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History

A Peek Behind the Iron Curtain's Technology

When he took control of the Soviet Union in 1985, Mikhail Gorbachev made computer science and microelectronics a central goal for his leadership, declaring that "Microelectronics, computer technology, instrument making, and the entire information science industry...are the catalysts of progress."[1] At the time, the Soviet Union was falling significantly behind the West's abilities in this field, and competition from the United States was seen as a fundamental, existential threat to the Union, or as the official Communist Party journal, *Kommunist*, called it, "an arena of fundamental competition between the two socio-economic systems."[2] He spearheaded a wide-spread computer literacy campaign, leading the movement behind the creation of a new, mandatory course in all Soviet secondary schools: "Principles of Information Science and Computers", with one goal: universal computer literacy.[3]

This course and its curriculum, when compared to efforts in the United States and to other aspects of the Soviet schooling system, turned out to be unique in many ways. One quality that almost immediately sets it apart was that it did not teach computer literacy in the modern-day sense, such as by learning to use a word processor or email software, but instead focused on "algorithmic thinking"[4]: teaching students how to solve a given problem algorithmically, and how to actually program the computer to have it carry out the desired algorithm.[5]

[1] Richard W. Judy and Jane M. Lommel, "The New Soviet Computer Literacy Campaign," *Educational Communication and Technology* 34, no. 2 (1982): 108.
[2] Ibid., 108.
[3] Ibid.
[4] Ibid., 111.
[5] Ibid.

What set apart the computer literacy effort from its contemporaries was that the entire subject was fairly new at the time, and, as such, the teachers recruited to launch this ambitious new program had little to no experience with it.[6] This necessitated the development of a very radical curriculum design, one that, oddly enough, shares some resemblance to the ideas of Helen Parkhurst and the Dalton Plan. The course was built around a central student workbook, described by one of the central figures behind the development of the curriculum as “the main resource available [to teachers] to influence their pupils”.[7] This workbook contained assignments for the students, describing complex algorithms in simple terms and enabling a student to work on their own.[8] This was a significant departure from the standard hierarchy in the Soviet schooling system: the teacher imparts knowledge on the student, who is only there to receive that knowledge.[9] Therefore, many teachers saw this new workbook system as a challenge to their authority, one that could result in a scenario where the student was ahead of the teacher![10] This bold paradigm shift, combined with a general “computer phobia”[11] and the fact that teachers were required to attend a mandatory summer retraining course, resulted in the computer literacy program being met with significant amounts of resistance.[12]

One requirement that would seem pretty critical to the success of computer literacy program is the availability of computers in schools. Unfortunately for the Soviet Union, this turned out to be easier said than done. One of the leading figures behind the program, Andrei Petrovich Ershov, estimated the need for 50,000 computer labs, requiring over a million computers, at a cost of about 2 to 3 billion rubles--a significant portion of the 10 billion ruble total

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[6] Ibid., 114.
[7] Ibid.
[8] Ibid., 117.
[9] Ibid., 114.
[10] Ibid.
[11] Ibid.
[12] Ibid., 120.

budget for the entire Soviet schooling system![13] This brings a broader question into consideration: were computers available to regular Soviet citizens, and, if so, what were their capabilities?

Despite the rather grandiose plans by the government, the most tangible progress in both hardware and software development came from the hobbyist community. In 1982, Радио (*Radio*), a popular electronics hobbyist magazine, began to publish a series of articles, titled "A First Step".[14] These articles described the architecture and concepts behind a new computer, the Микро-80 (Micro-80), culminating in the publication of the electrical schematic, with enough information to enable a hobbyist to build their own version, assuming they could acquire the necessary parts.[15] Built around the КР580ИК80 processor, a clone of the Intel's 8080, the Micro-80 was initially met with little interest from government figures and ministries.[16] Among hobbyists, however, the computer was met with significant interest. Many turned to black markets so that they could actually acquire the required processor and control logic, purchasing parts stolen from factories and other organizations.[17] The Micro-80 also inspired the creation of more advanced designs, such as the Радио-86РК (Radio-86RK)[18] (which, as the name suggests, was also published in *Radio*), and the Radio-86RK ended up being one of the main catalysts behind the Soviet microcomputing revolution.[19]

The Radio-86RK was notable because it was the precursor for many mass-produced computers in the Soviet Union, such as the Микроша (Microsha).[20] These mass-produced

