Red Clones: The Soviet Computer Hobby Movement of the 1980s

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The Soviet microcomputer hobby movement began in the early 1980s. It passed through two main developmental stages before it melted away a decade later, leaving behind a country enchanted with microcomputing. This article traces the development of the movement and assesses its significance and place in the USSR's history of computing.

The political and economic barriers erected by the Cold War affected more than the flow of Western dual-use technology (that is, technology with both military and commercial applications) to the Soviet Union and other East European countries. They also delayed the dawn of personal computing in the Soviet bloc. By the end of the 1970s, there were still no signs of microcomputers on the USSR's consumer electronics market, and there were no computer hobbyists who could reshape the Soviet society's perception of computing as successfully as North American computer enthusiasts reshaped theirs. However, the barriers did not stop the flow of technical information entirely, and a decade later, the Soviet computing landscape was filled with myriad home computer brands, thanks to the dynamic computer hobby activities that sprang out of Moscow, Leningrad, and other large Soviet urban centers. The main focus of this article is on that movement—the movement that should not have happened.

The conditions that initiated the North American computer hobby movement of the 1970s (such as access to microprocessors and information about them) were mostly absent in the USSR, and that, at least partially, explains why Soviet electronics hobby activities of the time did not include building and experimenting with computers. By the end of the 1970s, the Soviet electronics industry was in a position to pick and choose among the many proven Western designs for home and personal computers; the selected designs could have been copied and mass manufactured to move Soviet society swiftly into the microcomputing era, skipping the hobby computing phase all together. Indeed, that's what had happened in East European countries such as Bulgaria. The ПРАВЕЦ 8x [Pravetz 8x] series microcomputers were Bulgarian clones of the Apple II+, IIe, and IIc computers. Mass manufactured from 1982 until 1994, they provided computing support for many sectors of the Bulgarian economy and its educational system.[1] That, it seems, prevented a large-scale computer hardware hobbyism in Bulgaria.

Things did not happen in exactly that way in the USSR, however. In the early 1980s, at the time when North American computer hobbyists were unplugging their soldering guns, Soviet electronic hobbyism suddenly branched into computing, a development that eventually had a profound effect on Soviet society's introduction to computing. Why did that happen? What was the much-delayed Soviet computer hobby movement to achieve? In this article, I address these questions by analyzing the movement's origins and developmental stages, and I attempt to assess the movements place in the USSR's history of computing.

Could Soviet Computer Hobbyism Have Emerged in the 1970s?

The subject of the North American computer hobby movement of the 1970s and its impact on the creation and shaping of the personal computer industry has received wide coverage in scholarly and popular publications and need only be recapped briefly here.[2] The movement grew out of a more than half-a-century-long tradition of radio and electrics hobbyism backed by a variety of hobby magazines such as *Modern Electrics* (renamed

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Electrical Experimenter) and *Popular Electricity in Plain English,* both launched in 1908; *Radio-Craft,* first published in 1929 and renamed *Radio-Electronics* in 1948; and *Popular Electronics*—perhaps one of the most influential hobby electronics magazines of the last century—which was launched in 1954.[3] Since the end of the 1940s, computer enthusiasts and dedicated educators had been involved in a range of computing-related activities from the design of computer toys and educational aids to publishing and setting up computer social groups and organizations.[4] The introduction of the first 8-bit microprocessors onto the market in the early 1970s triggered the outbreak of homebrew computer activities that spawned the North American computer hobby movement. Technological advancement in the semiconductor industry was as important to that process as were the strength of electronics hobbyism and the presence of the intellectual drive to redefine the social status of computing. In the words of historian Paul Ceruzzi, "When these forces met in the middle, they would bring about a revolution in personal computing."[5]

