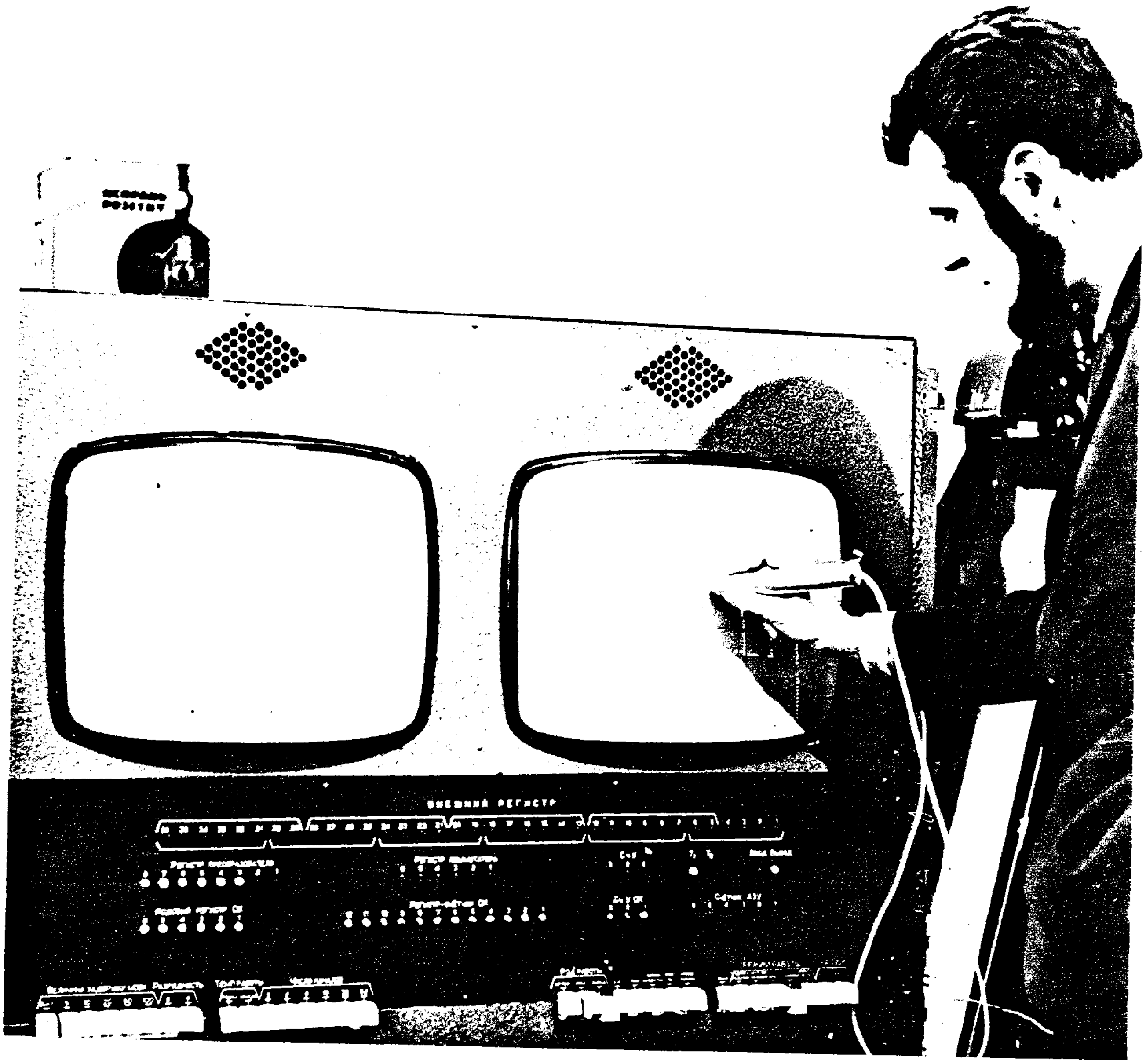
Glushkov: The screen is an "electronic blackboard" on which it is possible to enter numbers and systems of equations (up to 1000 characters), just as on a regular school blackboard. The operator sitting in front of the screen immediately sees the working field of the computer, which shows the group of formulas used by the researcher for calculations. The "chalk" for this blackboard outwardly resembles a regular ballpoint pen. By passing this "light pen" on the screen, the researcher underlines certain elements in the formulas. The underlined part of the formula begins to flicker; the computer "acknowledges" that some reconstruction is necessary in this section of the program.

Naturally, the computation time is considerably reduced (by 20-30 percent). All possible "tedious" calculations—all operations based on standard rules—are performed by the machine itself, but man tells it how, when, and which mathematical operation to use.

Up to now, only the Soviet Union has developed a computer which utilizes an "electronic blackboard" for formula conversions.

The new Soviet computer has sufficiently large capabilities. The Mir-2 computer can simultaneously store 12,000 characters, which equals six to seven pages of text. It has a more "powerful" language and greater "knowledge." This computer knows "from birth" the basic for-

For original article source, see page iv.



CRT unit with light pen for inputting graphical representations to a computer. Developed by the Kiev Institute of Automation. A similar device has been announced as a standard feature of the new Mir-2 computer. (Photo courtesy of Novosti Press Agency) (File No. 2603P) mulas which we learned in school; it also knows some things taught in higher educational institutions. The new machine will be an indispensable instrument to specialists using mathematics in their research. In addition, this computer can serve as a unique "highly intellectual" input device to larger computers.

COMMENTARY

An announcement of the Mir-2 computer has been expected for some time, so the unveiling by Glushkov does not come as a surprise. The incorporation of a graphic terminal with a light pen on the Mir-2 is news, however.

The present, sketchy article is not very informative as to the particulars, but it does appear that the Mir-2 is the first Soviet machine to be designed for use of such a device.

The accompanying photograph shows a dual-CRT device with light pen, developed at the Institute of Automation of the Ukrainian Gosplan. There is nothing to indicate that this is the unit used on the Mir-2. However, it is the first photograph of a Soviet light pen terminal. It was announced in October in the Novosti Press Agency's English-language *Science and Engineering* newsletter. The article on this innovation clearly states that the terminal is a CRT, while Glushkov identifies his terminal only as an "electronic blackboard TV screen."

An interview with Volodya Zajtsev, chief of the laboratory that developed the Institute of Automation's light pen terminal, states that "an electron beam scans the screen of the cathode-ray tube by lines and frames in about the same way as it does in the picture tube of a TV receiver. Each line is made up of dots that can give up light. A succession of these dots can form a curve or an outline.

"The memory of the input unit has as many magnetic cores as there are dots on the screen. When a dot is fluorescent, the respective magnetic core is energized (which corresponds to a "1" in binary notation); when a dot is extinguished, the respective magnetic core is de-energized (which corresponds to a "0").

"When the operator moves the pen with a built-in photocell (or, more exactly, a photo-multiplier) across the screen, it enhances the faint glow of the dots occurring under it, and the instantaneous flash triggers a circuit which reads a "1" into the respective magnetic core, and the dot comes on.

"The trace can be erased wholly or in parts. In the former case, a circuit is activated which erases all 1's in all the cells of the memory. In the latter case, after a suitable switching operation, the pen is traced backwards, and instead of 1's, zeroes are read into the respective magnetic cores, and the dots go out.

"To be more exact, the dots do not actually go out completely. Simply, they glow very faintly, almost unnoticeably against the grey background of the screen. But this is enough for the photomultiplier."

The interview concludes with the statement that the device "holds out great promise" for character recognition, and indicates that work is going on to develop suitable character recognition algorithms. There is no mention in the text of the existence or use of the second screen.

The Mir-2 attachment does not appear to be any more than a standard light pen application. The only use of the light pen to which Glushkov alludes is as a pointer, indicating portions of displayed formulas that the user intends to work with. It is assumed that a typewriter terminal provides the actual data input. The terminal of the Institute of Automation can be used in some sense for curve plotting and graphical design operations.

In the Mir-2 article, Glushkov again fails to resolve the question of the capability of Mir-2 to operate on-line with larger machines. He has hinted in the past of this feature, and closes his statement in the present article by noting that the Mir-2 can serve as a "unique...input device to a larger computer." This raises the possibility of some sort of time-sharing philosophy, wherein the Mir-2 serves as either a stand-alone, personalized computer, or as an input terminal to a larger system.

The Mir-2 is a follow-on to the Mir-1, which was the subject of a feature in *SC:RNI*, February 1969 (pp. 8-24). The work of Glushkov and his Institute of Cybernetics on the Mir-1 was specifically cited in the awarding of the Order of Lenin to the Institute and the title Hero of Socialist Labor to Glushkov.

The use of a light pen on an oscillograph for processing amplitude spectra was noted in 1967. It appeared to be on-line to a Minsk-2 computer (see *SC:RNI*/68/15, pp. 15-19). There is also work underway in Novosibirsk on the development of a graphic tablet using a stylus with a shielded capacitive pickup in its tip; the stylus is used to trace graphical data onto an x-y conversion matrix tablet made up of mutually orthogonal rows of conducting strips with the x- and y-planes electrically isolated (reported at the First All-Union Conference on Computational Systems, Novosibirsk, 1967; *Trudy*, No. 6, 1968, pp. 19-29).
—WH

Soviet Computers: A Historical Survey

SCR Feature

George Rudins

Introduction

The development of the world's first digital computers was greatly accelerated by the military needs of World War II; the requirement for rapid and accurate solution of numerous military problems, as well as the obvious value of computers in actual operations—logistics, planning, scientific research, etc.—ensured computer projects of generous financial support from the military, resulting in a meteoric development of computer technology in the U.S.

The ENIAC, the first large-scale computer, was completed at the University of Pennsylvania in 1946. In 1954, the development of the surface barrier transistor at the Philco Corporation heralded the age of the totally transistorized computer—several orders of magnitude faster than its predecessors. By 1959, U.S. computer manufacturers were already experimenting with integrated circuit hardware, which finally appeared in 1961-63. Today, only 23 years after the development of the ENIAC, the U.S. is on the threshold of a fourth computer generation—the application of LSI (large-scale integration) to computer technology.

Soviet advances in the computer field, by comparison, have been extremely slow. There is little detailed information available on digital computer design work in the USSR prior to 1953. The Soviets, however, certainly had knowledge of computer progress in the West—perhaps even access to some of the older computers.

The first "modern" Soviet calculating machine, an analog device capable of solving systems of differential equations, was developed in 1941 at the USSR Academy of Sciences and, subsequently, manufactured by the Voskov Sestroetskij Plant. Since then, the USSR has been conducting significant research on the design of the entire range of analog computers and devices, and has produced some rather advanced models—e.g., the MN-10, a small totally-transistorized table model unit intended for the solution of ordinary nonlinear differential equation systems of up to the sixth order; the MN-11, a model capable of automatically carrying out a search for six unknown parameters in accordance with six specified conditions in a single system of differential equations; the MN-14, a medium-sized unit of modular construction (372 interchangeable blocks, containing 3100 tubes and over 8000 diodes and triodes) intended for simulating complex dynamic systems described by ordinary nonlinear differential equations of up to 20 variables with large numbers of nonlinear dependencies; and numerous others.

Most analog computer developments have taken place at the Institute of Automation and Remote Control of the USSR Academy of Sciences, although the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences has also made important contributions to this field—e.g., the Institute has designed and built several models of specialized analog devices for performing analysis of three-dimensional rigid structures, including a very interesting 48-integrator electronic analog computer designed by Professor Pukhov. At present, analog computers appear to be developing in the direction of hybrid analog-digital systems. For example, a modified version of the MN-10 (the MN-10M) is being used with a Dnepr digital computer in a hybrid computation system, and an MN-11 has been linked to a BESM-3M digital computer in an engineering design modeling system.

Another early Soviet machine was the EV-80 punchcard calculator developed in 1950. It physically resembled the IBM 604 punchcard computer. The electronic circuitry is also very similar, but the Soviet card device had three card feeds rather than the one, as on the U.S. machine. An improved version, the EV-80-3, appeared in 1960 (serial production began in 1961), and was an immediate production success.

The success of the EV-80-3 led to the development of a still further improved punchcard calculator, the ATE-80, in 1961-62. It was designed by the Scientific Research Institute of Calculating Machines (NIIschetmash).

The ATE-80 is an electronic alphanumeric tabulator designed for accounting and planning operations. It is fully-transistorized and has a magnetic drum memory with a capacity of 1K words and a cycle time of 20 millisec; it performs 500 opns/sec.

Although designed in 1961-62, serial production of the ATE-80 did not begin until about 1967 (at a plant in Vilnius, Lithuania). An experimental model of the machine did not undergo interagency testing until 1965-66.

During this period, instead of producing modern electronic punchcard calculators, utilizing transistorized circuitry (such as the ATE-80), the Soviets were turning out the EV-80-3 vacuum-tube keyboard machine—a very costly (35,000 rubles each), inefficient unit.

Work on the first Soviet digital computer, the MESM (an acronym for "small electronic calculating machine"), began in 1948 and was completed in 1951. The MESM, said to be the first sequence-controlled computer in continental Europe, was designed by Academician S. A. Lebedev at the Computer Center (later reorganized into the Institute of Cybernetics) of the Ukrainian SSR Academy of Sciences. It had a flip-flop circuit memory capable of accommodating 31 words and 63 instructions, and contained 7000-8000 vacuum tubes; in comparison, the ENIAC had 18,000 vacuum tubes and a flip-flop memory of 20 words (designers of the ENIAC did not consider a large memory to be necessary, since it was not intended to be a stored-program computer).

The history of Soviet computers, however, does not really begin until 1953—the year Stalin died. With Stalin's death, a dark era in the USSR—which he had directed for 30 years—came to an end. Living standards improved substantially; production of consumer goods, as well as industrial production in general, increased; and working conditions improved. But more important to computer development and Soviet science in general, the number of universities and technical schools was increased and greater emphasis was placed on scientific studies—resulting in achievements such as the construction of the hydrogen bomb in 1953, the launching of Sputnik in 1957, and numerous other advances in the fields of solid-state and nuclear physics.

The post-1953 easing of political tensions mellowed ideological opposition to the concept of cybernetics (i.e., automation)—a concept that contradicts the basic tenets of Soviet Marxist-Leninist ideology by ascribing intellectual processes, peculiar to man and nontransferable (according to the Soviet doctrine), to a machine. Cybernetics, from the time Norbert Wiener's book, *Cybernetics: Or Control and Communication in the Animal and Machine,* first appeared in 1948 until the mid-fifties, was under constant attack for its incompatibility with Marxist-Leninist ideology. Fortunately for the USSR, the efforts of such politically influential supporters of cybernetics as Admiral Aksel I. Berg, who understood the importance of this concept, eventually led to Soviet acceptance of cybernetics. Berg was among the first to advocate organization of cybernetics research in scientific and industrial establishments, for which he was rewarded by being appointed Chairman of the Scientific Council on Cybernetics of the Presidium of the USSR Academy of Sciences and by being recognized as the political leader of the cybernetics movement in the USSR.

After 1953, Soviet computer development picked up momentum. Design of the first member of the important Ural family was completed in 1954; serial production began in 1955. In 1953-54, the BESM-1, Strela, and Lem-1 computers became operational. Research initiated in the mid-fifties resulted in the appearance of over a dozen new digital computers by 1960 (see accompanying chart).

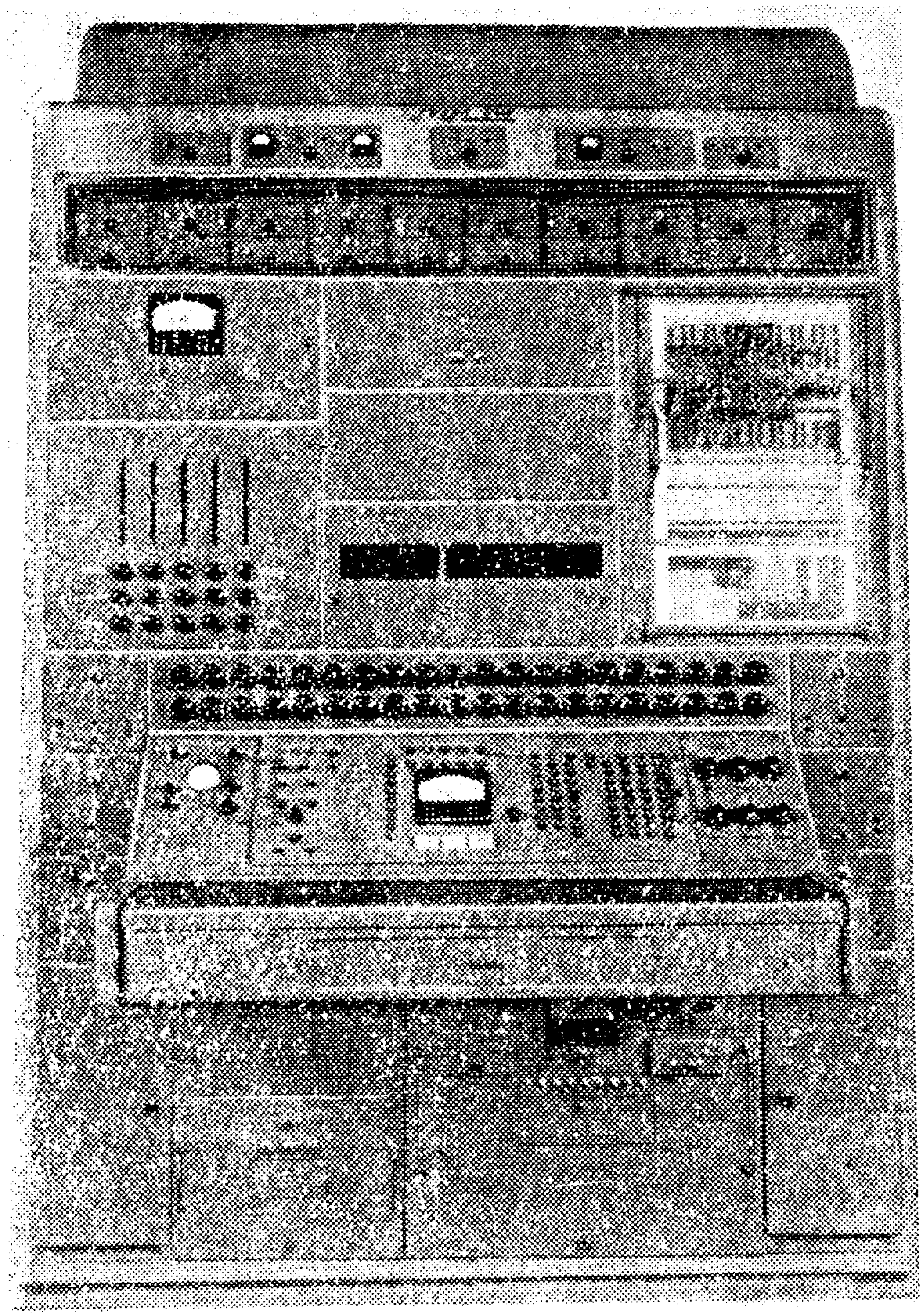
Early Soviet Computers

The most advanced computer research, particularly in the earlier years, was conducted under the leadership of Academician S. A. Lebedev—designer of the MESM. Shortly after completing his work on the MESM, Lebedev was appointed Director of the Institute of Precise Mechanics and Computer Engineering (IPMCE) in Moscow, where in 1952 he completed the design of the first BESM (an acronym for "high-speed electronic calculating machine"), the Soviets' first large electronic computer; it was connected by off-line teletype with the nearby Computer Center of the USSR Academy of Sciences.

The BESM-1 (as it was later called) was a binary, 39-bit, 3-address, floating-point, vacuum-tube (4000 tubes) machine; it originally had an acoustic delay-line memory of unknown capacity and performed 1000 opns/sec. From 1952 to 1957, the computer underwent extensive testing and was periodically improved. In 1954, the original memory was replaced with a Williams-type electrostatic store, increasing operating speed to 7000-8000 opns/sec. In 1957, a magnetic core memory (an early model of such a store) was installed, raising primary storage capacity to 1K 40-bit words. Secondary storage consisted of a 5120-word drum and four 30,000-word magnetic tape units. Input was from papertape at 20 words/sec; output was to a numeric printer at 1000 14-col lines/min, or to a papertape punch. It was a fast, reliable machine for its period; it came close to matching the performance of the IBM 701.

Only one BESM-1 is known to have been constructed, although there is some indication of as many as three. Some of the units identified as BESM-1 are probably BESM-2 machines or one-of-a-kind prototypes somewhere between the BESM-1 and BESM-2.

Also in 1953, I. S. Bruk, of the USSR Academy of Sciences' Institute of Electronic Control Computers, developed the M-2 computer, a small general-purpose, digital machine; a prototype, the M-1, had been developed in late 1951. In comparison to the BESM computer, it was a significantly smaller, more economical machine, with very limited arithmetic facilities. A highly modified version of the M-2, the M-3, appeared in 1957; it had an operating



MN-14
(File No. 01189P)

speed of 30 opns/sec, and was intended for small-volume mathematical calculations. In 1959, the M-3's drum memory was replaced with a core store of 2K capacity, increasing operating speed to 1500 opns/sec.

The Laboratory of Electromodeling (LEM) of the All-Union Institute of Scientific and Technical Information (VINITI), headed by L. I. Gutenmakher, was also involved in the early computer work. It was the center for the development of what are now called information-retrieval or library-problem machines, but its projects were not very fruitful. The only machine known to have been produced by the Laboratory is the Lem, a rather obscure, inefficient (but rather reliable), small, general-purpose, digital computer. The Lem-1 appeared in 1955, followed by an improved model, the Lem-1-16, in 1957; a still further modified Lem, the Lem-1-24, was produced somewhat later.

Very little is known about these machines. They were intended not only for the solution of mathematical problems, but also for carrying out experimental work related to the solution of logical and data-processing problems. The Lems utilized modular magnetic cores in the form of small plug-in units as their basic hardware elements. Vacuum tubes (numbering around 100) were supposedly used only in the power supply units. The exceptional performance of the Ural computers in data processing applications made the Lems appear quite crude in comparison, and they were unable to compete in the computer market.

In 1959-60, a one-of-a-kind electronic computer was developed by A. N. Myamlin, then at Leningrad State University. The Myamlin machine was interesting in that it was the first Soviet computer to incorporate complete error checking and real-time features. It was a vacuum-tube machine with a 4K core store (4 microsec cycle time), capable of operating at 50,000 opns/sec; it was never industrially produced.

In 1960, another data processing machine, the Era, appeared. It was designed by the Scientific Research Institute of Calculating Machines of the USSR State Committee on Radioelectronics, and had a 4K core store (13 microsec cycle time) and a speed of 12,000 opns/sec. It had some distinct advantages over the other available machines (the Lems and Urals)—greater core storage and a higher operating speed; however, it was soon made obsolete by the appearance of more advanced Ural models incorporating transistorized circuitry (the Era was a vacuum-tube machine).

Simultaneously with the BESM-1, the Strela computer (3-address, 2000-3000 opns/sec, with a 2K, 43-bit-word, barrier grid electrostatic store) was developed under the direction of Yu. Ya. Basilevskij at the Institute of Mechanics and Instrument Design of the Ministry of the Radio Industry; it went into serial production at the Moscow Calculating Machines (SAM) Plant in 1953 (the first Soviet computer to be industrially produced).

Several Strela machines are still in use in the USSR today, as are most ancient Soviet computers, because of an insufficient supply of newer models. A somewhat improved version of the Strela, the Strela-3, appeared in 1956, but contributed very little in terms of technical innovations to Soviet progress in this field.

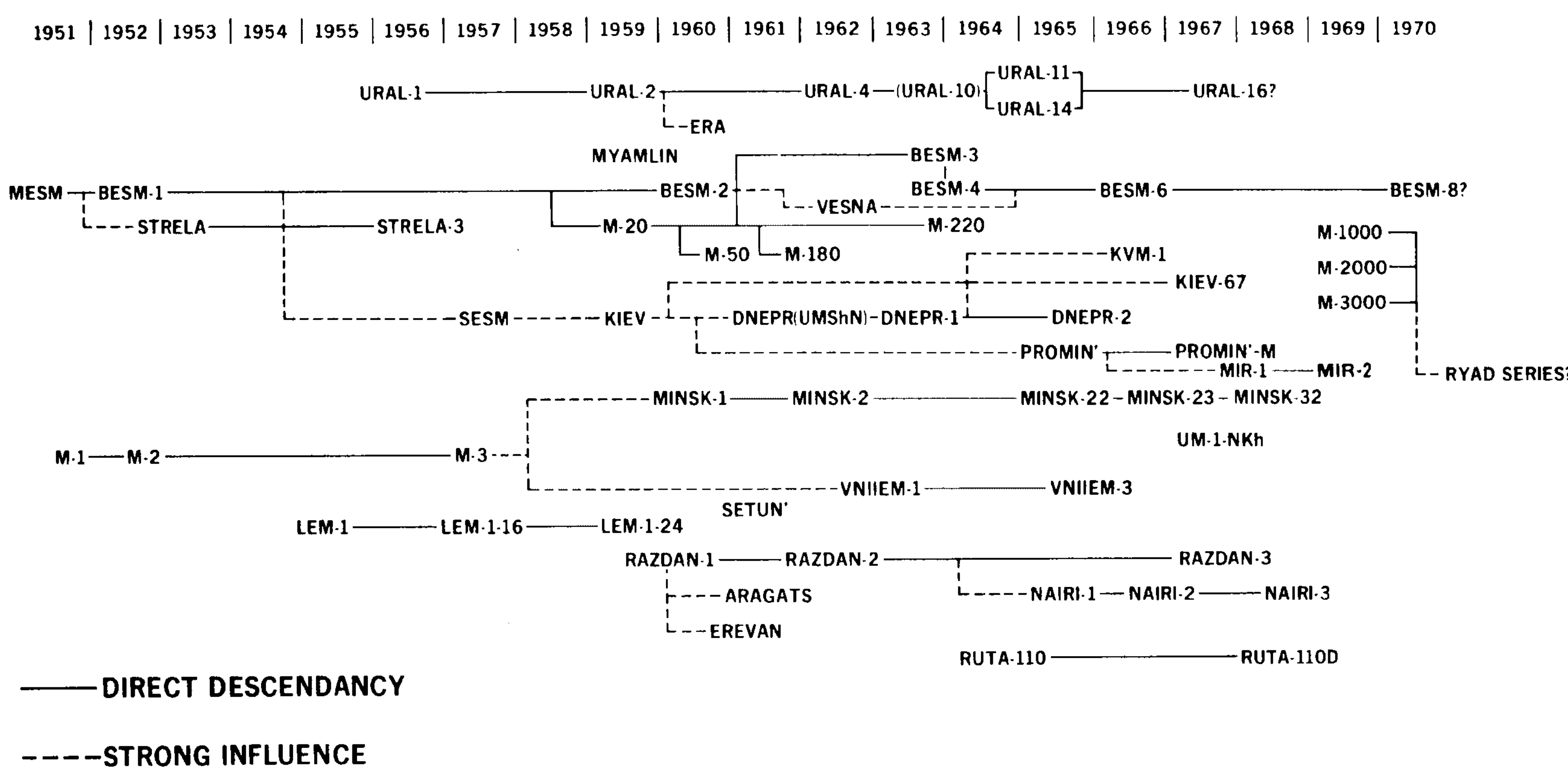
In addition to designing the Strela machine, Yu. Ya. Basilevskij did the basic design work for the first Ural computer, the Ural-1, which was one of the earliest machines to be industrially produced on a large scale in the USSR—production began in 1955. It was manufactured at the Penza SAM Plant, which is located about 350 miles east and slightly south of Moscow. Computers in the Ural series are among the most reliable and best known of the Soviet computers.

The Ural-1 was a single-address (the Soviets' first single-address computer), fixed-point machine capable of performing 100 opns/sec; it had a magnetic drum memory with a capacity of 1K 36-bit words and a cycle time of 10 millisec. It used decimal and octal number representation for I/O, but binary internally. Secondary storage consisted of one magnetic tape unit with a capacity of 40,000 words.

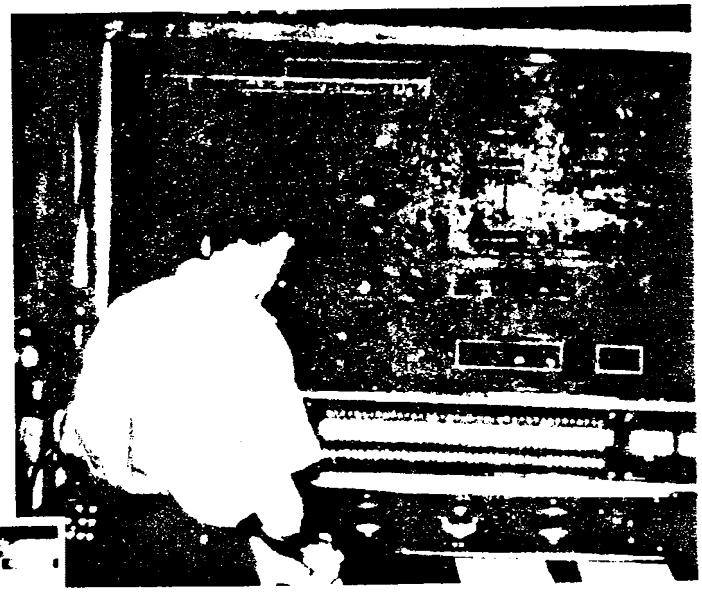
For several years the Ural-1 was serially produced and several hundred units were built (many are still in operation). It has a good logical design which makes it very efficient for the solution of simple problems; it is roughly comparable to the IBM 650, but with a different internal organization.

Utilizing the basic components of the Ural-1, the product engineering group at Penza—headed by B. I. Rameev, who worked with Basilevskij in designing the Ural-1—designed the Ural-2 in 1958 and the Ural-4 in 1960. Both of these machines are vacuum-tube models with ferrite core memories capable of storing 2K 40-bit words and have operating speeds of 5000 opns/sec (1-address); the Ural-4 is similar to the IBM 705. These two machines differed from the Ural-1 principally in primary storage hardware and secondary storage capacity (the Ural-2 could handle up to 100,000 words on magnetic tape; the Ural-4 up to five million). In addition, the Ural-4 was capable of handling alphanumeric information in data processing, economic planning, and other applications.

The first Soviet computer with alphanumeric I/O capabilities, the Setun', was developed in 1958 as part of a graduate student project at Moscow State University; N. P. Brusenzov, who worked on the Strela with Basilevskij, was also involved in this project. The Setun' was capable of performing 4000 opns/sec (1-address), and had 81-18-bit words of core store. It was the world's only computer to ever use base-3 logic. According to the Soviets, base-3

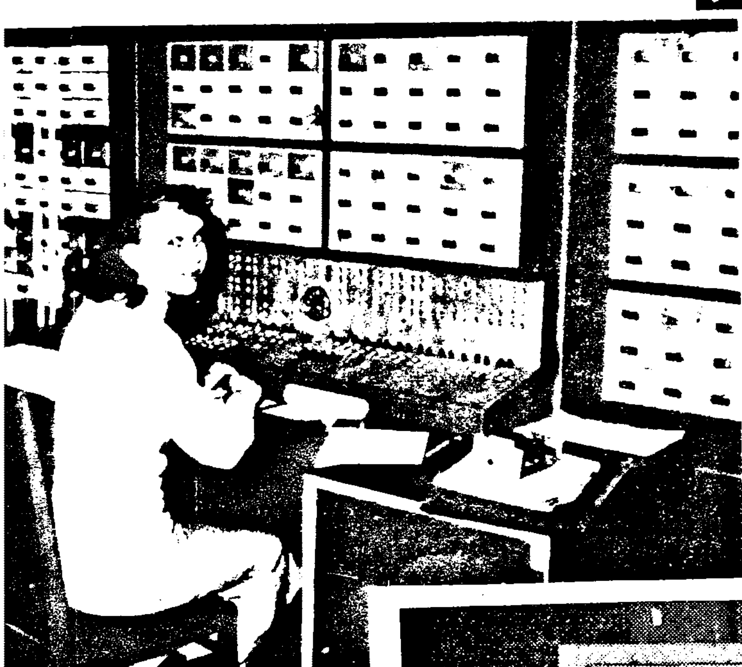

1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 | 1969 | 1970
URAL-1
URAL-2
ERA
URAL-4
(URAL-10)
URAL-11
URAL-14
URAL-16?
MYAMLIN
MESM
BESM-1
STRELA
STRELA-3
BESM-2
VESNA
BESM-3
BESM-4
BESM-6
BESM-8?
M-20
M-50
M-180
M-220
M-1000
M-2000
M-3000
RYAD SERIES?
SESM
KIEV
DNEPR(UMShN)-DNEPR-1
DNEPR-2
KVM-1
KIEV-67
PROMIN'
PROMIN'-M
MIR-1
MIR-2
M-1
M-2
M-3
MINSK-1
MINSK-2
MINSK-22 – MINSK-23 – MINSK-32
UM-1-NKh
VNIIEM-1
VNIIEM-3
SETUN'
LEM-1
LEM-1-16
LEM-1-24
RAZDAN-1
RAZDAN-2
RAZDAN-3
ARAGATS
EREVAN
NAIRI-1
NAIRI-2
NAIRI-3
RUTA-110
RUTA-110D
DIRECT DESCENDANCY
STRONG INFLUENCE

logic was supposed to provide the most efficient utilization of hardware. Since a base-3 electronic technique is nonexistent, they decided to construct a base-4 machine and to utilize only three of the four possible states. Although the entire project was regarded as an educational training program for engineers, an attempt was made to serially produce it, but it failed miserably—base-3 logic turned out to be highly impractical.

