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Abstract

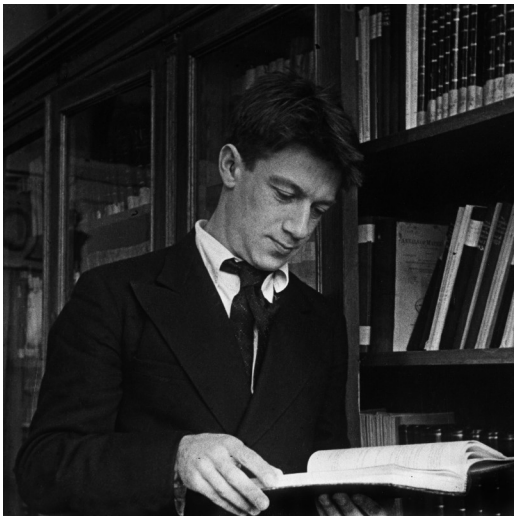
Sergei L'vovich Sobolev is the eminent mathematician whose work had a substantial influence on the development of twentieth century mathematics. Sobolev made fundamental contributions to the theory of partial differential equations, functional analysis, function theory, mathematical physics, and computational mathematics.

Less well known is the fact that Sergei Sobolev was the founder of Computer Science in the USSR/Russia. He took active participation in the development of the architecture of the first Soviet computer M1 and in developing the first computer program in the USSR for "atomic project". Really in fact he was the first professional programmers in Russia. Thanks to him, theoretical and practical programming became scientific disciplines.

Sobolev was born in St. Petersburg on October 6, 1908. He mastered the high school material on his own, and entered university in 1925. After the graduation from the university in 1929 Sobolev began work in the Seismological Institute of the USSR Academy of Sciences. Together with Academician Vladimir Smirnov, he discovered a new field in mathematical physics - functionally invariant solutions that allow solving a number of the most complicated problems associated with wave processes in seismology.

In 1932 S. L. Sobolev started working in the Department of Differential Equations of the Steklov Mathematical Institute of the USSR Academy of Sciences. Sobolev made fundamental contributions to the theory of partial differential equations, functional analysis, function theory, mathematical physics, and computational mathematics. His outstanding mathematical results were highly appreciated by his colleagues. At the age of 25, he was elected a corresponding member of the USSR Academy of Sciences, and at 31 he was already an academician [1].

In 1943, Sobolev began working at LIPAN (LIPAN is the Russian abbreviation for the Laboratory for Measuring Instruments of the USSR Academy of Sciences), which later became known as the Kurchatov Institute of Atomic Energy. The laboratory worked intensely to build a nuclear shield for the USSR. This was a period of hard creative work for all members of the institute staff to create new technology and special equipment.



Sobolev joined the group of academician Kikoin, where they dealt with the problem of uranium enrichment using cascades of diffusion machines for isotope separation. Sobolev worked both in the plutonium-239 group and in the uranium-235 group. He organized the work of the computing department, organized the process of industrial separation of isotopes and was responsible for reducing production losses. Sobolev faced applied mathematical problems the solution of which required tremendous effort because it was necessary to calculate, optimize and predict extremely complicated processes never studied before [2].

He worked with physicists and was involved with a lot of numerical computation at a time when computer was not yet available as a calculating tool. The number of applications requiring accurate calculations has steadily increased. The price of the error was very high. This concerned both technical issues and political responsibility.

Therefore, all calculations were performed by at least three independent people. This was well understood by the leaders of the work on the creation of the atomic bomb; the leadership of the country also understood this. Therefore, on June 10, 1948, the Government of the USSR adopted special resolution No. 1990-774 under the heading "Top Secret." This decision obliged to expand the calculation department at the Mathematical Institute of the Academy of Sciences (MIAS), as well as to organize calculation groups in the Leningrad branch of the institute, and in the Institute of Geophysics of the Academy of Sciences [3]. In Moscow the work of the MIAS department was headed by Corresponding Member of Academy Lazar Lyusternik, and in the Leningrad branch of the Institute by the future Nobel laureate Leonid Kantorovich. The overall management of the work was assigned to the deputy director of the institute, the future president of the Academy of Sciences, academician Mstislav Keldysh. At the Institute of Geophysics, calculations in explosion physics were led by Andrey Tikhonov, corresponding member of the Academy of Sciences.