The Soviet radio and electrics hobbyism tradition also goes back a long way. The first publications for radio amateurs started to appear in the 1920s. *Радиолюбитель* [*Radio Amateur*] and *Радио всем* [*Radio for Everybody*] were launched in 1924 and 1925, respectively. In 1930, they merged into a single publication, *Радиофронт* [*Radiofront*], which in 1946 became *Радио* [*Radio*] and was arguably the most popular Soviet electronics hobby magazine.[6] During the Soviet era, radio and electronics hobby activities were well-supported by the state, which sponsored inventor clubs and national exhibits. The prestigious All-Union Exhibit of Achievements of Radio Amateurs-Constructors showcased the achievements of Soviet inventors from the mid-1930s. However, if one excludes the black market in electronic components, there wasn't much more on the Soviet electronics hobby landscape of the 1970s. In drastic contrast to space exploration themes, computing was mostly absent from Soviet science and technology posters and postage stamps, which were powerful propaganda tools during the Cold War era. Therefore, it was a dearth of information about computers and semiconductor products, plus an absence of computer educators, enthusiasts, and hackers, that painted the backdrop for the Soviet electronics hobby activities. What the hobbyists lacked the most was access to novel semiconductor devices such as microprocessors and to information about them. In the 1970s, *Radio* did publish articles on digital electronics, but it never ventured into the world of microprocessors in any significant way. For instance, one of the earliest series of educational articles explaining modern computers to electronics hobbyists, published in *Radio* in 1978, only mentioned the microprocessor as a novel integrated CPU device.[7]

In a large geopolitical context, the microprocessor's absence from experimenters' workbenches on the Soviet side of the Iron Curtain was one of the repercussions of the Cold War. Since the advent of the war, the United States and its NATO allies had tried to restrict the flow of militarily strategic technology to the Soviet Union and other member countries of the Council for Mutual Economic Assistance (or CMEA).[8] In 1949, the NATO countries (excluding Iceland) and Japan formed the Coordinating Committee for Multilateral Export Controls (CoCom), an informal nontreaty organization whose objective was to set up a comprehensive system of export controls and enforcement measures to restrict the transfer of those technologies and products to CMEA countries that could significantly advance military capabilities of the Soviet bloc. Furthermore, several countries introduced unilateral export control laws for national security, foreign policy, and economic reasons.[9]

While export controls impeded the progress of CMEA's computer industry and widened the technological gap in the area of computing, they did not entirely stop the flow of Western computer technologies and products through the Iron Curtain,[10] as exemplified by the Единая Система [Uniform System] computer development program.

In 1969, the USSR and the majority of other CMEA countries signed the multilateral agreement on collaboration in the area of the development, production, and utilization of computers.[11] The main outcome of the agreement was the decision to join the Soviets in their effort to manufacture the common computer platform—the Uniform System—in order to, among other objectives, produce a family of high-performing computer systems, compatible across the Soviet bloc.[12] Instead of committing millions of rubles to the research and development of an indigenous high-performing family of compatible

Figure 1. Sergey Popov operating his Micro-80 computer at the Moscow Institute of Electronic Engineering in 1979. The computer is connected to a Hungarian-made Videoton-340 terminal. (Photograph courtesy of Sergey Popov.)

mainframes, CMEA settled on cloning the IBM System/360 architecture, obtaining the necessary information through legal channels and covert efforts.[13] The System/360's supremacy in the world's mainframe market and its vast software library made it an irresistible blueprint for the next generation of CMEA mainframes. However, by the time CMEA showcased its first computers of the Uniform System family during the "ЕС ЭВМ–1973" international exhibit that took place in Moscow in May 1973, almost a decade after the launch of the IBM System/360 family,[14] a new threat appeared on the CMEA high-technology horizon: the large-scale integration (LSI) of semiconductor devices. Novel semiconductor technologies and products, such as the microprocessor, of course made the CoCom's export controls lists.

