Fund Collection: “Electronic Digital Computing Machines” at the Polytechnic Museum

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Abstract. The Polytechnic Museum began to collect calculating devices and computing machines in the first years of its formation in the 1860s.. Today, the Museum has the Fund Collection “Electronic Digital Computing Machines”, which consists from seven systematic collections and eleven personal funds of Russian scientists. There are about three hundred objects and over sixteen hundred documentary, printed, and graphical items today. All four generations of electronic digital computing machines are presented in the museum. In addition, the museum created eleven personal funds of Russian scientists who devoted their activity to computer science. The museum has opened these funds, which include collections from S. Lebedev, I. Bruk, B. Rameev, V. Glushkov and others. It is very important to point out that this fund collection is the only one of such variety and size in Russia.

Keywords: Polytechnic Museum, collection, personal funds, electronic digital computing machines,

1 Introduction

The idea of establishing a Polytechnic Museum first took place in the 1860s. The country had been going through the reforming epoch of Alexander II. The foundation of a national capitalism had also been forming, thus, new knowledge and technological ideas were greatly required.

In 1864, the “Emperor society of amateurs for natural sciences anthropology and ethnography” (ESANSAE) had emerged. The main task undertaken by the scientists who had joined the society was their assistance to scientific progress and the dissemination of natural and scientific knowledge. As an educational complex, the members of the emperor society founded the first library, known as the Central Polytechnic Library. Later in 1872, they established the General Educational Museum of Applied Sciences, known to us today as the Polytechnic Museum.

Some of the exhibits of All-Russian Polytechnic Exhibition of 1872 were devoted to the bicentennial of Peter the Great; these exhibits became the foundation for the future museum. The computer engineering department was one of those exhibits and had certainly attracted everyone’s attention. The simplest devices for counting and the up-to-date computers represented the history of their progress. The Polytechnic Museum began to collect calculating devices and computing machines in the first

years of its formation. Today, the Museum has the Fund Collection "Electronic Digital Computing Machines", which consists from seven systematic collections and eleven personal funds of Russian scientists.

2 The Fund Collection

The fund collection of "Electronic Digital Computing Machines" (EDCM) was formed in the 1960s. There are about three hundred objects and over sixteen hundred documentary, printed, and graphical items today. In addition, the museum created eleven personal funds of Russian scientists who devoted their activity to computer science. The museum has opened these funds, which include collections from S. Lebedev, I. Bruk, B. Rameev, V. Glushkov, U. Bazilevskiy, N. Matjukhin, M. Kartsev, A. Kitov, N. Brousentsov, V. Petrov, and V. Burtsev. It is very important to point out that this fund collection is the only one of such variety and size in Russia.

The first electronic digital computing machines appeared in our country in 1951 and allowed scientists to solve difficult scientific and technical tasks. They were the Small Electronic Calculating Machine (MESM), developed under leadership of academician Sergei Lebedev, and the Automatic Digital Computer (M-1), developed under leadership of Isaak Bruk. N. Matjukhin and M. Kartsev were among the developers of the M-1 computer and later, they created computer engineering schools of their own. The documentary materials about these machines and its developers appear in the halls of computer engineering. The original report of the M-1 Automatic Digital Computer, developed in the Laboratory of Electro-systems at the Institute of Energy of the USSR Academy of Sciences, is one of the most interesting documents in our department.

In 1948, Isaak Bruk together with Bashir Rameev received the first author's certificate of the Automatic Digital Computing Machine in Russia. The museum is the custodian of this certificate. Later, B. Rameev created the "Ural" family of computers. One can see the Small Automatic Electronic Digital Computing Machine, the "Ural-1", in the Polytechnic Museum exhibition. Some museum objects of computer science have obtained the status of "Relic of science and technology"; as such, they are under protection of the museum and the state. The Small Automatic Electronic Digital Computing Machine "Ural-1", some units of the first Soviet serial computer "Strela" and other museum objects have designated such status. There are several units of the first Soviet serial computer "Strela", developed in 1952 by the Special Engineering Bureau SKB-245 in the EDCM Fund collection of Polytechnic Museum. These are the fragments of the Control Pulte, several processor blocks realized on the vacuum-valves, the six cathode-ray tubes (elements of quick-access storage), and wide ferromagnetic tape used as an external information carrier.