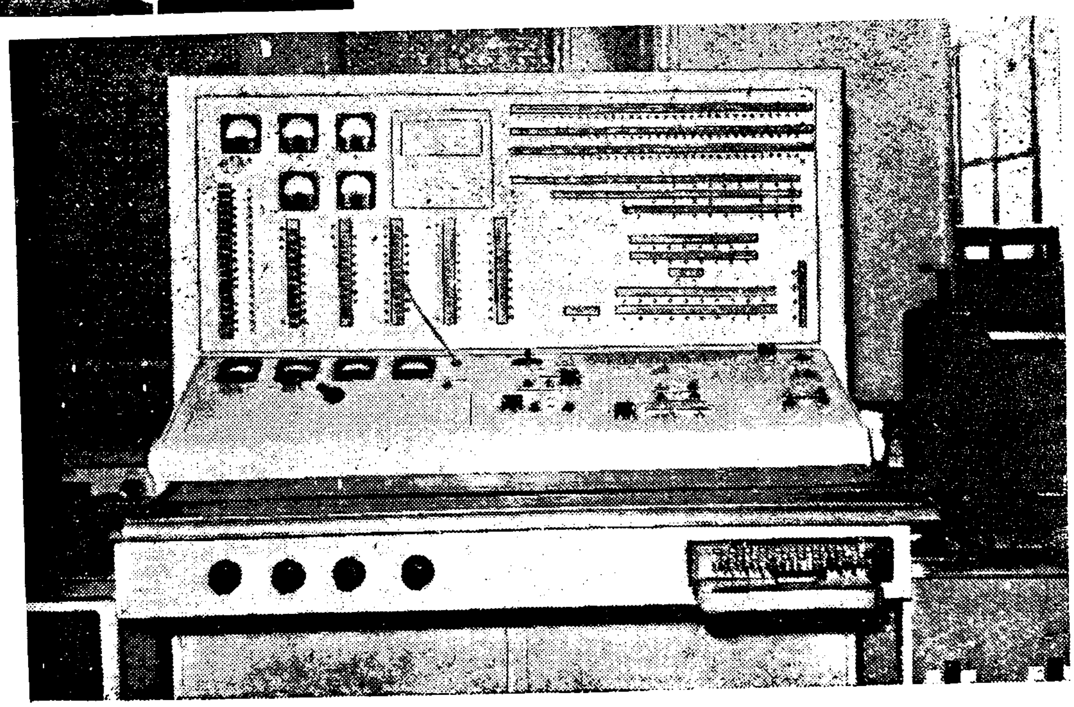


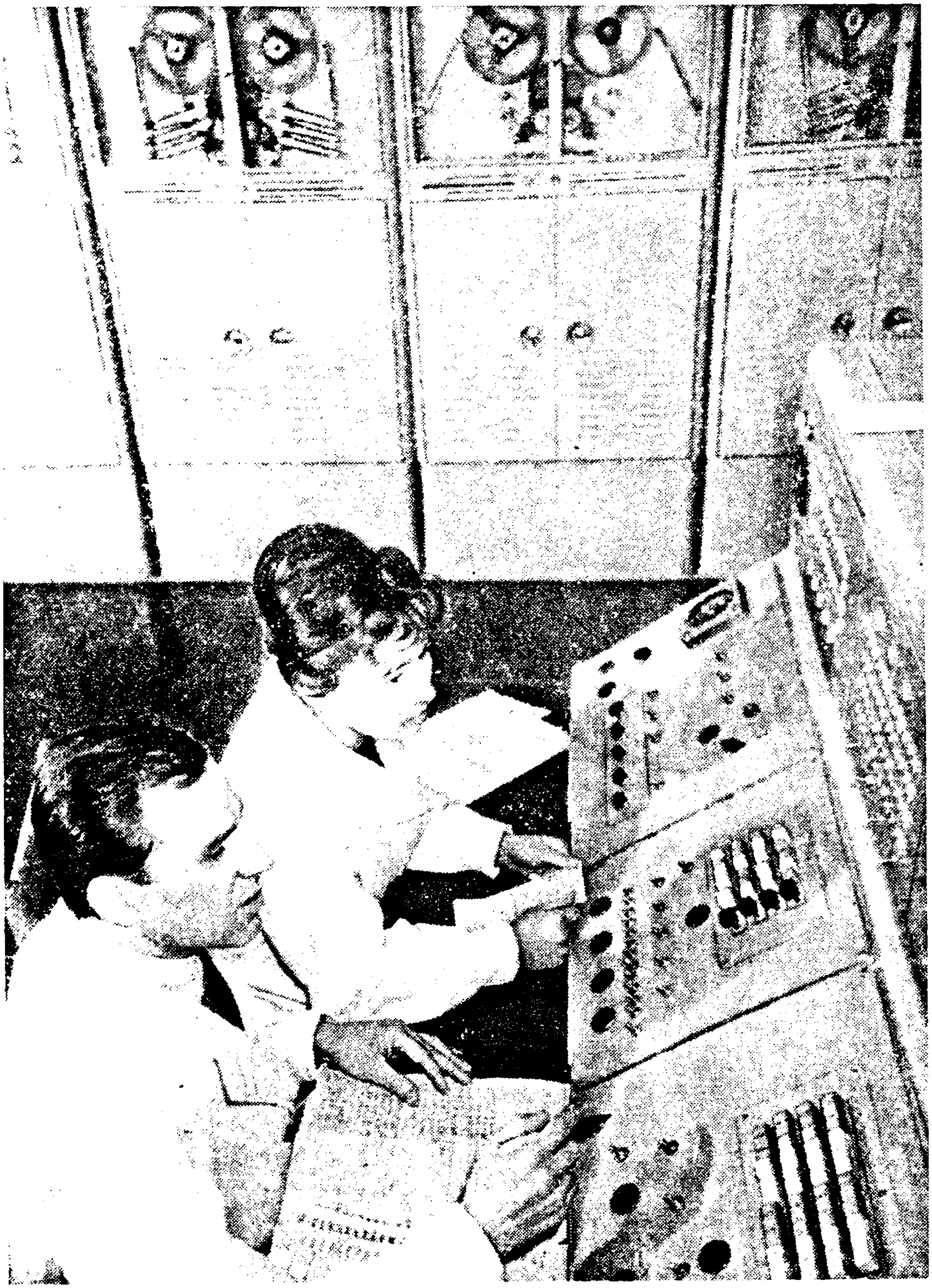
(File No. 01525P)

Setun'
(File No. 01525P)

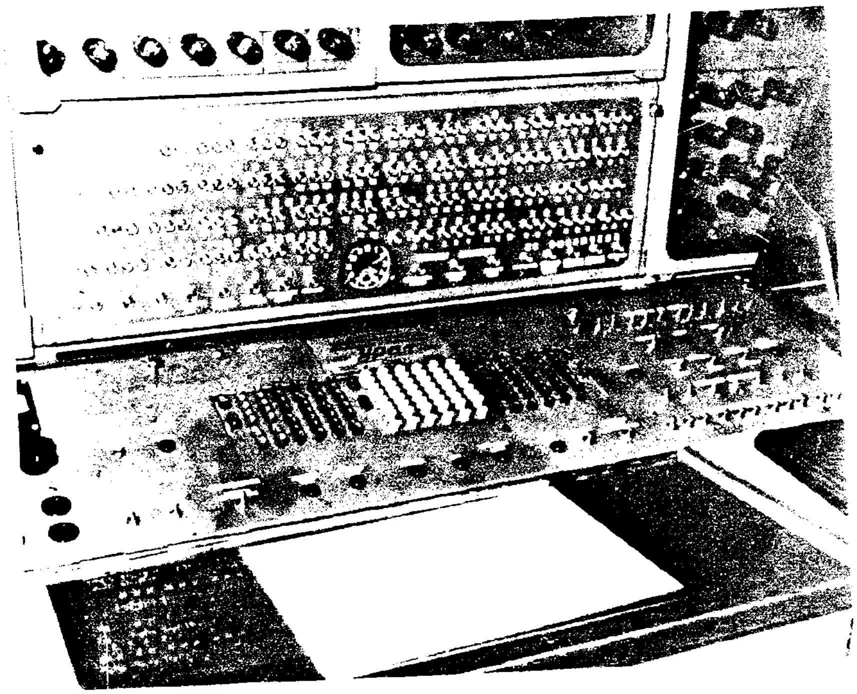


M-2
(File No. 01431P)

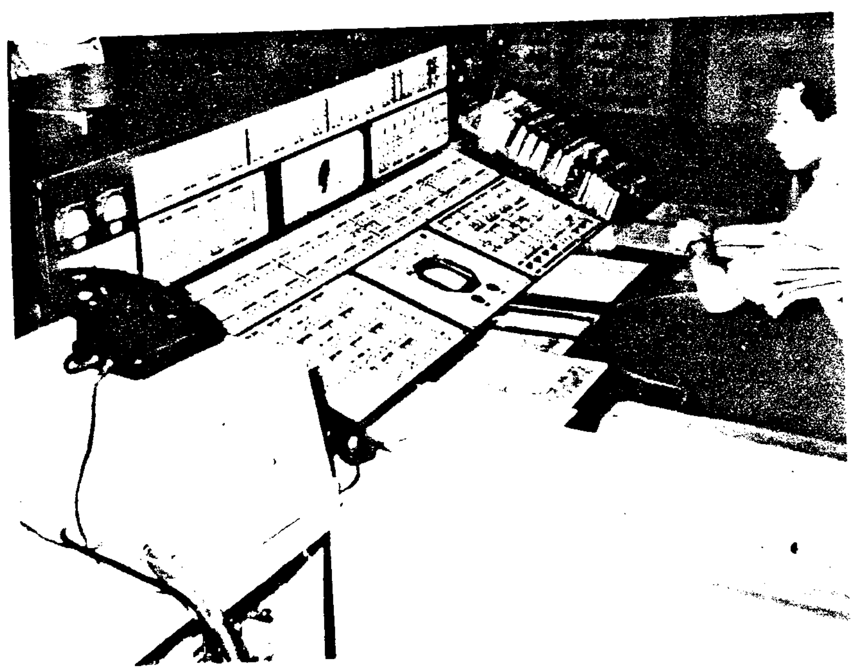




Era
(File No. 00353P)



Ural-1
(File No. 01525P)



Strela
(File No. 01525P)

Lebedev and IPMCE

During the period that the Urals, Setun', M-2, and M-3 machines were being developed, S. A. Lebedev was continuing his development of the BESM series at the Institute of Precise Mechanics and Computer Engineering. Almost immediately after completing the BESM-1, Lebedev turned his attention to designing a follow-on, the BESM-2. It required seven years to complete, but did not introduce any significant innovations. BESM-2 differs from the BESM-1 primarily in its use of semiconductor diodes (the BESM-1 was an all vacuum-tube machine) and its greater memory capacity, both primary and auxiliary; the logic design remained practically unchanged. The BESM-2 appears to be only a simple redesign of the BESM-1, in order to make it more suitable for serial production. Although there are some modifications in the later machine, the two are reportedly program-compatible.

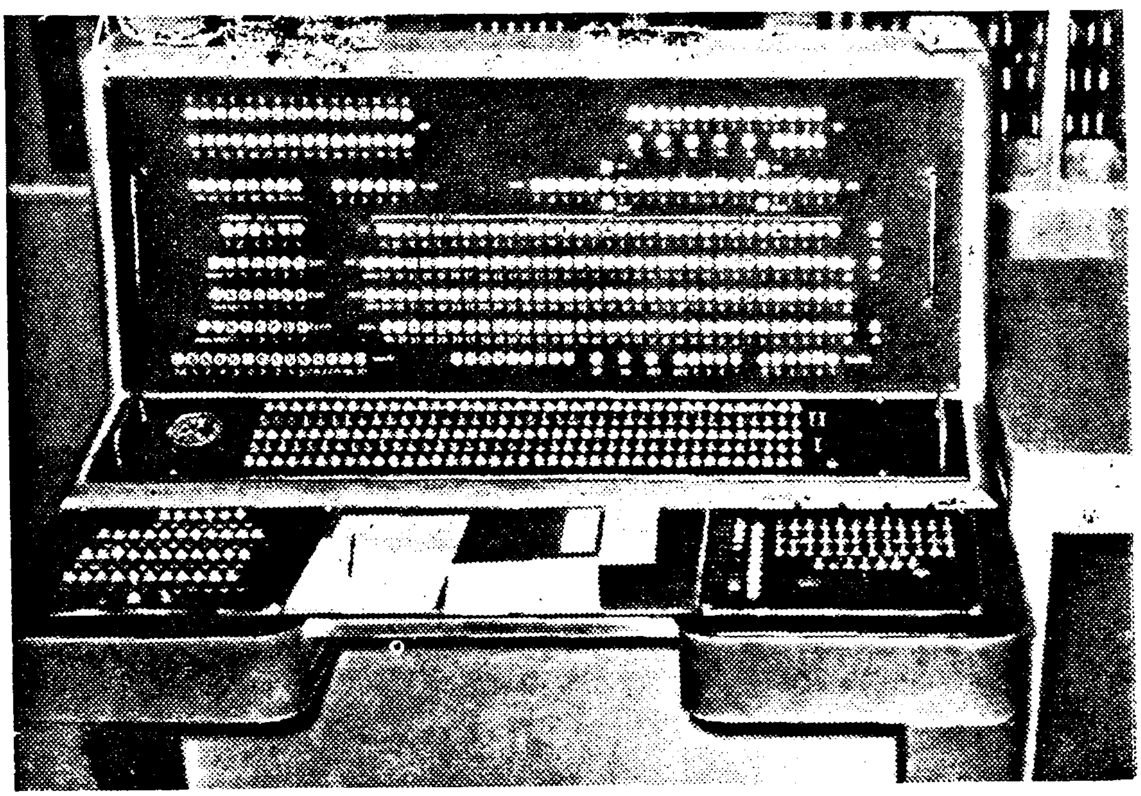
The BESM-2 is a 3-address, floating-point, binary machine capable of 8000-10,000 opns/sec. It has a 2K 39-bit-word core store, with a secondary storage of 100,000-200,000 words via two drum and four magnetic tape units. The basic machine cycle is 10 microsec (a holdover from the BESM-1 design), while the store cycle time is 6 microsec. Over 100 of these machines were produced.

Under development simultaneously with the BESM-2 was a computer intented for industrial applications, the M-20, which turned out to be the workhorse of the Soviet industrial automation effort. Generally speaking, the Ural series was intended for economics and data processing applications; the BESM series (particularly the later models), for scientific applications; and the M-20 was designed to be the industrial counterpart of the BESM-2.

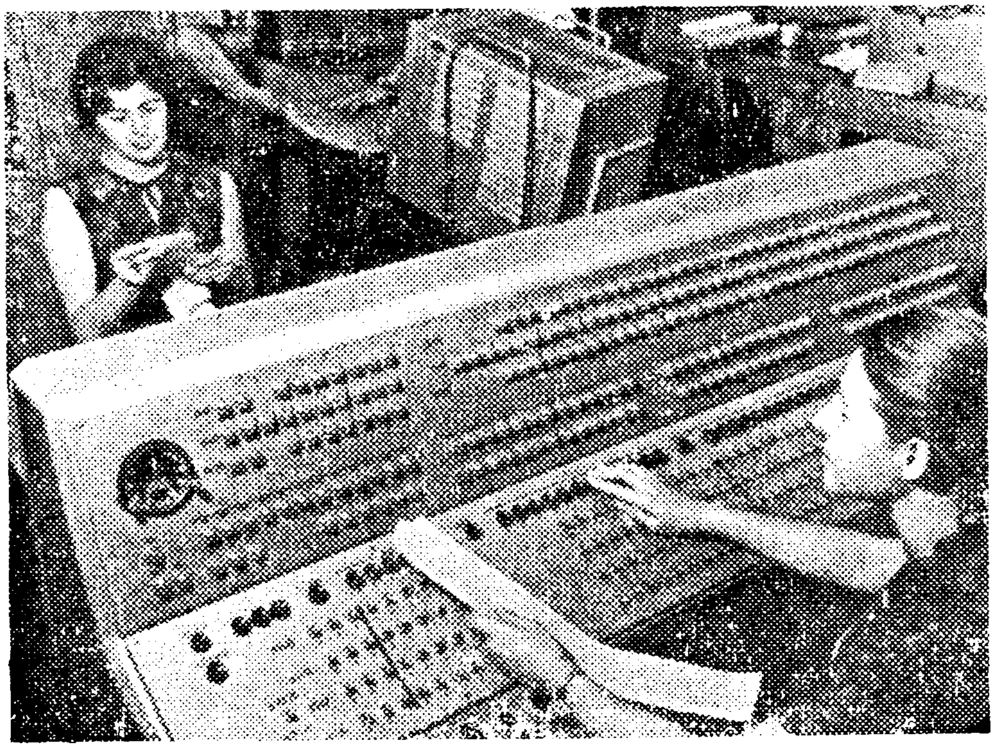
The M-20 was designed by S. A. Lebedev, with the aid of M. K. Sulim, then at the Moscow Calculating Machines Plant, one of the places where it was manufactured (it was also built at other facilities of the Ministry of the Radio Industry). Design work began in the mid-fifties, was completed in 1957, and it went into production in 1959.

The first few units of Lebedev's machines are generally produced at a factory in Ulyanovsk (Lenin's birthplace). Further production is then taken over by other factories or NIIschetmash (Scientific Research Institute of Calculating Machines); the latter was the principal producer of the M-20.

The M-20 is a 3-address, 45-bit-word, binary machine capable of 20,000 opns/sec; it has a 4K core memory with



BESM-2
(File No. 01250P



BESM-3M
(File No. 01538)

a cycle time of 6 microsec. The M-20 has alphanumeric input capability via punchcards at a rate of 60 cards/min; output is to a 30-card/min card punch or to a 20-line/sec numeric printer. Secondary storage is on three 4096-word drums and four 75,000-word tape units. The hardware contains 4500 vacuum tubes and 35,000 diodes. It is generally rated as somewhat below an IBM 7090.

Lebedev, along with his design group, was nominated for the Lenin Prize for the development of the M-20 which, at the time of its announcement, was the Soviets' best machine; however, the award was not made on the grounds that the M-20 did not represent any advances in the state-of-the-art when foreign technology was considered.

The M-20, for example, did not contain many of the sophisticated features of machine organization found in U.S. designs, such as a trapping mode, multilevel indexing, overlapped and buffered I/O channels, or an interrupt system. While most of these features are used to facilitate programming convenience or to increase operating speed, some have been incorporated because they were found to be essential to certain operations. An interrupt system is absolutely necessary for situations where a computer must receive information on a time scale unrelated to the time scale of the machine, and a multiple indexing system is invaluable in linear programming and for I/O in economics computations.

There have been reports of an M-50 under development, which would operate at 8000 opns/sec and have a core store of 8K. However, there are indications that the M-50 had several shortcomings and was unsuitable for production, and very little has been published about the M-180, whose design began around 1960.

In the early sixties work was also being done on a transistorized version of the M-20, the M-220; it is not known who had the responsibility for this updating work. However, while the M-220 was being developed as the "official" transistorized version of the M-20, some young engineers and technicians were designing and building their own "unofficial" transistorized M-20, which eventually became the center of a bureaucratic squabble. Opposition to the unofficial machine centered around M. K. Sulim, who issued an order on March 30, 1964 (by which time the machine had been completed) prohibiting work on it. Sulim, then the Deputy Chairman of the State Committee on Radioelectronics, was engaged in a controversy with Lebedev over development of the transistorized M-20 (Lebedev wanted to repeat the logical structure of the M-20; Sulim wanted to modify it). Since Lebedev's design activities are probably subordinate to the State Committee, Sulim would seem to have had the advantage, and the unofficial machine may thus have been a subterfuge employed by Lebedev to present the State Committee with a *fait accompli.*

The unofficial machine was legalized only after a state commission headed by Academician A. A. Dorodnitsyn visited the unidentified plant where the machine was being assembled, tested the new machine, and pronounced it to be highly productive, very reliable, and relatively inexpensive to build. After gaining legitimacy, the machine's further development was taken over by Lebedev's Institute of Precise Mechanics and Computer Engineering and christened the BESM-3. The same year (1964), it went into production under the name BESM-4 (another slightly modified version of the same machine, the BESM-3M, went into production at about the same time).

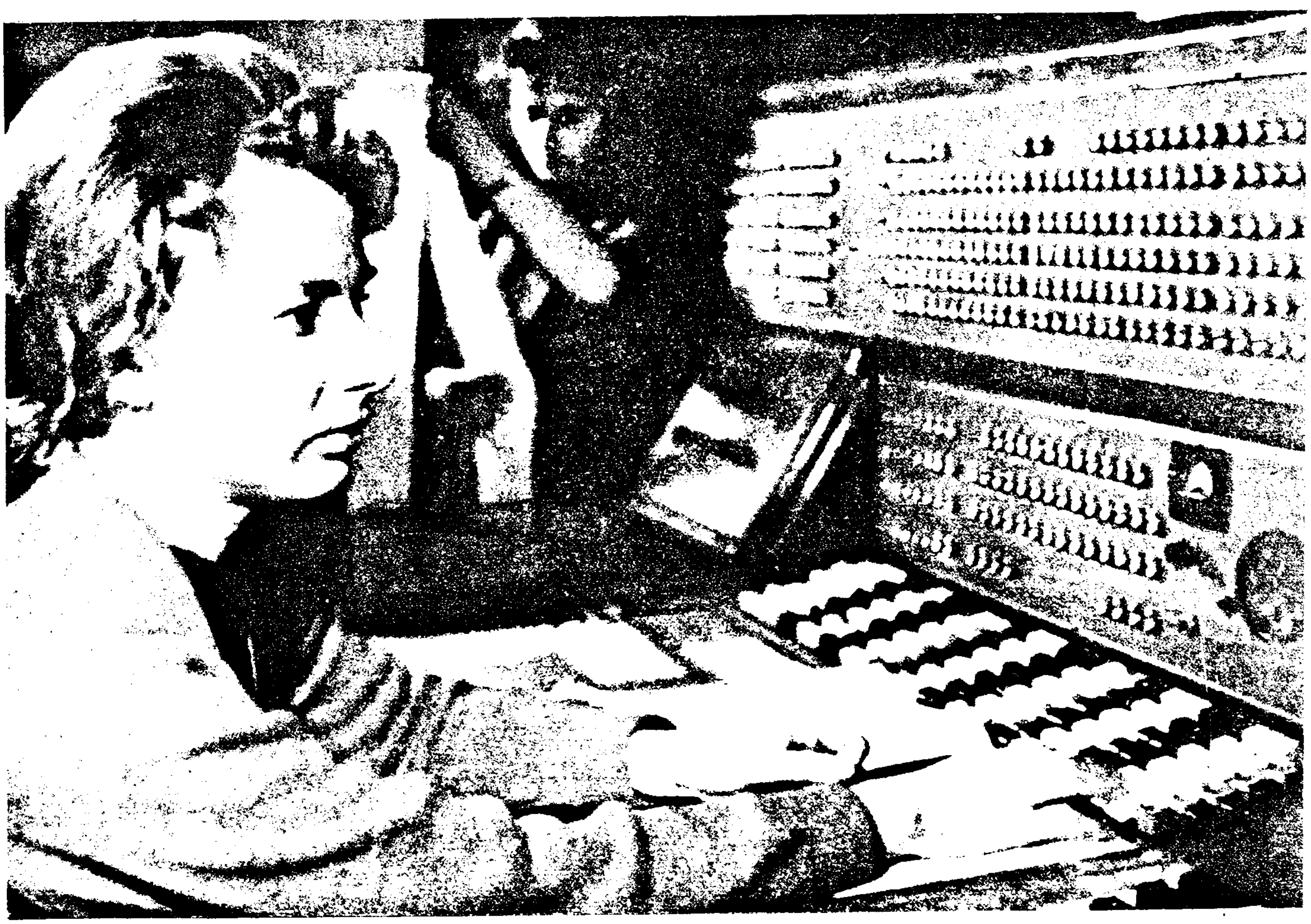
The BESM-4 is a fully transistorized, 3-address, binary machine, utilizing printed circuits throughout. It has a core store of 8K (augmentable to 16K) 45-bit words with a 10 microsec access time; its operating speed is 20,000 opns/sec. A typical configuration consists of four 16K drums, and drives for four or eight one-million-word tapes.

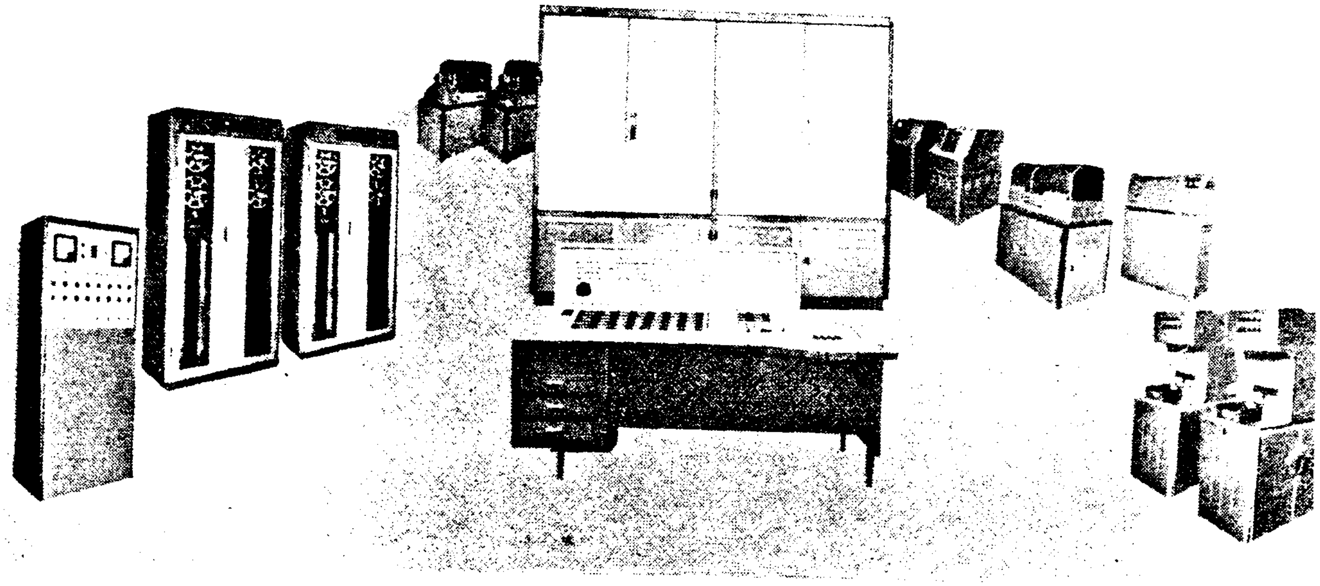
The M-220 also went into production late in 1964 and about 100 units were built (about 50 BESM-3Ms and BESM-4s were produced). The M-220 is also a fully transistorized, 3-address, binary machine. It has a 4K 47-bit-word core store, with a cycle time of 6 microsec; 45 bits are used for data representation, one bit for parity checking, and one for checking the word address. Primary storage is reportedly augmentable to 16K. The magnetic tape store has a capacity of four million words, one million on each of four tape drives; the magnetic drum store provides an additional 24K storage. Its operating speed is 20,000 opns/sec.

The M-20, M-50, M-180, M-220 line should not be confused with the M-1, M-2, M-3 series designed by I. S. Bruk, nor with the MN series of analog computers mentioned earlier. Also, the BESM and M-20 series should not be viewed as a true family of computers, in the Western sense, for they actually represent successive design generations. Soviet computer designers only recently have begun to develop true computer family groups—e.g., the Ural-11, -14, and -16 series and the the M-1000, -2000, -3000 group.

S. A. Lebedev's greatest achievement to date (for

M-20
(File No. 01421P)





BESM-4
(File No. 01061P)

which he received the State Prize in 1969) is the design and development of the BESM-6 computer, the largest and fastest of the known Soviet computing machines. Design was completed in 1964-65 and serial production began at the Moscow SAM Plant in 1966; less than a dozen are believed to have been built. The BESM-6 represents a marked advance in Soviet computer design and engineering, incorporating all solid-state construction, speeds more commensurate with application demands than in any previously known Soviet machine (said to be one million opns/sec), and I/O units more on a par with equivalent U.S. equipment than available on any other Soviet computer. It is not a program compatible version of the BESM-4.

Nevertheless, the BESM-6 is still rather limited in many respects. Its core store accommodates only 32K 50-bit words, and is not expandable under the current architecture. Its true operating speed according to U.S. studies is probably in the 300,000-600,000 opns/sec range, which is probably due to inefficient software; the complete BESM-6 software package only became available a few months ago. Its peripheral equipment is totally inadequate —e.g., disc storage is not available; no Western observer has ever seen a Soviet machine equipped with an operating disc unit, although the Ruta-110D is reported to have one. Discs have been under development in the USSR for quite some time, but are not known to be commercially produced; there are no indications of any current plans to add discs to the BESM-6. The 16 drums (32K capacity per unit) and 32 tapes (1,000,000-word capacity per unit) currently used with the BESM-6 are not the ones originally planned for it. Earlier specifications called for eight drums at 16K each.

Although its storage capabilities and peripheral equipment are limited, the BESM-6 incorporates a number of sophisticated design features—e.g., look ahead, program interrupt, 16 index registers, dynamic relocation and relative addressing, memory protection, some multiprogramming capabilities, and overlapping of arithmetic operations with data transfer between the storage units, I/O devices, and the various registers. It is not, however, of modular design; little variation is possible in the configuration of the CPU.

The BESM-6 has the newest and fastest known store in a Soviet machine; its ferrite core memory cycle time of 2 microsec makes it comparable to memories developed in the U.S. in the early sixties. The store incorporates some rather advanced features—paging, overlap, and scratchpad memory. A store with a 500-nanosec cycle time has reportedly been developed for use in the BESM-6, but there are none known to be operational at this time.

In terms of published technical specifications, the BESM-6 is a single-address (the first single-address machine to be produced by the Lebedev design group), floating-point, binary machine with a claimed operating speed of 1,000,000 opns/sec. It has a 50-bit word length, includ-

M-220
(File No. 2505P)

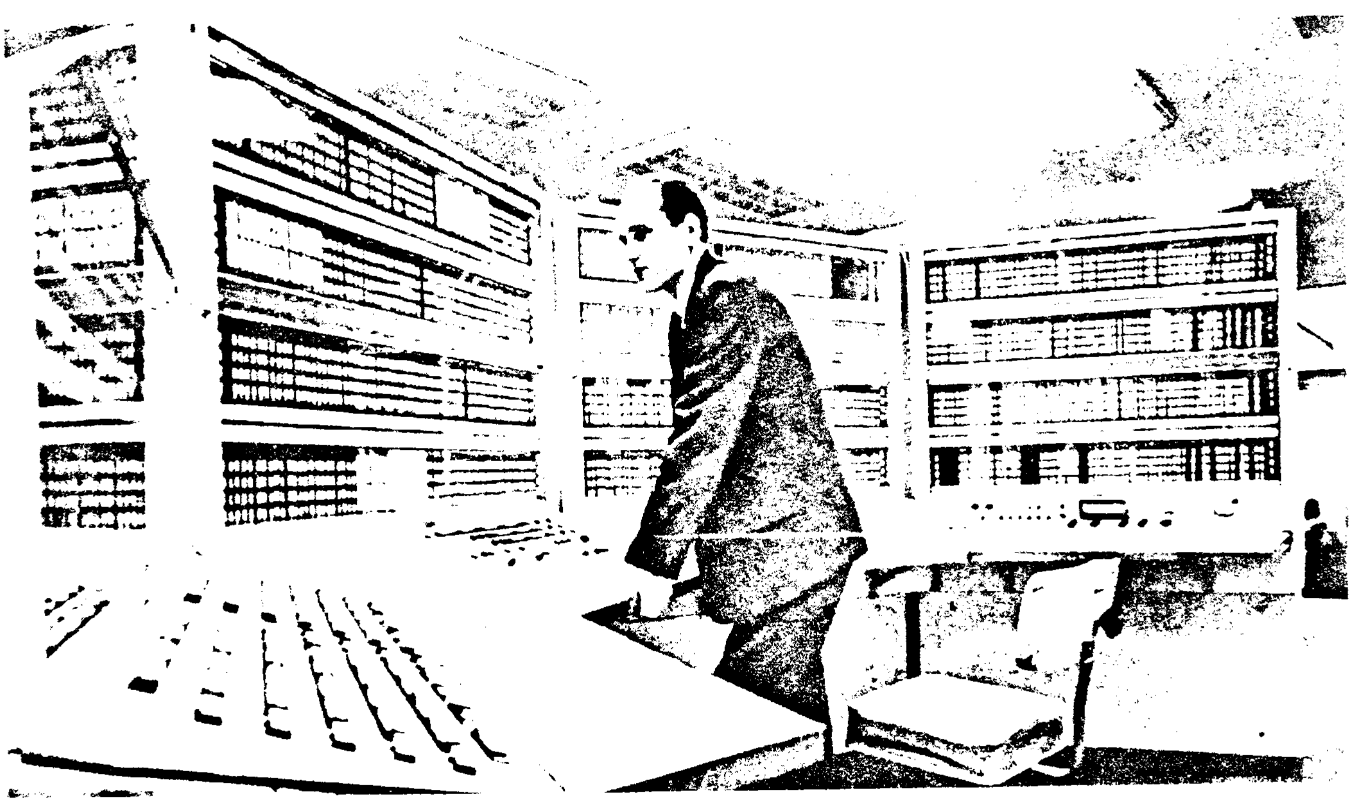
ing two bits for parity checking; the mantissa has 40 bits plus a 1-bit sign; the exponent, six bits plus 1-bit sign. Core capacity is 32K 50-bit words arranged in eight blocks. Its hardware contains 120,000 diodes and 40,000 germanium transistors. It can be considered roughly equal to the IBM 7094 and, according to some experts, copies many features of Great Britain's Atlas computer—e.g., paging and overlapped memory.

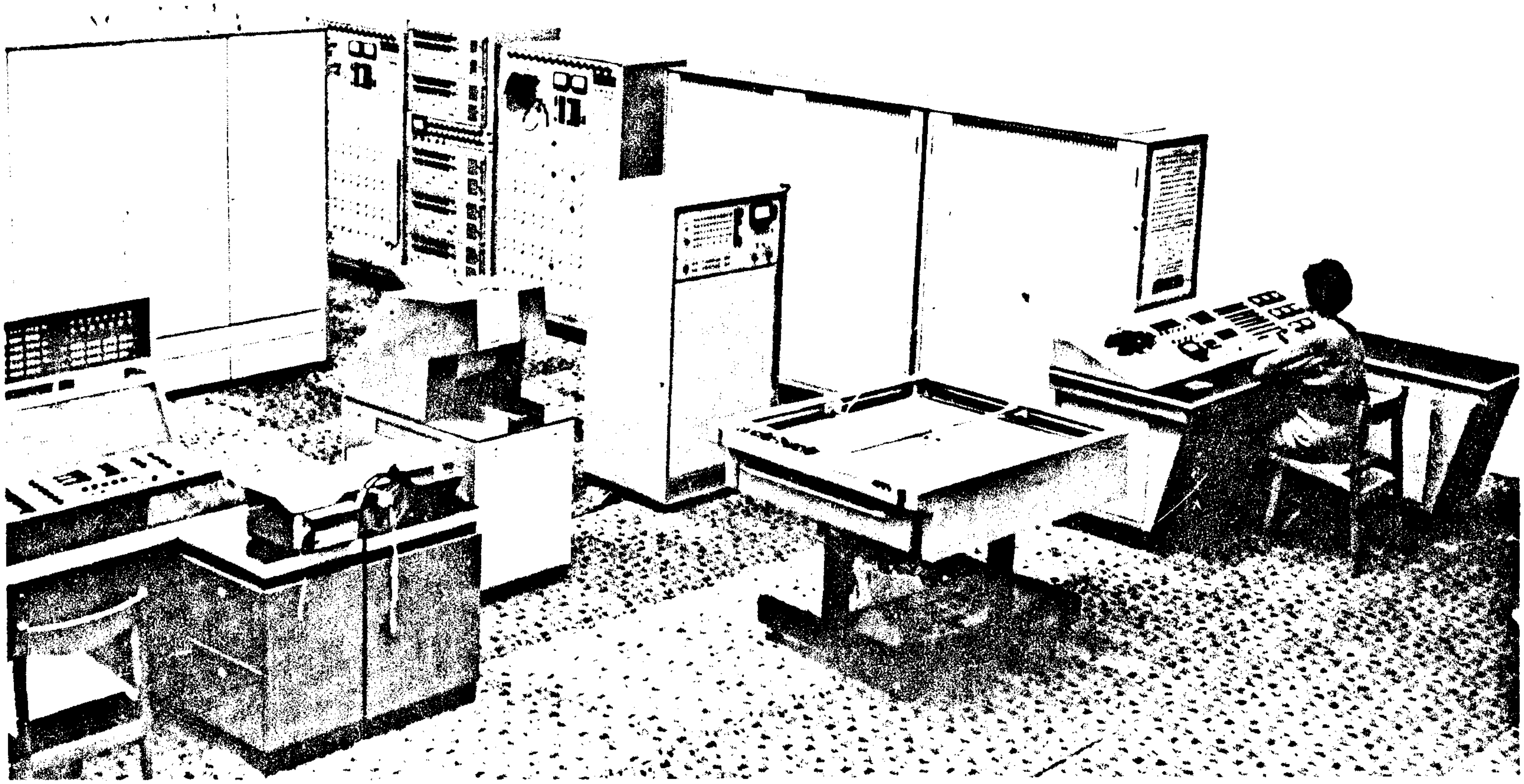
The BESM-6 was preceded by another high-speed machine, the Vesna, which was never serially produced because its design did not lend itself to economical mass production. The few prototypes that were constructed had the same word length as the BESM-6, an operating speed of 200,000-300,000 opns/sec, and a core store of 64K. Its similarity to the BESM-6 suggests that it may have served as a model, possibly even designed by Lebedev himself. It also copies many of the Atlas design features, and may have been the product of Soviet efforts to reproduce a Western design far ahead of their own state-of-the-art.

Shortly after the announcement of the BESM-6 in 1965, L. N. Korolev, a designer under Lebedev, and N. A. Mel'nikov, Lebedev's second-in-command, indicated publicly that Lebedev's group was developing a follow-on model a full order of magnitude more powerful, incorporating many more advanced features, improved parallel operation, and more sophisticated multiprogramming capabilities. If design is proceeding on schedule, the follow-on model will be announced sometime in 1970. The goal of the project is to develop a machine comparable to the CDC 6000 series.

The development of the field, so far as the USSR Academy of Sciences is concerned, has centered around Lebedev and his prestigious Institute of Precise Mechanics and Computer Engineering. However, there has also been considerable parallel development by other laboratories and institutes connected with other Soviet ministries and industrial organizations as well as other USSR republics —Ukraine, Armenia, Belorussia, Lithuania, etc. (Some of the earlier work in other institutes has already been discussed.)

BESM-6
(File No. 1392P)





M-220 Configuration
(File No. 01771P)

Rameev and the Penza SAM Plant

After preparing the scientific foundation for the development of the Ural series, Yu. Ya. Basilevskij's contribution diminished, and he was succeeded by B. I. Rameev, principal designer of the URAL-2, and other, unknown members of the product engineering group at Penza.

During the early sixties, the Penza design group was concentrating its attention and resources on developing a very advanced family of computers for data processing applications—something the Soviets were in dire need of. The earlier, domestically produced computers best suited for planning and economic applications, the Ural-4 and Era, were inadequate for Soviet needs—e.g., the Ural-4, in addition to being rather slow (due to vacuum-tube logic), required a special subroutine for conversion into binary when decimal data was input, and programs had to be punched in BCD, which is very inconvenient for code checking.

Their research yielded three computers of modular construction that could be configured to accommodate a wide variety of users. The three machines—Ural-11, Ural-14, and Ural-16—represent the first Soviet series of compatible computers, whose engineering design minimizes the number of different circuit modules utilized (thereby improving reliability and reducing maintenance requirements). The semi-conductor logic of all three machines is based on a series of modular hardware elements called the Ural-10, conceived in 1961.