The far-reaching political, military, and economic ramifications of the rapid progress in semiconductor technologies forced the USSR to promptly find a way to respond to the new technological race. As was the case with the Uniform System program, the Soviets resorted mostly to functional duplication and reverse engineering of Western semiconductor devices, backed by large-scale industrial espionage efforts to acquire advanced IC technology, manufacturing, and test equipment, as well as end products.[15]

The first Soviet LSI CPU chipsets came in the mid-1970s from Zelenograd, the USSR's Silicon Valley. The K587 four-chip bit-slice CPU was used in several Электроника [Electronics]-series computers, but there is no evidence of any significant impact of these early, low-volume Soviet microcomputers on the diffusion of computing in Soviet society.[16] According to some technology analysts, by the early 1980s, there were about 15 Soviet microprocessor chipsets, most of them clones of Western devices, even down to their part numbers.[17] In spite of full recognition of the significance of microprocessor and microcomputer technologies for the future economic and social development of the USSR (given, for instance, during the 1981 XXVI Congress of the Soviet Communist Party) and despite strong state support for the inventor movement, Soviet industry was unable to manufacture state-of-the-art microprocessors and memory chips in quantities that would make them available on the open market and would generate domestic demand for such products outside of military and strategic industrial sectors.[18] That manufacturing incapacity also kept the Soviet electronics hobbyists of the 1970s and early 1980s away from experimenting with the microprocessor.

The First Step

In 1978, the Moscow Institute of Electronic Engineering (MIEE) obtained an early sample of the Soviet KR580IK80 single-chip microprocessor. The device was a functional analogue of the Intel 8080 CPU, replicated at the Kiev Research Institute of Microdevices between 1976 and 1978 and manufactured by the company Кристалл [Cristal].[19] Three MIEE employees (Gennady Zelenko, Victor Panov, and Sergey Popov) decided to experiment with the chip and to build a computer around it. Thanks, in part, to the availability of the Intel 8080 technical literature, they had a working prototype of the computer the following year. They named it Микро-80 [Micro-80] and decided to popularize it (see Figure 1). The state companies and government officials seemed unimpressed with their effort. "We, understanding the potential of microprocessors and microcomputers, contacted various organizations. The big computer firms, the ministries. No one understood us," recollected Popov.[20] Then they turned to *Radio*. "At that time, the *Radio* magazine had a circulation of over 1 million copies, and a readership of a few million people." continued Popov. "I had been reading the magazine since 1966, and so I proposed to my colleagues to contact the editors." The magazine's editor in chief liked the microcomputer theme, possibly because it perfectly fit the prioritization of the microprocessor

and microcomputer technologies directive adopted by the 1981 XXVI Congress of the Soviet Communist Party. In September 1982, *Radio* began publishing "The First Step," Zelenko, Panov, and Popov's series of articles demystify the microprocessor and its programming for electronics hobbyists.[21]

The authors provided the schematic diagram and principles of operation of their rudimentary microcomputer for illustrative purposes only. To their surprise, many *Radio* readers decided to embark on the Micro-80 construction project despite the fact that most of the required chips, including the computer's KR580 CPU, could only be purchased on the black market where they occasionally ended up after being stolen from factories and organizations.[22] In hundreds of letters addressed to the authors, hobbyists across the country requested more construction details. All of a sudden, in a country where retail clerks were routinely tallying a sale using pen and paper or an abacus,[23] Soviet electronics enthusiasts wanted to build computers of their own.

The Micro-80 was the first microcomputer project published in the Soviet Union. Although by Popov's own estimate only a few hundred Micro-80s were actually built, the project's publication ignited microcomputer hobby activities, similar to the impact the Mark-8 and the Altair 8800 hobby computer designs had in turning the attention of North American electronics hobbyists to computers in the mid-1970s.[24]

By 1985, the Soviet hobby movement was in full swing. In August of that year, *Radio* published a review of the 32nd All-Union Exhibit of Achievements of Radio Amateurs-Constructors. The review acknowledged that, for the first time, microcomputers stole the show. More than 20 microcomputers were shown by Soviet hobbyists, micros with names such as Альфа-85 [Alpha-85] and АПАС-80 [APAS-80], a KR580-based micro built by members of an amateur radio club Патриот [Patriot].[25]

Still, the movement did not create any network of computer clubs or user groups. As explained by Popov, the Micro-80 computers were assembled mostly by individuals working alone. "It was practically impossible to organize a hobby club and find a place for meetings without permission from the government and party authorities."