In the USSR, programming appeared long before the creation of the first electronic computers. The first program (then they called the computing instruction) were written at the Mathematical Institute of the Academy of Sciences in the 30-ies of the last century. In 1934 in the Mathematical Institute was created Department of approximate calculations to develop new methods of numerical calculations for applications. One of the important part of this department was a separate structural unit - computing group. The size of this department was constantly growing. By the end of the 1940s the Department of approximate calculations was the largest structural unit of the Institute. In the department worked about 80 percent of employees of the Institute.

The Academy of Sciences had a special and very high status in the Soviet Union, gathering under its umbrella the country’s most competent professionals and strongest research centers. It had its own engineering design units, even factories and plants. For this reason, the atomic project was launched at the Academy of Sciences. All basic calculations for the atomic project, as well as for missiles and other means of atomic devices delivery, were also carried out at the institutes of the Academy of Sciences.

Since 1946, the Academy of Sciences has repeatedly appealed to the Government with the initiative to create a special institute for the development of high-performance destination computers. In 1948, the USSR Council of Ministers adopted a resolution to set up a center named Institute of Precision Mechanics and Computer Engineering (IPMCT) within the Academy of Sciences system.

Initially, the Institute's works were focused solely on the creation of specialized mechanical computers. It was not planned to carry out any work on the creation of universal electronic computers for at least the next five years. It was presumed that the creation of universal electronic computers is a matter of the distant future, when the element base (radio tubes) will be more stable in operation.

The key date not only for the history of the development of the institute, but also in the history of the development of the computer industry of the USSR was July 6, 1949. On this day, a meeting of the Bureau of the Department of Technical Sciences (DTS) of the Academy of Sciences took place. It was dedicated to the discussion of the results of the IPMCT activity examination conducted by the commission of the DTS under the leadership of academician Mstislav Keldysh. It was a very good choice. Keldysh was the head of the MIAS computational department, responsible for all the computational support for atomic and missile projects, responsible for performing calculations on time. He better than others in the USSR understood what would be the consequences, if the nation lagged behind others in the development of new types of computers. Each new computing task will lead to an inevitable increase in the staff of computing divisions and departments, and verification of accuracy will become a snowball problem.

Keldysh has severely criticized the Institute for the complete lack of plans to create universal electronic computers. He expressed firm confidence that any work on the creation of narrowly specialized mechanical computers should be stopped. All activities of the institute should be focused on the creation of universal electronic computers. In an acute polemic that took place at the meeting, most speakers disagreed with Keldysh's opinion that priority must be given to the development of general-purpose electronic computers. All that has been achieved Keldysh, it's the mention in the DTS Bureau's decision, that the development of electronic computers should be included in the list of the main tasks of the Institute in the coming years.

However, this was enough. Soon, due to the efforts of Keldysh, the institute was reoriented to the development of the universal computers. The development of work on the creation of universal electronic computers was recognized as a priority task. In early 1950, the IPMCE leadership was replaced [4].

The TDS Bureau's meeting and its resolution considerably sped up general-purpose computer development, opened a new area of computer engineering. In 1950, the Government substantially increased the funding needed to expedite the development of electronic computers. New industry leaders, the creators of first Soviet computers Isaak Brook and Sergey Lebedev moved forward.

TDS Bureau was closed meeting, at which Sergey Sobolev was among the special invited. He immediately appreciated the prospects of creating a new type of computer technology and became its ardent advocate.