The Ural-11 is a small general-purpose digital computer, intended for handling planning and accounting problems in small and medium-size enterprises.* It can also be used to rewrite information from one set of data storage units to another.

The Ural-11 is a fixed-point, single-address, binary machine. It has an operating speed of 3000 opns/sec and a core store of 4K (augmentable to 16K) 24-bit words with a cycle time of 9 microsec; up to 16 I/O devices may be connected.

There are six Ural-11 models (Ural-11A through Ural-11F), each intended for a specific application environment, differing only in the configuration of the peripheral equipment.

The Ural-14 is a medium-capacity, general-purpose computer specifically designed for economic planning and production accounting applications. It can be integrated into a complex data processing system consisting of several machines linked to remote terminals.

It is a fixed-point, single-address, binary machine, capable of operating at 10,000 opns/sec. It has a core store of 8K (augmentable to 64K) 24-bit words, with a cycle time of 9 microsec. It can process seven problems simultaneously, and can handle up to 24 external units in a variable configuration; circuit control is used for data storage, transfer, and processing.

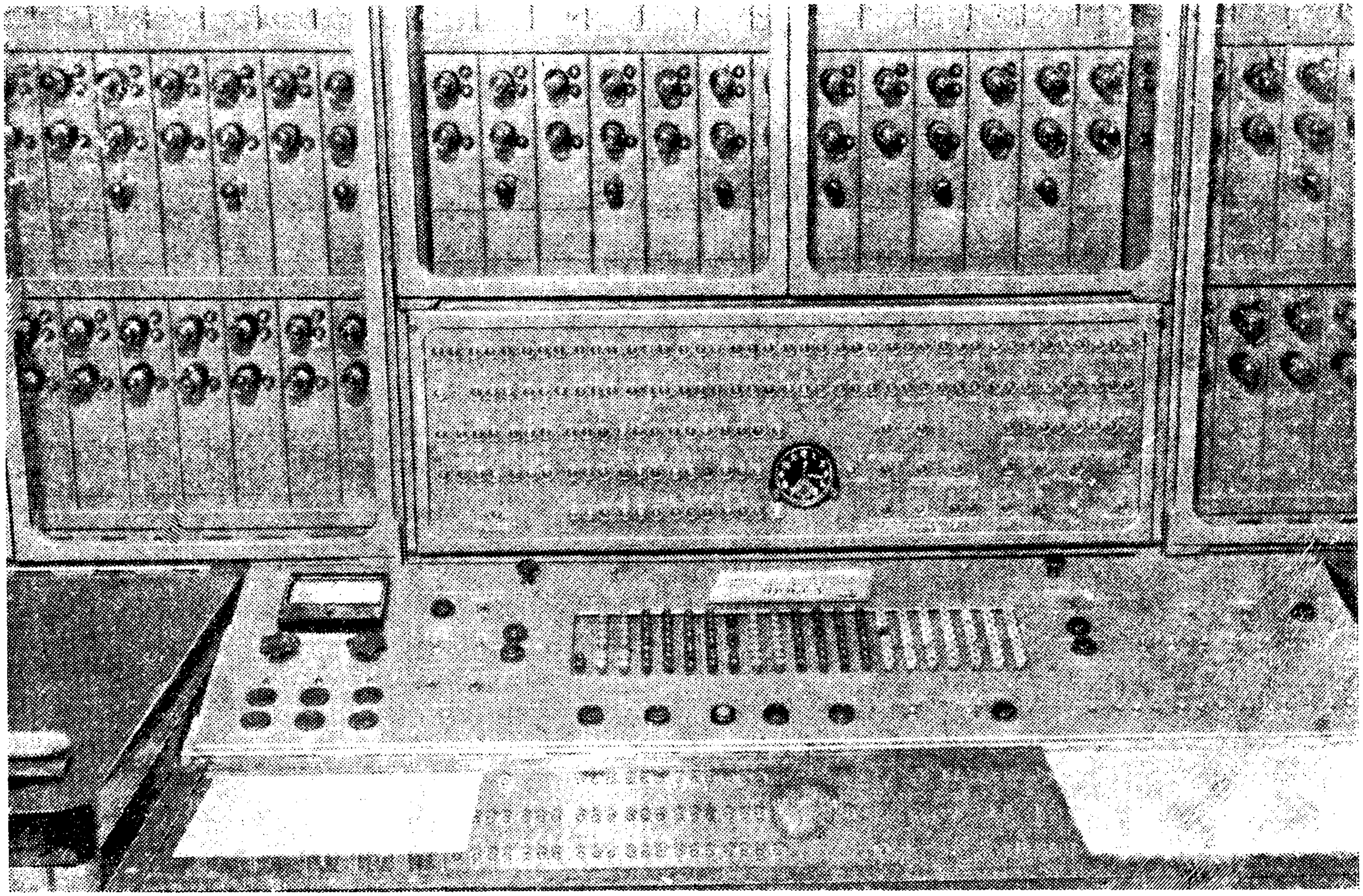
The largest of the Soviet data processing machines is the Ural-16. It is primarily intended for large-scale economic-planning applications in large computer centers. The machine's modular design permits it to be upgraded by adding more units for various purposes and in various quantities. Thus, the characteristics of the computer can be greatly altered to suit the application requirements.

The Ural-16 has the largest announced Soviet core memory—said to be 512K. Its typical configuration, however, has a core store of 8K (augmentable to 64K) 48-bit words, also with a 9 microsec cycle time. It is capable of both fixed and floating-point computations at 50,000-70,000 opns/sec. Its modular construction permits the linking of a large number of peripheral devices—as many as are needed for any given application. As with the Ural-14, the Ural-16 can execute seven programs simultaneously.

Design of the Ural-11 and -14 machines was completed in 1963, and their serial production was initiated in 1964-65; a Ural-16 prototype was completed in 1965 and it was scheduled for serial production in 1967; however, mounting evidence suggests that the Ural-16 is not readily available as yet—either Penza is behind schedule or is only able to produce this machine in very limited quantities. Approximately 100 Ural-11s have been manufactured, and close to 200 Ural-14s.

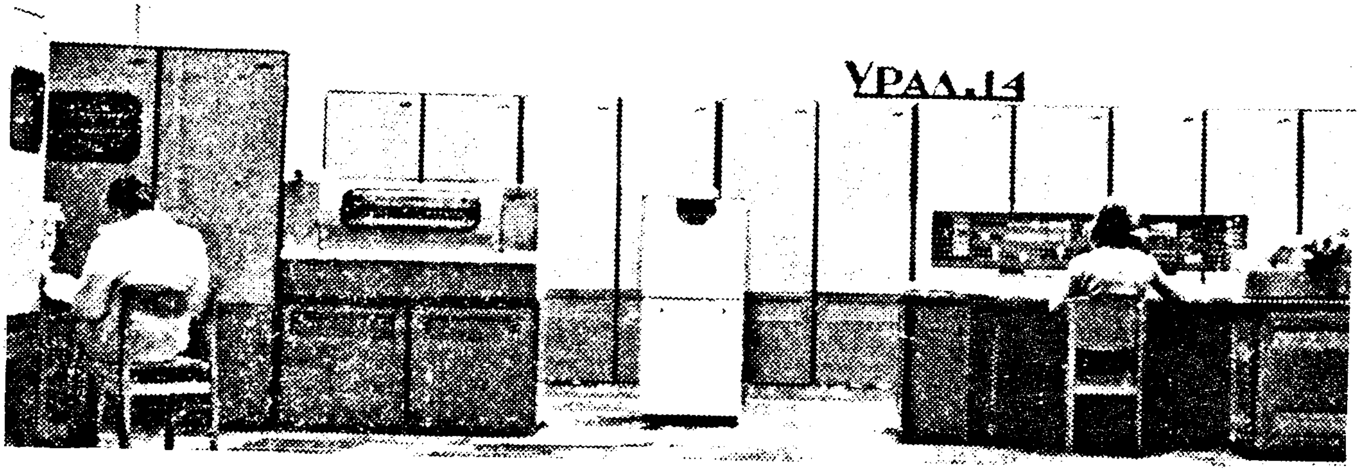
This series was continually being improved during the mid-sixties in an attempt to increase their operational productivity and reliability—e.g., the average operational speed of the Ural-11 was increased to 10,000 opns/sec.

*Soviet designers place considerable emphasis on analyzing the set of problems to be encountered by a given machine, and then developing the most efficient configuration for the given needs.



Ural-4
(File No. 00857P)

Ural-11
(File No. 01245P)



Glushkov and the Ukrainian Institute of Cybernetics

The Institute of Cybernetics of the Ukrainian SSR Academy of Sciences grew out of the group Lebedev headed when designing the MESM. After Lebedev's transfer to Moscow, the group served as a branch organization of the Institute of Precise Mechanics and Computer Engineering. In 1956, the group was organized into an independent Computer Center with Academician V. M. Glushkov as its head. The Center's numerous achievements in the field of cybernetics lead to its expansion in 1962, at which time it was renamed the Institute of Cybernetics.

Upon assuming command in 1956, Glushkov decided the Center should build at least one machine, for the experience. They modeled their computer, the SESM (an acronym for "intermediate electronic calculating machine"), after Lebedev's MESM and BESM-1, as the name suggests. However, the SESM was quite different from its predecessors. Design of the SESM had actually been begun by Lebedev in 1951.

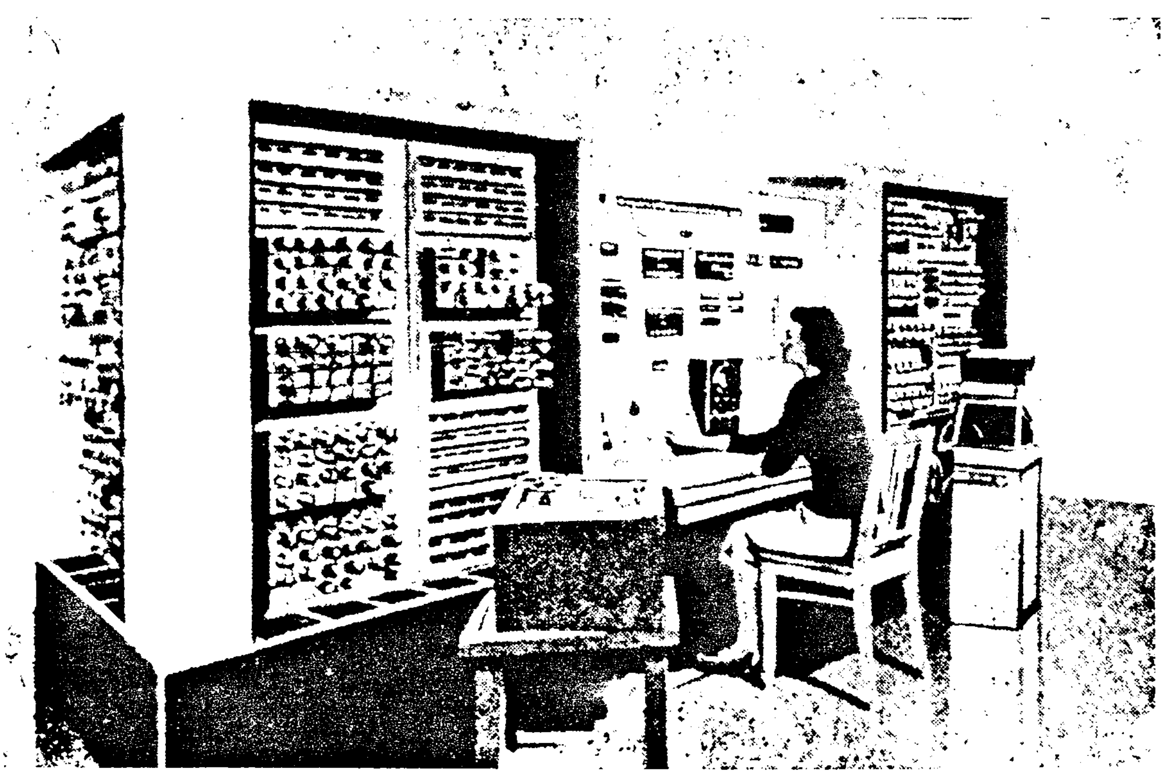
The SESM was a special-purpose, one-of-a-kind digital computer (completed in 1957-58), intended for solving sets of linear equations of orders up to 120, expandable to orders of 480 (the numerical method of solution was based on the Gauss-Seidel iteration technique). The solution of an incompletely specified 18x18 matrix required 148 iterations, or about two hours.

The first serially produced machine designed by Glushkov was the Kiev; design began in 1958 and was completed late in 1959. It became part of the basic equipment of the Institute and has been widely used for the solution of scientific problems and problems related to the planning of the Ukrainian Republic's economy; more recently, it has been applied to production control.

The Kiev is a fixed-point, 3-address, binary, vacuum-tube machine. The principal store is a 2K 41-bit-word ferrite core store of the BESM-2 type. The average operating speed is 5000 opns/sec (asynchronous), and the arithmetic unit is capable of adding, shifting, multiplying, and dividing.

An improved version of the Kiev appeared a few years later. It had a more advanced core store of the same capacity, and the operating speed was increased to 10,000

SESM
(File No. 00365P)



opns/sec. A more extensive checking system was also incorporated—e.g., arithmetic operations were automatically repeated under marginal conditions and the result compared.

In the early sixties, the Soviets recognized the benefits that could be realized from the introduction of computer methods—i.e., automation—to industry, and initiated a large-scale industrial automation effort, which led to the development of numerous production control machines. Glushkov's contributions to this effort were the Kiev-67 special-purpose computer and the Dnepr series of machines.

The Kiev-67, announced in 1967, was specifically designed for controlling cathode-ray technological processes in the production of electronic components. With this machine, the Soviets hoped to further their efforts to achieve totally automated computer production. At the present time, most of their computer components are still being assembled manually, which increases their cost and decreases reliability. Often, the time necessary for the development and production of a digital computer is longer than the time in which it becomes obsolete—three to four years.

Very little is known about the technical specifications of the Kiev-67, except that with just one command the machine is said to be capable of processing any of the six most frequently encountered geometrical shapes of random size (point rasters, rectangles, parallel lines, oblique lines, circles, and all types of planes). By manipulating these shapes and their relationships and by assigning their processing in a predetermined time sequence, it is theoretically possible to develop complex circuits to construct any needed functional unit (module).

The Kiev-67 is currently being used at the Institute of Cybernetics in conjunction with a super-high-vacuum electron-beam unit in an experimental system for microcircuit production control. The Kiev-67 should not be confused with the general-purpose machine discussed earlier, the Kiev; it resembles the original Kiev in name only.

The Dnepr computer, or the UMShN as it was earlier called, was also designed by Glushkov for production control applications. This machine is also referred to as the Dnipro, which is its designation in the Ukrainian language. The UMShN designator identifies it as a general-purpose control computer. Design of the first Dnepr computer, the Dnepr-1, began in 1959, a prototype was operational in 1961-62, and it entered serial production in 1964. It was originally rejected for production, but Glushkov—whose political influence is continually increasing and who is gradually supplanting Aksel Berg as the spokesman for Soviet cybernetics—brought political pressure to bear. B. N. Malinovskij, leader of the group that designed the Dnepr (Glushkov served in an advisory capacity), was nominated for the 1965 Lenin Prize, but was disqualified on the same grounds as was the designer of the M-20 mentioned earlier—the design did not represent any advances over foreign technology.

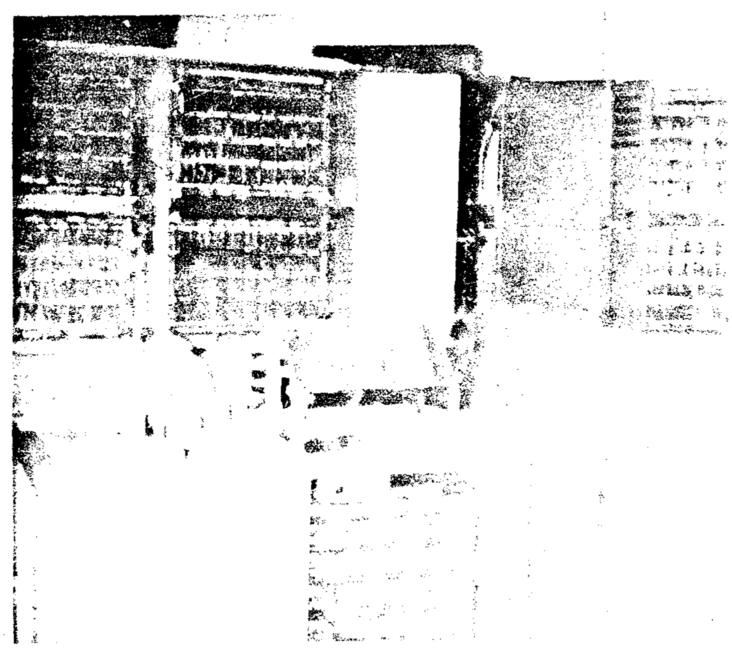
The Dnepr-1 is a small, general-purpose computer with a core store of 512 (augmentable to 2K) 26-bit words and a cycle time of 18 microsec. Its hardware is based on transistors and semiconductor diodes, and it has a relatively slow average operating speed of 10,000-12,000 opns/sec (2-address).

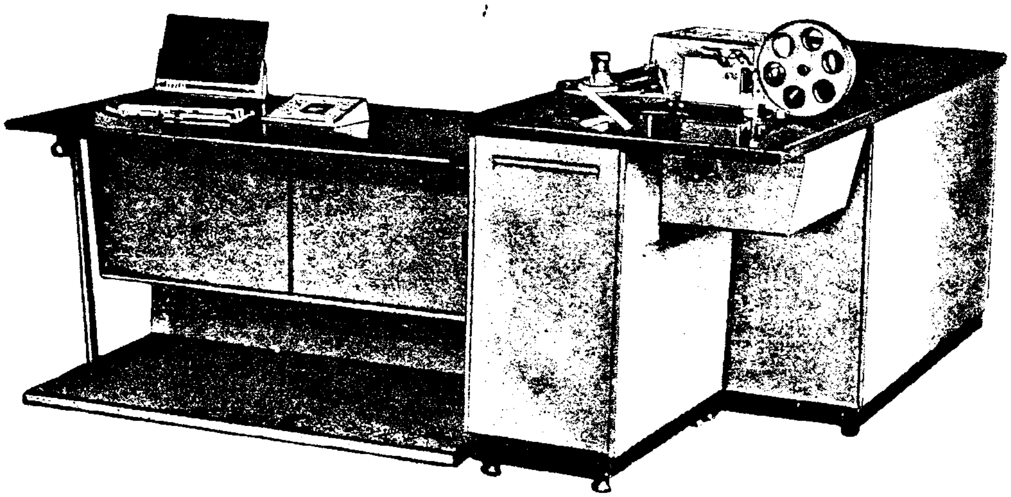
It is designed to control and regulate production processes in various industrial fields. Under program control, it is capable of interrogating up to 250 transmitters of continual action type installed at control points, or up to 1344 of the relay type.

An improved version of the Dnepr-1, the Dnepr-2, appeared in 1964-65, but very little has been published concerning it. It is said to be a highly sophisticated machine, incorporating a number of technological advances. Two slightly modified versions of the Dnepr-2—the Dnepr-21, intended for the collection and processing of a large volume of data, and the Dnepr-22, which effects process control—have been incorporated into a production control system. There has also been speculation of a Dnepr-4 machine in the works.

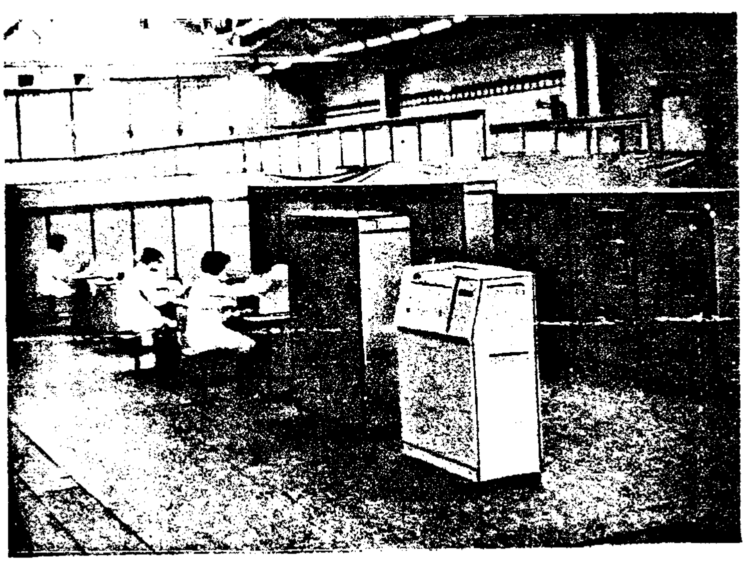
The Ukrainian Institute of Cybernetics is the leading Soviet design agency working on small, personal comput-

Kiev
(File No. 01525P)

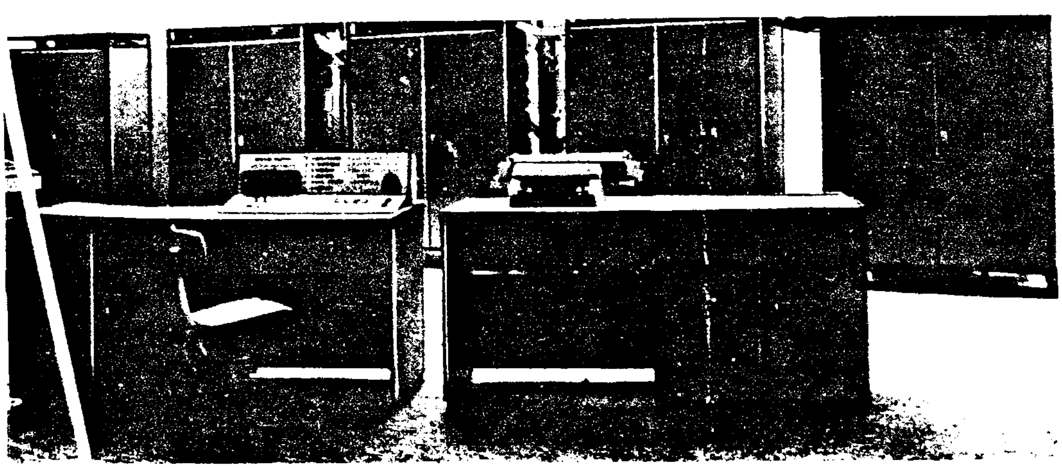


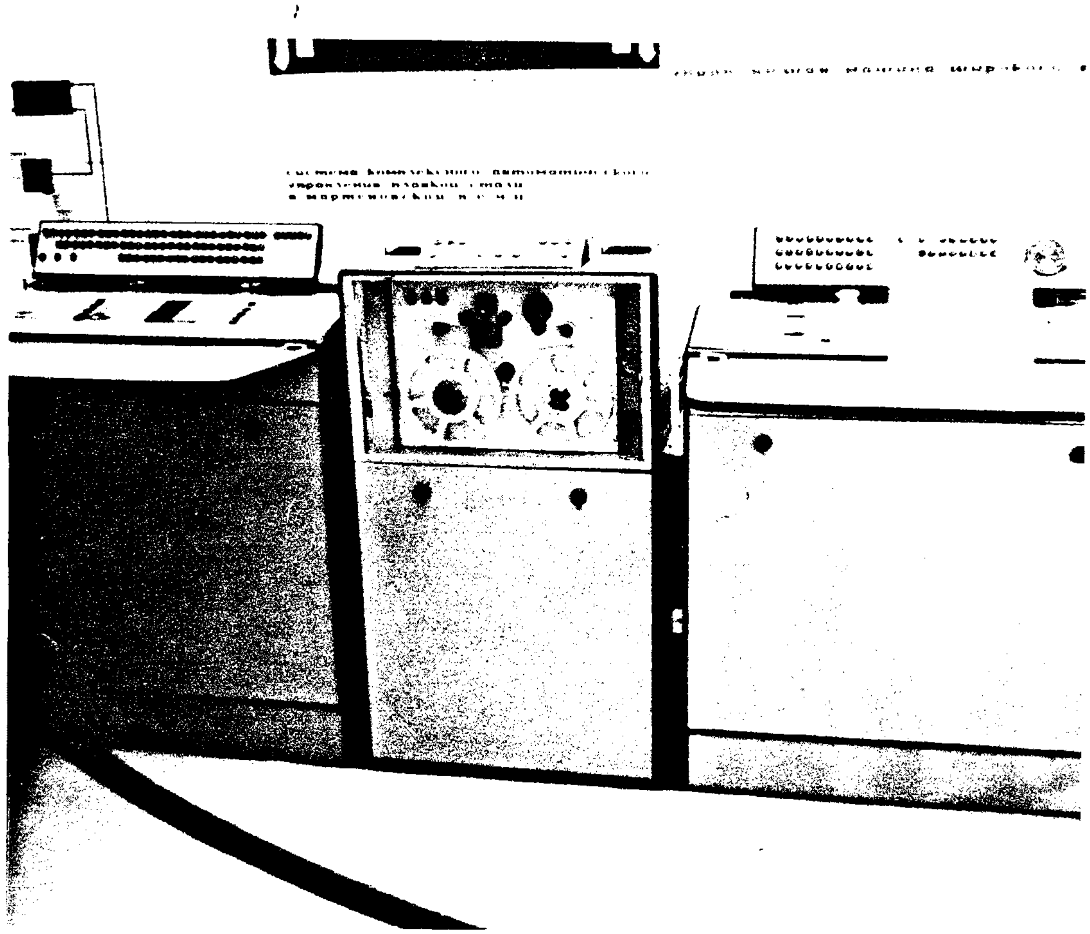


Kiev-67
(File No. 02443P)



Dnepr-2
(File No. 02445P)





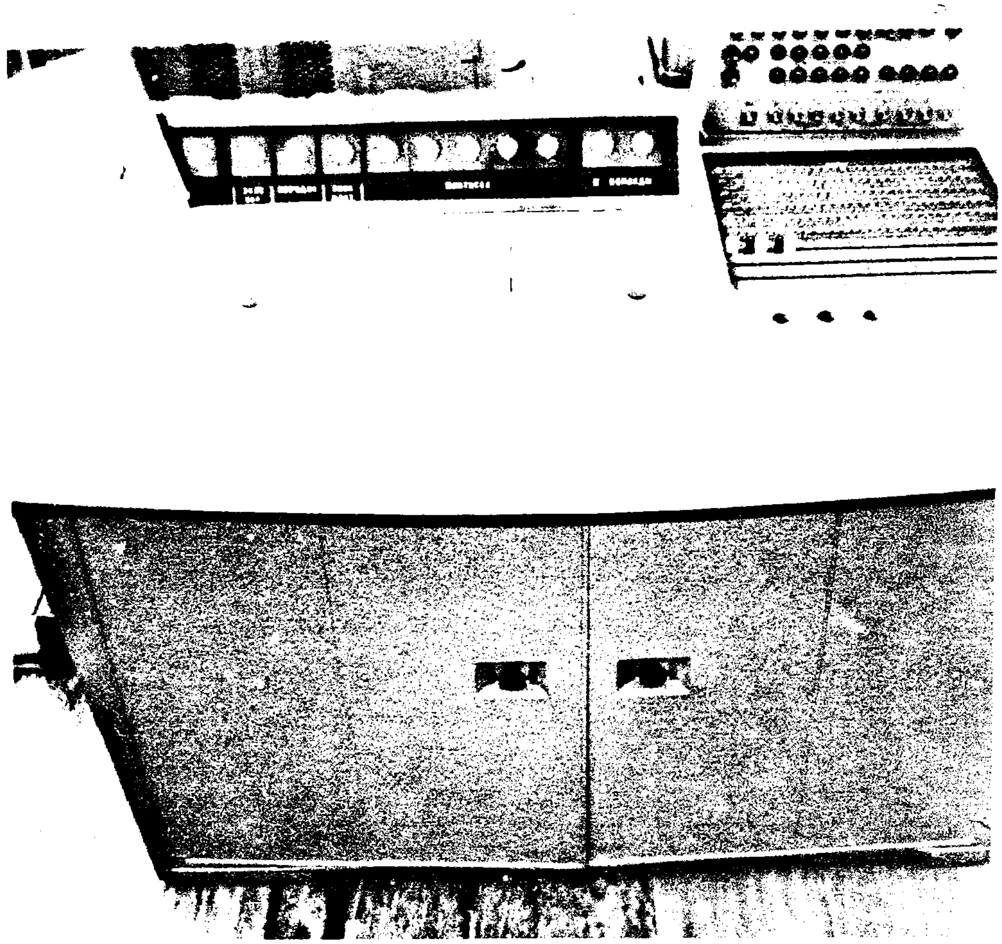
ers for scientific applications. The Promin' and Mir computers designed by Glushkov's group occupy only 5 sq m of floor space and consume less than .5 kw of power.

The Promin' is a floating-point, single-address, binary-decimal, semiconductorized machine. It is capable of 800 opns/sec, and has a core store of 162 32-bit words. Serial production of this machine began in 1965; about a dozen units have been constructed. A slightly modified model, the Promin'-M, appeared in 1967, and was serially produced by the Severodonetsk Instrument Construction Plant in the Ukraine.

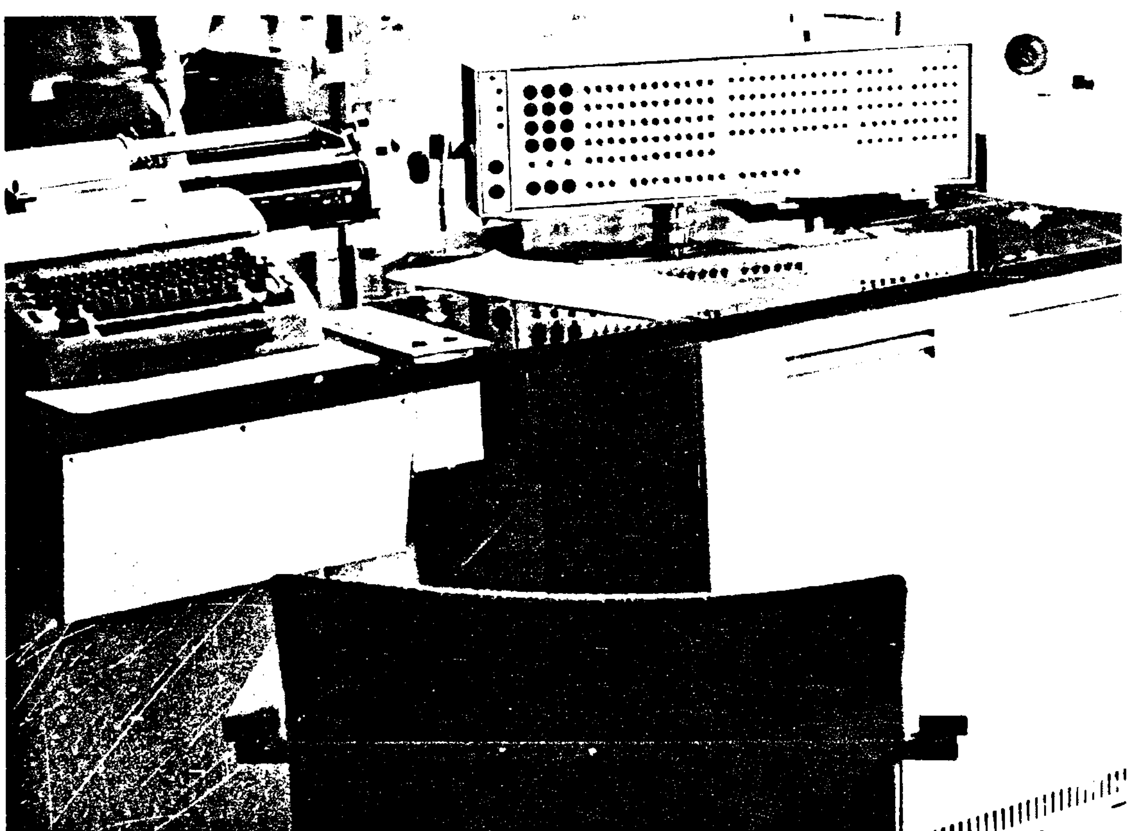
The most advanced computer developed by Glushkov is the Mir model. In spite of its small dimensions, this machine can solve frequently-occurring, sophisticated mathematical problems in a relatively short time; Mir hardware is designed to directly handle complex mathematical functions, such as integration—i.e., the design itself contains the basic programs. It was designed especially for scientific and engineering computations and can be operated quite easily by personnel without a special knowledge of programming since it utilizes a special microprogram control device which integrates the algorithmic language and the machine language, thereby significantly simplifying the programming process.

The Mir-1 (the production version of the Mir) performs 250 opns/sec, and has a core store of 4K (unexpandable) 12-bit words with a cycle time of 24 microsec. It is interesting to note that Soviets frequently refer to the Promin' as a Mir-type machine, although the Promin' predates the Mir (the Mir was announced in 1966, at which time it was assumed to be already in serial production).

In the software system used on the Mir-1, the precision indication is carried at the beginning of the program itself and, thus, the user can change the precision indication when necessary. When this is done, however, the interpretive system operating in the machine must go back and restructure stored data to fit the new precision requirements. The most common mode of use is to have the user enter a program and have it run immediately, but it is said



Promin'
(File No. 01849P)



Mir-1
(File No. 01054P)

to be possible to punch programs on papertape for later reuse.

A follow-on to the Mir computer, the Mir-2, was announced by Glushkov, in the November 8, 1969, issue of *Pravda*. Very little is known at this time about its technical specifications and operating characteristics, but a most intriguing feature has been disclosed—the Mir-2 is equipped with an on-line graphic input terminal and light pen (the first Soviet machine to have such a capability).

Glushkov and his design group were awarded a 1968 USSR State Prize for their work on the design principles and software of the Mir-1 computer—another important feather in the cap of Viktor M. Glushkov; Glushkov was also awarded a Lenin Prize in 1964 for his work in the theory of digital automata.

The Ukrainian Institute of Cybernetics apparently works in close cooperation with institutes and industrial plants located in Severodonetsk, Ukraine—e.g., the Promin'-M computer is manufactured by the Severodonetsk Instrument Construction Plant, which also produces most of the machines designed by the Severodonetsk Scientific Research Institute of Control Computers. Many of the computers developed at the latter Institute have incorporated hardware elements and operational features very similar to those of the Kiev and Dnepr line of computers.

Severodonetsk Scientific Research Institute of Control Computers

As the name implies, the Severodonetsk Institute is a highly specialized research organization engaged in the design and development of control machines; it is under the USSR Ministry of Instrument Construction, Means of Automation, and Control Systems. The Institute occupies a leading role in the USSR's automation effort; it appears to be the center for Soviet ASVT (modular computer systems) work. ASVT represents a large-scale Soviet effort to develop advanced computers that are of modular design and program compatible with the IBM System/360. Since the announcement of System/360 machines, the Soviets have been conducting significant research in an attempt to develop a comparable system, (S. A. Lebedev, after learning of the newly developed IBM system, is said to have proposed an ITM-360 system, a pun based on the Russian initials for the Institute of Precise Mechanics, ITM).

The first system developed by the Severodonestsk Institute (probably before it took on the ASVT project) was the SOU-1 control system, which was developed in 1965 and was displayed at the 1966 Interorgtekhnika Exhibit in Moscow. The three-machine system, composed of the MPPI-1, UM-1, and KVM-1, was intended for process control applications in a hierarchical mode (with the KVM-1 as the executive computer), but the machines were not compatible—e.g., they had incommensurate word lengths. The hierarchical mode of operation is a 3-stage scheme: In the first stage, sensors are fed into MPPI-1 machines located nearby (for analog-to-digital conversion)—at this level, one machine can accept responsibility for the sensors of a neighbor in order to improve reliability; in the second stage, UM-1 machines accept inputs from and supervise a pair of MPPI-1s—here, also, a neighbor can pick up the load; in the final stage, the KVM-1 supervises the entire operation and can pick up stage-2 loads if failure so requires. The distance between the KVM-1 and the process itself can be up to 15 kilometers.

The MPPI-1 is capable of operating in several modes: as an automatic centralized information collector through the programmed interrogation of sensors; as a mathematical processor of streams of parameter values; as a device for outputting information to an operator on the status of basic production processing equipment; as an alarm device in the event of technological failures; and as a transmitter of data to other units of an operational control system, such as the SOU-1.