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[13] Ibid., 117.
[14] Zbigniew Stachniak, "Red Clones: The Soviet Computer Hobby Movement of the 1980s," *IEEE Annals of the History of Computing* 37, no. 1 (2015): 13.
[15] G. Zelenko, V. Panov, and S. Popov, "РАДИОЛЮБИТЕЛЮ О МИКРОПРОЦЕССОРАХ И МИКРО-ЗВМ," *Радио*, December 1982, 31-34.
[16] Stachniak, "Red Clones," 14.
[17] Ibid., 15.
[18] Ibid.
[19] Ibid.
[20] Ibid., 16.

computers, however, faced significant supply issues, requiring an interested customer to 'subscribe' to the product and wait for their turn to purchase it.[21] Ultimately, these supply issues combined with prohibitively high prices meant that these mass-produced computers were only truly available in school computer labs, with home users being forced to acquire individual parts and assemble their own computer based on the instructions in *Radio*.[22]

In parallel, personal computing in the United States was taking off. In 1981, IBM released their landmark IBM PC, setting multiple industry standards for personal computing, some of which persist to this day![23] The video game industry was also in a period of growth, having experienced an industry-wide crash in 1983 and undergoing a period of recovery after the 1985 launch of the Nintendo Entertainment System.[24] The Soviet consumer, and the nation as a whole, remained isolated from these events, yet one Soviet academician would turn out to have a huge influence on the West's video game industry, though there might have been no way of realizing it at the time.

Alexey Pajitnov, a member of the Academy of Science of the USSR, was supposed to perform research into speech recognition--technology that the KGB had great interest in due to its potential for making large-scale eavesdropping easier.[25] As part of his research, Pajitnov had access to his own, personal computer, an Electronika 60, which he experimented with on the side, developing his own programs.[26] Inspired by pentomino tiling puzzles from his youth, Pajitnov created a rudimentary version of a game he called Tetris.[27] Tetris proved itself to be an addictive game and spread like wildfire after he shared copies with his colleagues, spread like

[21] Ibid., 17.
[22] Ibid.
[23] Computer History Museum. "Timeline of Computer History." Accessed May 21, 2018.
[24] Ibid.
[25] Jagger Gravning, "The Man Who Made 'Tetris'," *Motherboard*, November 20, 2014.
[26] Phil Hoad, "Tetris: how we made the addictive computer game," *The Guardian*, June 2, 2014.
[27] Ibid.

wildfire.[28] By 1987, this game began to catch the eye of entrepreneurs and major video game companies outside of the Iron Curtain, such as Nintendo, Atari, and the British software company Andromeda.[29] Those three companies became locked in a battle over who could obtain the rights to distribute the game, and Pajitnov, who the Soviet government prohibited from making any licensing agreements, was forced to defer to the ministry of the government that handled import and export of computer technology, Elektronorgtechnica (or Elorg for short).[30] Representatives from each of the three companies negotiated with Elorg separately, and Elorg, confused as to what they were licensing and exactly what rights were being sought, gave the companies three different, conflicting answers, resulting in several fierce legal battles in the West over what companies retained which rights.[31]

Ultimately, Tetris serves as an example to showcase software developed and available in the Soviet Union, and how the Soviet Union interacted with the rest of the world when it came to computer technology. Tetris was developed as an independent side project by a computer enthusiast and was distributed to other hobbyists via sharing personal copies floppy disks, a far cry from the situation in the West, which by this point had established billion dollar software companies releasing software in an organized and industrial fashion, available for purchase in retail stores.[32] The struggle that Western companies faced when trying to acquire the rights to publish Tetris for their home countries illustrates what happens when these two worlds clash, an occasion that was still rather rare at the time. For Nintendo, the company that ultimately ended up winning the licensing battle, Tetris was the game bundled with every sale of their new handheld console, the Game Boy, and resulted in a huge commercial success for the system,

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[28] Ibid.
[29] Atari HQ. “Tetris: a History.” Accessed May 20, 2018.
[30] Ibid.
[31] Ibid.
[32] Jagger Gravning, “The Man Who Made 'Tetris'.”

with over 30 million cartridges being manufactured.[33] Henk Rogers, who was in charge of acquiring the rights for Nintendo, put it succinctly: “Tetris made Game Boy and Game Boy made Tetris”.[34] The three companies competing for Tetris knew it would be an incredible success in the Western world, hence their intense efforts in the difficult negotiations with Elorg. One can imagine that if Tetris, a technology triggering incredible amounts of interest, was so difficult to export, other pieces of software developed in the Soviet Union were virtually impossible to export. The Tetris saga serves to illustrate just how sharp the divide was between East and West, and underscores the depth of isolation caused by the iron curtain for Soviet Union’s computing technology.

