Armenian Computers: First Generations

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Abstract. Armenia was one of the leading centers of Soviet electronic and computer industry. The first in the USSR semiconductor computer, Razdan-2, was designed and built in Armenia in 1960. Armenian computers of the Nairi series for a decade were one of the main calculating facilities of Soviet scientists and engineers. This article is about the first period of the development of Armenian computer technology.

Keywords: Yerevan Scientific Research Institute of Mathematical Machines (YerNIIMM), First Generation Computer, M-3 Computer, Aragats, Razdan, Nairi.

1 Introduction

After the end of the Second World War, the Armenian Soviet Socialist Republic began a rapid development of its industry, including electrotechnical branch. Large enterprises began to work in the capital of the Republic – Yerevan and other cities of Armenia. This caused the need of training highly qualified specialists in Armenian universities. Armenia did not have a rich raw material and energy base, so emphasis was made on training specialists in natural sciences. Several well-known Armenian scientists in the mid-1950s proposed to the Central Committee of the Communist Party of Armenia to develop a new scientific and technical direction for the Republic, focusing on electronics and computer technology. The party accepted the proposal and sent it to the Central Committee of the CPSU.

By that time, the Soviet leadership had already understood the important role of the computer technology and realized the necessity to liquidate the backlog in this field from the U.S. [1, 2]. The Armenian SSR became one of several regions of the USSR that were chosen to implement the program for the creation of big plants and scientific institutions for the development of computer technology. On 29 June 1956, Resolution No. 897 of the USSR Council of Ministers was adopted: “On the Organization in the Armenian SSR Research Institutes, R&D Bureaus and Instrument-Making Plants in the Structure of the Ministry of Instrument Making and Automation.” In particular, it was prescribed to organize a research institute of mathematical machines in Yerevan and a research institute of automation in Kirovakan (now Vanadzor).

On 14 July 1956, the Yerevan Scientific Research Institute of Mathematical Machines (YerNIIMM) was established. The leading role in YerNIIMM activity was played by young mathematician Sergey Mergelyan (Fig. 1), who was appointed as the first head of the institute, and Bogdan Melik-Shakhnazarov was appointed as the chief engineer. Mergelyan (1928–2008) was an extraordinary person and a great scientist. He was the youngest Ph.D. in the history of the USSR (his degree was awarded at the age of 20), the youngest corresponding member of the USSR Academy of Sciences (since 1953, the title was awarded at the age of 24), and the youngest academician of Armenian Academy of Sciences (since 1956). Mergelyan's theorem, which gives the complete solution of the problem of approximation by polynomials, is recognized as classical. He also played outstanding role in the history of Armenian computing. A detailed story of his life is presented in [3, 4].

Fig. 1. Sergey Mergelyan.

In 1957, the Computing Center of the Armenian Academy of Sciences and the Yerevan State University was established. It was closely related with YerNIIMM. In the "YerNIIMM Statute" the main tasks were determined, including:

- carrying out research, theoretical and design work on the design of mathematical digital machines;
- manufacture of electronic digital computers (EDC);
- identification of the needs of the USSR national economy in EDC [5].

Divisions for the development and implementation of computer technology were organized. There were design department, department of automatic systems design, department of mathematical support and testing, subdivision of system analysis and design, electronic design, laboratory for testing of electronic devices and subdivision for working out technical documentation. In order to develop the electronic devices and computers, a special factory was organized in 1960 as a YerNIIMM subdivision. It produced and tested prototypes and formulated technological requirements before the equipment was transferred to serial production. This organization made it possible to achieve high efficiency, working jointly with many research institutes and factories within the framework of established cooperation. In 1961, the Electron factory was built in Yerevan for industrial assembly of computers.

YerNIIMM's first employees were graduates of the electrotechnical faculty of Yerevan Polytechnic Institute (YerPI), the physical-mathematical faculty of Yerevan State University (YerSU), and invited graduates from universities of Moscow, Leningrad and other cities of the USSR. Also, a group of scientists from YerPI and YerSU with a wide research experience was involved in the work (L. Grigoryan, A. Sagoyan, A. Edigaryan, M. Ayvazyan, R. Kazaryan, etc.).