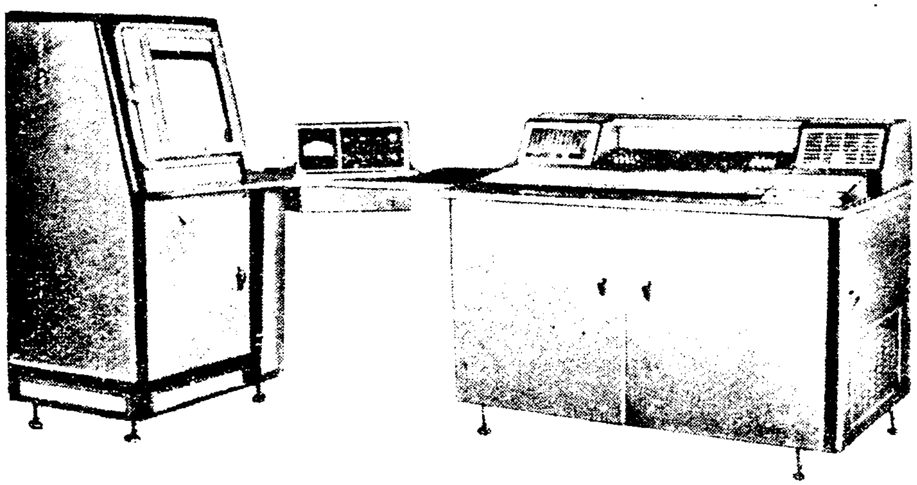
The MPPI-1 is a single-address, fixed-point, binary machine which performs 900 additions/sec. Primary storage is on ferrite cores with a capacity of 512 26-bit words. Design was completed around 1962-63.

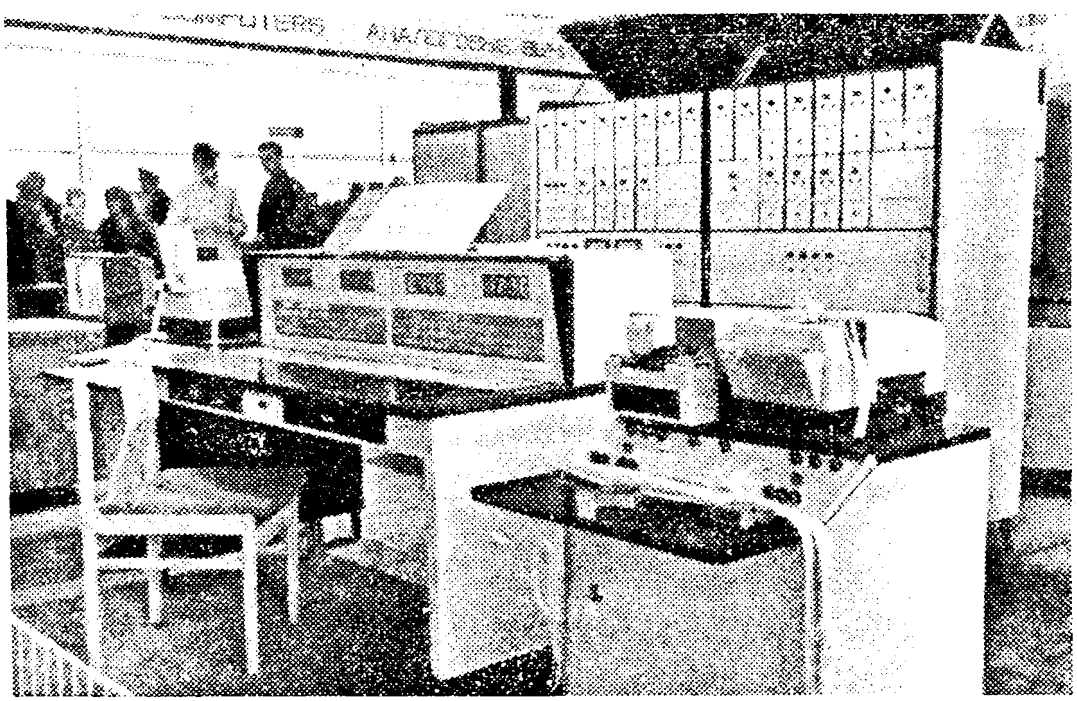
The UM-1 ("UM" stands for "control computer") is intended both for independent operation and as part of the SOU-1 system. The computing unit has 30 different arithmetic and logical operations, with fixed-point binary data representation; address modification is accomplished with the aid of index registers. It also has an interrupt system with 16 priorities and capability for automatic indexing of instructions, with up to six different index quantities available for use in each program.

Up to four main memory units can be used, each with a capacity of 1024 21-bit words. Average operating speed of the machine is 250-300 opns/sec (or 900 additions/sec). The computer's basic logic elements are in the form of a magnetic core-diode matrix based on 3-phase shift registers with phase-overlap, along with ferrite-transistor decoders with magnetic bias and semiconductor gates. It appeared at about the same time as the MPPI-1.

The third machine in this group, the KVM-1, is a rather advanced and highly sophisticated (by Soviet standards) general-purpose computer, specifically designed to be the executive machine in the SOU-1 system. The date work began on this computer is not known, but it was put into serial production in 1965.

The KVM-1 includes such features as instruction look-ahead (similar to the STRETCH computer) where it examines up to seven instructions, both direct and indirect addressing (indirect addressing is multilevel), and additional KVM-1s can be connected to form multiprocessor





systems (usually, this connection is made over one of the 64 automatic I/O channels). It has six index registers, four of which are used as base registers, and two as modifier registers. The instruction set permits double indexing. I/O is overlapped with computing operations (a feature not found in many of the earlier Soviet machines).

The KVM-1 is a single-address, floating-point, binary machine capable of performing 100,000 additions/sec. It has a ferrite core memory with a capacity of 32K 50-bit words (half-words are also directly addressable) and a cycle time of 8 microseconds. Secondary storage capacity is at a maximum of 20 million words.

A general-purpose configuration consists of the 32K main memory, four magnetic tapes, a line printer, a card reader, and a card punch. This would cost over one million rubles, far more than figures given for any other Soviet computer configuration except the BESM-6, which costs over three million rubles.

The SOU-1 system, however, apparently exists only in theory. There is no evidence that the system is actually in use; only vague descriptive references to the SOU-1 system have appeared in the Soviet literature. Perhaps they were unable to integrate the three machines (which, at first glance, seem to be incompatible) into an efficiently functioning network, or the SOU-1 system project could have been combined with the ASVT project, which was assigned to the Severodonetsk group in 1965; the largest machine developed as a result of the ASVT work, the M-3000, is remarkably similar in performance to the KVM-1.

Serial production of three additional computer models —M-1000, M-2000, and M-3000—developed by the same organization was announced in 1969. These models are the first known products of Soviet ASVT research, but were designed principally for process control applications. Being of modular design (modeled after the IBM System/360), they can reportedly be configurated into any required multimachine system. Word lengths of these machines reflect the ASVT adherence to 360 standards. Nominal word length is 32 bits, with 16-bit half-words and 64-bit double-words also directly addressable. Each 8-bit byte also includes a parity bit, increasing the total number of bits-per-word to 36.

A very interesting characteristic of these machines is that their hardware is based on the logic elements of the Mir-1, further evidence of collaboration between Glushkov's Institute and the Severodonetsk group. Such an affiliation represents a significant break in tradition; the Institute of Cybernetics has never been known to work on the development of large computers or systems, and Soviet research institutes are usually very competitive (much like U.S. industrial laboratories) and do not share their discoveries with other organizations unless ordered to do so by the State. In the past, computer design projects of such great importance as ASVT have tended to be assigned to Moscow—primarily to Lebedev's Institute of Precise Mechanics and Computer Engineering.

Although these machines are the product of a modular design effort, they exhibit some serious inconsistencies. For example, the Soviets have stated that not all of the peripheral devices developed for this series are "compatible with any one of the currently existing models." And, the instruction repertoire for the M-1000 machine is not the same as that for the M-2000 and M-3000.

The M-1000 computer is specifically intended for automated process control applications. In a multiprocessor, hierarchical system, it can be used at the lower level, or as a slave machine to the M-2000 and M-3000 computers. The M-1000 CPU operates in a general-purpose instruction system mode, facilitating the execution of arithmetic (fixed-point), logic, operand transfer, control, and multiprogramming operations; the total instruction repertoire consists of 28 commands.

The M-1000 has a 1K (augmentable to 32K) 16-bit-word core store with an 8-microsec access time, and can perform 20,000 additions/sec. Up to eight control units with a total of up to 256 addressable I/O units can be connected to its CPU.

In addition to the features found in the M-1000, the M-2000, and M-3000 have an interrupt system, memory protection (necessary for multiprogramming or time sharing), and overlap of I/O operations with CPU processing. The CPUs of both models operate with the same instruction system, except that some operations (e.g., the processing of decimal and symbolic data) which extend the range of problems that can be machine computed are executed by a microprogram in the M-2000 model and by special hardware in the M-3000 model. Main memory of both models consists of immediate-access storage units with a capacity of 8K 36-bit words and an 8-microsecond cycle time, and read-only storage units with a capacity of 8K 36-bit words and a cycle time of 3 microsec; the memory of the M-2000 can contain as many as six storage units, while that of the M-3000 as many as eleven—in any combination of immediate-access and read-only units.

The M-2000 has an average operating speed of 27K opns/sec (40K additions/sec; 10K-15K multiplications/-sec), while the M-3000 model's average operating speed is about 60K opns/sec (100K additions/sec; 25K fixed-point multiplications/sec; 40K short-word, floating-point, additions/sec; 25K long-word, floating-point, additions/sec; 15K floating-point multiplications/sec; and 70K logical and control opns/sec).

The M-3000 is currently being incorporated into the Sirena automatic ticketing and seat reservations system being developed for Aeroflot, the Soviet airline. The M-

3000 will serve as the executive computer in the Sirena system, which will also print out the actual tickets at the reservations counter. The Institute of Automation and Remote Control in Moscow, among others, is responsible for the development of this system.

The Ryad Project

The Ryad project represents what is believed to be a separate Soviet effort to develop System/360-compatible computer hardware. The Ryad machines will probably incorporate some monolithic integrated circuit technology (perhaps utilizing American-made circuits imported via Finland), and will include models capable of performing 200,000-3 million opns/sec.

The first hint of Soviet attempts to "leap into the third-generation" appeared in October 1967, when the Deputy Minister of the USSR Radio Industry made reference to "work underway in our country in support of so-called 'third-generation' computers, based on integrated circuits." This reference was very likely to the Ryad project, and suggests that work on this project began in 1967 or earlier.

A report in the September 1969 issue of *Datamation* magazine identifies Ryad as a joint project of six Soviet bloc countries to develop third-generation machines. According to a later article in *The Economist* (October 18, 1969), the Czechs, East Germans, and Poles were assigned the responsibility for the manufacture of small processors and peripherals; the Hungarians, for the bulk of the software; the Bulgarians and Romanians, for the manufacture of some of the minor sub-components; and the Soviets were to be responsible for all major design and development work, in addition to underwriting and supervising the entire project. However, numerous disagreements among the member countries have developed as to the handling and financing of the project, and it is not known at this time whether or not they have been resolved. The Minsk Ordzhonikidze Plant was identified as the headquarters for the Ryad project.

According to the same article, the project was devised without a full-scale feasibility study or cost projection. The Soviets assumed that by 1975 they would have a network of 800 linked, Ryad-equipped, regional data processing centers, and would be meeting the commercial and scientific computing needs of all the East European countries as well as their own. The Soviets estimated that they would catch up with American technology by 1980; by then, assuming the American computer population peaks out at 38,000 in 1971, the number of computers in Eastern Europe (according to the Soviets) would equal the number in the U.S.

The Economist article suggests that the USSR lost the moon race because of a lack of reliable, large-capacity computer systems comparable to those employed in the American space effort, and that the Ryad project represents a Soviet effort to overcome this shortcoming. The USSR was also unable to build microminiaturized computers of the type found on Apollo spacecraft, and, as a result, the machines on board Soviet spacecraft occupy a greater percentage of the disposable payload and process considerably less data.

There are indications the Ryad project is encountering serious difficulties. *The Economist* article presents the argument that, for the past year, the Soviet press has repeatedly hinted that the project was almost complete, and yet design completion still has not been announced. In detailed briefings given to certain Comecon countries, the Soviets indicated that the project would be completed by May 1969; then the target date was changed to July. As of this writing, the USSR still has not made any encouraging announcements as to the success of the project. Further, the Soviets have placed an order for five computers from ICL of Britain, scheduled for delivery within the next two years, at a cost of five million pounds. These machines are said to be for state planning applications, suggesting that they are being purchased as insurance against failure or significant delay in the Ryad project.

S. N. Mergelyan and the Armenian Institute of Computing Machines

Only a short time ago there was not a single enterprise of the radio and electronics industry located in the Armenian Republic. Today, however, Armenia has its own research institutes, design bureaus, and applied laboratories, which conduct research in various fields of electronics and radio technology. In addition, the Republic's electronics industry has expanded geographically, and is no longer concentrated in Erevan. Dozens of other Armenian cities have developed industrial plants and factories for the production of numerous items. A short distance from Erevan, a new industrial center, the Abouyan Industrial City, has already been completed.

Armenian industrial expansion was a by-product of the efforts of a small group of electronics specialists (lead by S. N. Mergelyan) of the Computer Laboratory of the Institute of Mathematics and Mechanics of the Armenian SSR Academy of Sciences to organize a Republic computer research institute. As a result of their efforts, the Institute of Computing Machines was founded in 1956-57, and Mergelyan was appointed as its Director.

Three years later (in 1959-60), the new Institute completed the design of the Armenian Republic's first computers—the Aragats (8000-10,000 opns/sec; ferrite core store with 1K capacity and 16-microsec cycle time), a vacuum-tube machine similar in design to the M-20; the Ararat, a lower-capacity version of the Aragats; and the Erevan, a small, one-of-a-kind, vacuum-tube machine.[7] The machines were intended for process control applications, but very few were built; they lost out to the VNIEEM and Dnepr line of computers.

The Institute of Computing Machines was one of the first in the USSR to abandon the use of vacuum tubes in electronic devices; its designers concentrated on developing fully-transistorized machines. And, in 1961 at the Exhibition of National Economic Achievements in Moscow, the Institute displayed the USSR's first totally transistorized computer, the Razdan-2, which was put into serial production at an Armenian plant in 1962-63. A prototype of the Razdan-2, the Razdan-1, was completed in 1960, but was never serially produced.

The Razdan-2 is a small, 2-address computer, capable of 5000 opns/sec. It has a ferrite core store with a capacity of 2K 36-bit words and a cycle time of 24 microsec, and an external store capacity of 120,000 words on magnetic tape.

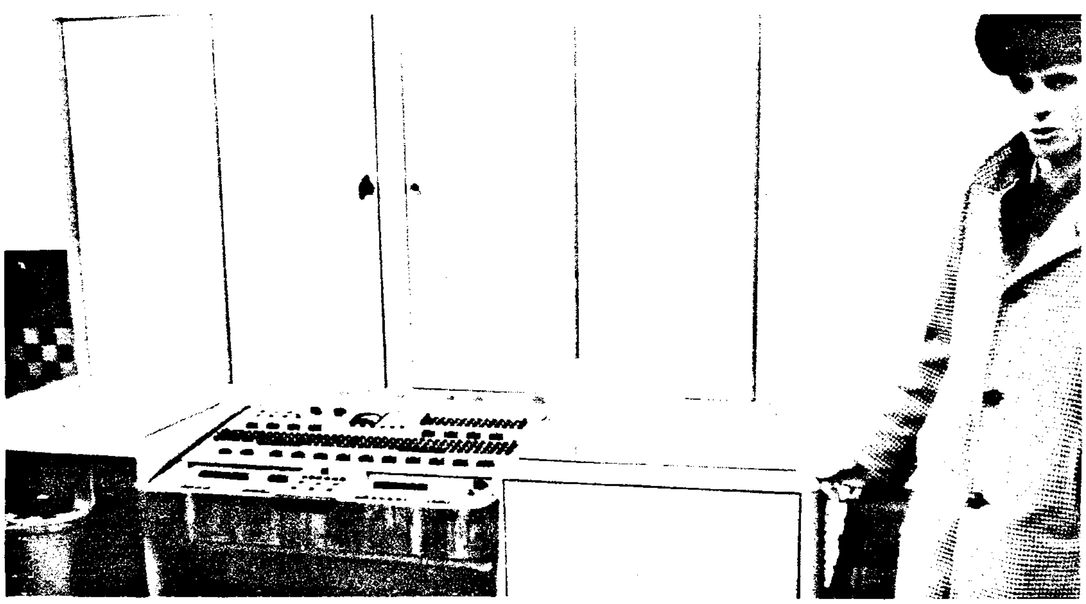
In 1965, the Institute announced design completion of a much larger machine, the Razdan-3, which entered serial production in 1967. The Razdan-3 is a totally different machine from the Razdan-2. Its hardware is of a more sophisticated nature; the core store is both larger and of a more advanced design; its secondary storage capacity is more than two orders of magnitude greater; and its operating speed is five times greater. Over 150 of these models have been constructed, and are being sold at 100,000 rubles per unit.

The Razdan-3 is a 2-address, floating-point, binary, fully-transistorized machine. Its average operating speed is 20,000-25,000 opns/sec, and its core store capacity is 16K (augmentable to 32K) 48-bit words with a cycle time of 8-10 microsec. Secondary storage capacity is 10 million words on magnetic tape and 100,000 on magnetic drums. It requires 160 sq m of floor space (the BESM-6 occupies 200 sq m) and consumes 50 kw of power (the BESM-6 consumes 20 kw). A follow-on to the Razdan-3 is in the works at Mergelyan's Institute. The Razdans are intended for the solution of scientific and engineering problems in computing centers, scientific research organizations, industry, and university laboratories and design centers.

In 1964-65, the Institute turned its attention to developing integrated circuit hardware, and was successful; in 1968-69, Mergelyan's Institute completed work on the Nairi-3 computer, which is the first USSR computer to utilize integrated circuit components. The Nairi-3 is said to be four times smaller than its predecessors and can be time-shared to serve 64 users simultaneously; it can be equipped with remote terminals for data I/O.

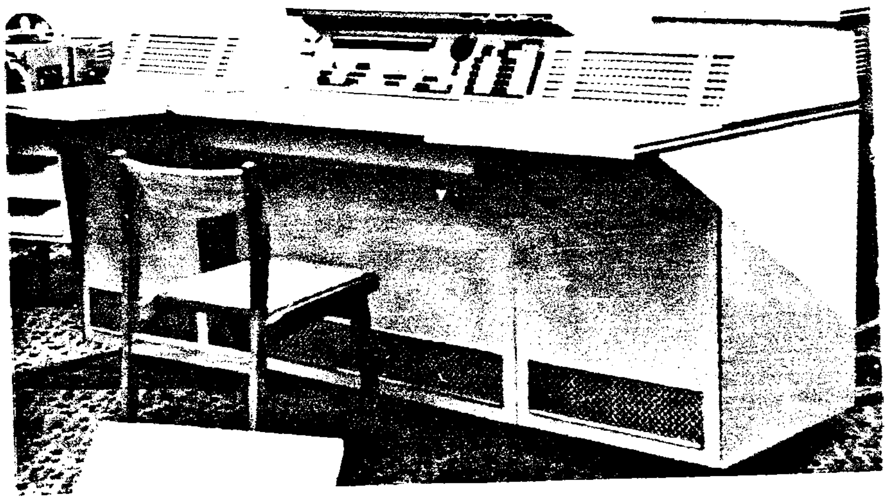
The Nairi-3's immediate access storage capacity is 4K words (augmentable to 32K); its read-only memory unit is said to be capable of storing an additional 32K words. It can perform 15,000-20,000 opns/sec, and is said to be able to read programs written in the languages of other machines.

The first machine in the Nairi series, the Nairi-1, was completed in 1964 and was put into serial production in 1965. It was a very successful production machine (over 500 were manufactured—more than any other Soviet ma-



Razdan-2
(File No. 01849P)

Nairi-1
(File No. 01855P)



chine). It was simple to construct and was quite reliable (by Soviet standards).

The average operating speed of the Nairi-1 was 2000 opns/sec (2-address); its ferrite core memory had a capacity of 1K 36-bit words with a cycle time of 20 microsec; the hardware was fully transistorized. Overall, it was similar to the IBM 1620.

An interesting feature of the Nairi-1 is the claim that programming is done automatically. Problems are input in a language close to that of mathematics and are solved without preliminary preparation. All that is needed is to introduce the necessary coefficients and initial data, and the machine solves the problems automatically by means of an internal library of subroutines. It was designed to solve engineering, scientific, and economic problems.

A slightly improved version of the Nairi-1, the Nairi-2, appeared in 1966-67. It differed from the Nairi-1 primarily in its use of printed circuits, which facilitated further miniaturization of the unit and provided greater reliability. The core store capacity of the Nairi-2 is 2K 36-bit words, and it performs 4000 additions/sec.

V. V. Przhiyalkovskij and the Minsk Ordzhonikidze Plant

The first electronic computer constructed in Belorussia was the Luch; it was designed in the late 1950s (design work began in 1954-55) at the Belorussian SSR Academy of Sciences' Institute of Physics and Mathematics, under the direction of Ivan V. Lebedev (no relation to S. A. Lebedev, designer of the BESMs). The Luch is a small machine capable of performing about 4000 additions/sec; it is similar to the Mir in that the solution of certain complex mathematical functions is designed into the hardware—e.g., the extraction of a square root is a one-step operation. It was specifically designed for process control applications in the chemical industry. Very little else is known about the machine, but it is doubtful that it was ever serially produced.

The most significant computer research in Belorussia is conducted at the Minsk Ordzhonikidze Plant. The importance of this plant lies in that it is the home of the Minsk series of computers—one of the most widely available and widely used series of computers in the USSR, particularly the Minsk-22 model. The Minsk line is both designed and built at this plant. V. V. Przhiyakkovskij is the head engineer of the plant's design bureau; he is assisted by an experienced staff of designers, such as G. D. Smirnov, N. A. Mal'tsev, V. K. Nadenenko, and others.

Work on the first Minsk machine, the Minsk-1, began around 1956 and was completed in 1958-59; serial production began in 1960 and about 200 units were built. The Minsk-1, as are all the Minsk machines except the -23 and -32 models, is designed for process control applications.

The Minsk-1 is a low-capacity, 2-address, fixed-point, vacuum-tube machine capable of performing 2000-3000 opns/sec (other machines in the Minsk series are of medium-capacity and utilize transistors and semiconductor diodes in their hardware). Its core store has a capacity of 1K 31-bit words with a 25 microsec cycle time; maximum secondary storage is 64K via magnetic tape.

Work on the Minsk-2, which was completed in 1961, was begun immediately after Minsk-1 design completion; it was put into serial production in 1962 and close to 300 units were manufactured. The Minsk-2 is of a very much more advanced design; it is a medium-capacity machine with fully transistorized logic and operates in both fixed-and floating-point modes. It is a binary, 2-address machine with an average operating speed of 5000-6000 opns/sec. The memory is ferrite core with a capacity of 4K (augmentable to 8K) 37-bit words and a cycle time of 24 microsec. The Minsk-2 design permits overlapping I/O operations with CPU processing.

The successor to the Minsk-2 was the Minsk-22, which differs from the earlier machine mainly in its use of superior I/O equipment. The Minsk-2 had only four paper-tape drives, while the Minsk-22 can be hooked up to as many as 16 magnetic tape units, each with a capacity of up to 100,000 37-bit words; exchange rate with core is 2500 words/sec. A prototype of the Minsk-22 appeared in 1963, and serial production began in 1965. Well over 300 units have been built. Between 1961 and 1964, several other Minsk models—Minsk-11, Minsk-12, and Minsk-14—appeared, but little is known about them and few were built. A slightly modified Minsk-22, the Minsk-22M, was designed in 1965-66 for the solution of engineering problems.

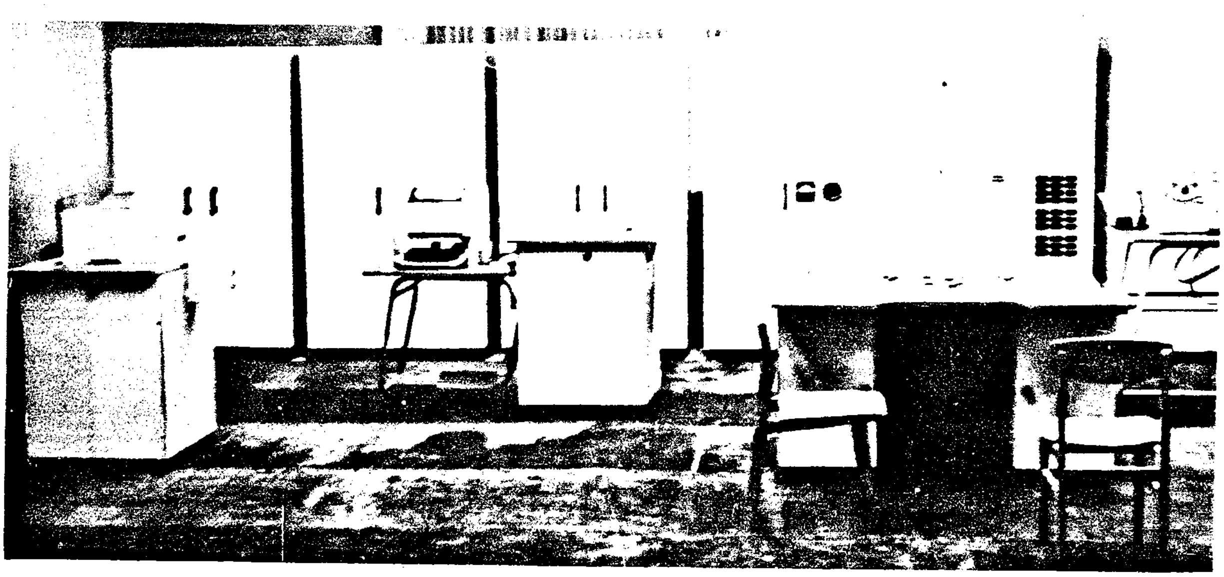
Another version of the Minsk-22, modified to improve information processing performance in business and management applications—i.e., accounting, economic planning, etc.—was designed in 1964, but was not serially produced until 1966-67. The Minsk-23, as it was called, is equipped with special I/O units allowing input directly from source documents without the use of punchcards; the exact nature of these units is not known—i.e., whether they are optical scanners or operate on some other principle. It accepts input in decimal as well as binary form.

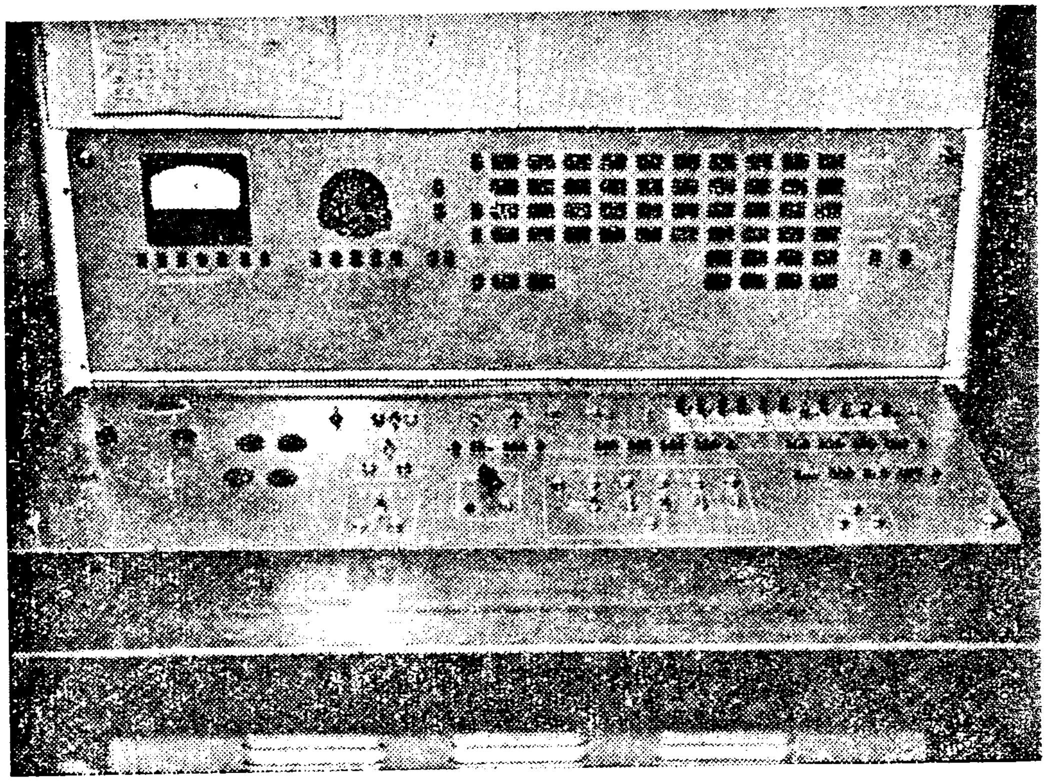
The core store of the Minsk-23 can accommodate 40K characters and has a 26-microsec cycle time; it is the only known Soviet machine capable of handling variable word-lengths. Its operating speed is approximately 2500 opns/-sec.

The largest and fastest computer in the Minsk line is the Minsk-32; it differs significantly from its predecessors, the Minsk-22 and Minsk-22M. Its 32K memory capacity is eight times greater (augmentable to 64K); the processing speed is considerably increased (30,000-35,000 opns/-sec); it operates in true parallel mode (all other Minsk models performed sequentially—only the Minsk-22 and 22M had some overlap between input and processing operations); it can process three or four problems simultaneously; and, using special commutators, it is possible to connect up to 136 I/O devices (almost ten times more than before), including additional magnetic tape and drum stores, various devices for receiving information from telegraph and telephone channels, special sensors, etc. These features facilitate the solution of a wide range of problems in various fields, in contrast to the purely engineering problems solved with the Minsk-22M; it is program compatible with the Minsk-22M. The Minsk-32 was first announced in 1967, and went into serial production in 1968-69.

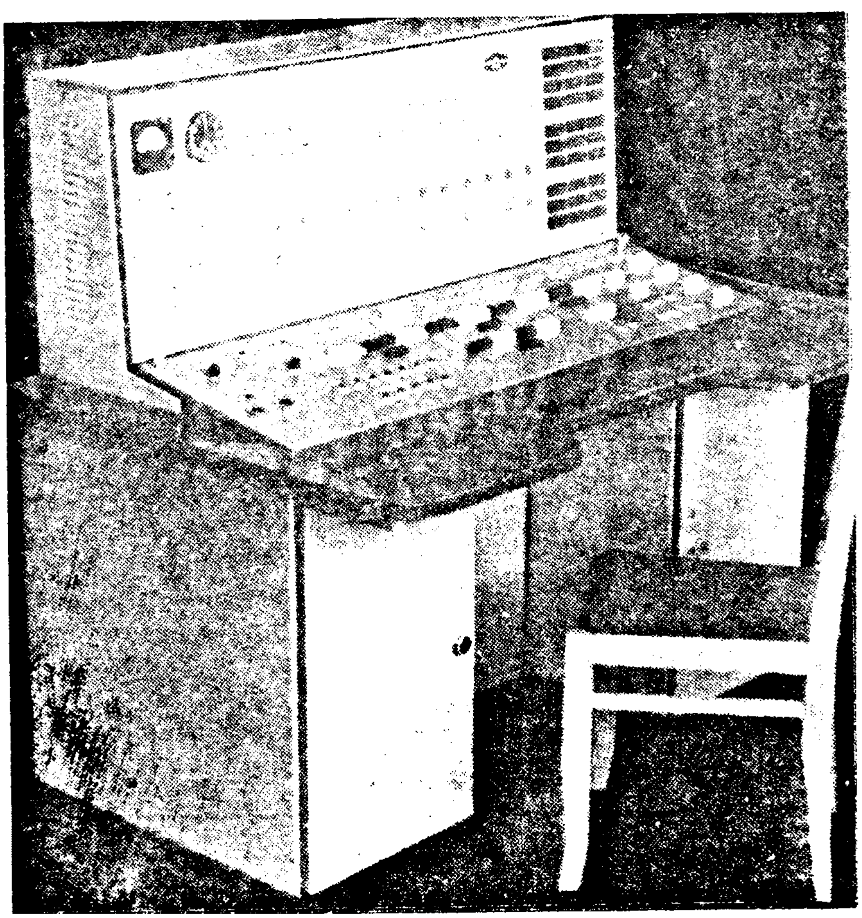
E. V. Evreinov and Yu. G. Kosarev have been experimenting with the design of a multimachine system known as the Minsk-222. The goal of their project was to achieve high productivity through the organization of several Minsk-2 and Minsk-22 computers into a homogeneous

Minsk-22
(File No. 01855P)

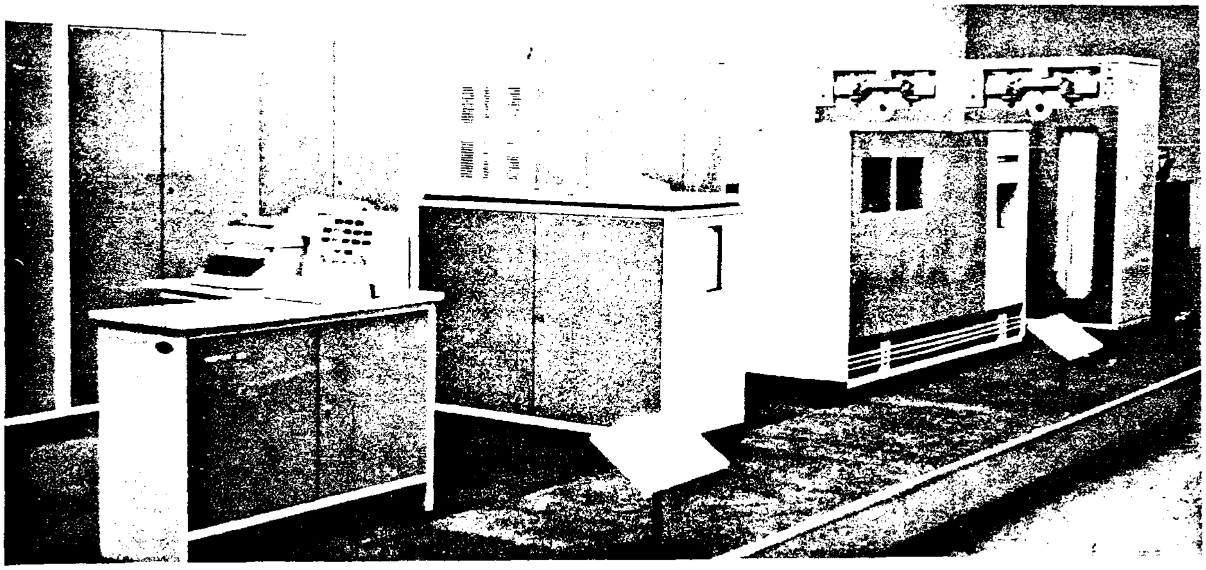




Minsk-1
(File No. 02525P)



Minsk-2
(File No. 00672P)



Minsk-23
(File No. 01855P)

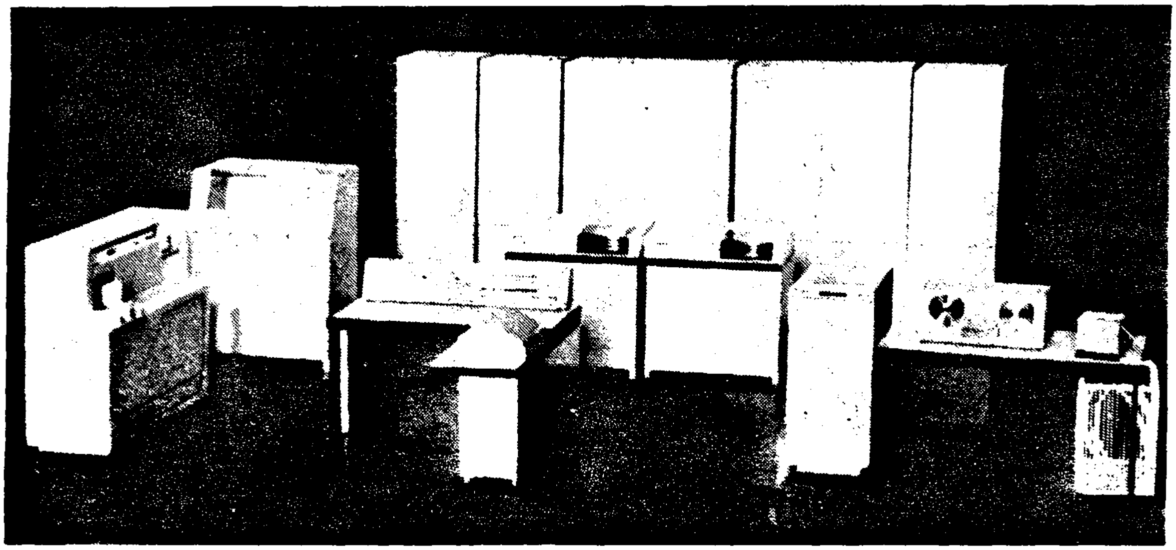
system. The Minsk-222 system was reported, at the General Meeting of the USSR Academy of Sciences in March 1968, to be in the testing stage (on the basis of two Minsk-22 machines and a single Minsk-2). It was reported that productivity could be increased by 1.5-38 times over that attainable in a single machine. However, the documentation provided by Evreinov and Kosarev did not seem to bear out their claims. Evreinov and Kosarev continue to publish articles on their project, but they all simply rehash the original findings and projections. There are indications that this multimachine-system project has been abandoned.