3 Generation of Machines

Usually all electronic digital computing machines are divided into four generations. The Small Automatic Electronic Digital Computing Machine "Ural-1" presents the first generation of machines in the museum. The processor of these machines was

realized on electronic tubes, and operative memory was realized on magnetic drum or cathode-ray tubes.

Then the second generation of machines is represented by electronic digital computing machine “Razdan-3”. They built the processor using semiconductors and operative memory on ferrite cores. There were several ferrite cubes in one machine. There are many matrixes of ferrite cores inside such cube. We can see how these devices worked on the demonstration model.

The museum collects and keeps the various types of memory on ferrite cores. For example, it contains the Ferrite Cube of the Operative Memory of the Electronic Computing Machine (ECM) M-4, developed under leadership of M. Kartsev. The capacitor-type ROM block of the ECM M10 is a very interesting object, which was designed in the Scientific Research Institute of Computing Complexes also under the leadership of M. Kartsev.

The unified system of electronic computing machines on integrated circuits represents the third generation, developed in the USSR at the beginning of the 1970s in cooperation with the socialist countries. It represents a family of software compatible machines with different productivities that build on the unified elemental and constructive base with a unified structure and a unified set of peripheral units. The processor and the operative memory were mounted on integrated circuits.

We can see the Computing Center with the third generation machines through the model of the Electronic Computing Machine ES-1050 and some original units of this machine. We can see integrated circuits, which made the peculiar revolution in computing science, on the boards of the operative memory of the ES-3222. Plotters were used widely with these machines for the first time.

The processor and operative memory of the fourth generation of electronic computing machines appeared on very large-scale integrated circuits. We demonstrate the functioning of one of the first such Soviet computers – the Microprocessor Laboratory “MikroLab КР580ИК80” in the museum.

A remarkable exclusion is the experience of creating the ternary computers “Setun” and “Setun-70”at Moscow State University. The experience convincingly confirms practical preferences of ternary digital technique. N. Brousentsov initiated the design of small digital computing machine “Setun” in 1956. (Note that Setun is the little river that flows into the river “Moscow” near the University.) The Setun was a small, inexpensive computer that was simple to use and to service for schools, research laboratories, offices, and manufacture control. Fast miniature ferrite cores and semiconductor diodes were used as the element base for this machine. Simplicity, economy, and elegance of computer architecture are the direct and practically very important consequences of ternary machines. The computer “Setun” has the status of “Relic of science and technology”.

4 Special Machines and Recognition

There is a unique computer for spaceship use called the “Argon-16” that can be seen only in this museum. It contained a synchronous computer system with triple redundancy and majorization carried out on per unit base with eight levels. It consists of three computers with data channels and a set of interfaces to the control system.

The instruction set is specially designed for control tasks. I/O operations combine with the calculation process.

Since 1975, the "Argon-16" computer became the basic component of control systems of "Soyuz" spaceship, the "Progress" transport ships, and orbital space stations "Salute", "Almaz", and "Mir". Exclusive reliability had provided long usage for it. The total output for these machines is 380. No failure of the system was noted during its twenty-five years of operation when working in control systems. It is unrivalled among space computers by production volume. The specialized computers for aviation are presented in the Museum exposition.

In 2005, the museum received the "El'brus 3.1" computer system, developed at the Institute of Precision Mechanics and Computer Technology. It also received one processor block and one operative memory block of the "Electronica SS BIS-1" super computer, created under the leadership of academician V. Mel'nikov at the Cybernetics Problems Institute and the "Del'ta" Scientific Research Institute. In addition, the museum actively collects Russian and foreign personal computers.

We have on exhibition in the museum halls devoted to Soviet scientists and engineers who worked in computing science. We can see documentary, printings, and graphic materials of scientific, official, and biographic activity of these people in this exhibition.

In addition, there are materials about international recognition of Russian scientists in computer science. The International Computer Society of the Institute of Electrical and Electronic Engineers awards scientists of different countries the title "Computer Pioneer". Russian scientists S. Lebedev, A. Lyapunov, and V.Glushkov received this title in 1996. These diplomas and large bronze medals were given to the children of these scientists.