The *Radio* magazine itself became the main information hub for computer hobbyists. Through the 1980s, it would publish a variety of articles dealing with microcomputer architectures, programming, and applications. The magazine reported on microcomputer-related events (such as exhibits) and novelties. It initiated debates on the state of Soviet computer literacy programs and hobby movement. In January 1986, the magazine published a synopsis of the roundtable discussion, "Your Personal Computer," which it organized to discuss the obstacles faced by computer hobbyists. The discussion stressed problems such as the persistent unavailability of microprocessors on the open market, the shortage of good quality publications on microprocessors and microcomputers (both on elementary and advanced levels), and the need to acknowledge the contributions of programmers to the computer hobby movement.[26]

The Radio-86RK

The success of the Micro-80's publication paved the way to several other microcomputer construction projects published in mass-distributed magazines. The Ириша [Irisha] educational computer project appeared in 1985 in *Микропроцессорные Средства и Системы* [*Microprocessor Tools and Systems*] magazine, which launched a year earlier under the editorial control of an eminent Soviet computer scientist and proponent of computer education, Andrei Petrovich Ershov.[27] The magazine was the first Soviet periodical exclusively dedicated to microprocessors and their applications.

In 1987, *Моделист–конструктор* [*Modeler-Constructor*] published the Специалист [Specialist] microcomputer construction project authored by an Ukrainian engineer, A.F. Volkov.[28] The ЮТ-88 [UT-88] hobby computer was described in *Юный Техник* [*Young Technician*] magazine in 1989, and in January 1990, *Radio* published the construction details of the Орион-128 [Orion-128].[29] Table 1 lists several early Soviet microcomputer construction projects and hobby computers.

In 1986, Zelenko and Popov published another microcomputer project in *Radio,* coauthored with Dmitri Gorshkov and Yuri Ozerov. Their new Радио-86РК [Radio-86RK] computer was a substantial improvement over the Micro-80 concept.[30] While the Micro-80 unleashed the microcomputer hobby activities, the Radio-86RK lent considerable impetus to the otherwise inept and sluggish Soviet microcomputer industry as several variants of this design were created and turned into volume-manufactured home

Table 1. Soviet hobby computers, kits, and construction projects most frequently discussed in the Soviet publications of the 1980s.*

Name	Type	Manufacturer/designer	Year of release/ publication
Микро-80 [Micro-80]	Computer project	G. Zelenko, V. Panov, and S. Popov	1982–1983
Вектор-06Ц [Vector 06C]	Personal computer	D. Temirazov and A. Sokolov	1985
Ириша [Irisha]	Computer project	V.N. Baryshnikov et al.	1985-1987
Радио-86РК [Radio-86RK]	Computer project	D. Gorshkov et al.	1986
Электроника КР-01, 02, 03, 04 [Electronics KR-01, 02, 03, 04]	Computer kits	Various manufacturers	1986–1989
Специалист [Specialist]	Computer project	A. Volkov	1987
Кристалл2 [Cristal2]	Personal computer	V. Sugonyako and A. Vinogradov	1987
Ленинград-1 [Leningrad-1]	Single-board computer	S. Zonov	1988
Орион-128 [Orion-128]	Computer project	V. Sugonyako, V. Safronov, and K. Konenkov	1989
ЮТ-88 [UT-88]	Computer project	V. Bartenev	1989–1990

*The list, compiled by the author, is neither complete nor does it include popular clones and refinements of microcomputers included in the table. With the exception of the Leningrad that utilized the Zilog Z80 microprocessor, all listed computers employed the KR580 CPU.

computers by several state companies and the growing home computer cottage industry. The long list of Radio-86RK clones and refinements includes computers such as Альфа-БК [Alpha- BK], Апогей БК-01 [Apogee BK-01], Криста [Krista], Импульс-02 [Impuls-02], Партнер 01.01 [Partner 01.01], and Спектр 001, [Spectrum 001].[31] Furthermore, some electronics stores, such as Moscow's Young Technician, sold 86RK-based computer hobby kits named Радиоконструктор Электроника КР-01, -02, -03, and -04 [Electronics KR-01, -02, -03, -04] put together by various manufacturers.[32]