2 The M-3 Computer: The First Experience

Starting from 1953, the development of the M-3 computer designed for engineering calculations was started under the leadership of Nikolay Matyukhin in Moscow at the Laboratory of electrical systems of the Energy Institute of the USSR Academy of Sciences (director: Isaak Bruk). This work was not included in the national plan and was conducted jointly with the All-Union Scientific Research Institute of Electromechanics (VNIIEM; director: Academician Andronik Iosifyan). For this reason, the project could have remained unrealized. However, Soviet scientists and engineers at that time had an acute shortage of computing facilities. Three organizations – Sergey Korolev's R&D bureau (the leading institution of the Soviet space launchers program), VNIIEM, and the Institute of Mathematics of the Academy of Sciences of the Armenian SSR – decided to produce three M-3 prototypes for their needs. The first prototype was produced in 1956, debugged, and at the end of the same year was presented to the State Commission. According to the memoirs of well-known engineer Boris Kagan, "State Commission ... did not want to adopt the computer: they say, it was built illegally. But finally Commission had approved the project. But even in this case it was not possible for two years to solve a problem – to start serial production of M-3 computer."

The small-sized digital vacuum tube M-3 computer was intended for utilization at research institutes and R&D bureaus. The first exemplar was left in VNIIEM (Moscow) for testing, the second one was intended for the Yerevan Mathematical Institute of the Armenian Academy of Sciences, and the third for Sergey Korolev's R&D bureau. However, in 1956 YerNIIMM was founded and it was decided to send one M-3 computer there for test operation (see Figure 2 for basic parameters of the M-3).

In 1957–1958 at YerNIIMM under the leadership of B. Melik-Shakhnazarov, V. Rusanevich, and others, and with the participation of the staff of the Institute of Mechanics of the Academy of Sciences of Armenia (G. Ter-Mikaelyan, A. Pipinov, and others), in a very short time, modernization, assembly and adjustment of the M-3 computer was fulfilled. The modernization consisted in the introduction of new RAM on ferrite cores (1024 words). This allowed increasing the speed of the computer from 30 to 3000 ops.

Fig. 2. Parameters of the M-3 computer

Element base	Semiconductor diodes and 774 vacuum tubes (including 43 tubes in power supplies)
Arithmetic	Signed fixed-point
Number of bits	30
Commands	Three-address
Arithmetic unit	Parallel
Execution of basic arithmetical operations	Addition: 60 μs Subtraction: 75–120 μs Multiplication: 1,900 μs Division: 2,000 μs
Primary storage	Magnetic drum with a parallel selection of 2048 capacity of 30-bit binary numbers
Average performance	30 operations per second (ops)
Power consumption	10 kW
Occupied area	About 3 square meters

The improved M-3 computer model in 1958 was transferred to the Institute of Power Engineering named after Krzhizhanovsky of the USSR Academy of Sciences for solving problems in the field of energy. This work became the first step of YerNIIMM in computer technology.

The M-3 served as a prototype for two industrial series of computers: Minsk and GOAR (later renamed to "Razdan"). Thus, the creation of the M-3 computer played crucial role in the development and production of electronic computers in Armenia and another Soviet Republic: Belarus. Moreover, the first Hungarian electronic computer (which was also named M-3) and the first Chinese electronic computer 103 were almost entirely made on the basis of Soviet M-3 computer specifications [6].

3 Further Developments

By 1960, the main directions of the YerNIIMM research were defined as following:

- development and implementation of small- and medium-sized computers;
- development of specialized computer systems and automated control systems for unique purposes [5].

Research was also carried out in the fields of electronics, computer architecture design, software and test support, automation, power supply and storage devices, etc.