In 1951, work on the creation of the first Soviet computers M1 and MESM entered a decisive stage [5][6]. Sobolev began to work actively with the team of Isaac Brook in early 1951, as soon as the M1 computing unit has been assembled. He assessed at once the prospects that open with the appearance of high-performance computing machine.

Sobolev's influence on the process of creating the M1 was very significant. In particular, he actively supported the implementation of the two-address instruction. The creators of the first computers believed that a three-address command system must be implemented. Because it is natural and right. There are addresses of two operands and an address where the result should be placed. However Yuri Schrader, a young mathematician graduated Moscow University who was recruited to develop the technology for future programming on computers, drew attention to the fact that in many cases the result of the operation is one of the operands for the next operation. It was a brilliant idea, actively supported Sobolev. Application of the two-address instruction instead of three-address allowed to significantly expand the scope of addressable memory, and the range of problems solved on the M1, in particular, it allowed programming the calculations on the matrices.

It is noteworthy that in developing the next computer, called the M-2, Brook's team returned a step back and created a computer with a three-address command system. Therefore, according to the designers, the "correct computer" should support a three-address command system! The same opinion was held and the team worked

under the leadership of Lebedev. Even in the popular and successful BESM-4 computer, a three-address command system was implemented. And these were already the 1960s. The recognition and development of the idea of Sobolev came only 10 years later.

Schroeder possessed many-sided talent. He was a very talented mathematician who wrote several fundamental works in the early years of the formation of Computer Science. In 1970th Schrader was baptized in the Roman Catholic Church, an uncommon occurrence in the secular culture of the Soviet Union. Schrader's religious conversion resulted in his expulsion from the Communist Party and his demotion at the Institute. He continued his research in mathematics and computer science, but gradually he became more interested in the problems of philosophy. In the 1990s, he completely focused on the work of the field of philosophy, taught at the College of Catholic Theology of St. Thomas Aquinas and the Bible and Theological Institute of St. Andrew the Apostle in Moscow [7].

From October to December of 1951 M1 was used in test mode. At this time, Sobolev prepared and programmed a number of test tasks that have been successfully solved on the computer. The successful solution of test tasks convinced Sobolev and his team that the computer was working stably, that the computer could be used to perform complex scientific calculations. December 15, 1951 M1 was put into operation. In early 1952, Sobolev spent on M1 calculations for handling matrices of large dimension for problems related to the gaseous diffusion enrichment of uranium. In the USSR, it was the first application of electronic computer to perform complex scientific calculations.

It will not be a strong exaggeration to say that Sobolev was the first professional programmer in the USSR. His professionalism was manifested primarily in the fact that he well understood the architecture of the computer. He was well aware of the computing capabilities of M1, its strengths and weaknesses. He wrote a large number of tests for the machine to check its functionality, the correctness of calculations. In the program, prepared by himself or with his participation always provides for the possibility of failure of the machine during the computation, the possibility of storing intermediate data and resuming accounts using intermediate results. It was a very professional approach and an important example for other users of the computer in a

situation where there was no experience with computers, when there was not even such conception as a programming technique [8].

In 1952 Sobolev was invited to head the Chair of Computational Mathematics at the Mechanics and Mathematics Faculty of Moscow State University. Theoretical subjects were immediately supplemented by practical training on the counting machines. Since at that time there were only two computers in the country - M1 in Moscow and MESM in Kiev, students had to use Mercedes and Rheinmetall electrical computers to solve practical problems. It should be noted that even these calculators were in the Soviet Union in very limited quantities. There was a problem getting them for the university.

To read the course "Principles of programming" was invited Alexei Lyapunov. It was a very good choice. In his face Sobolev found companions and enthusiastic of using computers to solve scientific problems. The Chair of Computational Mathematics of Moscow State University is the founder of the schools of theoretical and practical programming in the USSR.