Since 1994, the Department of Computer Engineering and the Automata Department of the Russian Academy of Science awards a premium, named after S. Lebedev, for successes in area of computing systems development. This museum keeps copies of the diplomas awarded by Russian Academy of Sciences to Russian scientists.

5 Curator Activity and Scientific Research

It is well known that every Museum begins from an object that was donated or purchased. After that, this object is accepted for temporary registration. Therefore, a scientific researcher composes a detailed report for the special museum commission that decides whether to keep this object.

The collection curators write scientific conceptions of collections and they compile conception programs of them. The museum has the following scientific conceptions among others:

- Electronic Digital Computing Machines,
- Specialized Electronic Digital Computing Machines for military applications,
- External Data Medium,
- Electromechanical Calculating Machines,
- Punched-Card Machines, and
- Simple Calculating Analogue Instruments and Mechanisms.

The collection scientific conception determines the collection object and the collection function. In this document, curators compile the historic information and the objects completing and selection principles. Then they write the collection structure and composition. This document determines the curator activity in collection forming over many years.

One of the important types of the curator scientific research is the scientific description of the most important museum objects: writing the "Scientific Passport of the Museum Object". In this document, we try to gather the maximum information about the object and to interpret this information for the purpose of historical, scientific and museum significance.

The "Passport of the Museum Object" document is compiled for the most important and valuable objects of the collection. The document has thirty-seven information fields. It contains the following main parts: the "object description", the "operation principles", the "technique parameters", the "museum significance", "literature", and the "appendix". In the "Appendix" we can place information such as the designer biography of the object and the patents obtained on this object. All information in the "Scientific Passport of the Museum Object" must exist to confirm references to the information sources. Such sources are the self-object, literature, states in periodical publications, technical documentation, archives, and information from specialists.

One of the most important purposes of the Polytechnic Museum is to discover and to select the relics of science and engineering, to describe research, classify and systematize them, to take care of them (restoration, conservation, and protection), to introduce them into scientific use, and to popularize them.

A "relic of science and technology" is the material object, directly or indirectly connected with main stages of science and engineering development. This requires to keep the relic in conformity with its social and scientific significance and to use it in the general cultural system. Special information cards are compiled for such objects. Then an expert committee of the Polytechnic Museum, appointed from the Association of Scientific and Technology Museums of Russian Nationality Committee of ICOM, confers the status "relic of science and technology" if warranted.

Eight objects have achieved this status in the Fund Collection "Electronic Digital Computing Machines". These are

- The Small Automatic Electronic Digital Computing Machine "Ural-1",
- The Electronic- rays Tube and The Ferromagnetic Tape of the first Soviet serial computer "Strela",
- The Control Pulte of The Small EDCM "Setun",
- The ECM "MIR-2",
- The Ferrite Cube of The Magnetic Operative Memory,
- The Magnetic Drum of ECM "Minsk-32",
- The Unit for abonent's linking of the ECM M13, and
- The Capacitor Type ROM Blok of ECM M10.

Work on discovering "Relics of science and technology" will continue indefinitely.

The final stage of the curator scientific research is compiling the scientific catalogue on the fund collection. The catalogues "Mechanical Musical and Curious Automata", "Telegraph Sets", and other documents are published under the "Cultural

Russia Heritage" program.

Today, the Fund Collection "Electronic Digital Computing Machines" is actively being enriched and explored, so it is too early to compile a catalogue on this theme. Together with the academic institutes, trade research-production and exploratory centers, universities, various departments, and public scientific and technological organizations, the museum conducts scientific conferences, readings, round table discussions, and meetings devoted to distinguished Russian scientists and engineers, and important dates in history of science and technology.

The Polytechnic Museum has printed the albums "Relics of Science and Technology", books with speeches from the participants of polytechnic readingsthat are part of the museum. For example, it hosted "Cybernetics: Expectations and Results" and "Specialized Electronic Digital Computing Machines for the Army ".

Within its program called "Remarkable Engineering Projects of Russia", the museum printed books in which showed the results of scientific research of creative heritage of outstanding Russian scientists in area of computer engineering. For example, it published the article "Pioneer of Soviet Computing Industry: Sergey Lebedev" and "Creative Heritage of B. Rameeva: One of the Founders of Domestic Computing Technology".