Already in the years of 1958–1960, several computers of the first generation (on vacuum tubes) were developed in YerNIIMM: Aragats (chief designer: B. Khaikin), Razdan-1 (chief designer: E. Brusilovsky), and Yerevan (chief designer: M. Aivazyan).

Several researchers from the programming department of the Institute of Mathematics of the Siberian Branch of the USSR Academy of Sciences (Novosibirsk) were sent to Yerevan to help their Armenian colleagues (team leader: A. Merenkov). Tests were successfully completed in May 1960. Thus, Aragats (Fig. 3), Razdan and Yerevan became the first Armenian computers.

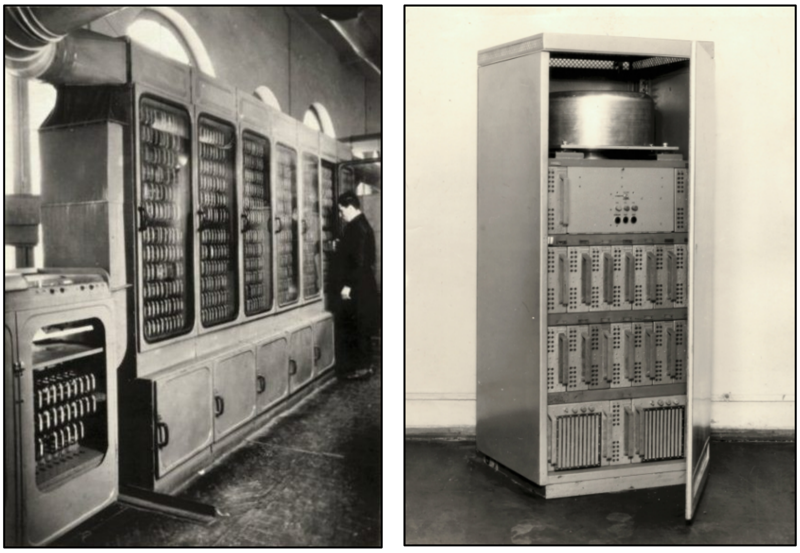

Fig. 3. Aragats computer and disk drive cabinet.

The State Commission highly appreciated this work and recommended the small-scale production of the Aragats computer. A total of four these computers were produced. The main designers were V. Karapetyan, A. Kuchukyan, V. Chiganov, S. Mkrtchyan, L. Asoyan, V. Grechka, R. Arutynyan, V. Arustamyan, V. Meleshchenko, and some others. See Fig. 4 for the basic paramaters of this computer.

It is worthwhile to mention that Aragats computer was the first Soviet computer shipped abroad: one exemplar was delivered to Hungary.

Fig. 4. Main parameters of Aragats computer.

Arithmetic	Floating point
Numbers	42-bits binary
Commands	58 three-address
Range of represented numbers	$0.25 \times 10^{-28} \div 0.9 \times 10^{19}$
Execution time of basic operations	Addition: 11,800 ops Multiplication: 4,400 ops Division: 2,600 ops
Average performance	8,000 ops
RAM storage on ferrite cores	1,024 numbers
External storage on magnetic tape	Four blocks of 645,000 numbers each

External storage on a magnetic drum	Two blocks of 1,024 numbers each
Speed of information input from film photo-reading device	36 numbers per second
Output of calculation results to printer	20 numbers per second
Vacuum tubes	3,500
Synchronous power generator	220 V, frequency 50 Hz
Power consumption	30 kW (without cooling system)
Occupied area	40 square meters

At this stage, the first (vacuum tube) generation of computers, designed and produced in Armenia, was completed.

4 Razdan-2 and Razdan-3

In 1958–1960 in YerNIIMM was designed the first computer in the USSR, completely assembled on semiconductor devices (chief designer: E. Brusilovsky, Fig. 5). It was the universal small-size computer Razdan-2 (Fig. 6).