Perhaps the best-known Radio-86RK refinement was the Микроша [Microsha] designed by the Radio-86RK's authors for mass manufacturing by the Moscow's Лианозовский Электромехнический Завод [Lianozov Electromechanical Company], the same company that in 1984 embarked on manufacturing the АГАТ [Agat] computer, a troubled Soviet clone of the Apple II.[33] In mid-July 1986, a Moscow store and showroom called Радиотехника [Radio-technics] demonstrated the Microsha to citizens. The two-day event brought large crowds of computer enthusiasts, most of whom had never seen a personal computer before.[34]

Soon after the Microsha's launch, its manufacturer opened a computer club in Moscow, making several Microsha and Agat computers available to the general public. Unfortunately, access to these computers was limited to those who could afford the 1.2 ruble/hour fee to work on an Agat or 0.5 ruble/hour to play a game on a Microsha at the time when a monthly salary of a starting engineer was between 120 and 140 rubles a month.[35] Microsha had no direct impact on the movement that brought it to life. It was an expensive personal computer with a hobby blueprint that could be assembled for a fraction of its 550 rubles price tag.[36] However, it was a popular entry-level choice for use at home and school thanks to the support coming from the Radio-86RK community.

The Radio-86RK project culminates the first wave of Soviet computer hobby activities that managed to create a vibrant microcomputer oasis on the barren Soviet personal computer landscape. Fortunately for the movement, the Moscow regime did not consider computer hobbyism to be politically dangerous, an activity that could have facilitated ideologically undesirable activism. On the contrary, its encouragement was exemplified by a large volume of microcomputer-related publications in Soviet youth-oriented magazines. In Popov's opinion, the Communist Party did not object to the popularization of microcomputing outside of the party-approved initiatives:

> These [Party] people saw no threat whatsoever to their dominant position in the information control. What threat can there be from a little

thing [the microprocessor], the size of a finger nail?

Furthermore, the lack of modems and the poor state of Soviet telephone network infrastructure not only isolated the movement internationally but also prevented Soviet microcomputing of the 1980s from creating its own cyberspace of Electronic Bulletin Board Systems and networks, frustrating the adoption of any of the forms of electronic activism practiced in the West.[37]

Enterprising Hackers in the Speccy Land

Although the impact of early hobby designs, such as the Radio-86RK, on the Soviet home computer field was considerable, by the end of the 1980s, the computer hobby movement branched away from the building of indigenous computers to focus on cloning one particular British computer: the Sinclair Research ZX Spectrum (or "Speccy," see Figure 2). The Soviet Speccy era had begun, and by the early 1990s, the Soviet microcomputer scene was dominated by myriad Speccy clones.

Several factors influenced Soviet computer hobbyists' engagement with the cloning of the ZX-Spectrum. The first of them was the dire state of the Soviet electronics industry, which, through the 1980s, was unable to manufacture home and personal computers in quantities that would create the necessary infrastructure for a computer-literate society. In spite of the new information technology-oriented economic plan for 1986–1990 and an ambitious computer literacy program, which, among other objectives, called for a million computers to be installed in Soviet high schools by 1990, the barriers to the mass manufacture of personal and home computers remained intact, allowing only for minuscule production outputs and setting prohibitive retail prices.[38]

The highly publicized Электроника БК-0010 [Electronics BK-0010] computer best illustrates the situation. Released in 1984, the BK-0010 was arguably the first "volume-manufactured" Soviet home computer. It was codeveloped outside of the hobby movement at the prestigious Research Institute of Precision Technologies in Zelenograd and the company Экситон [Exciton].[39] However, due to low manufacturing output, the computer was only available by subscription and only in the Electronics retail stores located in Moscow, Leningrad, and Minsk. This method of

Figure 2. The Sinclair ZX-Spectrum 48K. (Photograph by Bill Bertram, May 2005.)