Sigma Association of Lithuania

The Sigma Association is a combine of industrial enterprises engaged in the development and production of computer hardware; it was the USSR's first combine to specialize in this area. Sigma was founded in Vilnius, the capital of Lithuania. The industrial enterprises in the Association were initially engaged in the manufacture of simple calculators, which provided them with some background experience for the development and manufacture of more complex machines. In the early sixties, the members of the Association launched a project to develop a multiconfiguration computer complex, the Ruta-110, which became operational around 1964-65 and entered serial production in 1965-66. Construction of a Ruta prototype was done in parallel with design, thereby greatly decreasing the time required for development.

The Ruta-110 is a low-capacity computer system; the

Minsk-32
(File No. 02192P)



Ruta-110D
(File No. 02446P)

CPU has a core store of 16K characters and operates at about 2000 opns/sec. The Ruta can be time-shared to accommodate up to five subscribers, via telephone and telegraph channels.

The Ruta-110 represents a Soviet effort to overcome the inadequacy of their peripheral equipment—primarily, I/O devices and secondary storage. It is the first Soviet computer to be so well provided with fairly reliable peripheral equipment.

The Ruta-110 complex is composed of fourteen devices—magnetic tape drives, punchcard and papertape readers, a rudimentary optical scanner (the Ruta-701), and others—with various functions that are all integral parts of the basic structure and can be configurated in any fashion necessary for any given application (it is mainly intended for process control applications).

Numerous configurations of the Ruta complex are possible—each is designated by a literal following the name of the complex—e.g., Ruta-110I is the information-processing version; Ruta-110K (the smallest of its modified versions) is called the card model because it uses punchcards and papertape as storage media; the Ruta-110D is said to be equipped with magnetic disc storage; and several other configurations.

Although the 110D has been announced as having disc storage, there are indications that the disc unit is not yet available. The 110D version was supposed to be on display at the Automation-69 International Exhibition held in Moscow in May 1969; however, no Western observer reported seeing it. And a recent Soviet newspaper article suggested that the disc unit was still in the process of being developed; the article stated that the organization entrusted with the task of developing the disc unit for the Ruta ran out of funds before completing the job and had to turn over the task to another organization for completion.

VNIIEM and UM-1-NKh Production Control Machines

The only important Soviet computers not yet discussed are the VNIIEM and UM-1-NKh series of production control machines. The abbreviation VNIEEM stands for the All-Union Scientific Research Institute of Electromechanics—the designer of the VNIIEM series. The first VNIIEM machine, the VNIIEM-1, was designed in 1962-63, but was outclassed by machines of the M-220 and Minsk-22 type. This led to the development of the VNIIEM-3 in 1966, which was a very much improved version of the VNIIEM-1.

The VNIIEM-3 was able to function in a real-time mode in controlling industrial processes—i.e., it reacted to various situations arising from the controlled processing by issuing appropriate corrective commands; it was also provided with program-interrupt capabilities, permitting the machine upon receipt of appropriate external signals to digress from the current program and to carry out actions specified by the interrupt signal.

The basic configuration of the VNIEEM-3 includes a 40,000-opns/sec CPU which functions as the central control for all devices in the configuration; a general-purpose converter for communication between the CPU and the 500-channel analog-digital-analog converter; a start-stop photo-input unit for handling data input from papertape at a speed of 1000 words/sec with the ability to halt on any byte; a papertape perforator for handling data output from the CPU to papertape at a speed of 20 bytes/sec; an electric typewriter or teletype for outputting alphanumeric data; and an interrupt block which, together with the CPU, can execute program interrupts on the basis of external signals. The expanded configuration can include several general-purpose converters, photo-input devices, magnetic-tape secondary storage units, alphanumeric lower-case printers, external ferrite-core memory units for expanding the machine's main memory, etc.

The VNIIEM-3 is a fixed-point, single-address, binary machine, with a core store capacity of 4K (expandable to 28K in modules of 8K each) 24-bit words and an 8-microsec access time. It is capable of operating in a multimachine mode—with up to a maximum of six units. The VNIIEM-3 is fully compatible with the earlier version, and many of their components are interchangeable.

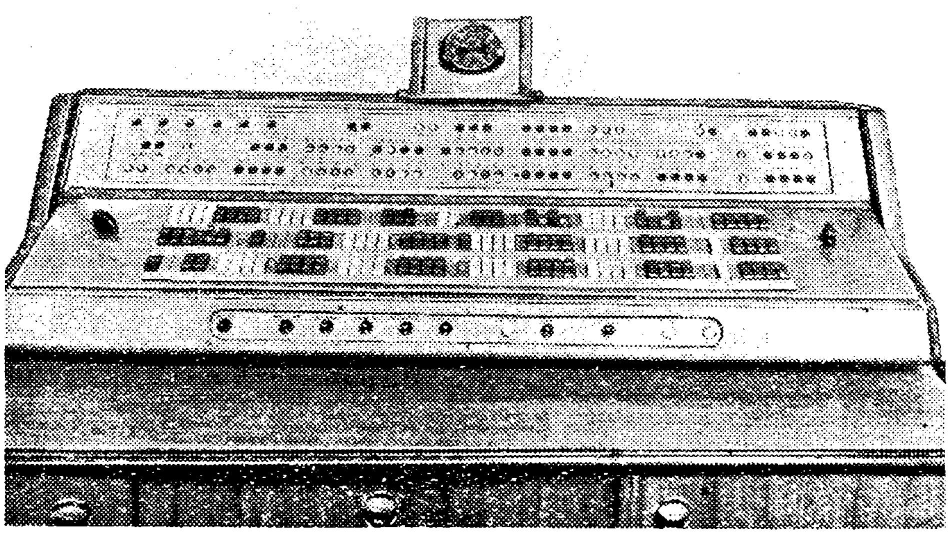
The VNIIEM-3 is an "orphan" computer. The ministry that designed it has no capability for manufacturing it, and the Ministry of Instrument Construction, Means of Automation, and Control Systems, one of the leading Soviet producers of computers, wants no part of it since it is not one of its own machines.

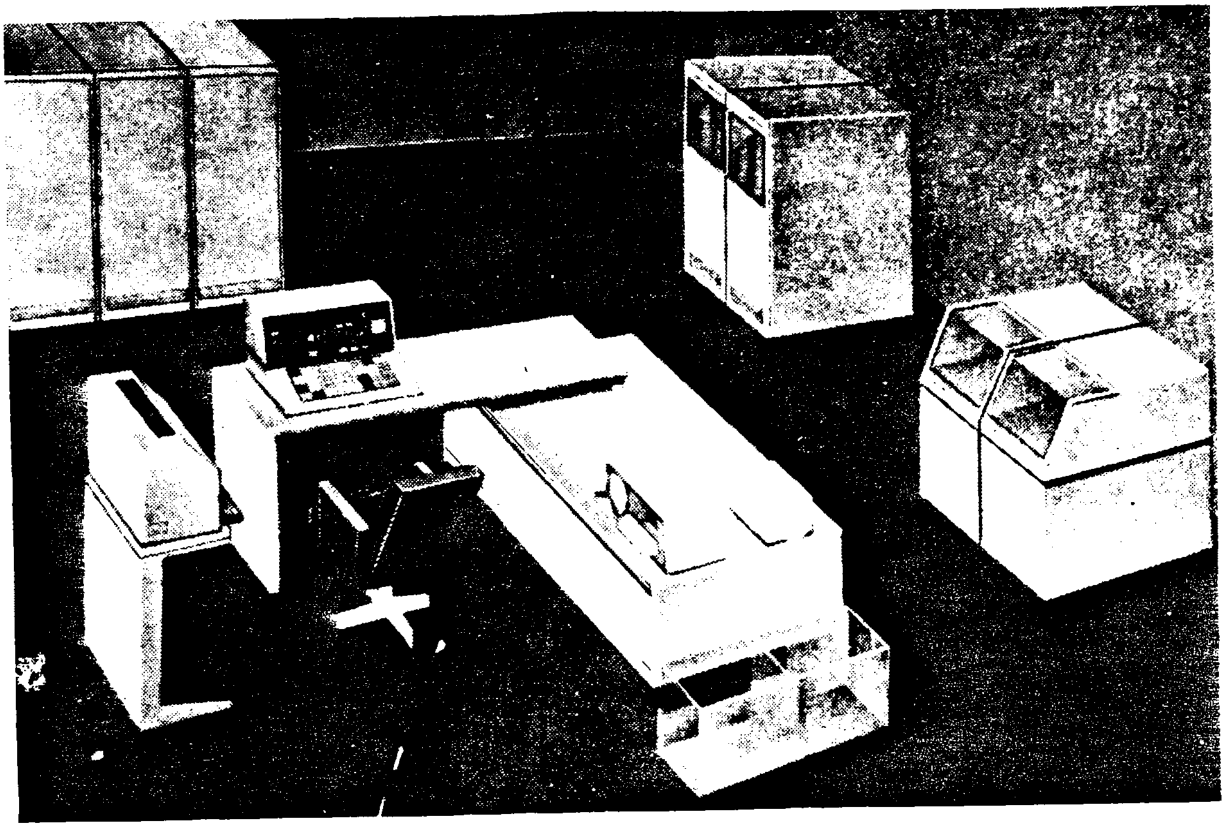
The UM-1-NKh (not to be confused with the UM-1 designed in Severodonetsk) was designed jointly by the Ministry of the Electronics Industry and the Ministry of Instrument Construction, Means of Automation, and Control Systems, and was subsequently manufactured by the Leningrad Electrical Machines Plant (in 1967). F. G. Staros and his design group were recently awarded the 1969 State Prize for the design of the UM-1-NKh.

The UM-1-NKh computer is intended for the control of production processes in various branches of Soviet industry. The machine has four memory blocks. The read-only storage unit and the main memory are connected directly to the arithmetic unit. The read-only store is a diode matrix with a capacity of 512 15-bit words and an interpreter; it is designed for the storage of constants transmitted to the arithmetic unit, as indicated by addresses sent from the instruction register or memory to the interpreter via horizontal and vertical pre-interpreters. The memory program block stores machine instructions and transmits them to the instruction register under control of the program counter.

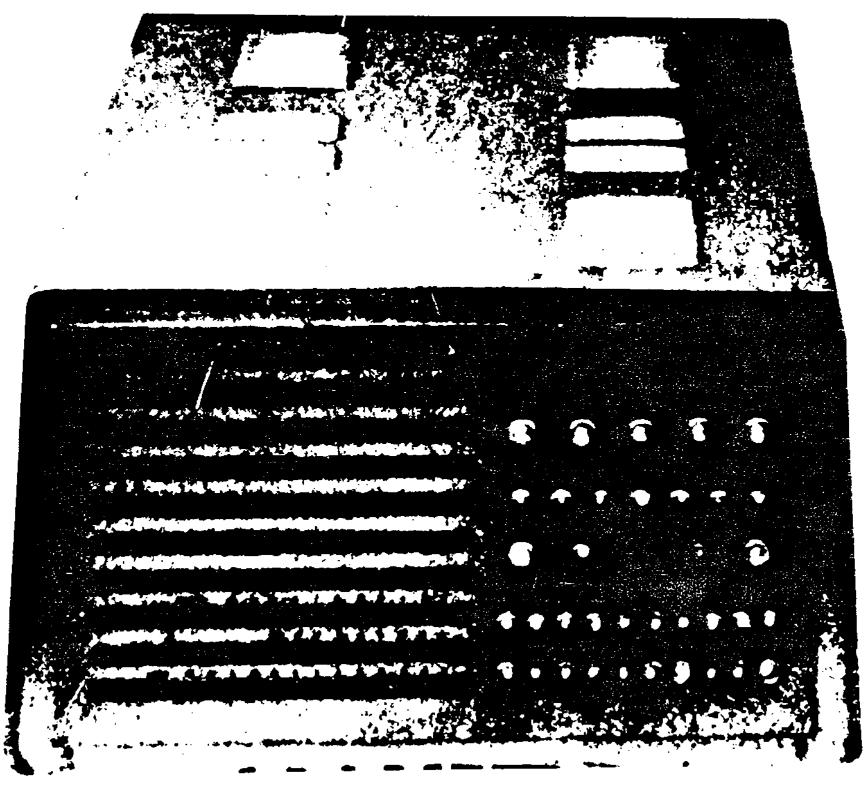
The main memory of the UM-1-NKh can be either of ferrite core (2K capacity) or of ferrite plate (256-word capacity). It is the only known Soviet model to employ a ferrite plate memory. It is a desk-size, fixed-point, binary machine with asynchronous parallel operation, capable of performing 1000 opns/sec. The instruction system is either two- or three-address, depending on which memory unit is being used; it can handle up to 32 instructions (15 for arithmetic operations, ten for information transmission, and seven for program control); and it has an interrupt system.

VNIIEM-1
(File No. 00833P)





VNIIEM-3
(File No. 01103P)



UM-1-NKh
(File No. 00360P)

The UM-1-NKh production assembly line. (File No. 00360P)

Shortcomings in Soviet Computer Development

There are two basic problems causing the USSR to lag far behind the U.S. (5-10 years) in computer technology —an inadequate R&D program, and a lack of adequate quality control in industry. Complicating each of these problems is the fact that the USSR does not regard computer technology as one of its top priorities. Only where the use of computers directly benefits some higher-priority activity, such as mass production, are they given sufficient emphasis. Strictly speaking, there is no such official field as computer technology included in the national budget. This makes capitalization in the ministries quite easy, since detailed itemization is not needed. A minister has the right to redistribute funds allocated to his organization as he deems fit and, since each minister is judged by his success in his own particular field, he will frequently skimp on funds for the development of computer techniques in order to meet or surpass the quota imposed by the Government on his organization's field of specialization.

The R&D Gap

The Soviets long ago identified the R&D gap as a major shortcoming of their system; in some cases it was as long as 10-15 years between the time a scientific discovery was made and its subsequent application to computer technology. Soviet scientists have made great progress in the field of solid-state physics; they have developed integrated circuit components and other advanced microminiaturized circuits—e.g., thin-film and hybrid circuits. The Soviets, however, have yet to widely implement these circuits in their computer hardware; the first Soviet computer to utilize integrated circuitry was the Nairi-3, which was only announced during the past year.

In the last few years, there has been an increase in the number of published articles by prominent Soviets identifying this shortcoming and calling for the reorganization of R&D. Academician V. Trapeznikov, Director of the Institute of Automation and Remote Control, for example, recently criticized the current 8-12 year lag in implementing new technology, particularly the flow of useless information. He explained that in a number of departments of a certain ministry superfluous information comprises 90 percent of all information transmitted to higher levels (he considered as superfluous only information which no one in the entire ministry could give a reason for retaining); the volume of superfluous information passing from lower units to higher ones in this ministry amounts to about 2000 pages monthly.

In addition to being overburdened with superfluous data, the ministries and the organizations complain about

Characteristics of Principal Current and Announced Soviet Computers.

Computer	Addresses	Operating Speed (1000 opns/sec)	Memory Capacity (1000 words)/ Cycle Time	Word Length (bits)	Primary Application	Approximate Cost (1000 rubles)
M-1000	1	20*	1 / 8 μsec	16	Process Control	--
M-2000	1	40*	8 / 8 μsec	32	Varies	--
M-3000	1	100*	8 / 8 μsec	32	Varies	--
BESM-2	3	8-10	2 / 6 μsec	39	Scientific	350
BESM-4	3	20	8 / 10 μsec	45	Scientific	250
BESM-6	1	1000*	32 / 2 μsec	50	Scientific	3000
M-20	3	20	4 / 6 μsec	45	Industrial	500
M-220	3	20	4 / 6 μsec	47	Varies	600
Ural-11	1	10	4 / 9 μsec	24	Data Processing	100
Ural-14	1	10	8 / 9 μsec	24	Data Processing	150
Ural-16	1	50-70	8 / 9 μsec	48	Data Processing	600
Minsk-22	2	5-6	4 / 24 μsec	37	Production Control	250
Minsk-23	--	2-3	40† / 26 μsec	Variable	Data Processing	--
Minsk-32	--	30-35	32 / --	--	Data Processing	--
Mir-1	1	.25	4 / 24 μsec	12	Scientific	--
Promin'	1	.8	.162 / --	32	Scientific	500
Dnepr-1	2	10	.512 / 18 μsec	26	Process Control	100
Razdan-2	2	5	2 / 24 μsec	36	Scientific	50
Razdan-3	2	20	16 / 8-10 μsec	48	Scientific	150
Nairi-2	2	4*	2 / 20 μsec	36	Scientific, Data Processing	75
Nairi-3	2	15-20	4 / --	36	Scientific, Data Processing	--
VNIIEM-3	1	40	4 / 8 μsec	24	Process Control	--
UM-1-NKh	2	1	2 / --	15	Process Control	--

*Additions/sec.

†Characters.

delays in the publication of valuable scientific articles. The editor of the Russian journal *High-Energy Chemistry* recently criticized the time lag between the receipt of articles by journals and their subsequent appearance in print; in the journals published by the USSR Academy of Sciences this time lag is on an average of 18 months. The only suggestion that has been made to overcome this problem is to emphasize the publication in journals of abstracts and brief annotations of new articles, the complete texts of which could be obtained upon request.

Another problem contributing to the R&D gap is the large number of jurisdictions under which computers are designed and produced; one source claimed that his projects in the computer field required the approval of as many as ten organizations. Lebedev, for example, before designing a new machine needed not only the approval of the USSR Academy of Sciences to which his Institute was subordinate, but also that of the State Committee on Radioelectronics which also had some control over his activities. The American spirit of industrial competition, which accelerates U.S. technological developments, is replaced in the USSR by jurisdictional jealousies which retard technological progress. Let us take the VNIIEM-3 computer as an example. It was developed at an institute of one of the Soviet ministries; the state committee that tested it found it to be more than satisfactory. But, the Ministry of Instrument Construction, Means of Automation, and Control Systems did not want to become involved with its production; it had its own machines of the same type. Production, as a result, has been delayed by several years, and as far as is known it still is not being serially produced. Neither USSR Gosplan nor the Committee on Science and Technology has been able to crack the stubborn opposition by the ministries on many such questions.

In addition, so far there has been no unanimity of opinion even on such a basic problem as the further development of computer technology. Some advocate computers of the general-purpose type. Others say that they are expensive, awkward, and unreliable, and that the main emphasis must be directed toward the construction of inexpensive, reliable, special-purpose machines. Some, like S. A. Lebedev, advocate the construction of high-speed, high-capacity machines on a par with the world's best. Others feel that the USSR should concentrate on improving already developed machines—primarily in terms of reliability and software—while still others advocate the development of multi-machine systems as a way of improving operational speed and capacity and, at the same time, avoiding the costly development and production of new, large computers. Debate is still raging on such minor points as whether 3-address machines are superior to single-address ones.

The first noteworthy Soviet effort to reduce the R&D shortcomings occurred in 1968 with the promulgation of a series of Party and Government decrees on the reorganization of R&D. The emphasis of these directives was on strengthening the application of scientific findings and developments, and on accelerating the integration of new techniques into the national economy. A much expanded system of incentives, coupled with greater autonomy for the research director, could lead to a more rational and unfettered functioning of the research effort.

Three recently developed Soviet computers were somehow able to avoid delays in serial production: the Ruta-110, the Mir-1, and the Minsk-32. The Ruta-110 entered serial production immediately after the testing of a prototype unit. The experimental model of the Mir, suitable for serial production, was developed jointly by the Institute of Cybernetics and the production plant. As a result, the gap between experimental development of the machine and its introduction into the national economy was reduced to a minimum. The Minsk-32 was tested in November 1968 and by December of the same year the Minsk Ordzhonikidze Plant had already produced the first serial model.

Lack of Quality Control in Soviet Industry

One of the major shortcomings of the USSR industry is its quantity orientation. The success of a plant is measured in terms of fulfillment and over-fulfillment of production quotas set by the State. Naturally, if the quota is in terms of quantity, quality will suffer. And so, there are stories of a Soviet lamp shade factory that produced lamp shades of only one color; to manufacture shades in various colors was a nuisance and decreased the total number of shades that could be produced. Also, there is the story of a nail plant which concentrated its production on long, fat nails, because its quota was in terms of pounds of nails produced.

With their industry oriented in this fashion, it is astounding that the Soviets have advanced as far as they have in computer technology. Imagine a Soviet electronics plant concentrating on the mass production of transistors, if its quota is in terms of the number of transistors produced without regard to their usefulness or reliability. Quality and variability of design are constantly being sacrificed by plant managers to achieve the production of the maximum number of units per year. The lack of quality control becomes immediately obvious to even a casual visitor to the USSR—Western electrical devices cannot be used in the Soviet Union because of constant fluctuations in the magnitude of the power supply. As a result, major Soviet computer centers, for whom a constant power supply is essential for the proper operation of their machines, have installed their own private power sources.

A major handicap to Soviet production has been, and continues to be, the poor quality of electronic components and the very high rejection rates of defective units (a problem that the Soviet press has dwelled on in the past). Virtually all Soviet computer development programs are constantly being delayed by the low reliability of the components with which the computer designers have to work. Glushkov has lamented that Soviet magnetic tapes cannot reliably store information for longer than a month. The 16 track magnetic tapes for the Minsk-22, probably the most important general-purpose machine for management applications, have six tracks for data, two for parity checking, and then all eight are duplicated for reliability. Eighty-column card readers in common use cannot read all 80 columns. Punchcards for even the recent Ural models require a six-out-of-twelve punch code per column, due to reader reliability problems. Newer computer systems, such as the BESM-6, are tending strongly towards peripheral equipment duplication, as a way around the reliability problem.

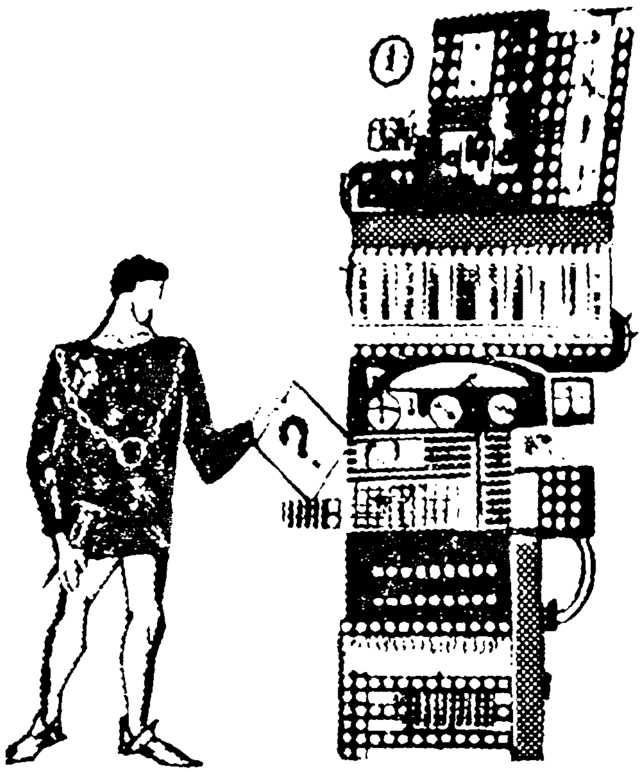
Only most recently have manufacturers begun to assume any responsibility for software or for the installation, debugging, and maintenance of the machines they manufacture. Traditionally, the manufacturer was concerned only with production, and had no interest as to who would receive the machines, much less in installing and servicing them. The Penza and Minsk plants traditionally have been the only Soviet manufacturers to ship computer systems to customers assembled and ready for installation; other producers often ship disassembled components, leaving to the customer the problem of their assembly and debugging. As a solution to this problem, some Soviets have suggested emulating the practices of Western manufacturers in providing continuing service to customers, as well as developing a system of profit incentives.

Conclusions

In summary, the aggregate of existing Soviet computer models displays many of the design concepts and system organization features found in advanced U.S. models. No significant innovations can be seen in Soviet computer research, although their literature reflects appreciation of the latest Western concepts. Most of the widely available Soviet machines still employ circuitry comparable to that of U.S. models in the fifties, but of lower reliability.

The Soviets have been successful in many areas of computer related research—e.g., solid-state physics; however, they are deprived of many of the benefits from their successes because of a poorly developed R&D program. The Soviets are known to have designed microminiaturized and integrated circuits far more advanced than any observed in Soviet computers. Designers of the new circuitry find themselves facing the critical problem of introducing the new technology into industry.

The productivity of Soviet R&D scientists is extremely low, and the entire system of R&D management would have to be drastically revised before it could be made to function efficiently. Numerous articles by prominent Soviet scientists have identified this problem and the problem of quality control, and have labeled these two problems as the major shortcomings of the Soviet computer development effort.



"To be, or not to be..."
(Hamlet tries his question on a computer.)
Source: *Izvestiya,* Nov. 16, 1969.
(File No. 2608P)

State Prizes Awarded

Selected 1969 State Prizes in the Area of Science and Technology.

For the development and introduction into the national economy of the highly efficient BESM-6 general-purpose computer:

Lebedev, Sergej Alekseevich—Academician, Director of the Institute of Precise Mechanics and Computer Engineering of the USSR Academy of Sciences, Project Leader;

Mel'nikov, Vladimir Andreevich—Candidate of Technical Sciences;

Laut, Valerij Nazarovich—Candidate of Technical Sciences;

Korolev, Lev Nikolaevich—Doctor of Physicomathematical Sciences, head of the laboratories;

Sokolov, Andrej Andreevich—Department Head;

Tyapkin, Marko Valerianovich—Department Head;

Smirnov, Vladimir Ivanovich—Department Head;

Zak, Leonid Aleksandrovich—Department Head;

Tomilin, Aleksandr Nikolaevich—Chief Designer;

Semeshkin, Vol'demar Ivanovich—Chief Engineer of the Moscow Calculating Machines Plant;

Ivanov, Valentin Andreevich—Chief of the Special Design Office of the Moscow Calculating Machines Plant.

For the developing a small electronic control computer and the UM-1-NKh control computing complex, and their introduction into the first digital control systems of various branches of the national economy:

Staros, Filipp Georgievich—Doctor of Technical Sciences, Chief Designer, and Project Leader;

Val'kov, Vitalij Mikhajlovich—Department Head;

Pankin, Vladimir Efimovich—Department Head;

Berg, Iozef Veniaminovich—Candidate of Technical Sciences, Chief Engineer;

Borodin, Nikolaj Innokent'evich—Candidate of Technical Sciences, Deputy Chief Designer;

Danilin, Yurij Ivanovich—Former Deputy Chief Engineer of the Design Bureau of Industrial Automation;

Majorov, Sergej Aleksandrovich—Candidate of Technical Sciences, Prorector of the Leningrad Institute of Precise Mechanics and Optics;

Inkinen, Viktor Viktorovich—Director of the Leningrad Electromechanical Plant;

Rybakov, Viktor Vasil'evich—Chief Engineer,

Ivanov, Pavel Sergeevich—Chief of the Special Design Bureau;

Vul'f, Moisej Yakovlevich—Chief Specialist of the Leningrad Experimental Design Department of VNII Proektelektromontazh.

For development and widespread introduction of systems for automating the petroleum industry of Azerbaijan:

Abdullaev, Asker Alekper-ogly—Candidate of Technical Sciences, Director of the Neftekhimavtomat Scientific Research and Design Institute, Project Leader;

Aliev, Tofik Mamedovich—Doctor of Technical Sciences, Deputy Director;

Aslanov, Mukhtar Makhmud-ogly—Department Head;

Tsaturov, Georgij Sarkisovich—Department Head;

Melik-Shakhnazarov, Aleksandr Mikhajlovich—Doctor of Technical Sciences, Department Head at the M. Azizbekov Azerbaijan Institute of Petroleum and Chemistry;

Nabiev, Izzet Akhmed-ogly—Candidate of Technical Sciences, Docent of the M. Azizbekov Azerbaijan Institute of Petroleum and Chemistry;

Amirov, Ali Dzhabarovich—Candidate of Technical Sciences, former Chief of Azneft,

Sulejmanov, Alekper Bagir-ogly—Doctor of Technical Sciences, Deputy Minister of the Azerbaijan Petroleum Extracting Industry.

For original article source, see page iv.

Keldysh and Maksarev Comment on Prizes

The newspaper Sotsialisticheskaya Industriya *recently published the Resolutions of the Central Committee of the Communist Party of the Soviet Union and the USSR Council of Ministers on "Awarding the 1969 USSR State Prizes in the Area of Science and Technology." Academician M. Keldysh, President of the USSR Academy of Sciences, and Yu. E. Maksarev, Deputy Chairman of the Committee on the Lenin and State Prizes in the Area of Science and Technology, commented on the State Prizes.*

...In the current scientific and technical revolution, computer science deserves a special place. A significant achievement in this area was the development and introduction of the BESM-6 computer by Academician S. A. Lebedev and his staff. The machine is capable of one million arithmetic operations per second, faster than any other domestic computer, and it consumes very little power in the process...

A staff of specialists headed by F. G. Staros developed the UM-1-NKh, a small semiconductorized electronic computer and control complex, which has been introduced in the power, glass and electronics industries. These machines are capable of 5000 additions and 1000 multiplications per second...

A. Abdullaev, T. Aliev, and others developed and introduced systems for automating the Azerbaijani petroleum industry. As a result, nearly 7000 oil wells have been automated, and 10 million rubles have been saved in the last eight years...

The newly developed and highly efficient automatic thickness gauging and tension monitoring systems have had a great effect on the country's rolling mill industry. The system was developed by N. N. Druzhinin and A. G. Mirev, and has been successfully applied at the Magnitogorsk and Cherepovetsk Metallurgical Combines...

Important work in industrial automation has been done by M. A. Levitin, L. V. Rapoport, and others. They developed and introduced a series of automatic lines for the production of nonwire-wound carbon resistors with axial terminals. Forty such lines are already in operation.

Reliability Statistics For the BESM-2

N. P. Zagumennov

The BESM-2 high-speed computer was designed by the Institute of Precise Mechanics and Computer Engineering of the USSR Academy of Sciences. All the material in this report has been obtained based on the experience of using two such machines, arbitrarily called BESM-A and BESM-B; the first one was put into continuous use on February 23, 1960, and the second on August 20, 1962. The machines were used around the clock, including Sundays. Operations were organized in four shifts.

Useful machine time is considered as the time required for correct calculations (as confirmed by subsequent analysis) and the time used for program debugging. On the average, this time amounted to 15.8 hours per day for BESM-A, and 16.3 hours per day for BESM-B, or 65.6 to 68.0 percent of the entire time the machine was up. (See Table 1.) This is explained by the fact that during the first years of operation, a large amount of work in the improvement of the individual machine circuits was done to increase operational reliability, so that a considerable percentage of the total up-time was devoted to preventive maintenance.

Table 1
Operational Time Breakdown for Two BESM-2 Computers.

Computer	Time Distribution: Useful Machine Time, hours	%	Maintenance, hours	%	Down-Time, hours	%	Total, hours	%
BESM-A (from 1961)	21,294	65.6	8,981	27.6	2,210	6.8	32,485	100
BESM-B (from 1963)	11,286	68.0	4,360	26.3	954	5.7	16,600	100

More than 200 efficiency suggestions were developed and introduced by service personnel during the operating time of the BESM-2. Until August 1964, the machines' operation schedule included monthly preventive maintenance of three days and quarterly preventive maintenance of five days. During this time, the engineering-technical staff tried to increase operational reliability by replacing critical elements. But after a three-day planned preventive maintenance check the computer still could not begin normal operation. This circumstance is confirmed by operating tests on two machines.

Machine operation established that these preventive checks increase operational reliability. Beginning in August 1964, however, a new method was introduced: checking on an "as needed" basis. The checking is done only when the machine does not solve a diagnostic problem. The productive operating time of each machine consequently increased to 19-20 hours per day; one of the machines even operated continuously for more than two days.

From processing the accumulated reliability data, the time of error-free operation [MTBF] for the BESM-2 computer was found to be approximately two hours. Excerpts of the types of failures observed from 1962-64 on the operation of the two computers are shown in Table 2.

Table 2

Elements in which Failure is Possible, and Other Possible Malfunctions	Number of Malfunctions (monthly average): BESM-A	BESM-B	Total	% of Total Number of Malfunctions
Standard (nonstandard) units	86.7	84.0	170.7	63.3
Vacuum tubes	14.4	8.7	23.1	8.5
Reader	11.2	10.1	21.3	7.9
Power supply	6.7	8.4	15.1	5.6
Printer	4.0	5.2	9.2	3.4
Specific connections	5.8	2.2	8.0	3.0
Radio parts (other than vacuum tubes)	2.1	1.2	3.3	1.2
Failure of electric power lines (city)	1.2	1.2	2.4	0.9
Other malfunctions	10.5	6.5	17.0	6.2
Total	142.6	127.5	270.1	100.0

The distribution of failures between elements of standard and nonstandard units during 1964 are shown in Table 3, which indicates that the greatest portion of failures is traced to vacuum tubes. (See also Table 4.)

Table 3

Name of Element of Standard (nonstandard) Unit in which Breakdown is Possible	Number of Breakdowns (monthly average): BESM-A	BESM-B	Total	% of the Total Number of Failures
Vacuum tube	156.5	172.3	328.8	52.4
Diode	58.0	51.8	109.8	17.5
Resistor	59.4	50.0	109.4	17.4
Transformer	25.5	22.3	47.8	7.6
Capacitor	7.1	4.4	11.5	1.8
Inductance coil	6.2	4.3	10.5	1.7
Delay line	0.5	0.8	1.3	0.2
Joint	0.3	0.6	0.9	0.1
Power break	4.1	4.1	8.2	1.3
Total	317.6	310.6	628.2	100.0

For original article source, see page iv.

Table 4

Cause of Vacuum Tube Failure	Number of Failures, %
Breaks and overheating of filaments	24.0
Bridging between electrodes	18.0
Change of parameters and emission loss	47.0
Cracks in envelopes, breakage of base and prongs, etc.	11.0

In order to increase the operational time of the vacuum tubes in the machines, tubes are first burned-in for 100 hours on a special test device. On the average, 1-3 of every 100 tubes is rejected. As a result, the actual average service life of vacuum tubes is 4000-5000 hours.

Much of the trouble is due to failure caused by poor contacts in tube panels and connectors, and in poor soldering points. Since there are more than 130,000 movable contacts and more than 350,000 solder joints in one machine, and since the malfunctions are random, a search for the poor contact often requires considerable time. (The BESM-2 circuits consist of approximately 4000 radio tubes, 5000 germanium diodes, 400,000 ferrite cores, and 80,000 other radio parts.)

The basic cause of capaciter failure is dielectric breakdown and bridging between the plates across the flanges (70-75 percent of all failures). The causes of resistor failure are breaks and contact faults (55-60 percent of all failures) and resistor overheating (35-40 percent). A pronounced role is also played by changes of resistor values (5-8 percent).

Breaks and contact faults are characteristic of fixed and variable wire-wound resistors of all types. Lead contact faults are observed in varnished metal-film heat-resistant carbon resistors. More than half of the burned-out resistors failed because of high overloads caused by the bridging of electrodes in vacuum tubes and by capacitor breakdown.

The most frequent causes of failures in pulse transformers and other wound pieces of equipment are disruptions in the dielectric strength of interwinding insulations and body insulation, breaks and burnout in wires, poor moisture protection, and severe heat conditions. Often, the cause of pulse-transformer failure is electrode bridging in vacuum tubes and capacitor breakdown.

The tests also showed that one of the causes of the BESM-2's operational reliability reduction is the frequent switching of power on and off to the machine. The transients that occur lead to malfunction, since the electronic circuits are under intolerable conditions.

One more factor which considerably influences the operational reliability of the machines, especially in summer, is the temperature of the air circulating in them. The machines operate stably when the temperature of the air coming out of the machine does not exceed P30°C.

A number of additional shortcomings were discovered which proved to have a definite influence on operational characteristics, including:

> Insufficient tape transport reliability: during the forward and reverse motion of the tape, and with a change in direction, breaks often occur because of imperfect design of the rewind and brake mechanism;
>
> The micarta tube adapters are not saturated with insulating lacquer, resulting in a breakdown between terminals with different ratings, or between a terminal and ground if the humidity exceeds 60-70 percent;
>
> The absence of a smooth filament control in heater transformers;
>
> Deficiencies in the preventive maintenance system: there is no way of checking individual PC boards;
>
> The inconvenience in working with the circuit and wiring diagrams of the machine units, which are specified individually by PC boards and not by operational procedures.

On the whole, the BESM-2 machines have been recommended as sufficiently reliable among vacuum-tube computers. By carrying out the corresponding technical and organizational practices in the use of these machines, their effectiveness can be considerably increased.

Automation Of the State Bank

A. Yu. Kaganovich
V. S. Rozhnov
Yu. A. Shibaev

The USSR State Bank (Gosbank) is the only organ of short-term credit and also the only savings and cash-emitting center in the country. The chief function of the State Bank is the organization of operational tasks connected with credit-accounting and cash services to the national economy. The Bank fulfills other functions as well. It issues and withdraws money from circulation, stores State funds, etc...