The primary storage made on ferrite cores of this computer consisted of 3,777 words 36-bits. Access time was 24 μs. To expand the range of tasks that required more memory, the computer was provided with an external storage device – a magnetic tape drive. The capacity of external storage device was 120,000 numbers; reading speed was 2,000 numbers per second. The data input was from punched tape. I/O devices provided data input to the computer from a photo-reading device on perforated film at a speed of 35 numbers per second and output of the results of calculations to the printer at a speed of 20 numbers per second. Basic parameters of this computer are shown in Fig. 7.

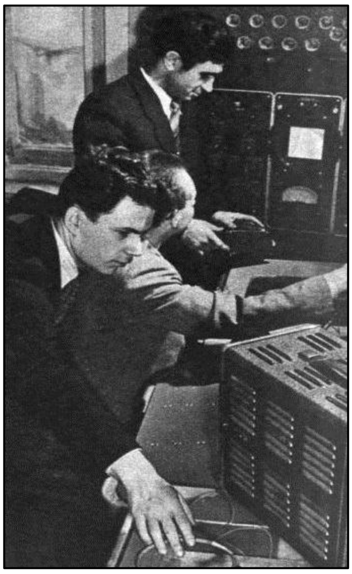

Fig. 5. E. Brusilovsky, Yu. Bostanjan, and B. Melik-Shakhnazarov (1959).

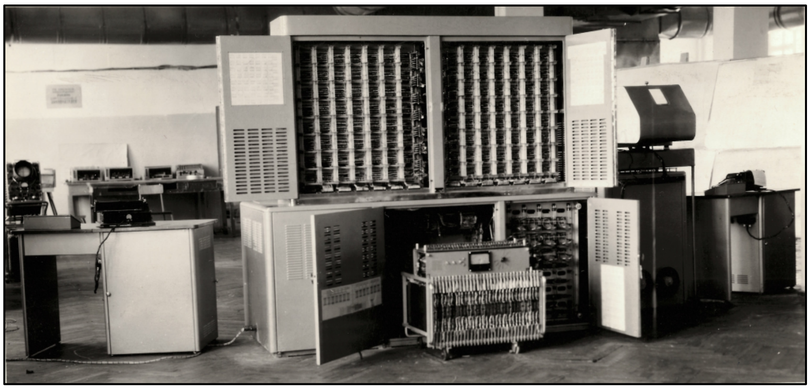

Fig. 6. The Razdan-2

Razdan-2 computers after modernization had been introduced in mass production since 1961, and in 1962 it was with great success exhibited at the Exhibition of Achievements of National Economy in Moscow. On the basis of the Razdan-2, the first mobile computing center for military purpose (1963–1968) was built in the USSR. In official documents the project was called as "Mobile computing center," or the "Platform" object [5].

Fig. 7. Main parameters of Razdan-2 computer.

Element base	Semiconductor devices; signed floating point arithmetic
Command structure	17 (basic) two-address commands, each with eight modifications
Number characteristics	36-bits binary Mantissa: 29 bits 5 digits Characteristic sign: 1 digit
Average performance	5,000 ops
Power supply	From a three-phase alternating current network with a voltage of 220/380 V, frequency of 50 Hz
Power consumption	About 3 kW
Temperature regime	From 10 to 25°C
Occupied area	20 square meters

In 1963, in order to effect the standardization of computer elements for the first time in the Soviet Union, the unified constructive complex "Magnesium" was developed based on the most advanced technologies at that time: semiconductor devices and printed wiring (chief designer: V. Karapetyan). The main ideas, design characteristics and technologies of Magnesium were laid in the basis of the Razdan-3 computer (Fig. 8) and some other computers. The Razdan-3 computer (1965; chief designer: V. Rusanevich) had an average performance of 15,000–20,000 ops and 32 kB of main storage [7]. This computer was recognized as one of the most advanced Soviet computers of the second generation and became one of the first exported Soviet computers. Its production was organized at the experimental YerNIIMM and at the Electron factory.