The using computers for computational tasks of varying complexity has since become one of the main areas of Sobolev's activity. On his initiative, in the second half of 1951, the Institute of Atomic Energy began designing its own electronic computer called CEM (Computing Electronic Machine). It was put into operation in 1953.

In 1955, it was replaced by a CEM-2 computer, assembled on new elements of radio electronics, which made it possible to increase its performance tenfold in relation to CEM-1.

At the same time Sobolev became interested in the idea of creating a small computer, a suitable by cost, size, and reliability for research and university laboratories. At Moscow University he organized the seminar, which was attended by staff of the University, the Institute of Atomic Energy, and other institutes of the Academy of Sciences. The task of creating a small, reliable and cheap computer was delivered in April 1956 at one of these seminars.

In 1958, the computer began to work in test mode. The Council of Ministers interdepartmental commission adopted a resolution on the "Setun" series production. In 1962 - 1965 was released 46 computers. Despite the positive reviews, the ease of use and the presence of orders in 1965 the production of "Setun" was discontinued.

In the 1950s in the Soviet Union Marxist materialist ideology prevailed over all daily activities, including over science. With the advent of high-performance computers came into existence the interest to use them not only for calculations, but also for modeling biological, economical, and management processes. In those days they were united by one word - cybernetics.

But all that was not related to the use of computers as an accelerator calculations, was unacceptable to the Marxist ideology. Any idea of using computers to model processes in biology, economics, or management has been harshly criticized. Cybernetics was declared as a bourgeois pseudoscience. The apotheosis of the offensive on cybernetics was an article published in the fifth issue of the journal "Problems of Philosophy" in 1953. It was placed in the "Critique of bourgeois ideology" section under the heading "Whom does cybernetics serve?" [9]. The title of the article itself already indicated that noone patriotic scientist in the USSR could engage in such an odious science.

In the USSR, all knew that the articles that have appeared in such magazines as "Problems of Philosophy", expressed the official view. In fact it was direction to immediately roll up all of the research in this area.

However, there were people who dared to disagree with the official point of view. Moreover, they showed courage, written response to the article and brought it in the same magazine. Sobolev, together with the Lyapunov and Kitov, wrote an article "The main features of cybernetics" and presented it to the editor of the journal "Problems of Philosophy" in the same 1953 [10]. The article was published only two years later, after the death of Stalin. But although it was not published immediately, yet it has become widely known. Party leaders were allowed to conduct seminars and conferences, where supporters and opponents of cybernetics could freely express their opinion. So the publication of this article in 1955 was an official recognition of cybernetics as an allowed science. Cybernetics received official status.

After a decade, the situation repeated itself. Sobolev supported the work of Leonid Kantorovich on the application of mathematical methods in economics (for which Kantarovich subsequently received the Nobel Prize). At that time, the use of mathematics and computers for modeling economics was still considered unacceptable from the point of view of Marxist ideology.

In the formation of computer science in the USSR participated engineers, scientists, mathematicians, computer scientists, linguists, representatives of other specialties. But perhaps Sobolev best of all other understood the importance and future prospects associated with the emergence of computers. He was the only academics, leader one of major scientific and engineering area, who had the experience of computer programming. Based on this experience, he was be able to realistically assess the prospects for the use of computers, see the problems that need to be addressed for the mass use of computers. And not only appreciate, but also to take practical action to support and develop new directions.

Work on the "atomic project" helped Sobolev to see new bright colors in the understanding of mathematics. According to him, it was then that he understood a very important point. For many problems, the non-abstract question of the existence of a solution is important. The concrete idea is important, how to find a reasonable approximate solution to a predetermined date. Since then, computer science and computational mathematics have always been in the field of his interests.

Sergei Sobolev is one of the greatest mathematicians of the XX century, who made a fundamental contribution to modern science, who initiated a number of new research directions in modern mathematics. He can also rightly be called the pioneer of Russian and Soviet computer science.

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