sales for household goods was typical of Soviet-era retail. Consumers had to subscribe for a product and wait their turn to get items such as a radio receiver, a freezer, or a TV set. A barebones BK-0010 machine in a box sold for 650 rubles (about half a year's salary for a starting engineer). Without any peripherals or applications software, it was more of a luxurious hobby project than an affordable family computer.[40] According to data published in *Radio,* by mid-1987, only about 2,000 BK-0010's were sold, and although plans for 1987 called for 40,000 computers, only 7,000 were destined for the retail market (the majority of the BK-0010s were to be shipped to schools). None of these production targets were reached. When asked by a *Radio* reporter whether it would be easier to purchase a home computer in the near future, G.P. Morozov, the director of the BK-0010's manufacturer Exciton, replied frankly, "I don't think so."[41,42]

The large variety of Radio-86RK-inspired products did not solve the home computer inaccessibility problem either because commercial clones of the 86RK could be as expensive as the BK-0010 (for instance, the Partner 01.01 retailed at 750 rubles). Therefore, it is not surprising that in several regions of the USSR computer enthusiasts begun to search for an affordable, under-100-ruble alternative to the BK-0010 and the commercial 86RK clones.

Another factor that turned some computer enthusiasts' attention to the ZX Spectrum in the second half of the 1980s was the lack of software for hobby and commercially

retailed home computers. The BK-0010 was sold only with audio cassettes containing samples of Focal and Basic programs, the game *Tetris,* and some test programs. Radio-86RK enthusiasts had to thumb the pages of the 1987 and 1988 issues of *Radio* to get the source code of the Basic interpreter as well as an editor, assembler, and disassembler—programming tools that North American hobbyists were developing more than a decade earlier. The few published games for the Radio-86RK were primitive because the computer did not have graphics or color display capabilities. In short, the BK-0010, the Radio-86RK family, and other early home computers failed to generate a viable personal computer software industry.

At the same time, the microcomputer news coming from the West spoke not of new computer construction projects or better software debugging tools but of vast libraries of game titles, the 8-bit electronic Wonderland accessible through small and inexpensive "software players" such as the ZX Spectrum. This small 8-bit home computer was released by the British company Sinclair Research in 1982. The simplicity of its operation and its low price, good quality graphics and sound, and an extensive software library made it one of the most popular home computers in Europe.

After 1985, the ZX Spectrum could be imported to the USSR because computers of its class were no longer on the export controls lists. However, the computer's price, import duties, and high retail margins made it prohibitively expensive. While paying 1,700 rubles for genuine ZX Spectrum computers was not an option, cloning them was. According to the oral history testimonials of Soviet microcomputer pioneers, some of the ZX Spectrum machines brought to the USSR in the mid-1980s were disassembled and analyzed, and then detailed schematic diagrams were produced.[43] The main challenge in cloning the ZX Spectrum was to find a replacement for its custom uncommitted logic array (ULA) chip that controlled many of the computer's functions such as the display, keyboard, and tape recorder interface. Initially, the "cloners" functionally simulated the ULA chip with the available discrete components. By the early 1990s, Russian clones of that chip as well as of the Zilog Z80 microprocessor employed in the Spectrum were produced.

As in the case of the Radio-86RK, the schematic diagrams of ZX Spectrum clones were in circulation all over the Soviet Union, which resulted in many variants of the Spectrum being put together by hobbyists and state companies. The making and impact of the Leningrad clone designed by Sergey Zonov in 1987–1988 best illustrates that process. The Leningrad was a bare bones version of the ZX Spectrum 48K and, at that time, the simplest among the clones.[44] Like many early computer hobbyists, Zonov was influenced by the Micro-80 computer that he built and experimented with. It was mostly the gossip about the unmatched gaming capabilities of the Spectrum that turned Zonov's attention to the cloning project. He obtained and simplified the ZX Spectrum 48K's schematic diagrams and, after building a few prototypes, distributed his computer's technical information and the printed circuit board layout.[45] Carefully soldering fewer than 50 ICs and a few other electronic components onto the Zonov's Leningrad board produced a rudimentary ZX Spectrum-compatible software player. The Leningrad's design simplicity, ease of assembly, and reliability made it one of the most popular ZX Spectrum clones, resulting in a variety of homebrew and commercial variants of the computer with names such as Composite, Дельта-Н [Delta N], ИТЦ Спектрум [ITC Spectrum], Рита [Rita], Spectrum-Contact, and ZX Spectrum St. Petersburg or with generic names such as Spectrum, Spectrum 48, ZX-Spectrum, and Spectrum Sinclair (see Figure 3).[46]