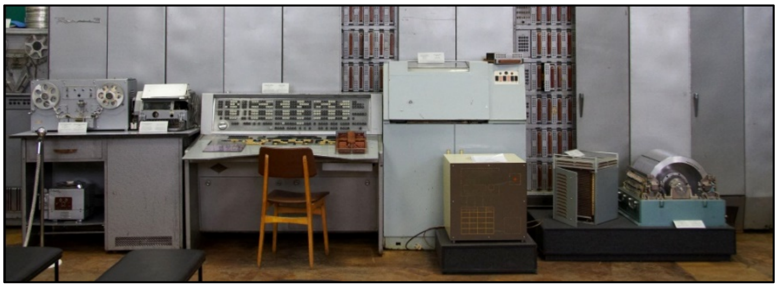

Fig. 8. The Razdan-3 computer.

Less known are other developments of the YerNIIMM second-generation computers – Araks (1964, Fig. 9), Masis (1965, Fig. 10), [8] and Dvin (1967).

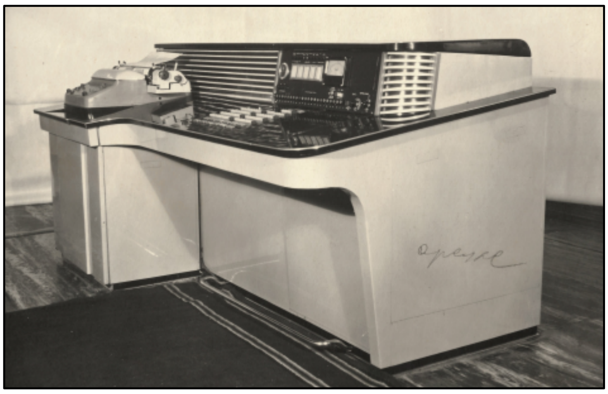

Fig. 9. The Arax computer.

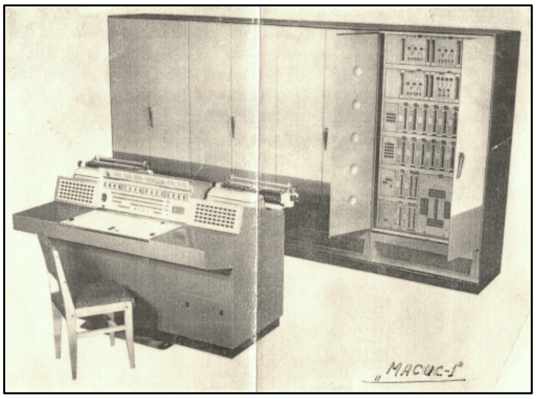

Fig. 10. The Masis computer.

5 Nairi and Nairi-2

Especially it is worthwhile to mention the most known, mass-produced small computers of the Nairi series: Nairi, Nairi-2, Nairi-3, Nairi-3-1, Nairi-3-2, Nairi-3-3. (The name comes from ancient Armenian territory, which the Assyrians in the second millennium BC called the "country of Nairi," that is, a "country of rivers").

The development of the first and second models of the Nairi computer was carried out in 1962–1964. It became the first widely used Soviet small computer. The specific characteristics of Nairi computers, which are very similar to main features of modern PCs, were simple maintenance, reduced dimensions, high reliability, and, most importantly, easy learning for specialists in any field of science and technology.

The designer of these computers was Grachya Ovsepyan (born in 1933) (Fig. 11). In 1946, he and his family immigrated to Armenia from Lebanon. Ovsepyan graduated from Faculty of Physics of the Yerevan State University and then with great difficulty got the position of a laboratory assistant in recently organized classified YerNIIMM institute. He worked at the department of E. Brusilovsky, who developed the Razdan computer (the dramatic fate of G. Ovsepyan is described in [9, 10]).

