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DIGITAL COMPUTERS IN THE SOVIET UNION

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The following is a survey of the manufacture and use of digital computers in the Soviet Union. At the end of the article a tabulation of the specifications of various Soviet computers is given.

Construction of Large Computers

Construction of large computers was begun in the Soviet Union in 1948. The first small electronic computer, MESM, was completed at the Mathematical Institute of the Ukrainian Academy of Sciences in Kiev, under the direction of Academician S. A. Lebedev. At almost the same time, Academician Lebedev built a large electronic computer, the BESM, at the Academy of Sciences of the Soviet Union in Moscow. This computer belongs to the same class as the IBM series 700 computers. The BESM was completed in 1952. A few months later, in 1953, in the Laboratory of the Construction Bureau of the Ministry for Machine-Building and Automatization of the Soviet Union, a second large computer, the STRELA, was completed under the direction of Professor Yu. Ya. Basilevski. The principal difference between the BESM and STRELA is that BESM is about $2\frac{1}{2}$ times faster than STRELA. However, STRELA has the bigger memory capacity.

Construction of Medium and Small Computers

In the Laboratory for Switching and Controlling Systems of the Academy of Sciences of the Soviet Union, a small electronic computer, M-1 (Machine No. 1), was built in the Spring of 1952 under the direction of corresponding member of the Academy of Sciences, I. S. Bruk. In December 1952 a second machine, this one a medium-sized electronic computer was completed, and became operational toward the end of 1954. It was at that time also modernized and brought up-to-date. In 1953 in the Laboratory for Switching and Controlling Systems of the Academy of Sciences, a medium-sized computer called the Digital Electronic Machine, CEM-1, was completed. This computer serves for the solution of mathematical problems of the laboratory in which it was built. In 1954 in the Laboratory of the Scientific Research Institute of the Ministry for Precise Mechanics, a small electronic computer, URAL, was completed under the direction of engineer B. I. Rameyev. Since that time, up to 5 per month have been manufactured in series production. In 1957 in the Laboratory for Switching and Controlling Systems of the Academy of Sciences, a small computer, M-3, was built in cooperation with the Scientific Research Institute for the electro-technical industry. Up to 5 per month are now being produced.

In the Computing Center of the Academy of Sciences of the Ukrainian Soviet Republic in Kiev, a modern electronic computer, KIEV, was completed in 1959. This is a multi-channel computer

on which several problems can be solved simultaneously.* Its control, memory, and arithmetic units are completely independent of each other and work on different frequencies.** The computer occupies a space of 40 square meters and is capable of deciding the optimal control of sequence operations. It serves to solve large scale mathematical problems, as well as to direct and control technological processes in the metallurgical, chemical, oil industry, etc. The computer is equipped with 2,000 miniature tubes and belongs to the class of medium-sized machines. The second KIEV machine has been installed in Dubna near Moscow for the purpose of atomic research in the nuclear power station. In the capital city of the White Russian Soviet Republic, two computers, MINSK-I and MINSK-II, are being built. Young graduates of the Moscow University and young scientific members of the Energetics Institute built a small computer in 1957. This computer is named after the small Setun river near Moscow, and became operational at the end of 1959. It is now in the Computer Center of Moscow University. Input and output are decimal, but a subroutine translates the decimal numbers

*From the surrounding material, the machine described here is clearly the general-purpose KIEV machine built by V. M. Glushkov and colleagues and seen in 1959 by the computer delegation. So far as is known, the KIEV had no facility for multi-programming. However, some visitors to the IFAC in 1960 reported a machine also called KIEV, but intended to be a process control computer. The two sentences which reference this footnote suggest that the two machines may be one and the same, and there has been confusion in the reporting. Alternatively, there may be two machines and the author of this article has mixed his facts. Ed.

**This means that the machine is asynchronous. Ed.

into base-3. This means that levels +1, 0, and -1 are used. The Soviet Newspaper, Krasnaia Zvezda of 26 March 1960 stated that the computer M-20 had been completed; as the number 20 indicates, it does 20,000 operations per second. To support punched card machines, a computer, EV 80-3 is being built. The number indicates that this is a machine for 80-column punched cards and is model 3.

Class 1 (Large)

BESM
STRELA
M-20

Class 2 (Medium sized)

M-2
CEM-1
KIEV

(Small)

MESM
M-1
M-3
URAL
SETUN

The computer URAL at a rate of 5 per month since 1955, and the machine M-3 at the same rate since 1957, are being built in series. One can assume that by the end of June, 1960 about 350 URAL computers, and about 150-200 M-3 computers have been completed. Including other machines, such as the BESM and STRELA, the total number of computers in the Soviet Union can be estimated at around 600 machines.