At the present time, the State Bank serves more than 650,000 industrial enterprises of State farms, collective farms, construction projects, institutions, and various other organizations. The scope of processed bank information is constantly growing. In 1940, a month's work averaged 43 million operations, while in 1961 the average was 102 million, and in 1967, more than 125 million...

During the years 1926-29, the State Bank borrowed a few calculators from other establishments and began using them experimentally for accounting purposes... From then on, the Bank's mechanization of accounting and calculating tasks underwent several basic changes.

The first change took place between 1926 and World War II (1926-41), and was characterized by the experimental use of imported calculating and punchcard equipment, mainly in the larger offices of the Bank.

The second period (1946-50) saw the establishment of the Machine Accounting Offices (MSU) and the reintroduction of calculators put out of commission during the war and the temporary occupation; the creation of the new Machine Accounting Stations (MSS) based on domestic, pre-war calculators; the introduction of a three-shift work period at the Machine Accounting Stations for the purpose of speeding up the accounting processes of banking operations; and the acquisition of SDU-110 adding machines and their introduction into State Bank installations...

The following period (1951-55) was characterized by widespread introduction of domestic SDU-138 calculating machines which facilitated the mechanization of both analytical and financial accounting operations, and by the culmination of the mechanization of basic accounting tasks at all Bank centers. At this time, summary card punches were introduced at the Machine Accounting Stations, as well as the automatic preparation of balance punchcards. Processing of intraregional documents was transferred from the Mechanized Accounting Office (FMU) [established in 1931] to the Machine Accounting Stations at a number of offices.

During that period, new Machine Accounting Stations were organized and the structure of the operational accounting staffs was perfected as a result of the mechanization of accounting tasks. Thus, the work productivity of the operational personnel increased, and accounting was centralized by the introduction of calculating machines for the complex processing of banking information...

From 1956 to 1960, technological processes were further improved, along with the mechanization of accounting and calculating tasks and the expansion of mechanized operations. Calculating machines were used in a centralized way. All documents on interbranch turnover were transmitted from the State Bank offices to the Machine Accounting Stations for processing, with transmission of punchcards only on interregional interbranch turnover to the Mechanized Accounting Office. The Machine Accounting Stations of a series of State Bank offices began to service the Bank's customers, particularly the All-Union Bank for the Financing of Capital Investments (Strojbank)...

The 1961-65 period witnessed the formation of the first computer centers, the use of high-speed electronic machines, the introduction of multi-counter accounting machines, the equipping of the Machine Accounting Stations with punchcard machines of the T5M tabulator type (including summary cardpunches and reproducers), the establishment of communication facilities between the Mechanized Accounting Offices and Bank installations, expansion of the number of Machine Accounting Stations serving State Bank installations (and savings banks and Strojbank establishments).

Thus, during this period essential changes took place in the composition and use of the Bank's accounting technology...

For original article source, see page iv.

In the near future, the introduction of an automatic collection system, transmission and processing of summary bank economic information, the organization of new computing centers at the large offices, and an increase in the number of establishments served by remote Machine Accounting Stations and computer centers will be accomplished. In short, an automated banking information system will be established.

The development of computing installations at the Bank during 1951-68 is illustrated in the following chart.

Punchcard equipment is basic to the Machine Accounting Stations (organized in a separate section at large State Bank offices). The most common type is the T5M tabulator...

The Mechanized Accounting Office of the State Bank was established in 1931 for calculating and controlling interbranch turnover. The basic equipment is punchcard machines which process information for the State Bank Administration, the Foreign Trade Bank, and for Moscow city and regional State Bank offices. Centralized accounting and control of interregional interbranch calculations are also conducted. The Mechanized Accounting Office, from the first day of its existence, has been a multiple machine accounting office, one of the largest in the Soviet Union.

Years	State Bank Offices	Computational Installations and Installations Served by Them					
		MSB[a]	MSS (& FMU)		Computer Centers		
		Installations Serviced	No.	Installations Serviced	No.	Installations Serviced	Nonmechanized Installations
1951	4914	329	14	86	-	-	4497
1956	5022	4542	39	227	-	-	253
1961	4212	3843	45	285	-	-	84
1966	4084	3602	51	423	2	2	29
1968	4109	3585	56	525	2	4	8

[a]MSB = Machine Computation Bureau.

As is illustrated by the chart, the processing of the Bank's economic information is realized at present in 99.8 percent of the establishments with the aid of computers. In addition, 87.2 percent of them use calculating machines, and 12.8 percent are serviced by Machine Accounting Stations and the Mechanized Accounting Office. In 1963, a computer center was established at the State Bank administrative office, and in 1965 at the Leningrad office.

A Machine Computation Bureau is characterized by the use of keyboard calculators, mainly tabular equipment. A Machine Accounting Station uses punchcard equipment. At the Mechanized Accounting Office, punchcard machines constitute the basic equipment. Computer centers are based on the application of high-speed computers.

SDM-133 calculating machines are in use at the Machine Computation Bureaus (MSB) of the State Bank, together with Optimatik and Askota-170 multi-counter accounting machines and SDM-107 adding machines...

Computer centers have been organized at the administrative offices of the State Bank and at the Bank's Leningrad office. In the future, their number will be increased as part of a reorganization of a number of Machine Accounting Stations at the larger State Bank offices. Computer centers at offices are called upon to process all types of bank information. The computer center at the administrative office of the State Bank must provide automated processing of all banking information on a national scale...

The structure of the computer center at the State Bank administrative office has been determined by the nature of the material to be processed, by the processing methods used, and by other factors. Currently, the computer center employs Ural-4 and Ural-14 computers, and uses both a direct and a remote system of communication with State

Bank offices, which also has an effect on the structure of the center...

The computer center processes information arriving from Machine Accounting Station offices (on punchcards). The Machine Accounting Stations receive information in the form of documents from State Bank establishments, and prepare punchcards based on that information. Thus, the computer center does not have a direct connection with the departments and city administrative offices, and fulfills only the function of automatic processing of information...

In the processing of statistical and planning information at the computer center, the following occurs: information is received from the serviced installations (offices, Foreign Trade Bank, etc.), the received information is verified, cards are punched and verified, and the data is processed on the computer.

Information arrives at the computer center by means of either remote communication channels or by mail or transport. In the former case, the information arrives on papertape; in the latter case, as reporting telegrams or primary documents. For this purpose, punchcards prepared at a Machine Accounting Station or the Mechanized Accounting Office can also be used.

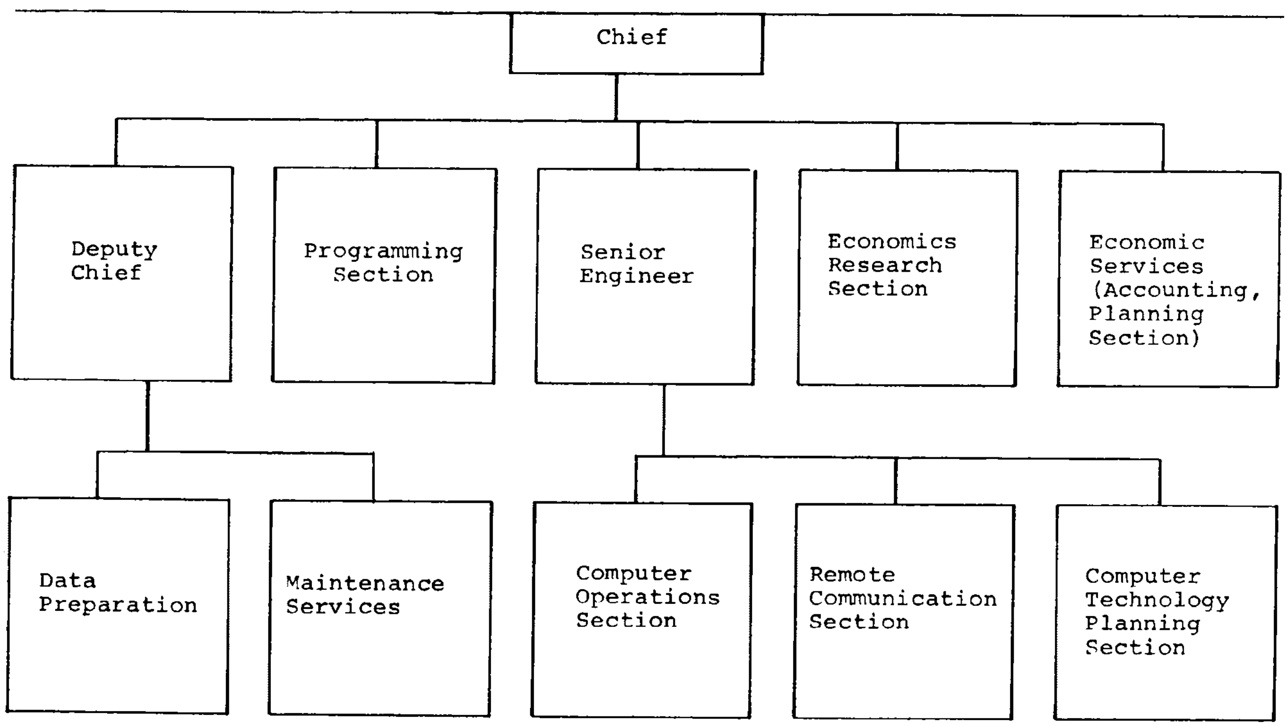
The received information is first checked logically. The verification of papertape information is done by computer, while that of telegrams and documents is done manually.

Verified information recorded on papertape is fed into the computer for processing. The information in accounting telegrams and primary documents is initially recorded on punchcards and then fed into the computer. Punchcards are used either for direct input to the computer or to generate papertape.

After the job is run and checked for accuracy, the results are transferred to the appropriate departments and offices of the State Bank.

The processing at office computer centers, handling operational accounting information, is done in a somewhat different manner. Information received from departments and sections is verified and recorded on punchcards (which are also verified). Then, compilation of accounting journals occurs, together with the compilation of personal accounts, balance sheets, balance reports based on accounts, and interest rate lists. After compilation is completed, accounting reports (registers) are issued.

Information arriving at these computer centers can be in the form of papertape if remote communication is established, on punchcards if decentralized keypunching exists, and on primary documents if neither remote communication nor keypunching exist. In the latter case, keypunching must be done at the computer center. Subsequently, data is ready to be processed, after first being sorted. Later, based on this data, the necessary accounting regis-



[REPORT ON INCIDENCE OF COMPUTER OVERHEATING]

Month	Hours in Overheated State	Useful Operating Time (hr)		Service Time (hr)				Percentage of Useful Operating Time
					Including			
					Preventive Maintenance			
		Planned	Actual	Total	Planned	Actual	Idle Time	
July	383	303	226	157	80	130	27	59.0
August	371	279	241	130	92	120	10	64.9
September	378	298	273	105	80	86	19	72.2
Total for Third Quarter	1132	880	740	392	252	336	56	65.3

ters are compiled. In addition to the mentioned registers, the computers also process budget accounts, reports for accounting departments, reports on cash turnover, etc...

The number of professional personnel at Machine Accounting Stations depends on the type and quantity of calculators and office equipment. The number of operators is determined by the kinds of calculators, their quantity, output norm, and the work shift structure. Keyboard and keypunch machines and verifiers are used by one person per shift. In calculating the number of operators, only the basic machines are considered, not the spares. Sorters and tabulators are usually manned by one operator per shift for every 2-4 machines; special-purpose punchcard machines require one operator for several machines. The number of computer console operators is determined by the number of computers, the shift system, and the operational environment.

The number of engineers and programmers depends on the scope of the volume of work to be processed by the computers. The number of mechanics and engineers needed for the maintenance of computers and other machines depends on the number of machines and their servicing norms. Technical servicing norms are determined on the basis of the complexity and location of the equipment. Usually, a single mechanic services 15-20 adding and calculating machines, 12-16 keypunch machines and verifiers, 6-10 accounting machines and sorters, up to 3-5 tabulators and special-purpose keypunch machines. The appropriate number of technical service personnel is established for each computer. For example, the Ural-4 computer is serviced by 4-8 engineers and technicians, the Ural-14, by four.

The number of managerial personnel is determined by a special staff schedule...

Machine Accounting Office quarters should comply with both technical and health norms. This depends on the number of personnel, and on the quantity of calculators and auxiliary equipment. The area norm is established in accordance with the type of calculators used. About 3 sq m are needed to house one keyboard machine and operator; for sorters, 5.5 sq m; for tabulators with summary card punches, 8.5 sq m; for the Ural-4 computer, 200 sq m; for the Ural-14, up to 250 sq m. The Machine Accounting Office personnel requires 3 sq m of space; the manager and his assistant, 12 sq m. In addition, each production section should occupy separate, isolated quarters...

As for power, 0.6 kw are needed for a T5M tabulator, 40 kw for the Ural-4, and 60 kw for the Ural-14. Each 5 sq m area needs a minimum 0.15 kw of lighting...

For calculating the productive operating time and the technological state of the computer, a technical journal is maintained for each machine and external device, as well as a journal recording each computer's use by programmers. These journals are compiled daily. Calculation of productive operating time is recorded in the technical journal for each day's work, and at the end of the review period analogous indices are compiled for the month, quarter, and year. The following is an example of a quarterly computer operation report:

...The machine-hour is the gauge of the volume of work, and also a calculation unit for the computer center.

The cost plan includes an estimate of expenses and a calculation of the price of each unit of the work load.

An estimate of expenses at a computer center includes the following items:

The largest part of the expenses represents wages to programmers, engineers, technicians, and operators. A particularly large sum is spent on algorithmization and programming of banking problems, which is usual during an initiation period. For example, 46-48 percent of the engineering and technical labor expenses go to algorithmization and programming personnel. These expenses will decrease relatively and absolutely as algorithmization of the banking procedures and the formation of a library of machine programs are accomplished...

The cost of a machine-hour of computer time is estimated by dividing the total cost by the productive operating time of the machine. The planned cost is determined on the basis of planning data, and the actual cost on the basis of actual data. At some computer centers, the cost of machine time is calculated separately from that of the man-days required for algorithmization and programming. In this case, independent accounts of expenditures for the computer and for programmers must be kept...

It should be mentioned that the cost of leasing a telegraph line for a distance of 100 kms is 15 rubles; for a distance of 100-200 kms, 25 rubles per 24 hours; and for 200 to 300 kms, 37 rubles; etc.

Expenditure	Total (1000 rubles)
Wages of engineering and technical workers and operators	101.0
Contributions to social insurance	4.6
Wages of administrative and managerial personnel	7.9
Contributions to social insurance	0.4
Bonuses	2.3
Travel expenses	4.5
Furnishings and maintenance of offices and equipment	22.5
Routine repair of buildings, and inventory	9.5
Typographic and office expenditures	4.0
Telegraph, telephone, and postal expenses	0.7
Miscellaneous	0.8
Training	0.3
Sinking-fund deductions	16.9
Maintenance and rental of transport	0.3
Total	175.7

COMMENTARY

This is the first article we have published on mechanization and automation at the State Bank. It appears to be a good summary of the latest developments and plans, and of the history of the State Bank's interest in automating its accounting procedures.

Banking procedures in the Soviet Union are quite crude by Western standards, and the Bank engages in a comparatively limited number of activities (for example, there is no such thing as a checking account).

The Bank's use of the Ural-14 computer is logical, since it was this sort of application for which the Ural-11, -14, and -16 series was designed. One would assume that the Bank is interested in the Ural-16, although no mention of it is made; perhaps its chronic nonavailability has forced the Bank to proceed with its automation plans on the basis of the Ural-14 as the central machine.

It is interesting to note that a second book on the State Bank was published by the same publisher at about the same time (in 1968) as the present book. Entitled *Accounting and Operational Technology at the State Bank,* by S. Pleshkov, *et al.*, it covers the use of punchcard equipment in terms indicating that more advanced technological means are not being applied. The chapter on State Bank Machine Accounting Stations contrasts the efficiencies realized by those Stations using punchcard equipment as against those still using adding machines and calculators exclusively.

There is simply no reconciling of the two books; the one would appear to have been written ten years ago when contrasted to the other. Pleshkov indicates that only a limited amount of information on each transaction is captured in machine readable form, and that 45-col punchcards are used. There is no mention of computers.

An article in *Ekonomicheskaya gazeta,* No. 4, January 1969, stated that computers were about to be installed at the State Bank in Moscow for processing banking data of the Moscow region. It noted the need to establish training courses for programmers and to develop a new system of transaction documentation (see *SC:RVI*/69/2, p. 105). This would suggest that computer-based automation of the State Bank was not as advanced as indicated by the book by Kaganovich, *et al.*

The table showing a "typical" computer operation report has been included in the translation because of its potential authenticity. It was intended by the authors only as an example of the types of reports needed. But it is interesting to note the nature of the report and the figures it contains. It reports on the number of machine hours during which the computer was in an overheated state. If the report is for a single computer, operated 24 hours each day throughout the quarter, then over 50 percent of the operating time was in a state of overheating. Productive computing was realized during two-thirds of this time, however. The severe problem of overheating in Soviet computers is also indicated in the article in this issue of *SCR* on performance statistics for two BESM-2 computers.—WH

The STEM Special-Purpose Computer

K. A. Tinn
E. Kh. Tyugu

The STEM special purpose computer is a small digital machine with a small immediate-access memory (up to 256 words) and a large secondary store (up to 24,000 words). The various STEM models are supplied with different sets of programs for solving particular types of engineering problems: location of cutting areas and labor output norms, standardization and cutting of materials, determination of welding points, procurement estimates, etc. The first STEM computer has been in operation at the Leningrad Kirov Plant since 1964 and is programmed for calculating cutting points and temporal engineering norms for work executed on lathes and on boring, milling, sharpening, and rotating machines. The general view of the STEM computer used at the plant is shown in the accompanying photo.

The same algorithms used in general-purpose computers can be used in the STEM machine. Data on the most frequently used machines, materials, and instruments can also be stored in the STEM computer. In executing calculations, models of the cutting process and the working time are used; the cutting model is optimized. The main feature of the computer is the method of input and conversion of raw data and the output of results. Data I/0 is conducted via an on-line electric typewriter. Raw data is typewritten by the operator (typist or production-norm engineer). In typing, each symbol (letter or number) is converted to electrical signals which are stored in the computer. In outputting the results of calculations, the typewriter keyboard is blocked; the signals from the computer are transmitted to the typewriter. According to these signals, the electric typewriter types the results of calculations.

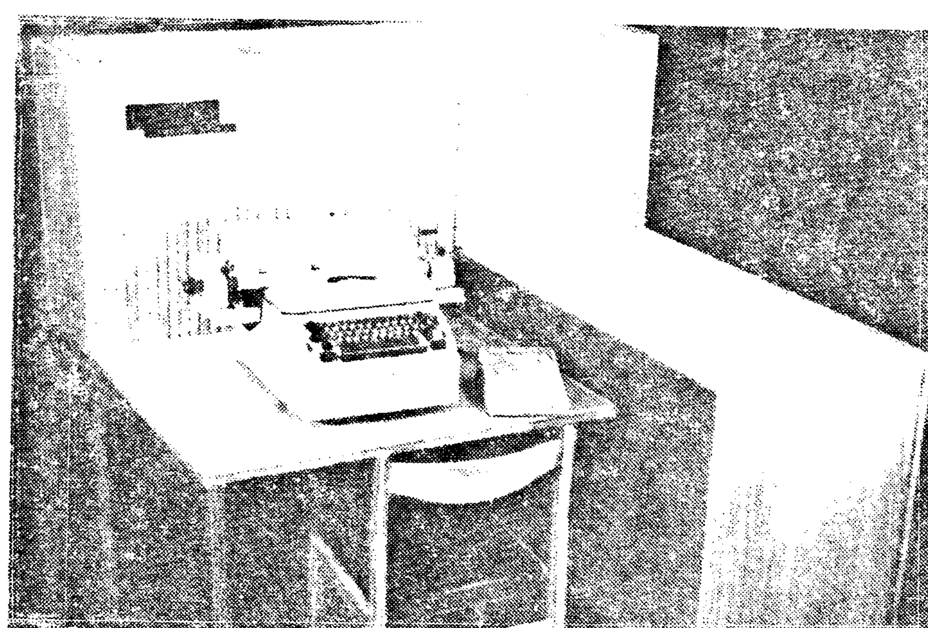
The STEM computer is equipped with a program of logical analysis and correction of data. Therefore, raw data is typed without coding. The program for processing input data is compiled so that the data can be typed on a regular production norm/instruction card. The results of calculations are printed on the same card. Thus, the STEM computer produces completed production norm instruction cards. Carbon paper can be used to produce up to five copies.

The execution of calculations for one transfer takes an average of ten seconds. Input of raw data requires up to 15 seconds. In the new STEM computer models, the computing time will be the same as the input time for raw data of the next transfer.

The computer is controlled via the typewriter by means of keywords, and via a small control panel with a few keys.

It costs only 5.1 rubles/hr to operate the STEM computer, whereas it costs 25 rubles/hr to operate a Minsk-22 machine.

The low cost, simplicity of operation, and reliability of the STEM computer permit its use in the chief engineer's office and the payroll and labor section of a machine construction plant, and in a number of other organizations which are involved in the design of technological processes and labor norms.



The STEM Special-Purpose Computer
(File No. 2617P)

For original article source, see page iv.

Achievements In the Technical And Mathematical Sciences: 1968

Ya. V. Pejve,
Chief Scientific Secretary of the Presidium of the USSR Academy of Sciences

Physicotechnical and Mathematical Sciences

...In the past year, important results were obtained in several basic divisions of applied mathematics. In basic mathematics and mathematical logic, a solution was found to the problem of identity and contingency in free periodic groups of odd order, and for a proof of the finiteness of any abelian group within these groups (Steklov Mathematics Institute). Interesting results have been obtained in algebra, including the theory of linear groups, semi-groups, rings, modules, and matrix representability. The Institute of Mathematics of the USSR Academy of Sciences' Siberian Department has developed new methods and formulas for problems in this area.

In recent years, research has been developing on algebraic geometry and topology. A number of achievements have been made in the development of the theory of differential equations with partial derivatives and the theory of regular differential equations. The Steklov Mathematics Institute has completed the development of axiomatic bases for variational calculus.

Successful research is being conducted in computational mathematics. Important results have been obtained in the area of numerical methods for solving differential equations with partial derivatives. A numerical method for solving elliptic types of problems for areas with complex boundaries has been developed at the Institute of Applied Mathematics.

Further achievements have been made in theoretical and applied research on cybernetics. Special attention has been given to the development of mathematical methods of cybernetics, the theories of information and reliability, engineering cybernetics, computer systems, application of cybernetic methods and hardware in biology, medicine, economics, transport, power engineering, etc...

At the Institute of Automation and Remote Control (Engineering Cybernetics), methods have been developed for optimizing complex interconnected systems for controlling the operation of petroleum deposits, petroleum processing systems, chemical reactors, complex power systems, etc. A number of new systems and elements has been developed at the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, including a planning, accounting, and management system in the Zaporozhstal' steel plant, a machine for plotting graphic information in automated design and processing of scientific research, small, high-speed logic elements for digital computing devices, micromodules based on metal oxide semiconductors, a series of cathode-ray tubes for outputting data from a computer, etc. This work has been conducted jointly by the Institute of Automation and Remote Control (Engineering Cybernetics), the Institute of Electronics and Computer Technology of the Latvian SSR Academy of Sciences, the Institute of Engineering Cybernetics of the Belorussian SSR Academy of Sciences, the Moscow Power Engineering Institute, and others.

Important problems have been solved in information transmission, distribution, and processing by the Institute of Problems of Information Transmission. The Institute of Automation and Electrometry of the USSR Academy's Siberian Department has developed instruments for airborne electromagnetic prospecting which do not need ground installations to excite the electromagnetic field. This economic method sharply increases the productivity of prospecting.

International Relations

In 1968, the USSR Academy of Sciences devoted much attention to improving international relations. During 1968, 4609 scientists from USSR Academy institutions went on scientific missions to foreign countries, and 6472 people visited the USSR from abroad. Scientific missions have been used for improving scientific training, studying research conducted in foreign scientific centers, and participating in international and national scientific congresses, conferences, and symposia. Last year, 918 Soviet scientists participated in 208 meetings, conferences, and symposia conducted in the socialist countries. The USSR Academy of Sciences conducted 83 scientific events in which 1586 scientists from socialist nations participated.

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The Vassal Language

U. G. Martin

The Vassal language is a system for automating the allocation of memory in an M-20 computer operating on-line with a teletype input device. The principles of this language are analogous to those of some earlier languages used in the USA for automatic programming (Assembler languages) and can be easily adapted to any computer. However, the Vassal language differs significantly from systems for automatic memory allocation which are now used in the USSR. Since manual programming will not be eliminated in the near future, small-scale automatic systems, such as the Vassal system, can be used advantageously.

It is easier to write and understand programs written in the Vassal language than those written in machine language, and the Vassal language offers an easy solution to some debugging problems. Increased readability is due to the fact that the operation codes and operand addresses form short words and abbreviations that can be related to the commands and constants to which they correspond in the program. And with the Vassal language, the operator's errors are often automatically detected during translation by a diagnostic unit, and are corrected with the aid of a translator. The major advantage of programs written in the Vassal language is the fact that they can be automatically relocated in any area of immediate-access memory. In addition, an assembler written in Vassal is of very high speed, since it does not utilize the M-20's internal memory.

It is most practical to use the Vassal language when ALGOL is difficult or impossible; for example, in coding and in writing translators and certain standard subroutines, and in solving data processing problems.

The Vassal language is used for programming small and average size problems. The length of problems which the present assembler (a machine program with a maximum of about 1300_8 commands, excluding the allocation for data in memory) can translate is up to 243_{10} punchcards or up to $23{,}328_{10}$ teletype symbols.

The Vassal language permits the use of up to 617_8 different symbols, and each can be used in a program the necessary number of times.

COMMENTARY

The author of this article may be William H. Martin, a former employee of the National Security Agency, who, with Bernon F. Mitchell, defected to the Soviet Union in September 1960. The initials "W. H." would normally be rendered "U. G." in transliteration if the name had been Russified.

Martin was reported in 1962 to be living in Leningrad with his Russian wife where he was studying for an advanced degree in statistics at the Institute of Mathematics. He expressed a desire at that time to move to Moscow; the book from which the present article is taken is the Transactions of the Lebedev Physics Institute, located in Moscow. He also revealed that he had taken the name Sokolovskij.

Mitchell is believed to be working in a scientific information institute, perhaps as a translator.—WH

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The Computer: Detective And Sociologist

If we gave criminal investigators a pencil and asked them to illustrate the state of today's criminal law, they might depict a criminal surrounded by computers, spectrographs, night-sight instruments, photorobots, photoelectrical calorimeters, and other complex instruments and devices.

Since the beginning of 1968, the Riga police have been using the Ural-11B computer, thus initiating one of the country's first experiments in computerized detective work. It is interesting that in the heat of the dispute over whether a machine can replace a composer, poet, teacher, or detective-story writer (we believe that it can replace the latter), the policeman's profession has been forgotten. Criminologists did not rush to change this situation. To them it was more peaceful in the investigation world without detective robots searching for criminal robots who had stolen an important GPS3 bulb from a neighbor. Meanwhile, the Ural got down to work, and not without success.

An electronic computer can store in its memory more information than all of the country's investigative services can store in their files. Theoretically, the machine searches by analogy and analysis of a vast number of clues. Operators constantly replenish computer files with information about crimes and persons committing them. All the characteristics of a man who commits a crime are entered in detail on a special card: his distinguishing characteristics, nickname, habits, educational status, method of operation (it is said that just as every woman puts on lipstick in her own way, so every criminal has his own method of operation), term of punishment, etc. All information is coded and teletyped into the computer's magnetic memory, which, in contrast to human memory, is not subject to sclerosis...

In addition to detective work, the computer is also useful in crime prevention. For years, Riga detectives visualized the "average criminal" as a young man, 20-25 years of age, from an unhappy family, with less than an eight-year education, few interests, an extremely poor vocabulary, a predisposition towards drunkeness, and a tendancy to frequently change employment. Now computers, through extensive sociological investigations, will check this criminal prototype against facts. They will elaborate and specify empirical data, and analyze the reasons for crime in actual cases...

Several years ago, an American engineer analyzed the voices of 25,000 people. He used an electronic analyzer capable of recording vocal diagrams—i.e., graphic descriptions of voices. The recognition accuracy was 97 percent. According to the Soviet press, not only was a similar instrument developed in the USSR, but Georgian scientists have also succeeded in teaching a computer to recognize human voices. The computer rapidly compares the code of the given voice to the codes stored in its memory.

...Theoretically, it is also possible to teach a computer to recognize handwriting...

The development of modern criminology contributes to the establishment of objectivity in legal matters, and modern criminological techniques facilitate the use of computers in solving crimes.

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Automation of Production: The Party View

I. I. Artobolevskij
Academician

S. V. Shukhardin
Doctor of Technical Sciences

...The transition to fully automated production and its further development presents complex social problems which will strongly affect the economic reform. Improvement of the technological level of production, of electrical equipment, and of automation hardware, and the introduction of computing devices and material incentives, strongly demand effective interbranch redistribution of manpower. These improvements would also necessitate a change in the professional staffing of workers, and an optimal union of physical and mental effort. Thus, a rational distribution of the country's industry and population is required...

At present, a transition from mechanized factory production to fully automated production is taking place. The main feature in the development of the capitalistic mechanized factory production was the worker's machine; in Communist production this machine is replaced by a fully automatic one. It is important to examine the transition from manual to fully automatic machines.

The development of automated machine systems provides a continuity to, and maximum increase in labor productivity. Therefore, the main trend in the development of production processes is the transfer from a system of manual machines to the automation of individual technological processes, and later to a fully automated system. Thus, man will not participate directly in the production cycle—i.e., he will not execute the technological, controlling, and logical functions necessary for the operation of machinery and mechanisms. Instead of being its chief agent, man will work in parallel to the production process.

A transfer to complete automation of mass and serial production requires a drastic change not only in the character, but also in the division of labor. An automated machine system requires both highly qualified production experts, and the application of a collective labor organization based on the coordination of procedural and polytechnical training.

A transfer from manual machines to fully automatic machines can be achieved by first establishing the individual control links, and later incorporating them into a control machine. (*Control machine* connotes a special device capable of executing a specific set of control operations.) Thus, man is responsible only for the maintenance and adjustment of equipment, while the management and control process is handled automatically.

All automated machines are characterized by a set of power drives, transmitting mechanisms, a programmed device, a mechanism for processing programs, a control unit, short- and long-term storage units, debugging devices, and devices which determine the optimal operational condition of the automated system. In automated systems, hardware replaces the direct functions of man, including the logical and control functions. This is the essence of today's scientific-technical revolution which is generating the conditions necessary for transferring from mechanized factory production to fully automated production, with widespread application in all spheres of human activity.

Improvement of the production level depends largely on the degree of automation. The goal is to obtain the greatest amount of high-quality production from the total permitted labor expenditures—i.e., not only from basic work (research, design, and system regulation), but also from the on-going effort (the execution of technological operations and maintenance of the system). If this condition is not fulfilled, the introduction of automated systems will be unprofitable and impractical. Experience dictates that a successful solution to the problem of automation requires a redesign of the product, the technological process, and the hardware. Only then will it be possible to develop productive and reliable automated systems which will be simple to produce, and which will meet the specifications of fully automated production.

Experience also indicates that when only data sensors and computing devices are introduced, and the old technological processes and hardware of mechanized factory production are retained, the economical aspects and the efficiency of automation are not raised. On the contrary, the technical-economic indices deteriorate. Although automation tends to improve production, it is not an end

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in itself, but the means of improving the efficiency of overall production. A scientific approach that will determine the level of automation of certain production processes, and sensible and scientifically based criteria for the degree of automation, will result in reliable and efficient automated systems.

...The scientific problems of today have evolved into systems of developing branches of science which are mastered by appropriate methods of research. These problems include classification and systematization of individual sciences and their interrelationships and interactions; the application of research methods used in certain sciences to the investigation of other sciences; and the development of new areas of knowledge by combining several sciences (for example, geochemistry, bionics). Of special importance is the interaction of technical (applied) sciences and cybernetics, the theory of probability, theoretical and practical mechanics, and theoretical physics. It is necessary to thoroughly investigate the processes of this interaction, and to determine the structure of individual sciences and of science as a whole. This will provide more efficient methods of scientific research.

Apparently, one of the main criteria for judging preparedness of an enterprise to adopt scientific and technical achievements, and to revolutionize production methods, is the degree of automation. Therefore, the main trend of production development is the transfer to complete automation, which is characterized by a continuous technological process and complete emancipation of man from actual production work.

Scientific Basis For Management

K. Rudnev,
Minister of Instrument Construction, Means of Automation, and Control Systems, USSR

On the eve of 1970, which culminates the current Five-Year Plan and appears to be the starting point for new advances on all fronts of Soviet economics, let me express a few ideas concerning the improvement of industrial management, based on economic-mathematical methods and computer technology. This problem is not new; much has been published in this area in the past few years. I am referring to the need for widespread introduction of automated means of control into all sections of the national economy.

The resolutions of the September 1965 Plenary Session of the Central Committee of the Communist Party, which approved the branch of industry mode of management and a new system of planning and economic stimulation, have done much to improve industrial management. Today, efficient management is needed more than ever, owing to increased industrial production in order to satisfy growing consumer demands and to the introduction of autonomous cost-accounting procedures in all sections of industry. A singularity of purpose and equality of all members of the industrial process, characteristic of a socialist State, acquires a special force. This singularity makes a rational system of control most effective, since it suits everyone—from the worker, to the director of the plant, to the head of the ministry.

Several days ago, the Central Committee of the Communist Party and the Council of Ministers of the USSR approved measures for improving management and making it more economical. These measures urge the application of the branch principle of control and the new system of planning and economic stimulation. A wider introduction of automation into the national economy would further improve the management apparatus, and reduce the expense of its upkeep.

Analysis indicates that the rate of growth of a plan's operating efficiency, in terms of mass productivity, is significantly greater than the rate of growth of managerial work. In addition, the scope of the information necessary for control increases at the rate significantly greater than the growth-rate of the enterprise itself.

The following comparison can be cited: given that man is a highly organized system possessing great computing potential, in speed as well as memory, then, in proportion to the development of a material culture, his capability to develop information handling techniques for rational management is always greater than the practical possibilities of reducing information to a form suitable for input to a computer. For this reason, the coefficient of man's useful activity in management is, as yet, very low, and its improvement is slow, even though the possibility of filling this gap is very real.

In recent years, automated control systems have been yielding desired results, since there is no self-regulation of the productivity growth rate. This decreases the economic results of work, even when general plans have been fulfilled and profits achieved.

These individuals are correct only in one assumption: there is no automatic regulation of all economic indices in life. However, one cannot deduce from this fact that the new economic reform is not effective.

We believe that reforms of complex economic laws will not lead to effective self-regulatory systems. But with reforms, we can achieve useful indices of work by skillful use of such prerogatives as are at the disposal of the management boards and the Ministry, based on well prepared plans and strictly following the current methods of realization of all technical and economic measures. It must be remembered, however, that as the manager's responsibilities increase, facilities to aid him in decision-making should also increase.

Parallel to the development and introduction of automated control systems into industry and the Ministry, work on the development of a self-support basis in all areas of activity is being conducted, not only in industry but also in the management boards and the Ministry as a whole.

We believe that the basic entity of control in the Instrument Construction branch should be the self-support board. It is composed of a complex of enterprises with an appropriate design and scientific research base. The board is responsible for the development and technical level of all sub-branches.

Each board has a council of advisors (associated with the manager) that systematically reviews and makes recommendations on all important problems, and oversees the fulfillment of the proper economic and technical policy. The main production administrations of MIC-MACS have been working for almost two years on the fundamentals of the expounded principles. And, we have become convinced that this method is the correct and progressive one.

Similar work in improving industrial management is being conducted in many of the ministries of the country. The year 1970 will undoubtedly see the complete realization of this endeavor.

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Automated Design Evaluation

V. Vand,
Chief Specialist at the
Giprotis Economic-Mathematical
Research Institute of the
USSR Gosstroj

The problem of evaluating the design of a new enterprise, in terms of practicality and efficiency of incorporated technological and economic concepts, is of utmost importance. How should it be accomplished? What criteria should be used?

There is the theory of economic efficiency of capital investments, which could be applied to this evaluation. This technique involves the determination of profit norms, or the coefficient of efficiency, the application of which will preserve the proper and essential ratio between reducing production cost (resulting from the implementation of the new design), and the capital investment required to implement the new design. This theory, however, has some shortcomings, and many of its suppositions are still subject to debate.

Another related problem is the accumulation and application of design work experience. Design experience concerns establishing proper norms, which at present is a very tedious task employing vague and unreliable methods. Frequently, at the norm verification stage, the computed norms are found to be already obsolete... Nevertheless, using computed norms in evaluating design decisions represents a significant advance, for it facilitates the selection of variants close to the optimum. In addition, design time is reduced and design quality is improved.