6 Some Reflections

Today, the Polytechnic Museum is rightfully considered the main museum in Russia, showing the country's history of science and technology. As a scientific and methodic center of the museum management studies, it fulfills an entire set of important tasks.

The museum brings to light and shows the collections of other scientific and technical museums to further a fair preservation of national heritage. It is guiding a professional skill mastering in the work of the museums of technical profile. The museum coordinates the activities on finding, custodianship, and bringing to cultural circulation the most valuable, rare objects of science and technology from other museum collections of the country. It also assists in sharing the experience of foreign and home specialists with the scientific and technical museums.

As the leading museum of science and technological history, the Polytechnic Museum renders the methodic and practical help in establishing museums. In 1987, the Polytechnic Museum took part in the foundation of the Association of Scientific and Technical Museums under Russian Committee of ICOM (International Council of Museums). Today, the museum is a scientific organization and methodic center for the Association. Since the 1970s, the Polytechnic Museum is a Member of the International Council of Museums.

Students from several Moscow universities have internships in the museum. The museum suggests some themes and works that they can do. The main themes are:

1. Imitation of functioning different calculators and computing machines with help of new information technologies;
2. Creating slide shows on computing history through PowerPoint presentations;
3. Repairing and restoration the objects of the EDCM collections.

Students of Moscow State Academy of Instrument-making and Informatics created some animated models of objects from the calculating instruments collection using a

modern professional program called Macromedia Studio MX. Chebushev's arithmometer and S. Dgewons' logical machine are among them.

An example of student work on the second theme is the slide show titled "The First Personal Computer: The Altair". A student of the Moscow College of Information Technologies created it (№1533). Now for any categories of visitors it is possible to demonstrate with the PC the following slide shows developed by the author of report with the aid of the program PowerPoint:

- "Charles Babbage and his Computers";
- "Ada Lovelace - the First Programmer in the World";
- "Search of Versions in the Composition of Fairy Tales";
- "Anthem to Artificial Intellect".

The third topic is the most difficult. Unfortunately, it is practically impossible to restore the first electronic digital machines for demonstration of their work. However, with the aid of modern computers it is possible to show the operation of the separate devices. One of such complex demonstration was created on the base of plotter "US-7051M" and the personal computer, which works in the DOS medium. This plotter worked under the control of a special block in composition of United System computers. We do not have such a control block, but the student of Moscow Institute of Electronic and Mathematics developed a new interface between this plotter and personal computer on modern microchips (integrated circuits). The control programs, written in the algorithmic language C++, and the demonstration programs allow drawing of images chosen by the user from the computer library, for example, the logo of Polytechnic Museum. It is important to note that in the created demonstration complex in the base of plotter US-7051 and personal computer partially the history of appearance and development of the algorithmic languages is reflected and remains the same.

With the aid of modern multimedia computer, it is also possible to listen to computer music: from the first solo-voice melodies "Uralskie napevy" of R. Zaripov, to the polyphonic compositions of A. Stepanov (played on the first computing machines in the 1960s). They were rewritten from old recording tapes and enumerated before modern plays. They are written for the computer and the usual musical tools such as "Dialog of computer and violoncello".

In 2005, the museum began to carry out the work according to digitization of video films from the scientific-auxiliary fund of the museum. Five films are already in digital format. For example, the museum digitized "Academician Lebedev", "Machine Geometry and Graphics" and "Curved Surfaces in Automatization System". The museum plans to continue this work.

All scientific research and knowledge about the museum objects are used for enlightening, educating, and developing social-cultural activities in the museum. During the excursions "How People Learn to Calculate" and "From the Plum Stones to the Clockwork Calculators", the youngest schoolchildren can calculate on devices such as the Asian abacus, Russian frame-wooden counters, and arithmometers.

For the older school children, students from the professional schools and high schools, the museum holds overview excursions. These include "From the Abacus to the Modern Computer", "The world of EDCM", and some excursions that reveal more completely themes such as "Artificial Intelligence of Computer" and the "Time

Overtake Project" (devoted to the Charles Babbage Analytic Engine and Ada Lovelace), and the "Information Revolution in the Civilization History". During the autumn, spring, and winter holidays the museum holds short excursions for random visitors, usually parents with their children.