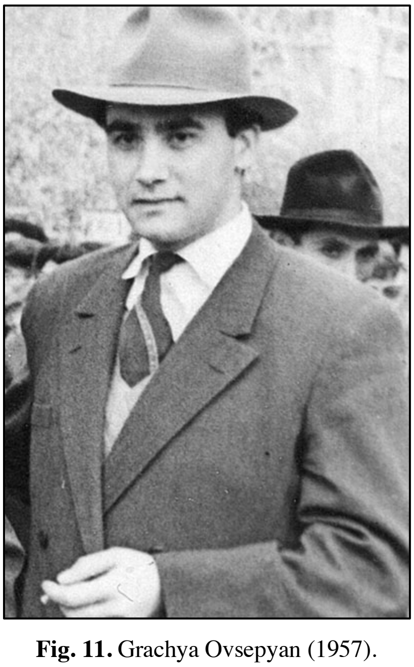

Fig. 11. Grachya Ovsepyan (1957).

In 1962 at the International computer exhibition in Moscow, Soviet leaders became acquainted with the French CAB-500 transistor computer. They were so impressed that decided to create a similar computer in the USSR. By this time, Ovsepyan's authority was so great that this work – and in fact development the computer of a new class, the small computer – was assigned to him.

Ovsepyan could not accept the demands of the Ministry of Instrument Making to develop a computer fully similar to French CAB-500. He clearly understood that the existing technologies in the USSR would not allow this. He decided to compensate for the technological deficiencies with the originality of technical solutions. Ovsepyan decided to use the microprogram control principle, and its implementation was completely original. Perhaps the lack of technologies played a certain positive role, forcing the developers of Nairi to go their own way.

In the technical specification of his computer, Ovsepyan provided the following principles:

1. The computer must be of parallel operation, i.e., when performing arithmetic operations, all the digits of a number should be read at once (not bitwise reading, as in computers of sequential operation).
2. The microprogram control principle should be used in construction.
3. Programs and microprograms are stored in a permanent memory of a large volume, implemented on removable cassettes.
4. For the arithmetic logic unit (ALU), a unified universal adder register should be used, which is also a buffer register for the main storage and external devices.
5. For the auxiliary registers of ALU and the control device, eight fixed memory cells with direct micro-command access should be used.
6. There should be a micro-program simulation of existing computers software.
7. Additional special microprogram and microcommand means should be developed for the implementation of special task algorithms.

Fundamentally new circuit designs and advanced software aimed at solving engineering problems arising in engineering practice allowed Ovsepyan to form the basic architecture of the whole Nairi family of small computers, which was patented in many countries. The Nairi (Fig 12) has become one of the most widespread small computers in the USSR, which found wide application in industry, research and higher educational institutions. Let us consider some of the patented solutions.

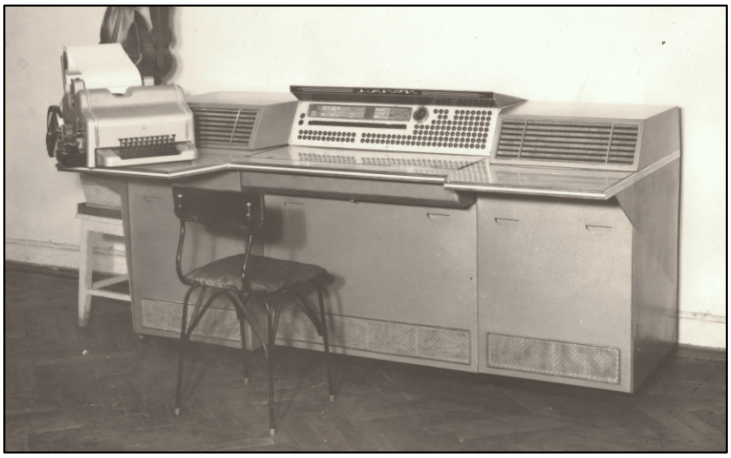

Fig. 12. Nairi computer.

For the first time for small computers in the early 1960s, a 36-bit processor architecture was proposed. It used also an arithmetic unit of a parallel type with through bit carry executed arithmetic and logical operations on numbers and commands. It consisted of one 36-bit universal register-adder. Groups of fixed cells of computer random access memory were used as the additional registers. For each fixed cell, the micro-operations of reading and writing were determined, which ensured independence of entire memory cycle and a great increase in performance. The performance of Nairi for fixed-point numbers addition was 2,000–3,000 ops, for fixed-point numbers multiplication 100 ops, and for operations on floating-point numbers 100 ops [11].