This, however, still does not fully resolve the problem of evaluating design quality. A possible solution is offered by Giprotis, the main institute of the USSR Gosstroj on the application of mathematical methods and electronic computers in construction. Advances in cybernetics, mathematics, and numerous other sciences have facilitated the development of a computer program permitting automated design evaluation based on data pertaining to past experience in this area. Using this program, the computer calculates unique norm indicators, selects the more important ones, applies criteria which minimize the number of possible erroneous conclusions, and precisely determines the permitted deviations from the norm.

In its general evaluation, the program indicates the design sections whose quality is in doubt, thereby simplifying further analysis and design perfection—if they are deemed necessary. An interesting peculiarity of the source program is that it does not require detailed information on evaluation criteria; analogous designs completed earlier are used in preparing the program.

Indicators of the analogous designs are adjusted, taking into consideration scientific progress, and then evaluated by a group of specialists. The source program is input to the computer where it is "educated" via stored information pertaining to other design work; it can be used later to evaluate new designs. As a result, the computer, using only a single source program along with design specifications, can output as many "educated" programs as there are branches in industry.

...A series of tests proved this method to be quite reliable. The method is already being used for design evaluations in the food industry, hydromelioration applications, radio-relay lines, and other areas...

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Automated Plan Evaluation System (ASPR)

In February 1969, the Scientific Council of the USSR Academy of Sciences met in Moscow to discuss "Optimal Planning and Administration of the National Economy." The Council's main concern was the development of an automated plan evaluation system (ASPR).

Some institutes have already studied the problems involved in developing such a system, including the Department for the Introduction of Economic-Mathematical Methods in the National Economy of USSR Gosplan, The Central Economic-Mathematics Institute (TsEMI), and Moscow State University. In 1966, a group of 60 specialists from these organizations was formed at USSR Gosplan. In order to create and introduce Gosplan's ASPR, the group has investigated national economic plan accounting operations, compiled a tentative timetable for developing this plan, and prepared 44 projects for realizing concrete plan accounts.

Work on creating the ASPR is being developed in most union republic Gosplans. M. E. Rakovskij, Deputy Chairman of USSR Gosplan, reported on the status of ASPR. He said that approximately 400 workers from 33 organizations are now engaged in developing ASPR jointly with republic organizations.

Rakovskij said that the creation of ASPR will increase the importance of estimative methods in improving the organization of national economic planning.

In 1969-70, it will be necessary to develop a draft for ASPR and to conduct experimental testing of the project's basic assumptions. Then, in the next five years, it will be possible to begin with working drafts and to gradually transfer to ASPR-aided national economic planning.

USSR Gosplan will direct the entire process of creating ASPR. It was recommended that TsEMI be the head organization, under Gosplan, for planning ASPR. Also involved in ASPR development will be the Institute of Automation and Remote Control of the USSR Academy of Sciences, the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, the State Computer Center of USSR Gosplan, the Central Statistical Administration, and the Institute of the Economics and Organization of Industrial Production of the Siberian Department of the USSR Academy of Sciences.

N. P. Fedorenko, Chairman of the Scientific Council of the USSR Academy of Sciences, called for a basic change in the methods and means of economic planning calculations. He said that branch automated control systems are already being developed in 28 all-union and republic ministries and departments. Apparently, this work will make it possible to resolve a number of the major scientific and organizational problems, and to coordinate these systems at the plant level.

It is hoped that ASPR will permit USSR Gosplan and the republic Gosplans to resolve the problems of national economic planning. As a man-machine system, ASPR will include computer equipment, interface equipment, communications devices, and specialists.

Fedorenko cited important changes that must be made before the introduction of the ASPR can occur. The training of USSR Gosplan personnel for automated plan evaluation work, and the creation of a department for that purpose, is one of the necessary changes. Another is an increase in the scientific level of the work of planning and economic organizations. He said that it is necessary to establish an experimental computer complex at the State Computer Center of USSR Gosplan for processing and experimentally using the primary subsystems of ASPR.

"The initial ASPR complex," Fedorenko explained, "should include such subsystems as ASPR for composite departments of USSR Gosplan, ASPR for any branch department of USSR Gosplan, and ASPR for one union republic Gosplan."

Ya. A. Oblomskij also spoke, outlining the problems of providing data to ASPR. Such problems include the complex of methods for coding information; methods for its distribution, accumulation, storage, and retrieval; and methods for processing initial documents and storing their data.

In the future, there will be more meetings to discuss ASPR and related economic reforms. The First All-Union Conference on Optimal Planning and Administration of the National Economy was planned for the third or fourth quarter of 1969.

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An "Emotional" Computer

Khar'kovskij

Emik, a product of the Institute of Cybernetics of the Ukrainian Academy of Sciences, is a rather strange character. When asked, "What is the date today?," Emik may innocently answer, "You know, I found a goose."

A laboratory technician escorts me to the next room; I am prepared for anything—a robot, an electronic box, a computer—. But on the table I see a pile of papertape, and on the wall a block-diagram. I am told that Emik is a program written on papertape. When it is run through a computer, the signals are processed by the interaction of two programs—one intellectual, the other emotional. Professor N. Amosov, Head of the Department of Biocybernetics, believes that to understand man a computer must be "armed" with emotions, since the thinking process, in his opinion, is an interaction of two such programs.

Emik knows 280 words. Linguists claim that knowing a thousand of the most frequently used words in any foreign language is sufficient to adequately communicate in that language. Emik, of course, can only understand simple word combinations.

A computer sorts words and estimates the probability of their combination. It uses a code: 0—impossible; 1—possible; ?—still undecided. This is what Emik answers when asked to establish the relationship of the noun "table" to the following verbs: "to fly"—?; "to crackle"—?; "to stand"—1; "to run"—0; "to whistle"—0.

In analyzing the characteristics of "table" and "closet," Emik tied them into one group. Emik reported that "father," "student," "professor," and "son" correspond to the verbs "to live," "to think," and "to speak," and grouped them under the concept of "man" (Emik attempted to add to this group a speaking object—"the radio"—but found that it had too little in common with "man").

Emik's memory has an address and an associative block. The first stores words and their relationships, and the second has the prepared questions and numbers designating the emotional evaluations. Input phrases are compared with those stored in memory and are evaluated on the basis of Emik's biography and his adjustment during the experimental stage (in the emotions block, an interaction occurs between the background and the "emotions" produced by the phrase.

In answering, Emik selects the most probable word for the specific combination. Thus the man/machine dialogue develops.

Up to now, Emik has been merely taught by man, who grades the accuracy of his responses. But the time may come when Emik or one of his brothers will leave his computer shelf in Kiev, pass through the Institute's glass doors, and enter the outside world as man's clever helper.

Regarding the association of man and machine, Academician V. M. Glushkov states, "We must clearly understand that a man equipped with thinking cybernetic machines will always be wiser and cleverer, not only than a man without machines, but also wiser than the machines would be without man. The problem of 'man or machine?' loses its importance in a socialist society."

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A Computer Goes Fishing

Sergej Yasson

In 1967, the Computer Center of the Main Administration of the Western Basin Fishing Industry was established in Riga, to organize statistical accounting, plan the work of the Basin administration, and investigate and manage its operation.

The Computer Center uses a Minsk-22 computer, operating 24 hours a day (less on Sundays and holidays). The work of the Center can be divided into three main areas, each important in itself, and each requiring large expenditures of machine time and mathematicians' labor.

The first and the most important area in the Center's operation is the development of an information retrieval system characterizing the work of the Western Basin fishing industry fleet. This task involves an immense amount of information which must be collected, input to the computer, verified, corrected, and sorted. The information is gathered from hundreds of vessels (industrial, processing, transport, service etc.) in the system of the State Trust of Fishing Industry Enterprises for Western Regions of the USSR (Zapryba). Each day the vessels report coordinates, fish haul, data on the mechanical condition of the ship, etc. The list of information consists of about 200 indices. When this information is received, the teletype communications system of the Basin administration works at full capacity. The information is transferred to papertape and input to the computer via a photoelectric papertape input unit. It would take dozens of persons many hours of work to process this information manually.

The information is processed, summarized, sorted, and transferred to magnetic tape. In addition to calculating operations, the computer also detects various errors due to communication interference, carelessness of operators, and equipment failures. The computer compares the extensive material stored in memory to the information being received and makes corrections independently, without human intervention.

The second direction in the work of the Computer Center is closely related to the first, and involves planning fleet operations. Obviously, practical and scientific planning is impossible without the accumulation of information on the daily production activity of the fleet. Planning the fleet's operation includes estimation of yields, fish output for different vessels, distribution of vessels in the fishing regions, etc.

The third direction in the work of the Center is the automation of the processing of accounting documentation—most importantly, payroll accounting. Mathematicians had to exert a great deal of effort to develop a convenient and efficient computer-based system for calculating wages. Different software had to be developed for calculating various wage scales for longshoremen and workers aboard fishing vessels. Wages are now regularly calculated for large industrial fishing trawlers and other similar vessels. The mathematicians of the Trust are developing additional programs which will consider specific aspects affecting the fishing industry (seasons, assignment of workers, etc.).

A System of Computers

Plans have been made to establish similar computer centers in other industrial administrations in the Basin. A Minsk-22 computer has already been installed in Kaliningrad; soon, computers will appear in the Estonian and Lithuanian fishing administrations. This will result in a powerful, unified computer system with joint operation of computers and an active exchange of accounting, planning, and statistical information. The main center in Riga will be enlarged and a new modern computer—the Minsk-32—will be added.

The extensive use of computers will present additional problems to mathematicians. The main one will be combining the three main directions of the Center's operation into one; this will require the development and introduction of new programs. Another problem will be to extend the information retrieval and the planning and accounting systems, which so far have been developed only for the fleet, to the fish-processing and ship-building enterprises, ports, and the fishing industry system of the Western Basin as a whole.

In trying to solve these problems, the Trust's computer engineers have made important contributions to the theory of programming and software. For example, in planning the operation of the fleet, they have developed methods for solving problems of discrete programming, constructed nonlinear mathematical models, and discovered methods for their execution. Numerous developments of the Riga mathematicians have been adopted by the computer centers of other basin administrations (the Azov-Black Sea, Far-Eastern, and Northern).

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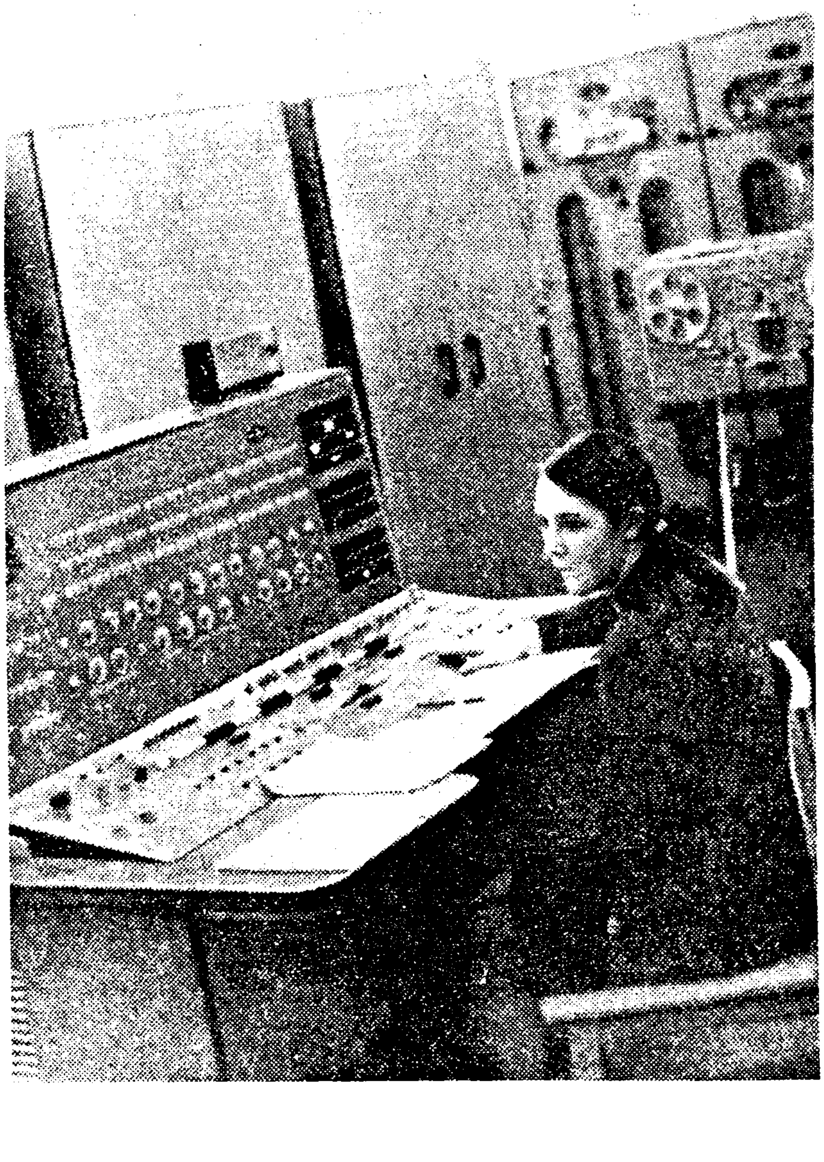
An International System of Computers

During the developmental period of the Computer Center, and later, when it was already in operation, the Trust's mathematicians maintained close contact with their Baltic neighbors—the workers of the German Democratic Republic (GDR) and the Polish fishing industry. These contacts have resulted in a continual exchange of technical information and experience. Plans have been made to join the Minsk-22 computer in Riga to the Robotron-300 used by the fishing industry in Rostock, GDR. Extensive exchange of information is predicted between the computer centers, especially information concerning the operation of vessels in the fishing industry. For better organization of communications between computer centers, communication instruments developed in the GDR will be installed in Riga.

Recently, Rostock mathematicians have developed an interesting system for controlling vessels which utilizes a series of new mathematical approaches. Soon this system will be used by the Trust's workers, who in turn have offered several new developments to their German colleagues. Such coordination of work in obtaining and processing accounting, planning, and statistical information presents wide possibilities for the partners. The knowledge of the main indices (daily yields of fish, etc.) of the German vessels will enable the Riga mathematicians to more fully and precisely plan the work of their own fleet in the same fishing regions, and vice versa.



The Minsk-22 Computer at Zapryb.
(File No. 2616P)

Will Thinking Machines Become Man's Enemy?

A. Dorodnitsyn,
Academician

Thinking machines will not become man's enemy. The very existence and development of such machines attests to the increasing strength and efficiency of the human intellect.

We can ask, Who will be the victor? Will the electronic computer triumph over man, whose biological possibilities are somewhat limited as compared with the mechanical capabilities of machines? Will the machine become hostile to man in time?

Theoretically, man can entrust any "thinking" operation to electronic computers. It is well known that machines can be developed which will even have feelings of their own. After all, the simplest feelings are physical sensations. A machine can perceive and differentiate them. A machine equipped with acoustic, optical, and thermal instruments (analogs of our sense organs) can perceive the environment and evaluate it. However, this is only true if the designer endows it with such properties—that is, if he introduces the appropriate devices into the machine system.

It is possible to develop a machine in which images perceived and decoded can be connected with certain emotions. Depending on the nature of perceptions and their evaluation, the machine will undertake certain actions. It is also possible to store a "will" in the computer—that is, to assign a certain goal to the computer's existence in the program.

Thus, a machine can become a human model in all respects. "Thinking" automated machines and robots are also possible. Theoretically, machines can be developed which will oppose man. This possibility gives rise to fantastic sociological theories which state that, in the future, there will be a society of machines which will enslave mankind. Such theories are reflected in pessimistic novels of science fiction writers, but, this is only an escape from reality, a misconception of the actual conditions under which machines will really "exist."

Everything in life is not as simple as in science fiction. A great inventor, like Captain Nemo, or an invisible man can single-handedly create a special "supermachine" only in the minds of writers. This does not happen in real life. Machines are not created by an individual, but by mankind; not by one small laboratory, but by vast associations.

For example, Academician Sergei A. Lebedev is an outstanding computer designer in the USSR. We all admire his talent and industriousness. But he could do nothing alone, without a large staff of talented people. In addition to this group, there are many large institutes also engaged in the development of physical and technological theories of machines. It is unlikely that they will all resort to collective suicide!

Of course, as long as there are states in the world where society is divided into antagonistic classes, we can find some groups of people, even states, which would want to use the power of machines to man's detriment. However, mankind will control these machines. History shows that even when machines were created to destroy man, they later became man's assistants.

Even atomic energy became a peaceful tool, with the nuclear power station following the bomb. Mankind invariably proves to be more intelligent and stronger than individuals, and ultimately transforms those things created with evil intent into peaceful tools...

If machines eventually have their own "will," will they become man's enemies of their own accord? No, man can reliably ensure the subordination of machines by providing them, from the very beginning, with an appropriate goal. For example, dogs who are very smart creatures serve man loyally and conscientiously. Even when man beats his dog, it continues to love and serve him. The attachment to man is programmed into the dog's nature. Such attachment is an emotion which can be fully reproduced in a machine. This is what computer designers will do, if they are normal, humane people.

The instinct of self-preservation is mankind's basic universal objective; it is an instinct developed through millions of years. Guided by it, mankind will protect itself against machines, and store in them the ideas and objectives aimed at preserving their masters.

This is why I am not at all frightened by the upcoming era of "thinking" machines.

These creations of the human mind will have little resemblance to today's computers. They will differ from today's computers more than the arithmometer differs from a modern machine.

However, this can only frighten people who have a low opinion of man's intellect and willpower.

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Industry and Production in the Year 2000

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Forecasting is a new branch of knowledge but it has already developed scientific methods for foreseeing the future of science and technology with a considerable degree of accuracy. The forecasts made by nineteenth century scientists for the beginning of the twentieth century were 80 percent correct. Many scientists of the latter half of the twentieth century estimate that the accuracy of forecasts made for the beginning of the twenty-first century has increased to 90-95 percent. This belief is based on the fact that the basic laws of scientific-technical progress have been discovered, practical methods of forecasting have been developed, and problems which can be solved successfully by scientists of various countries have been defined.

How will today's rapid scientific-technical progress affect the actual processes of producing the necessities of life, and what will be man's technology in the year 2000?

The technology of 2000 is based on fully automated production, which largely depends on the degree of application of control machines. By automating production control, these machines create a continuous technological process (within limits, of course). Control machines make it possible to transfer to hardware all production operations performed by man. The hardware requirement is great, since the more productive, accurate, and advanced the system (from the point of view of flexibility and the number of executed operations), the less the possibility for using man without causing a deterioration in the quality of the system operation. With a sufficiently large volume of work, even the task of pushing a buttom on a control panel becomes not only a tiresome operation, but a difficult one for a man whose reactions are comparatively slow and who tends to be absentminded and can easily push the wrong button. Therefore, even in this task he is replaced by a control machine.

The technology of the year 2000 is characterized by the application of large concentrations of energy, the utilization of super-high pressures, temperatures, and vacuums; very-high and very-low power drives; high velocities; long-distance communication; and an immense volume of information. This has led to the development of hardware which eliminates the direct participation of man in production. Man is not involved in the production cycle—i.e., he does not execute the technological, logical, and other labor functions which directly complement the work of the machines and mechanisms. In other words, man works side by side with production, but he is not its chief agent.

However, man is not eliminated from the sphere of production as a whole. He creates, improves, and verifies experimental designs, installs automated systems, assigns tasks (compiles work programs) to the automated production process, and follows the course of production. His main function, however, is to work in scientific areas and to try to understand the laws of nature and society. Mankind seeks and discovers methods and means of utilizing newly discovered laws and phenomena. Manual labor is used to various degrees in scientific research, design of experimental installations, adjustment of technological systems used in serial production, and in maintenance work. This work, however, brings the joy of creativity to people.

An enterprise of the future is not a plant as we see it today. It is located not in large, lighted buildings, but underground; it occupies little space, because it does not house people, and because all the technological systems are compact and assembled from highly reliable and precise miniaturized elements.

The entire process of obtaining and processing raw materials and assembling new equipment and machinery is conducted by automated systems which are controlled by logical machines. A logical machine (or a control machine) is capable of self-instruction. When it meets with unprogrammed phenomena, or deviates from the technological process, it transmits the new data to a special control device. This device, the so called center of an automated enterprise, is equipped with unique "sense organs" (various sensors, photocells, thermocouples, etc.)

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and "effectors"—i.e., components which are capable of affecting the environment.

Logical machines are located in the general-purpose "brain centers" and from there they control the production processes over long distances. These advanced systems are capable of self-instruction and self-regulation. They can also provide necessary help in case of failures, execute preventive maintenance, and control the quality of production. They can even self-reproduce. The circle of problems solved by a machine is so wide that man has to provide only general supervision.

The operational efficiency of an automated enterprise of the future, to a large degree, depends on full-capacity work loads and almost complete elimination of readjustments. Fully automated production is based on mass production which remains the same for a sufficiently long period of time. For this reason, interchangeability, including standardization, typification, normalization, and unification, is strongly developed. The technology requires strong cooperation among individual enterprises, which sharply increases the quality of production.

...The technology of the year 2000 makes it possible to significantly decrease the number of persons employed in [the industrial] branch of the national economy.

By using methods of selection and genetics, agricultural plants and animals have been cultivated which have new biological, physiological, and mechanical propertie-s...The application of achievements in the genetics of animal breeding make it possible to obtain products with optimal properties for machine use.

Automated control methods are widely applied in agriculture. It is possible to program the majority of processes for machine execution. Appropriate programs are input to the machine or are compiled by the machine itself, with the application of self-regulating and self-instructing systems. In many systems, human biological currents are used as the controlling pulses; in animal breeding, animal biological currents are applied. Systems controlled by man's vocal commands, optical beams, sensing elements, and other devices have been developed.

...In the last third of the [twentieth] century, solutions have been found to problems involving automatic search and transmission of various types of information, the development of direct automatic communication between enterprises and distribution organs, automated systems for controlling transport, and production of synthetic materials for super-light structures.

...Astronautics has become the stimulus of scientific research, resulting in the development of new trends in science and technology. Practical problems and human needs have fostered the mastering of space, resulting in such developments as weather satellites...

The greatest influence on technology was exerted by a communication system that relies on artificial earth satellites. It increased the distance of radio communication many thousands of times, and significantly improved its efficiency. Long-distance transmission of TV programs, long-distance two-way multichannel radio telephone service, and phototelegraphy and telephone communication not only shortened the distance between people, but established a new system for collecting, storing, processing, and transmitting information required for controlling technology.

The October 1968 resolution of the Central Committee of the CPSU and the USSR Council of Ministers, "On measures for increasing the efficiency of the work of scientific organizations and accelerating the use of scientific and technological achievements in the national economy," is oriented toward improving planning for the development of scientific-technical progress, forcasting methods in science and technolgy, and the responsibility of scientific research and design organizations of the ministries and departments for the state of specific areas of science and technology.

Will Automation Cause Unemployment In the USSR?

In the capitalist world, technical progress has always represented a threat to the workers. In most cases, technical progress is associated with labor intensity that increases at a rate which exhausts the worker. In addition, technical improvements lead to greater unemployment.

The following statement was published in an American newspaper: "For an unemployed person in Detroit, Pittsburgh, or Los Angeles, the machine personifies automation. It is a monster which deprives man of his livelihood, makes his family dependent on charitable organizations, and forces him to wander through the country day after day in a vain search for work."

Mechanization and automation is briefly described as "the road to disaster" by an American trade union newspaper, the *AFL-CIO News.*

An event in the German Federal Republic clearly demonstrates the effect of the constant threat of unemployment to workers. At the mechanized plant of a Ruhr steel industrialist, Helmut Zepi, rumors were deliberately spread of a forthcoming cut in production and increase in dismissals. The incidence of illness among steelmakers immediately increased. The fear of losing their jobs and being left on the street made such a strong impression on the workers that many could not withstand the stress.

What is the situation in the USSR, and can there be unemployment? After all, rapid progress is also taking place in the USSR and automation is being introduced in industry.

Signore Sovaretti, a representative of a well-known Italian firm, visited a Moscow small-car plant. The visitor carefully examined one of the automatic lines and noted its advantages and shortcomings. He asked, "Please tell me, how many people were employed in parts machining before this line was installed?"

"Ten people."

"How many are there now?"

"As you see, only two—a line adjuster and this young worker."

"Splendid. What has been the lot of the remaining eight people? Were they fired?

"No, none were fired. Work was found for everyone."

Signore Sovaretti doubtfully shook his head. Then he was taken to the shop office. Lists were examined and the eight workers who left the line were quickly located. Three have graduated from an evening technical school. One was working as a foreman in a neighboring section, and two were working as adjusters. Three machine operators remained in the same shop in their specialty and were also attending a school for working youth. They intended to improve their skills so that subsequently they could work on other automatic lines. The seventh was transferred to another shop. One 55-year-old worker retired.

This is an example from only one plant. As a rule, however, on a nation-wide scale the problem of unemployment arising from automation is being solved successfully. In the Soviet Union, automation does not lead to unemployment.

Production is expanding so rapidly in our country that it requires an ever-increasing number of workers. Confirmation of this can be found in any statistical handbook. For example, during the Seven-Year Plan alone, the average annual number of workers and employees in the national economy increased by 21 million, totaling almost 80 million in 1966.

If, in the future, the rapid growth of labor productivity, due to automation, threatens to cause large-scale unemployment, the work day will be reduced and the length of paid vacations will be increased (of course, without wage cuts). Workers will have more leisure time and will use it for studies, rest, sports, and cultural activities.

One may disagree and state that in some regions there will be a surplus of manpower, or that it will be difficult to find a job in one's specialization. Of course, the distribution of industry throughout the country's territory cannot be perfectly uniform. In some places, the need for workers, engineers, and employees will always be greater, and in others it will be smaller. However, this is not a sign of unemployment. Skillful hands, solid knowledge, and the desire to work will always find their proper application in the Soviet Union.

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Romanian Conference On Economic Cybernetics

R. Stroe

The fourth annual Scientific Session of the [Romanian] Center of Economic Computation and Economic Cybernetics was held in February 1969. The session presented an opportunity for disclosing and confronting the results of studies carried out during the preceding year, for promoting lively debates and a fruitful exchange of opinions, as well as for exchanging information on problems of economic computation and economic cybernetics.

The proceedings took place in a plenary meeting, and in sections and subsections, featuring within a unitary and integrated viewpoint the scope of the problems under consideration at the Center of Economic Computation and Economic Cybernetics, namely: economic cybernetics, operations research, informatics, and the applications of computers in economy.

The reports submitted were contributed by a great number of scientists, educators, experts in economics and mathematics, and engineers, reflecting varied directions and fields of research deriving from the practical needs of the Romanian economy, and combining basic and applied research. Over 190 authors signed the 143 papers listed on the agenda of this scientific session.

Several reports, dealing with the applications of cybernetics in economics and designed for a broad audience, were submitted during the plenary meeting. These reports were: "Notes on a Model of Reproduction on an Expanded Scale, as Conceived by Karl Marx," by Professor Miron Constantinescu; "Political Economy of Socialism and Mathematics," by Professor Dr. Emilian Dobrescu; "Progress and Trends in Operations Research," by Dr. Mircea Malita; "Application of Mathematical Methods to the Quantification and Optimization of Economic Processes," by Professor Nicolae Teodorescu, Member of the Academy; "Complex Computation Systems: Rational Utilization Concepts and Technical Economic Indexes," by Professor Mihai Draganescu, Professor Nicolae Racoveanu and Dr. Dragos Vaida.

In the Economic Cybernetics Symposium, 32 papers were submitted. Most of the topics concerned the application of cybernetic methods to planning and macroeconomic analysis problems. New trends in the use of economic cybernetic methods were emphasized with particular attention on simulation viewed as an analytical tool for macroeconomic phenomena. Moreover, considerable weight was given to reports on the balance of relationships among the various economic branches which are becoming more and more involved in planning and analyzing phenomena taking place at the level of the national economy. Current problems were particularly reflected in reports on calculation of technical indices, the use of balance in pricing and in directing price policy, the use of balance in determining gross output at the economic branch level, and the development of a dynamic model for the balance of relationships among the economic branches.

A great number of reports presented at the Economic Applications of Operations Research Symposium dealt with topics related to the use of mathematical techniques in ascertaining an optimal path for the progress of specific industrial branches and the optimal way to take into account available resources (raw materials, production capacities, manpower), in investment optimization, etc.

Over 60 papers were submitted during the symposium, giving rise to lively and interesting debates at a high scientific level. Many reports dealt with specific applications of operations research in various economic areas, such as electronics, transportation, goods turnover, energetics, agriculture (irrigation, wine growing, etc.), building activities, mechanical engineering, mining-geology, light manufacturing and food industry, and exports.

Moreover, the reports tackled some problems regarding optimal methods for carrying out such economic activities as work standardization, new product assimilation, and selection of personnel, as well as problems dealing with the optimization of indices or parameters of production activities (rhythms, resource utilization, labor productivity, quality control, etc).

Also included on the symposium agenda was a considerable number of theoretic subjects, including the application of graph theory to surveying social phenomena, the development of a stochastic programming model designed for the establishment of a monetary policy, a new variant of a lexicographical algorithm for integer solution of programs, and the use of utility theory in solving some linear programming problems with multiple optimum criteria.

The third symposium, entitled Informatics, Al-

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gorithms, and Programming Systems, discussed computer programming problems in economic computations, and software development in general.

Reports submitted at this symposium focused particularly on basic software development—a prerequisite for developing automated programming and for utilizing computational equipment to full capacity—as well as on the development of a large library of utility programs. Particularly noteworthy were reports on techniques used on checking the accuracy of an ALGOL 60 compiler, and the inversion of an 81st-order balance matrix by means of a NEAC 1240 computer in financial and banking activities.

The papers presented at the symposium on the Utilization of Computers in the Economy were characterized by their marked practical features. They referred to a great variety of problems, beginning with research on the introduction of computational systems in economic organizations and concluding with an analysis of the psychological implications of computer utilization in production management. They covered, for example, the development of specific solutions to numerous problems, such as optimal warehouse management through simulation techniques; mechanical and graphic processing of data on inventory management; the booking of tickets, rooms, and services at the National Travel Office through an automatic computation system; automation of payroll calculations at enterprises, coordinated through the Ministry of Petroleum; and production programming at the spare parts shop at the State Electro-Banat Company. Any of the practical solutions suggested, if implemented, would provide high efficiency in the activities of the industrial units and institutions for which they were developed.

...Discussions concentrated on four themes: the training of economists; the role of modern information processing methods in the investigation of economic and social problems; computational systems and programming methods; and modeling and simulation techniques.

...Conclusions drawn from the symposiums and discussions were pointed out in the closing speech of the proceedings, delivered by Dr. Stefan Birlea, First Vice-President of the National Council of Scientific Research.

He said that an initial research trend is the modeling of macroeconomic processes and the application of simulation techniques in the field of economics. Closely connected with this problem, and at the same time one of its particular aspects, is the need for extending research on inter-branch balances to the area of planning practices.

The problems tackled by research workers in the area of operations research, such as mathematical programming, optimization theory, graph theory, and inventory theory, are considered to be in full accord with production requirements.

As to the field of computer utilization and programming, he went on to say, it is necessary to comply with the trend, evidenced on a world scale, of developing software; furthermore, it will be necessary to increase the productivity of existing computers through telecontrol systems for management and computations, to increase their economic efficiency and to provide the most effective utilization of high-capacity computers.

The proceedings of the scientific session were a proof of the efforts being made in Romania for the widespread promotion of modern computational techniques and economic cybernetics, for the sound guidance of the activities carried on at the Center of Economic Computation and Economic Cybernetics with respect to theoretical progress in economic computation and economic cybernetics, as well as application of methods and techniques available for the management and organization of work in industrial units, economic branches, and the entire national economy.

WHO'S WHO?

Viktor M. Glushkov is Vice President of the Academy of Sciences of the Ukrainian SSR, and Director of the Academy's Institute of Cybernetics. He is also an Academician, and a winner of the Lenin and State Prizes.

Viktor M. Glushkov

In 1969 he became Hero of Socialist Labor and his Institute received the Order of Lenin for work in automata theory, for development of an industrial management information system, and for the design of the Mir-1 computer. The Kiev and Dnepr computers and automatic programming systems were also developed under his direction. Glushkov's research interests are varied, including such areas as computational mathematics, computer technology, and modern algebra. His research has produced a general algebraic theory of discrete automata, as well as methodology for studying self-organizing and adaptive automata systems. Other research at the Institute, also under Glushkov's direction, in the area of national economy has yielded important practical results. Glushkov, with more progressive ideas, and influence in both political and scientific arenas, is gradually replacing A. I. Berg as the political leader of the Soviet cybernetics movement. In November 1968, Glushkov, pioneering a Soviet software revolution, hosted the First All-Union Conference on Programming, the first large-scale Soviet effort to solve problems in software.

Admiral Aksel I. Berg

Aksel I. Berg, an Admiral in the Naval Engineering Corps, was among the first Soviets to realize the importance of developing a computer technology, and is considered the political leader of the cybernetics movement in the USSR. Though he is not a computer scientist, Berg was appointed Chairman of the Scientific Council on the Complex Problem of Cybernetics of the Presidium of the Academy of Sciences, USSR, following his proposals for a cybernetics research organization. Berg's major field of interest is radio electronics, and he was the first director of the Scientific Research Institute of Radio Engineering and Electronics, which he helped establish. During four decades of service in radio electronics, Berg was also Chairman of the Navy's Communications and Navigation Section (receiving the order of the Red Star); Director of the Scientific Research Naval Institute; Deputy People's Commissar of the Electrical Industry and, at the same time, Deputy Chairman of the Council on Radar; and Deputy Minister of Defense for Radioelectronics. He has been a member of the Academy of Sciences since 1946. Berg's major current interest is the introduction of computers into the educational system.

Sergei A. Lebedev is Director of the Institute of Precise Mechanics and Computer Engineering, Academy of Sciences, USSR, where the BESM computer line origi-

(File No. 2589) (File No. 02230P)

Sergei A. Lebedev (r.),
with assistant,
V. A. Mel'nikov.

Aleksandr A. Samarskij

nated. As the USSR's chief computer designer, Lebedev was responsible for the makeup of the Soviet Union's first operative, large capacity computer, the MESM, which was completed about 1952. Shortly after work on the MESM was completed at the Computer Center in Kiev, Lebedev traveled to Moscow, to become Director of the Institute of Precise Mechanics and Computer Engineering, and supervise the design of the BESM series, which includes the BESM-6, the Soviets' largest and fastest computer. About 1957 Lebedev also designed the M-20, a computer that is considered the "industrial" counterpart of the BESM-2.

Aleksandr A. Samarskij is a Corresponding Member of the USSR Academy of Sciences, and has received the Order of the Red Banner for his contributions in computational mathematics and mathematical physics. Samarskij's textbook on the equations of mathematical physics has been recognized both in the USSR and abroad. He is also noted for his research on the theory of difference circuits, on methods of solving multidimensional problems of mathematical physics, and on iterational techniques.

(File No. 01392P) (File No. 02486P) (File No. 2589)

Technical Conference on the Introduction and Improvement of Automated Production Control Systems, Norosibirsk Science City, November 12, 1969.

The purpose of the Conference was to determine precisely what domestic science has done in the area of developing and applying automated control systems, to determine the state of the process-control art in the Soviet Union, and to outline a course for further research. The Conference was attended by scientists, enterprise directors, and senior industrial engineers from 50 cities. Some 120 papers dealing with various aspects of the problem were discussed. *(Sotsialisticheskaya industriya,* November 12, 1969, p. 1)

Second Conference on Scientific and Methodological Problems of Creating an Automated System for Plan Evaluation, Erevan, 1969.

The Conference was sponsored by the USSR Academy of Sciences and the Armenian Academy of Sciences. Some 250 specialists from the USSR and Republic Gosplans, and from scientific research and design organizations participated. Papers were read by M. E. Rakovskij, Deputy Chairman of USSR Gosplan, Academician N. P. Fedorenko, and others. Rakovskij discussed the status and prospects for the development of computer technology and establishment of a network of computer centers at USSR and Republic Gosplans. He stated that some of these problems cannot be solved due to the existing shortage of computers. Rakovskij mentioned the system of models for the compilation of the Five-Year Plan which was developed by the Central Economic-Mathematics Institute (TsEMI) of the USSR Academy of Sciences.

The Conference was divided into four sections. The first was devoted to methodological problems in the development of the Automated System for Plan Evaluation (ASPR). The second section discussed the problems of developing specific subsystems for ASPR and described models for the communication, power engineering, and other industries. The third section was devoted to network planning methods for the development of the USSR national economic plan. The fourth section examined problems of information, software, and hardware. Speaking during this session, D. V. Yurin, of the USSR Gosplan Computer Bureau, reported on the centralized application of modern hardware for information processing (primarily, the application of papertape techniques) at USSR Gosplan. For this purpose, a special Computer Bureau has been established which is equipped with advanced equipment—i.e., automatic typewriters, computers, and table calculators. The bureau makes calculations for different departments of USSR Gosplan. V. S. Proskurov, of USSR Gosplan, examined the problems of information retrieval.