Initially, the Speccy enthusiasts exchanged information through informal gatherings that frequently took place in the neighborhoods of black markets. "There were no formal clubs," explained Zonov,

> usually we gathered near Young Technician store on [Leningrad's] Krasnoputilovskaya street, on Saturdays and Sundays. It was not a club but it was a place where everybody could find almost any electronic [integrated] circuit, could discuss any technical question. Also it was the main Electronic Black Market in our city. It was a place where we bought CPU, memory, and many other devices. It was a place where it was possible to earn money. For example, I made a device for checking digital chips and memory chips and earned money [that way].

Speccy-related newsletters and magazines, especially those distributed in electronic form on magnetic storage media, came later, in the 1990s. According to data compiled by

ZXPRES.RU, their volume peaked in 1997, when almost 400 issues were offered by over 70 of such publications.[47] Compared with the established state published hobby magazines such as *Radio* and *Young Technician*, these electronic Speccy publications were more responsive and welcoming because they were frequently rooted in the Speccy movement itself and had more reader-supplied content.

There was no shortage of genuine ZX Spectrum software on the Soviet market. Those who traveled to East European bloc countries brought back games and other programs cracked by Spectrum enthusiasts from Czechoslovakia and Poland who frequently added their "signatures" in the form of "introductions" (or "demos") to the games.[48] The popularity of these demos and growing interest in the development of domestic games for the clones resulted in the first wave of Russian Demoscene activities, a powerful computer art phenomenon that was born in the Western Europe in the mid-1980s and started to take its roots in Russia half a decade later.[49]

By the early 1990s, the Soviet ZX Spectrum cloning effort was possibly the largest among such undertakings anywhere. The Soviet Speccy machines varied with respect to the degree of compatibility with the British blueprint, and their inclusion of additional features such as built-in Russian fonts or turbo-loading procedures. Many of these computers bore the region of origin's name: Dubna, Krasnogorsk, Novosibirsk, Ural, Leningrad, and Moscow. All these activities clearly infringed on international copyright laws, but as Konstantin Elfimov (who participated in and later documented the Russian Speccy scene) explained, "No one had ever heard the word 'copyright' back then and producing a hacked English computer never counted as a crime."[50]

News of the European success of the ZX Spectrum and of the homebrewed Speccy frenzy eventually reached Zelenograd, where at the beginning of the 1990s, the functional analogues of the Spectrum's ULA chip and the Zilog Z80 CPU were developed.[51] Several state companies capitalized on the Spectrum enthusiasts' passionate efforts to make the home computing widespread and affordable. Using the chips from Zelenograd, they manufactured their own ZX Spectrum clones. These cloning efforts picked up in the early 1990s at a time when the political foundations of the USSR were crumbling and ended only when the Soviet 8-bit clones proved worthless in the new Internet-driven computing reality.

Figure 3. Spectrum-Contact, one of the variants of the Leningrad computer manufactured by the Leningrad-based start-up *Тахион* [Tahion]. The computer was housed in a small, rudimentary plastic enclosure. The computer's keyboard and its glossy stickers were readily available on the Speccy market and used in several other ZX-Spectrum clones. (Photograph by Z. Stachniak.)

Conclusion

The Soviet computer hobby movement took off in the mid-1980s in reaction to the hopelessly muddled process of creating the Soviet version of the Information Age, as a reaction to the stagnant and dysfunctional Soviet economy unable to kick-start a viable home and personal computer industry that was incapable of mass producing even rudimentary home computers and providing them with software. The rise and the impact of the Soviet Speccy suggests that the volume manufacture of computers such as the ZX Spectrum in the mid-1980s would satisfy the needs of computer enthusiasts and most likely confine hobby activities to the niche of electronics hobby clubs. But that did not happen; the low-volume and software-bereft BK-0010s and Microshas had negligible effect on the movement that firmly established itself in the second half of the 1980s.