Cassette type long-term memory (8 cassettes with a total capacity of 16,384 words) became a fundamentally new feature of computer architecture. It was used for two purposes: for organization of microprograms memory and for storing the built-in software. The choice of address for reading the necessary information was performed by decoder. The necessary length of micro-commands (72 bits) was provided by simultaneous reading of information from two cassettes. The rest of capacity (14,000, 36-bit words) was allocated for the storage of compilers from Assembler and BASIC languages, software packages for solving differential equations, linear algebra tasks, programs for direct calculation of various arithmetic expressions in interactive mode, programs for control of typewriter and punch tape I/O device, for charts and diagrams plotting. Part of the memory was designated for technological programs for testing all units both during computer manufacturing and operation. The memory cycle time (12 μs) made it possible to realize the entire range of tasks with time characteristics better than foreign small computers where magnetic drums were used as software storage devices.

Starting in 1964, the computer was manufactured at two factories: in Armenia and at Kazan computer factory. More than 600 computers were produced for the period from 1964 to 1970.

The most distinctive features of Nairi were shown at the jubilee International Leipzig Fair in spring of 1965 where small computers of various firms and countries were presented, such as England's ICL, France's Bull, Germany's Zuse, etc. The Nairi was the only microprogram 36-bit computer, which provided high performance and increased accuracy of calculations (other computers were 8 and 16 bits). The Nairi outperformed the competition because software was stored in a long-term storage device while in other computers it was stored in external devices such as a magnetic drum.

There were several varieties of Nairi:

- Nairi-M (1965) differed from the basic model by the set of external units (the punched tape input device FS-1500 was produced in Czechoslovakia and the output punched tape device PL-80 at Kazan typewriter factory);
- Nairi-S (1967) had a "Consul-254" electrified typewriter with a thyristor block developed at Kazan factory;
- Nairi-K (1967) differed from Nairi-S by memory capacity (it was increased up to 4,096 words).

The next model of the Nairi computer family was Nairi-2, developed in 1966. It is essentially a modification of the Nairi computer. The main characteristics of this computer were the increased capacity of RAM, utilization of more productive I/O devices and improved design solutions. It had memory on ferrite cores (10 thousand cores of 2 *mm* diameter in each block of 20×20 *cm* dimension). A long-term memory on the magnetic drum was also developed.

The Nairi-2 computer became the last computer of the second generation developed in Armenia. Nairi-3 (1970), realized on hybrid integrated circuits, belonged already to the third generation. This computer together with other computers of third generation, designed by Armenian scientists and engineers, deserves the separate consideration.

6 Conclusion

Armenian computers contributed significantly to the development of electronics and computer technology in the USSR. Along with computers of the Ural and Minsk series, they formed the basis of national computing in 1960–1970s.

The Armenian Soviet Socialist Republic, having passed through all the stages of the world practice in the development of computer technology, became one of the leading centers in the USSR for developing computer hardware and software systems. Armenian computers contributed significantly to the development of electronics and computer technology in the USSR. Along with computers of the Ural and Minsk series, they formed the basis of national computing in 1960–1970s.

In the modern world, the next technological revolution is taking place, the transition from a post-industrial society to an information society. Armenia does not have a rich raw material and energy base and can ensure a deserving position on the international labor market only by participating in the production of certain demanded computer and information technologies. The development of computer technology and radio-electronics in the period from 1956 to 1988 allowed Armenia to achieve significant success in the development of science, education, and industry. Today in the country, there are strong scientific schools in the field of computer technologies, universities still training good specialists. The historical experience of the formation and development of the Armenian computer technology shows that if these factors are present, the country can successfully reach the leading position in the IT industry, which will lead to a general rise of its economy. Thus, it is important to learn such the experience, part of which is presented in this paper.

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