To coordinate future work on ASPR the conference requested that:

First, USSR Gosplan, together with the Republic Gosplans, the USSR Academy of Sciences, and other interested organizations, formulate a single, comprehensive 1970-75 plan for the development and introduction of ASPR;

Second, USSR Gosplan and the State Committee on Science and Technology of the USSR Council of Ministers appoint the Central Economic-Mathematics Institute of the USSR Academy of Sciences as the leading organization for planning ASPR as a whole; that the State Computer Center of USSR Gosplan be in charge of the information, software, and hardware development, the technology of information processing, and the information retrieval aspects of ASPR; and that the work of the Republic computer centers and the State Computer Center of USSR Gosplan be coordinated to form a single system.

In the period between the annual All-Union Conferences, plans have been made to conduct conference-seminars on specific problems of ASPR development. For the systematic exchange of experience, it was recommended that USSR Gosplan and Academy of Sciences organize a publication entitled, "Information Bulletin on the ASPR."

The work of the Second Conference on Scientific and Methodological Problems on Creating an Automated Control System for Planning Evaluation will be issued as a separate publication. *(Ekonomika i matematicheskie metody,* No. 5, 1969, pp. 783-90)

Symposium on Economic-Mathematical Methods, Treskol, 1969.

The Symposium was sponsored by the Central Economic-Mathematics Institute of the USSR Academy of Sciences and the Scientific Council of the USSR Academy of Sciences on the Complex Problem of Optimal Planning and Control of the National Economy. Seventy-nine persons representing more than 20 scientific, design, and planning-economic organizations participated. Fifteen papers were read and discussed. The papers were mainly devoted to the problems of "nontraditional" applications of economic-mathematical modeling in solving new and interesting problems. *(Ekonomika i matematicheskie metody,* No. 5, 1969, pp. 791-92)

Higher Educational Institutions' Conference-Seminar on Mathematics for Engineers and Builders, Rostov Engineering and Construction Institute, late 1968.

The Conference's 150 participants heard 49 papers and other presentations dealing with contemporary problems in the mathematical training of construction engineers. K. S. Nekrasov, Head of the Section on Computer Technology of USSR Gosstroj, emphasized that each engineer must be familiar with computer capabilities, and know how to present a problem to mathematicians and programmers for compilation of algorithms and programs. Professor S. I. Zukhovitskij, Head of the Faculty of Applied Mathematics of the Moscow Engineering-Construction Institute, reported that the Faculty had written a text intended to give students an understanding of the concepts of algorithms, algorithmic language, standard programs, and programming small computers. The Institute is offering a special experimental course in the application of mathematical methods in city planning which deals with both linear and nonlinear programming methods. *(Vestnik vysshej shkoly,* No. 8, 1969, pp. 41-43)

All-Union Conference on Problems of Designing and Improving Educational Equipment, Moscow.

Forecasting the development of educational equipment for the next 10-15 years was a major theme of the Conference sponsored by the USSR Ministry of Education and the Scientific Research Institute of School Equipment and Educational Hardware of the USSR Academy of Pedagogical Sciences. The Academy's director, S. G. Shapovalenko, predicted that computers would be used for individualized instruction. Although he does not foresee the extensive use of computers for this purpose in the next 10-15 years, Shapovalenko anticipates lowering of computer prices and a simultaneous increase in memory and speed, a decrease in size, and simplification in servicing. The Director called for experimentation in these areas. *(Sovetskaya pedagogika,* No. 9, 1969, pp. 154-157)

NEW BOOKS

Berg, A. I., N. G. Bruevich, B. N. Petrov, *et al.* (eds.). **Automation of Intellectual Labor in Machine Construction: Transactions of a Scientific Session of the Department of Mechanics and Control Processes and of the Scientific Council on the Complex Problem of Cybernetics** *(Avtomatizatsiya umstvennogo truda v mashinostroenii: Trudy nauchnoj sessii Otdeleniya mekhaniki i protsessov upravleniya i Nauchnogo soveta po kompleksnoj probleme "kibernetika"),* Nauka, Moscow, 1969, 163 pp.

Automation of machine construction and design is the subject of this work, intended for scientists and engineers. The book includes:

Bruevich, N. G., "Basis for Automating Man's Intellectual Activity"
Goranskij, G. K., "Automation of Machine Design Using an Electronic Digital Computer"
Goranskij, G. K., A. G. Gorelik, and L. N. Lambin, "Processing of Geometric Information in the Automated Design of Machine Construction via an Electronic Digital Computer"
Tsvetkov, V. D., "A Multistep Method for Designing Operational Technological Processes Using a Computer"
Dumler, S. A., A. S. Grinberg, and M. B. Katsnel'son, "The Design of Automated Control Systems in Machine and Instrument Construction (Function, Structure, and Economic and Technical Parameters)"
Lugovskoj, V. M., "Reliability of Computational Forecasting and the Economic Precision of Mathematical Models of Processes and Designs"
Filippov, A. P., B. Ya. Kantor, "Some Methods for Solving Mechanical Problems Concerned with the Automation of Machine Construction"
Volgin, B. N., S. A. Yukhimchuk, "Application of Heuristic Programming to a Machine Construction Problem"
Venevtsev, V. M., I. B. Gertsbakh, Kh. B. Kordonskij, V. K. Linis, and M. S. Maksim, "Heuristic Method of Compiling Airline Passenger Lists with the Help of Computers"

Emel'yanov, G. V., and V. P. Skitovich (Leningrad State University). **A Book of Problems on Probability Theory and Mathematical Statistics** *(Zadachnik po teorii veroyatnostej i matematicheskoj statistike),* Leningrad State University Publishing House, 1967, 329 pp.

This university textbook contains 782 problems in the area of probability, statistics, theory of random processes, queueing theory, and information theory. It can be used by members of military academies, technological institutions, and university students.

The Soviet journal *Criticism and Bibliography (Kritika i bibliografiya)* recently published a negative review of the book, by V. N. Tutubalin, who flatly states that students should be forbidden to use this text. This criticism is most interesting since V. P. Skitovich is a rather well known Soviet mathematician. Tutubalin criticizes the poor selection of problems and the lack of editing—i.e., he argues that the problems are torpid and filled with typographical errors, inconsistencies, and fallacies.

Evreinov, E. V., and Ya. I. Fet (eds.) (Institute of Mathematics, Siberian Department, USSR Academy of Sciences). **Computer Systems** *(Vychislitel'nye sistemy),* No. 31, Nauka, Novosibirsk, 1969, 100 pp.

This collection of articles is a continuation of works on automating digital-machine design. The articles in this issue deal with the various stages of design.

In their article, I. V. Ilovajskij and E. E. Sergeeva discuss an algorithm for designing a flowchart for a digital device based on a description of its operation. They cite results of the algorithm's application.

A. K. Olefir deals with problems of ensuring the efficient operation of designed machines and systems.

The author of the subsequent article, V. G. Khoroshevskij, establishes a relation between the reliability of homogeneous digital systems and some economic indicators of their actual use.

The remaining articles, written by members of the Sverdlovsk Department of the Steklov Institute of Mathematics of the USSR Academy of Sciences, deal with the design of combination circuits of functional transformers. These articles contain a detailed description of the synthesis of minimal-depth circuits, and describe some results obtained by this method.

All algorithms published in this issue are written in the form of programs for general-purpose digital computers.

The book will be of value to specialists interested in the synthesis of digital systems.

Gol'shtejn, E. G., and F. G. Gurvich (eds.) (Central Economic-Mathematics Institute, USSR Academy of Sciences). **Mathematical Methods for Solving Economics Problems** *(Mathematicheskie metody resheniya ekonomicheskikh zadach),* No. 1, Nauka, 1969, 174 pp.

This collection of articles, selected from papers submitted to the journal *Economics and Mathematical Methods (Ekonomika i matematicheskie metody),* encompasses a wide area of problems, and, as a whole, gives a rather complete picture of the trends in current mathematics research concerned with economics applications. The 23 articles are grouped into six sections: linear programming, nonlinear programming, integer programming and combinatorial problems, graph extremal problems, economic-mathematical models, and stochastic models and probability methods.

The articles will be useful to those interested in the latest scientific achievements in mathematical economics. The table of contents includes:

I. LINEAR PROGRAMMING

Mukhacheva, E. A., "An Algorithm for Efficiently Cutting Rectangular Blanks"

Reut, V. B., "A Method for Solving an Assignment Problem"
Khoang Tui, Nguen Kuang Tkhai, "Two Specific Problems in Linear Programming"

II. NONLINEAR PROGRAMMING

Trius, E. B., G. G. Vil'chik, "The Solution of a Transportation Problem with Nonlinear Transport Values by the Sequential Reduction of Discrepancies"
Leonas, V. L., I. B. Motskus, "A Nonlinear Problem in Mathematical Programming"
Spivak, V. N., I. L. Khranovich, "The Kuhn-Tucker Theorem for Almost-Concave Functions"
Guter, R. S., "Optimization by Means of a Partial Improvement in Groups of Variables"
Gurin, L. S., "Optimization via Partial Improvement in Groups of Restricted Variables in the Presence of Noise"

III. INTEGER PROGRAMMING AND COMBINATORIAL PROBLEMS

Al'tshuler, L. M., V. M. Ryabov, "Approximation Method for Solving a Problem of Rational Grouping of Products for Planning Group Output"
Gajndrik, K. V., V. A. Zhitkov, "Optimal Solution of a Simplified Conveyance Problem"
Shembel', V. I., "Minimizing Maximum Production Deficit During Planning"
Klebanov, I. F., "An Algorithm for Solving a Discrete Programming Problem"

IV. GRAPH EXTREMAL PROBLEMS

Vantrusov, Yu. I., "Computation of Work Reserves via Network Graphs"
Zambitskij, D. K., P. S. Soltan, "An Experimental Graph Problem"
Lejfman, L. Ya., "Methods of Sequential Correlation of a Plan for Solving Problems of Resource Distribution in Network Planning"
Raevich, S. K., "Application of the Branches and Boundaries' Method for Solving a Problem of Resource Distribution"

V. ECONOMIC-MATHEMATICAL MODELS

Smagin, V. N., "A Mathematical Model for Renovating a Machine Pool"
Petersen, I. F., "On the Tendency for Magnifying the Effect of Using Regression Control Equations in Optimization Applications"
Alejnikov, B. I., M. M. Berkovich, "Optimal Redistribution of Resources"

VI. STOCHASTIC MODELS AND PROBABILITY METHODS

Polyak, D. G., "Multilinear Queueing Systems with Continuous Maintenance and Nonordinary Poisson Demand Flow"
Ryzhikov, Yu. I., "Queueing Theory Applications in Controlling Reserves"
Paramonov, Yu. M., O. R. Frolov, "Mathematical Models for Distributing Passengers Among Various Types of Transport"
Miroshnichenko, G. P., "Experimental Characteristics of the Distribution of Temporal Evaluations and a Unit System for Time Evaluations on a Network Graph"

Gurvich, F. G., B. N. Mikhalevskij, and B. S. Fomin (eds.) (Central Economic-Mathematics Institute, USSR Academy of Sciences). **Economic-Mathematical Models** *(Ekonomiko-matematicheskie modeli)*, No. 2, 1969, Nauka, Moscow, 1969, 158 pp.

This is the second volume in a series of monographs containing articles submitted to the journal *Economics and Mathematical Methods.* This volume deals with a wide range of planning, modeling, and information processing problems in the national economy and industry. It is divided into three parts and composed of the following articles:

I. ECONOMIC MODELING AND PLAN EVALUATIONS

Solov'ev, A. S., "Balance Analysis in Macroeconomic Modeling (Survey)"
Zhdanko, A. V., "The Problem of Dual Prices"
Zanegin, A. G., "Optimal Norm of Industrial Profit and Its Characteristics"
Roginskij, F. N., "Calculated Determination of Industrial Norm Coefficients of the Comparative Effectiveness of Capital Investments"
Mikhalevskij, B. N., Yu. P. Solov'ev, "Determining the Average Period of Need for Basic Products"
Alejnikov, B. I., G. Z. Davidovich, B. S. Fomin, "Block Approach to Solving Problems of Foreign Trade Optimization"

II. BRANCH AND FACTORY PROBLEMS. PROBLEMS OF ORGANIZING RESEARCH

Krastin', O. P., I. E. Gajle, and A. A. Lejerte, "Methodological Problems of Correlation Analysis"
Gnesin, M. B., V. V. Dubrovskij, "Formation of an Optimal Plan for the Realization of Finished-Product Production"
Gurvich, F. G., "Some Problems in Organizing Research"
Lagosha, B. A., "A Model of Operative Planning for the Merchant Fleet"
Trubin, V. A., "Operative Planning for the Distribution of Empty Railroad Cars"
Fedorovich, M. M., O. P. Krivoshein, "Economic-Mathematical Models of Net Cost of Production in Large Industries"
Kulagin, Yu. S., V. N. Efimov, "Automated Control Systems for Enterprises, and Problems in the Scientific Organization of Labor"

III. PROBLEMS OF INFORMATION PROCESSING

Mikhno, V. K., Yu. S. Arkhangel'skij, and V. A. Konoplitskij, "Designing an All-Union Production Classifier"
Grineva, S. N., V. M. Sokov, "Selecting the Optimal Number of Devices in an Information Collection and Transmission System"

(File No. 2626)

PRESS REVIEW, NOV. 1969

This section contains annotated listings of articles and photographs in the Soviet popular press dealing with cybernetics, computer technology, and general science. The listings are arranged by subject. Each entry abstracts the item, followed by the name of the newspaper, the publication date or issue number, page number, and transliterated heading (where applicable). Supplemental information follows in square brackets.

This issue covers November numbers of the daily newspapers **Pravda** (the Party organ), **Izvestiya** (the Government organ), **Krasnaya zvezda** (**Red Star**, the military paper), and **Sotsialisticheskaya industriya** (**Socialist Industry**, the CPSU Central Committee's paper); and the weeklies **Ekonomicheskaya gazeta** (**Economics Gazette**), **Nedelya** (**This Week**, the Sunday supplement magazine to **Izvestiya**), and **Moscow News** (an English-language paper). Compiled by Irene Agnew, George Rudins, Lydia Rudins, and Patricia L. Stephan.

Computing Equipment

The new Mir-2 computer is discussed by Academician V. M. Glushkov in an interview with a **Pravda** correspondent. (**Pravda**, 11/8, p. 6, Elektronnyj inzhener) [Translation, **SCR** this issue, "Glushkov Announces Mir-2 with Light-Pen Terminal."]

The Ruta-701 reader, designed at the Vilnius Calculating Machines Plant, operates on-line with a computer, and can read handwritten and typewritten scripts. (**Izv.,** 11/20, p. 6, Mashina uchitsya chitat')

The Minsk-22 computer is used at the Gorkij Automobile Plant for accounting and financial documentation. Transport, warehouse, and loading operations at the plant have been mechanized. (**Pravda,** 11/15, p. 2, Rabochikh men'she produktsii bol'she)

There are now more than 100 institutes and laboratories in the Armenian SSR. Such computers as Nairi-1, Nairi-2, and Razdan have been developed at some of these institutes. Recently, Armenian scientists have developed an even more efficient computer [Nairi-3] which is being serially produced this year. (**S.I.,** 11/16, p. 3, Budni uchenykh Armenii)

The Razdan-2 and the Minsk-22 computers are used at the Lenin Electrical Plant (Elektrozavod), one of the largest plants in Armenia. (**Izv.,** 11/14, p. 3, Tysyacha i odno delo)

The MKM small control computer, and the BUKA (a general-purpose automated domestic unit) were exhibited at the Leningrad House of Defense. The MKM control computer was designed by O. Safonov, Head of the Instruments Laboratory of the Kostomskij Agricultural Institute, and will be used for grading student tests. The BUKA robot is capable of switching on lights and radios at a preset time, answering the telephone and recording the caller's message, and assigning a hypnopedia program to the tape recorder for teaching English to its user while he sleeps. I. Tormozov, an engineer at the Smolensk Machine Construction Plant, designed the BUKA. (**Izv.,** 11/22, p. 5, Elektronnye pomoshchniki)

Control Systems

The Donetsk Machine Building Plant's automatic control system, installation of which began four years ago, differs from such well-known systems as those at the Lvov Television Plant and Minsk Tractor Plant. It is designed for plants with small serial or single-unit production. The informational-advisory system is responsible for future, current, and dynamic management. The hardware includes two Minsk-22 computers, six punchcard equipment units, information collection and processing equipment, shop monitoring posts, the Donetsk-1 information collection system, and a plant production monitoring system. The Plant set up a special Central Scientific Research Laboratory of Control Systems to implement the new system. Now, the Laboratory is developing various types of systems for other enterprises, including the Druzhkovka Machine Building Plant, Nikolaevsk Machine Plant, and Bryansk Plant. However, Laboratory Head V. Amitan notes that there are several unresolved problems. First, there is no cooperation between his enterprise and others that have been implementing automatic systems using the Minsk-22. The result is a great deal of duplication; each computer center is said to require up to 20-30 mathematicians to solve the same problems. Second, the hardware used in the systems is produced by enterprises under various agency jurisdictions, and the components are not compatible. The RM-80 punchcard interpreter obtained from Vilnius was designed to handle a code other than that used by the Minsk-22. Amitan calls for the State Committee on Standards, Measures, and Measuring Devices to solve the problems of standardizing hardware and coding systems. In his opinion, special institutions responsible for the entire computer package are necessary. One such self-supporting firm formed in Severodonetsk could, he suggests, not only organize the delivery of systems, but also service and rent computers and individual systems to small enterprises. (**Ek. gaz.,** No. 45, p. 11, Sovetuet EVM)

The Scientific Research Institute of Control Machines and Systems in Perm has developed an automated management system which is being introduced at a number of Perm machine building enterprises. According to the Institute's Director, E. Kurochkin, the system encompasses intra- and inter-shop planning calculations, and, on the plant level, intra- and inter-shop planning calculations, and, on the plant level, uses computer hardware to manage production and perform inventory, bookkeeping, and other calculations. The intra-shop planning is considered the most important subsystem. Three methods have been devised for planning small serial and single-unit production, and for continuous-line or large-serial production, a cascade of conveyors that produces many objects is described briefly. The system is off-line, in that it does not make decisions based on the data it gathers and processes. Plants realize 364,000 rubles annual savings from the system which pays for itself in ten months. A big problem in introducing the system is the enterprises' failure to prepare properly for its introduction. (**Ek. gaz.**, No. 45, p. 11, V tsekhe i na uchastke)

An automated control system for the chemical industry (ASU-khim) is being successfully applied in the Ukrainian SSR. (**S.I.**, 11/15, p. 2, Optimal'nyj variant) [See Brief Item, **SCR**, this issue.]

A quality control automatic line, developed at the First Ural New Pipe Plant and the Scientific Research Institute of Introscopy is being used in the pipe industry to check pipes from 30 to 102 millimeters in diameter and up to 12 meters in length. (**S.I.**, 11/13, p. 2, Nadezhnyj kontroler)

Automated control systems for large power stations and chemical and metallurgical combines are being developed at the Central Scientific Research Institute of Complex Automation. These systems are based on advanced computing equipment. The control system developed for the No. 21 Moscow Central Heating Plant is pictured. (**Pravda**, 11/20, p. 2)

Automated management systems have been introduced at a number of Belorussian enterprises, including Minsk Tractor, Clock and Automatic Lines Plants and at the Grodno Nitrogen Fertilizer Plant. The Institute of Engineering Cybernetics of the Belorussian Academy of Sciences is developing a comprehensive automated design and construction system for machine building. The mechanization of engineering work is hampered by insufficient production of necessary equipment and by inefficient use of existing equipment. (**Ek. gaz.**, No. 47, pp. 3-4, V soyuze bratskikh respublik)

The Kazakh SSR Five-Year Plan calls for the comprehensive mechanization or automation of approximately 150 enterprises, shops, and sections, and the production of 30 automated control systems. (**Ek. gaz.**, No. 46, pp. 3-4)

An automated production control system was recently put into operation at the Kharkov S. M. Kirov Turbine Plant. The "brain" of the system is the computer center. (**S.I.**, 11/30, p. 2, Elektronnyj "mozg" zavoda)

Information Services

Minsk-32 computers will be installed at the USSR Central Statistical Administration and used for the 1970 population census. The advanced, high-speed computer is capable of 65,000 opns/sec and has a 32,000 word immediate-access memory. (**Izv.**, 11/30, p. 4, Pyataya vsesoyuznaya)

A new Computer Center equipped with the Minsk-22 computer has been established at Samarkand State University. The computer executes up to 6000 opns/sec and is used in the city of Ulugbek for annual calculations. It is also used by geologists, hydrologists, and dozens of industrial enterprises and scientific research organizations. (**Izv.**, 11/25, p. 3, V schitannye sekundy)

General Science and Research

Plans for the construction of new scientific research centers in the RSFSR are discussed by Academician M. Millionshchikov, Vice President of the USSR Academy of Sciences. During the current Five-Year Plan, research centers will be established in the Ural region and the Far East. Higher educational centers will be organized by the USSR Ministry of Higher and Secondary Specialized Education in the Northern Caucasus. Subsequently, research centers will be established in the Northwest and Povolozh'e economic regions. Supplying the new centers with qualified personnel and necessary equipment is the most important prerequisite for successful operation of the new centers. (**Pravda**, 11/13, p. 2, Shirokie gorizonty)

The Estonian Institute of Cybernetics, though a relatively young institution, has successfully conducted research on process control and automation. The institute supplied the Kiviyli combine with a device which automatically detects errors in technological processes. It is now being introduced into many Formalin producing establishments throughout the Soviet Union. There are 25 other scientific establishments in Estonia, including 20 scientific research institutes employing 4189 scientists — 103 Doctors of Science and 1375 Candidates of Science. (**S.I.**, 11/11, p. 2, Nauka Estonii v Moskve)

Twentieth Century and Science is the title of an article by Professor S. Shukhardin, in which he discusses Soviet science and engineering. Scientists and design engineers are developing new models of machinery and equipment for all branches of the economy. The goal is to design machinery that would extensively mechanize and automate production, alleviate manual work, and achieve the highest level of productivity. Today, computers—another wonder of the scientific-engineering revolution of our time —are penetrating production, accounting and management, and scientific research. One of the more important applications of computers is the establishment and maintenance of the most profitable work regimes of controlled processes. (**Moscow News**, No. 45, p. 11, 20th Century and Science)

Workers of the Computer Center of the Siberian Department of the USSR Academy of Sciences are pictured near the Center's computer [BESM-6]. (**Pravda**, 11/24, p. 3)

Economics and Planning

The state's interest in automating planning and bookkeeping calculations and in mechanizing and automating engineering and managerial operations is stressed by USSR Minister of Finance, V. Garbuzov. He points out that great resources have been made available to develop the appropriate hardware for the above purposes. In some cases, however, computing hardware stands idle while calculations are done manually by large staffs of bookkeepers and statistical personnel. (**Ek. gaz.**, No. 48, pp. 7-8, Sovershenstvovat' i udeshevlyat' apparat upravleniya)

Some important structural problems in the USSR economy are discussed. One problem is maintaining priority growth rates in those branches that are determining factors in a modern economy. They include engineering, (above all, power engineering, electronics, instrument-building for science and industry, and the production of means of automation and computers), chemistry, and the pulp-and-paper industry. All of them are priority branches in the USSR, and their growth rates are higher than in the USA. (**Moscow News,** No. 43, p. 4, Scientific-Technological Revolution and USSR Economy)

Space

Automation's role in the recent flight of the Soyuz-6, -7, and -8 spacecraft was briefly discussed at a press conference held on November 4 at Moscow State University. (**Kr.zv.**, 11/6, p. 5, Kosmonavty i uchenye otvechayut na voprosy) [See Brief Item, **SCR,** this issue.]

Medicine

A diagnostic system based on computers has been developed at the Vishnevskij Institute of Surgery of the USSR Academy of Sciences. It is successfully used to trace congenital heart and jaundice defects. (**S.I.**, 11/16, p. 2, Elektronika v diagnostike)

Portable cardioscopes and new diagnostic instruments are being developed by the Lvov Plant of Radioelectronic Medical Instruments. (**Izv.**, 11/14, p. 1, Vklad truzhenikov L'vova)

Future medical specialists will work more with representatives of nonmedical fields—i.e., biophysicists, biochemists, mathematicians, cyberneticists, psychologists, sociologists, and economists. Future medical education must also include training in physics, mathematics, etc. The role of computers will grow in medical diagnosis. (**Izv.**, 11/22, p. 2, Sovremennye gippokraty)

Transport

The Minsk-22M computer is being used to develop new municipal transport instruction and record sheets by the Estonian Ministry of Automative Transport and Highways. The information, formerly processed in a month, is now being done in 24 hours by the computer. (**S.I.**, 11/15, p. 2, Elektronnaya mashina—pomoshchnik shofera)

Malfunctions in automobiles are diagnosed at the Experimental Diagnostic Station, developed by the Special Scientific Research Bureau of the Latvian Ministry of Automotive Transport and Highways. It is located in a large Riga transport enterprise and is based on electronic automated systems for control, collection, analysis, and output of information on the condition of the motor, electrical equipment, transmission, and brake system. (**Izv.**, 11/23, p. 6, Diagnoz avtomobilyu)

Program-controlled automobiles are predicted by A. Biryukov in an article on the future of automobile transportation. (**Ek. gaz.**, No. 46, p. 24, Avtomobil' menyaet oblik)

Industry

Experimental testing of machinery prior to serial production is discussed by V. Rostovskij, First Deputy Minister of Construction, Railroad, and Municipal Machine Building. He states that experimental laboratories and testing stations are experiencing a shortage of computers. Many components can be simulated and tested via a computer prior to the production of parts, thus reducing the design time. Computers must be used more extensively for processing experimental results. (**Pravda,** 11/18, p. 2, Mashiny sdayut ekzamen)

Small industries can be made more efficient with the help of cybernetics and computer technology. However, they must first be organized into industrial combines, since technical progress occurs faster in large economic complexes. This is particularly true in the founding, forging, and stamping industries. (**S.I.**, 11/13, p. 2, Vygody spetsializatsii)

The ZA151Ts special program-controlled grinding machine for producing shafts is being produced by the S. V. Kosior Machine Building Plant in Kharkov. The machine tool is pictured. (**Ek. gaz.**, No. 47, p. 24, Osvoil proizvodstvo spetsial'nykh krugoshlifoval'nykh stankov modeli ZA151Ts s programmnym upravleniem)

The Moscow Krasnyj Proletarij Plant is undergoing expansion. The first stage of reconstruction will prepare the plant for production of program-controlled machines and special-purpose precision tools. (**Izv.**, 11/20, p. 2, Rekonstruktsiya zavoda "Krasnyj Proletarij")

The SAND (continuous action steel smelting assembly) which allows completely automated control of this process has been developed by the Central Scientific Research Institute of Ferrous Metallurgy and the Gipromez Plant. Steel cost is said to be reduced by 3-4 percent. (**Ek. gaz.,** No. 45, p. 22, Konvejer stalevarov)

The introduction of automation into the restaurant industry has not been successful. However, the growing demand for traditional Russian dishes makes automation indispensable. The USSR Ministry of Light-Machine Construction, Food Industry, and Domestic Devices should centralize and coordinate work in that area. (**S.I.,** 11/18, p. 2, Budut li u kukhni avtomaticheskie ruki?)

The Ministry of Instrument Construction, Means of Automation, and Control Systems reported 103 percent fulfillment of its plan for January-October 1969. Instruments and computer hardware valued at 2094 million rubles were produced during this period, representing an 18 percent increase over the same period of 1968. (**Ek. gaz.,** No. 47, p. 2, Promyshlennost' SSSR za desyat' mesyatsev 1969 goda)

Five program-controlled machines have been constructed by Ryazan' machine builders and workers at the Central Scientific Research Institute of Machine Building Technology. Program control increases equipment productivity and improves product quality. (**Pravda,** 11/12, p. 1, Upravlyaet elektronika)

Exhibits and Conferences

A scientific conference on the introduction and improvement of automated production control systems began on November 12 at Akademgorodok near Novosibirsk. (**S.I.,** 11/12, p. 1, Mashiny planiruyut) [See Conferences, **SCR,** this issue.]

Honors and Awards

Developers of the BESM-6 general-purpose computer, L. N. Korolev, Doctor of Physicomathematical Sciences, V. A. Mel'nikov, Doctor of Technical Sciences, V. A. Ivanov, Chief of the Special Design and Planning Bureau of the Moscow Calculating Machines Plant, Academician S. A. Lebedev, Director of the Institute of Precise Mechanics and Computer Engineering of the USSR Academy of Sciences (project manager), and V. I. Semeshkin, Chief Engineer of the Moscow Calculating Machine Plant, are pictured. They have been awarded the 1969 USSR State Prize. (**Izv.,** 11/11, p. 5; **Pravda,** 11/7, p. 3, O prisuzhdenii gosudarstvennykh premij SSR 1969 goda v oblasti nauki i tekhniki; **Pravda,** 11/9, p. 3, Novyj otryad laureatov) [See "State Prizes Awarded," **SCR,** this issue.]

Education

A school of the future is being studied by the Moscow Institute of Social Forecasting. The research is directed toward adapting the curriculum to the swift progress of science, technology, and culture. Director of the Institute, Igor Bestuzhev-Lada, believes that, in spite of the increasing volume of information which has to be assimilated, children attending school in the year 2000 will study seven or eight years rather than ten. He also anticipates the automation of mental work. The school will make broad use of electronic teaching machines and automatic examiners. Hypnopedia—studying foreign languages and other subjects in a state of sleep—will be widespread. (**Moscow News,** No. 44, p. 10, Round the Country)

The educational program for economists has recently been changed to include more time for studying mathematical disciplines. A number of new courses have been added (probability theory, mathematical statistics, mathematical programming, etc.), and new specialities such as economic cybernetics have been introduced. Economics personnel are being trained in 31 specialized institutes and at 180 faculties in universities and technical, construction, and agricultural institutions. The need for modern computer hardware in economic laboratories is cited. (**Ek. gaz.,** No. 48, p. 17, Novye usloviya i ekonomicheskoe obrazovanie kadrov)

International

Plans for Soviet-Yugoslav cooperation in several research projects were approved at the recent 22nd session of the Soviet-Yugoslav Commission on Scientific and Technical Cooperation. The Experimental Design Bureau of Automation of the USSR Ministry of the Chemical Industry and M. Pupin Institute of Automation and Remote Communication (Yugoslavia) have agreed to joint development this year of algorithms for optimal control of multistage chemical processes. The Mosenergo, Lenenergo, and Latvenergo Plants and the Belgrade enterprise Elektrodistributsiya will conduct work on devices for relay protection, automation and remote control, and organization of operation of urban electrical networks. (**Ek. gaz.,** No. 47, p. 21, Poleznoe sotrudnichesktvo)

Polish research centers were aided by the Soviet Union in organizing and equipping the first Polish mechanized accounting stations. (**Ek. gaz.,** No. 47, p. 20, Svyazi krepnut)

Romania and Poland are said to be cooperating in producing automation hardware and control systems. (**Ek. gaz.,** No. 45, pp. 20-21, Po puti sotrudnichestva i progressa)

The Sharp Hayakawa Electric Co. Ltd., Osaka, advertises and pictures its Micro Compet integrated circuit calculator, reportedly the world's smallest. (**Ek. gaz.,** No. 47, p. 23/1, Kal'kulyator)

chine time at the computer centers of the USSR Academy of Sciences and Gosplan.
(From the article "Department of Economics of the USSR Academy of Sciences: Events of 1968," the journal *Voprosy Ekonomiki,* Moscow, May 1969, pp. 148-151 [File No. 2587].)

ELECTRONICS INDUSTRY TAKES THE LEAD IN POLAND. The electronics industry in Poland includes more than 40 enterprises, five scientific research institutes, and ten design bureaus; its products are exported to 30 countries. The two main electronics centers are the Warsaw Institute of Computers and the El'vro Plant in Wroclaw. The latest computer developed at the Warsaw Institute of Comptuers, the ZAM-41, has a large-capacity memory. The Institute will establish branches in Silesia and other areas, and will cooperate with other CEMA countries in developing a family of computers. The Institute is responsible for designing computers and their logical elements and testing the new models at the Institute's Experimental Plant. The El'vro Plant has been in operation for ten years. It's first computer, the Odra-1003, had a speed of 500 opns/sec. Its latest computer is the Odra-1304, which is many times faster than computers produced in some foreign countries, according to Polish experts.
From the article "Ritm El'vro," in the newspaper *Izvestiya,* November 18, 1969, p. 4 [File No. 2623].)

V. A. TRAPEZNIKOV HEADS RESEARCH ON SCIENTIFIC INSTITUTIONS. The Laboratory on the Economics of Scientific Research and Experimental Projects (LENIOR) was organized by the State Committee on Science and Technology in June 1967. The Laboratory's principle tasks were to study ways of increasing the efficiency of scientific organizations, and to develop principles of planning and managing scientific institutions and their relationships with industry. Now the Laboratory has been transformed into a section of the All-Union Scientific and Technical Information Center. Academician V. A. Trapeznikov exercises scientific and methodological management over the Section's Laboratories on the Methodology of Planning and Measuring the Efficacy of Scientific Research, Problems of Economic Incentive of Scientific Institutions, and Organization and Management of Scientific Institutions. The Section develops, on behalf of the State Committee on Science and Technology, methodological guidelines followed in the country's scientific institutions.
(From the article "LENIOR v proshlom i v nastoyashchem," in the journal *Voprosy ekonomiki,* No. 4, 1969, pp. 157-158 [File No. 2620].)

COMPUTER-ASSISTED MEDICAL PROGNOSTICATION. The Experimental Clinic for Hospital Therapy at Vilnius University, directed by Prof. Liubomiras Laucevicius, is using mathematical methods and computers to diagnose illnesses and make prognoses, especially of myocardial infarction. A leading researcher in mathematical prognosis at the Clinic is Dr. Ilya Stupelis. Prof. Laucevicius is also the Director of the Institute of Experimental Medicine in Vilnius, where work on computer-assisted diagnostics centers on joint ailments.
From the article "Mathematics and the Heart," by Evnika Svetlanova, in the magazine *Soviet Life,* November 1969, p. 57 [File No. 2622].)

ASU-khim IN THE UKRAINIAN SSR. The ASU-khim automatic control system developed for the chemical industry is a combination of organizational, economic, and mathematical techniques, incorporating computer technology, office mechanization, and communication. Its application in the Ukrainian chemical industry has been successful. The quality of statistical reports has been improved and their preparation time shortened; the work load of industrial combines has been decreased. The preparation of limit cards for one industry's materials, a job that used to take 30 man-days, is now done in 1.5 hours by the Minsk-22 computer. The new system pays for itself within 1.5 years, and expenses for administrative management personnel will be reduced from 98 kopeks per 1000 rubles of commodity output in 1968 to 48 kopeks in 1975.
(From the article "Optimal'nyj variant," in the newspaper *Sotsialisticheskaya industriya,* November 15, 1969, p. 2 [File No. 2611].)

RADIO TRANSMISSION SYSTEM IMPROVED. Soviet and Hungarian specialists have improved a sector of the "Druzhba" (friendship) transcontinental radio-relay system, resulting in reduced noise level, higher-quality linear characteristics, and transmission over a distance of 12,500 kilometers (two and a half times longer than the previous distance). The system, operating in the centimeter wave band, contains 240 stations, averaging 50 kilometers apart. The "Druzhba's" 1920 channels may be used for 12,000 simultaneous telephone calls or for the transmission of six TV programs. The "Druzhba's" capabilities include transmission of information from computation centers, of newspaper-page images, and of black-and-white and color TV signals. The system reportedly features high-quality voice transmission. The first two lines of the "Druzhba" system are being constructed between Moscow and Yaroslavl, and between Moscow and Stavropol.
(From the article "Two Thousand Voices on a Line," in the Novosti Press Agency's *Science and Engineering Newsletter,* No. 42, October 24, 1969. [File No. 2583].)

SOVIET-YUGOSLAV COOPERATION IN AUTOMATION RESEARCH. For several years a number of Yugoslav scientists have worked at the Institute of Automation and Remote Control of the USSR Academy of Sciences. Soviet scientists annually visit Yugoslavia to be briefed on Yugoslav work, and to lecture, consult, and participate in scientific conferences. Particularly fruitful contact has been established with the Yugoslav M. Pupin Institute of Automation and Remote Control.
(From the article "Kontakty sovetskikh i yugoslavskikh uchenykh," by I. N. Kiselev, in the journal *Vestnik Akademii nauk SSSR,* No. 2, 1969, p. 78 [File No. 2624].)