It is challenging to unequivocally assess the movement's place in the USSR's history of computing. Quantitative data showing the hobbyists' impact on the domestic home computer industry (measured, for

instance, by the numbers of hobby-inspired commercial products and their production levels) is neither available nor easy to compile. The same applies to assessing the movement's impact on computer literacy. Clearly, as demonstrated in this article, such impact was broad and far-reaching. The first phase of the movement that focused on self-educating its participants helped to fill pages of popular and technical press with home and personal computer themes, unwittingly stimulating and advancing general interest in personal computing. The hobbyists also offered alternative personal computer designs to those created by the struggling industry and prepared the ground for the emergence of the Soviet Speccy. The second phase was possibly the world's largest undertaking in ZX Spectrum's cloning. It rescued the Soviet home computer industry by offering blueprints for inexpensive to manufacture and easy-to-use software players and by creating strong market demand for them. It also created a vast and dynamic Speccy subculture and the Russian variant of Demoscene born in its wake.

However, the movement's proper assessment cannot exclude areas where the hobbyists were not as successful as they could have been. The movement focused on obsolete 8-bit hardware architectures exclusively and avoided the experimentation with 16-bit microprocessors such as the Soviet K1801BM1 employed in the BK-0010 home computer. It was also unable to create a microcomputer software industry or stimulate the state's interest in launching one. Hence, the movement could not significantly help narrow the Soviet's personal computing gap with the West (measured in terms of the technological sophistication, volume of computers produced, and the levels of penetration of business and educational sectors, among other factors). At best, it could only slow its widening. However, despite these weaknesses, the movement managed to fulfill the unforeseen function of linking the Soviet home computing experience with the Western computing heritage by allowing first-time computer users to experience the 8-bit digital world as fervently and passionately as their Western counterparts had done years earlier when the Apple IIs, Atari 400s and 800s, Commodore VIC-20s and C64s, and Sinclair ZX Spectrums were brought to homes and connected to TV sets for the first time.

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References and Notes

1. See A.R. Martin, "Red Hot Apples… or How We Learned to Stop Warring and Love the Pravetz," *inCider*, May 1990, pp. 39–42. Apple II technical specifications, including schematic diagram and firmware, were published by Apple Computer in the *Apple II Reference Manual*, Jan. 1978, chaps. C and D.
2. See, for example, P. Fresiberger and M. Swaine, *Fire in the Valley: The Making of the Personal Computer*, 2nd ed., McGraw-Hill, 2000; S. Levy, *Hackers: Heroes of the Computer Revolution*, O'Reilly Media, 2010; and D. Lungu and Z. Stachniak, "Following TRACE: The Computer Hobby Movement in Canada," *Scientia Canadensis*, vol. 34, no. 1, 2011, pp. 1–2.
3. K. Massie and S.D. Perry, "Hugi Gernsback and Radio Magazines: An Influential Intersection in Broadcast History," *J. Radio Studies*, vol. 9 no. 2, 2002, pp. 264–281.
4. See Fresiberger and Swaine, *Fire in the Valley*; Levy, *Hackers*; and Z. Stachniak, *Inventing the PC: The MCM/70 Story*, McGill–Queen's Univ. Press, 2011.
5. P.E. Ceruzzi, *A History of Modern Computing*, MIT Press, 1998, p. 221.
6. Data from the official *Radio* website, www.radio.ru/archive, as of Nov. 2013.
7. P. Svoren, "ЭВМ: Приглашение к знакомству" [Computer: Invitation to Get Acquainted], *Radio*, no. 3, 1978, pp. 54–56; no. 4, 1978, pp. 51–53; no. 5, 1978, pp. 50–52; no. 6, 1978, pp. 51–53.
8. The subject of computing during the Cold War era has been explored by many authors; see, for instance, P.N. Edward, *The Closed World*, MIT Press, 1997. CMEA was formed in January 1949 and initially included Bulgaria, Czechoslovakia, Hungary, Poland, Romania, and the USSR.
9. The UK's Cold War–era export controls were rooted in its Import, Export, and Customs Powers Act 1939; the United States enacted its Export Control Act in 1949, and Canada its Export and Import Permits Act in 1954. For a