One of the goals of this project was to create a concrete representation of what a Soviet-era personal computer might have looked like. I have therefore built such a computer, using parts originally available in the Soviet Union in the 1980s whenever possible. Initially, one challenge that I thought would be difficult to overcome was determining how to acquire these original hardware components. To my pleasant surprise, however, they are actually fairly easy to find, with countless eBay listings from sellers in different countries, mostly former Soviet republics like Romania and Bulgaria. Once these parts were purchased, they had to be connected to each other! To do so, I created an electrical schematic, a custom design inspired by those published in *Radio*, with a computer program called KiCad, and then used this framework to layout a circuit board. I then had this circuit board manufactured by a Chinese fabrication plant, ALLPCB, and soldered the parts to a circuit board by hand. This strategy initially may seem to go against the spirit of the project: hobbyists in the Soviet Union pretty obviously did not have access to a Chinese circuit board manufacturer! However, custom circuit

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[33] Atari HQ, “Tetris: a History.”
[34] Ibid.

board designs were in fact manufactured in the Soviet Union, both for mass-produced computers and as part of kits that were sold to hobbyists, and *Radio* is filled with page after page of (hand-drawn) circuit board layouts.[35] The sheer volume of connections required for a functioning computer necessitates the creation of a circuit board, both in the 1980s and still currently today.

As I was designing the computer, another obstacle emerged. Integrated circuits that were manufactured in the Eastern Bloc have a different spacing than their Western counterparts! The pins (the metal contacts on the sides of the chip) on a Western chip are spaced 0.1 inches, or 2.54 centimeters, apart from one another, whereas the Soviet parts have a pin spacing of 2.5 centimeters.[36] This seemingly minor difference required me to carefully design custom parts in KiCad (and interesting late-night e-mail exchanges with the Chinese manufacturer), ensuring that the non-standard spacing would be used when the circuit board was manufactured, but, more importantly, serves as a reminder of how just how divided the two countries were in terms of their technology.

A computer contains multiple different components, such as a processor, memory, video output, some form of input, and so on, with this computer being no different. This computer features a CPU manufactured by the East German government: the U880. A clone of the West's wildly successful Zilog Z80 processor[37], the U880 started production in 1980[38], four years after Zilog released the Z80 in the West.[39] The specific U880 used in this computer has the marking U9 on it, which is part of a standardized manufacture date encoding system by the East German

[35] Stachniak, "Red Clones," 16.
[36] Militärverlag de Deutsche Demokratische Republik, "Datenbuch Mikrorechner-schaltkreise," LSV 3539, March 31, 1988, 8.
[37] Ibid.
[38] Jörg Berkner, "Die Halbleiterindustrie in der DDR," *All-Electronics.de*, April 12, 2016.
[39] Steven Cass, "Chip Hall of Fame: Zilog Z80 Microprocessor," *IEEE Spectrum*, June 30, 2017.

government, and can be decoded to learn when the chip was produced: September 1986.[40] Another crucial component is the storage of the computer, which contains the actual code that is run. I initially chose to use four K573RF2 chips, each of which can store 2 kilobytes of data. Unfortunately, the chips I received, while seeming to function at lower speeds, failed when I tried to run them at a higher speed in the computer, leading me to believe that the parts I received are somehow defective. As a result, I was forced to substitute modern-day components for the memory; however, I ensured that there was no functional difference when I swapped these parts. That is, the computer still has the same amount of memory and same capabilities it would have had with the Soviet parts. A similar scenario occurred with the RAM of the computer and the Soviet KR537RU2 chips I had planned to use. For communication with the outside world, I used a Soviet KR580VV51A chip (manufactured during the third week of 1990) for connecting the computer to a laptop for debugging purposes, and, hidden underneath the display, a Soviet KR580VV55A chip (manufactured during the eighth week of 1989) to handle input from the six buttons in the bottom-right corner. For a display, I used a small, modern-day, monochrome LCD. Computers of the time mainly required a connection to a television set or CRT display, which I did not want to use in my project due to the complexity (and cost!) it would have added when it came to actually using the computer. However, the resolution of the LCD, 128 pixels wide and 64 pixels tall, is similar to the display capabilities of the computers available then, hence why I felt that it was an appropriate substitute. Finally, to handle communication between the parts, a trio of buffer chips was used (these, too, had to be modern-day parts, manufactured by Texas Instruments--Soviet equivalents did exist but I could not find any available for purchase), in addition to a V4028D decoding chip, manufactured in

[40] Deutsche Demokratische Republik, “Bauelemente der Elektronik KENNZEICHNUNG Herstellungsdatum,” TGL 31667, October 1979, 2.

June 1984[41] in East Germany, and a pair of K155LN1 inverter chips, manufactured during the twentieth week of 1989 in the Soviet Union.

[41] Ibid.

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