Modernization of Soviet Computers

With advancing techniques and technology, all computers become antiquated within 2 or 3 years and have therefore to be modernized. In the Soviet Union the following computers have been modernized. In the BESM the cathode ray tube memory has been replaced by a ferrite memory. The vacuum tubes have been partially replaced by semi-conductors. The speed was thereby increased and is now 10,000 operations per second. The computer STRELA also has experienced many changes and one speaks now of a STRELA-1 $\frac{1}{2}$. Nearly every user of a STRELA computer has effected certain changes. The most significant modernization, however, has been made with the computer URAL. This computer originally had a very low speed of 100 operations per second. Now it has 5,000 operations and the URAL-4, which is to be completed in 1962, is supposed to have a speed of 10,000 operations per second.* In most of the computers input and output equipment was increased.

Special Computers in the Soviet Union

Beside the general-purpose computers, several special computers have been built in the Soviet Union. The purpose of many special computers is evident from their names. For instance, the computer KRYSTALL serves for the calculation of molecular structures; the machine GRANITE, for the tabulation of statistical results of mass calculations, and the computer

*The URAL-II computer also has been completed and has a speed of 5,000 operations per second. Ed.

POGODA, for the tabulation of meteorological predictions. In the laboratory of the Mathematical Institute of the Ukrainian Academy of Sciences in Kiev under the direction of the Academician S. A. Lebedev and the scientific collaborator Z. L. Rabinovitch, a special electronic computer, SESM-I, was completed. It serves for the calculation of complicated hydrodynamic and hydro-technical buildings and construction. This is the first computer in Europe on which linear algebraic equations with up to 400 unknowns can be solved. In an 8-hour shift, the computer SESM-I replaces the work of 20 mathematicians working with mechanical calculators. The SESM-I, compared to a general-purpose computer, has only about one-tenth of the technical equipment and occupies an area of 8 square meters. One engineer and a technician are used for maintenance and operation. For optical tabulations, the computer LUCH (RAY) was built. Recently the Soviet Union was divided into 105 economic districts which have been equipped with their own calculating centers which will have punched card machines, and computers. Also, individual academies of sciences and universities own computing centers equipped with BESM or STRELA or other machines. The tabulating center of the Academy of Sciences in Tiflis, Georgia is now building a big computer which will be installed in a special building.* The Academy of Sciences in Tashkent built for their own tabulating center, a computer fashioned after the URAL. In the capital city of

*This is believed to be a BESM-II. Ed.

Armenia, Yerevan, there exists a research institute for mathematical machines with facilities in which computers are being built. Also in Rozda, a computer is in the process of being built.

Automation of Technological Processes

In the Soviet Union great care and attention is being given to the automation of technological processes. For instance, a tabulating center is being built for the petroleum industry, and the chemical industry, also for the machine tool industry of Baku which is equipped with digital and analog computers. In a scientific research institute in Tiflis, Georgia, a special computer is being built which is intended to be used for the automation of steel furnaces. The switching and controlling machine MARS 300, is equipped with an analog-to-digital converter for the regulation of technological processes. In the Soviet Union there exists very many computers for the control of machine tools. Various linear interpolators and differential analyzers are used for this purpose. The Lichachev works built an electronic computer with about 3,000 tubes which will have the name ERA and which is intended for the automation of technological processes. In 1961, twenty of these computers are supposed to be built and later on, one or two hundred are expected to be used every year.

SOVIET COMPUTERS

Machine	Year	Components	KW	Address	Type	No.	Digits	Dec. Point	Ops/Second	Memory		Input-Output
										Words	Type	
BESM-II	1952 1958	4000 T 5000 D 200000 Fe	35	3	P	2	39		8000 10000	2047 10240 120000	FK MT MB	LS MB SD
STRELA	1953	6000 T 25000 D	147	3	P	2	43		2000 3000	2047 200000	W1 MB	LK
M-2	1952 1954	1676 T 5000 D	29	2	P	2	34	F	2000	1024 50000	MT MB	LS
URAL-II	1954 1959	800 T 3000 D	8	1	SP	2	40	G	5000	2048 8192 100000 10000	FK MT MB LS	LS SD
CEM-1	1953	1900 T	14	2	S	2	31		230 495	4096 496	MT Hg	LS
M-3	1957	770 T 3000 D		2	P	2	31		1200 1500	2048 max.	MT FK	LS
KIEV	1959	2400 T	25	3	P	2	41	F	2000	24486 1024	MT FK	LS SD
SETUN	1957 1959	300 Tr 300 T 3800 D FK			P	3	9	F	4000	162 2000	FK MT	LS FS
M-20	1960			3	P	2	45	G	20000		FK	LK
M-50									50000			

T = Tubes
 D = Diodes
 Fe = Ferrite cores
 TR = Transistors
 F = Fixed Decimal Pt.

G = Floating Decimal Pt.
 P = Parallel
 FK = Magnetic Cores
 FS = Teletype
 Hg = Mercury Memory
 LK = Punched Cards

LS = Punched Tape
 MB = Magnetic Tape
 MT = Magnetic Drum
 SD = Hi-Speed Prtr.
 SP = Series Parallel
 W1 = Williams Tube