Peering through the Curtain: Soviet Computing through the Eyes of Western Experts

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A collection of trip reports from Western computer experts who visited the Soviet Union in the 1960s reveals details about interactions between these Westerners and their Soviet counterparts during the height of the Cold War. These previously unexplored first-hand perspectives help to illuminate how such interactions shaped and countered American perceptions of Soviet computing and the threats it posed to the West.

Digital computing was a key technology of the Cold War. Although atomic energy, intercontinental missiles, and aerospace were the most striking technological examples of the stand-off between the United States and the Soviet Union, electronic digital computers provided the computational power to design, test, and operate weapons systems. Computing was also an integral component of economic and social development. The emergence of information technology powered financial planning and management systems and facilitated new means of communication and control over industrial, military, and numerous other complex applications. As computers grew in power and versatility, their potential capabilities drew an increasing amount of interest and scrutiny on behalf of leaders on both sides of the Cold War.

Western governments, acutely aware of the importance of computing technology in Cold War strategy, made a concerted effort to understand Soviet ambitions and capabilities with computers. The American Central Intelligence Agency, for example, formed a branch dedicated to studying the threat of the Soviet computer-related field of cybernetics, while the US National Security Agency helped fund academic organizations like the Mosaic Group, which systematically studied Soviet computing for the purpose of informing policy, such as export control.[1]

The largely unidirectional flow of information and technologies, however, was a great impediment in the effort to study Soviet computing. Intelligence about the Western computer industry, in the form of academic journals, trade publications, software packages, and sometimes equipment, flowed through the porous Iron Curtain into the Soviet Union with surprising ease over the course of the Cold War.[2] Substantially less information regarding Soviet computing made its way West, and what did was often limited to Soviet state propaganda or controlled releases of data the Soviet leadership saw fit to report. In addition, as Stanislav Klimenko pointed out, the altogether different organization and form of Soviet science and industry, combined with other cross-cultural factors, such as mistranslation or misinterpretation of technical terms from Russian to English, made Soviet computing and computer science particularly difficult for Westerners to comprehend, even with careful study. For example, the feudal nature of Soviet computer science, with different "tribes" of scientists remaining largely isolated from one another based on their originating institutions or schools of thought, was an important element in the development and structure of Soviet computing, but was often missing or misrepresented in Western analyses of Soviet computer science until after the fall of the Soviet Union.[3] Klimenko also pointed out that, even in the presence of published Soviet sources, Westerners were still often left to speculate whether the Soviet author was

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referring to "real developments or just intentions." Poor and unclear Soviet-sourced information and the inherent difficulty for outsiders to interpret key elements of Soviet computing, such as scientific and industrial organization, invited speculation on behalf of analysts in the West, sometimes under the pull of political biases and motivations. To overcome the limitations of available information and mitigate the extremes of speculation, government agencies and policy analysts in the United States drew upon a multitude of sources to investigate and analyze Soviet computing potential. These sources included trip reports from Westerners who had visited Soviet computing centers or had interacted with members of the Soviet computing community.

Drawing from a large collection of trip reports compiled by two American organizations between 1957 and the end of the Cold War, this article explores a subset of trip reports that relate to the burgeoning of Soviet cybernetics during the 1960s. Originally intended to inform policy and provide interested parties in the United States with a glimpse inside the large and complex Soviet computing establishment, the trip reports addressed in this article have gone largely unexamined for their insights into the American interaction with Soviet computing and computing specialists during the Cold War. Far from mere technical discussions, the trip reports touched upon here offer valuable indicators of how Westerners with significant computing backgrounds perceived the Soviet computer industry, its driving forces, its capabilities, and the individuals behind it. The reports also highlight how those American perceptions formed, changed, and even differed from one another when confronted with living and working examples of "the other side." Depending on the focus and depth of analyses of the individuals encountering Soviet computing, and depending on what they were permitted to see, Western visitors could form contrasting views about the nature and capabilities of their Soviet technical and human counterparts. They also formed differing opinions as to the threat Soviet computing presented to the West.

The three trip reports examined in this article, and the larger collection from which they are drawn, are far from exhaustive explorations of American–Soviet relations involving computing during the Cold War and offer insights into the Soviet system only through the lens of contemporaneous Western visitors. However, they offer important clues as to how the West sought and obtained information about Soviet computing during the height of the Cold War, how Western fears and perceptions of the Soviets and their computing capabilities responded and changed when confronting first-hand experiences abroad, and how the insights, accurate or not, that Western computing specialists gained in the Soviet Union interacted with the perceptions and varying agendas relating to Soviet computing at home. These trip reports are representative of the nature and value of the larger collection in elaborating upon Western relations with and reactions to Soviet computing during key periods of computer development in the Cold War.[4]

Rand's Role in Report Collection

The Rand Corporation, a nonprofit think tank formed in 1946 to offer research and analysis for the US armed forces, actively sought trip reports from Westerners whose travels in the Soviet Union had brought them into contact with Soviet computing.[5] The official purposes behind these trips varied. For some, the Soviet Academy of Sciences invited Western computer experts, including academics and members of industry, to conduct speaking tours at Soviet computing centers and academic institutions. For others, Westerners connected to computing in their professional capacity drove through the Soviet Union on vacation, visiting Soviet academics during their travels. The report authors were frequently leading figures in their technological fields. Of the trip reports Rand collected, approximately 20 dated between 1957 and 1968 were donated to the Charles Babbage Institute. (Another 20 trip reports from a separate organization, the Mosaic Group, covering the 1980s and early 1990s, will be discussed in a follow-up article.) For the Rand trip reports, returning Western travelers would submit reports of their journeys to Willis Ware, head of Rand's Computer Science Department, or Ware would seek out reports of relevance to his department's interests. Ware stated that the National Joint Computer Committee–organized visit of an American technical delegation on electronic computers to the Soviet Union in 1959, of which Paul Armer (the first head of Computer Sciences at Rand) and Ware (Armer's successor) were members, produced not only an extensive trip report about Soviet computing, but also spurred a series of presentations and publications related to the topic. Rand publications included *Soviet Cybernetics: Recent News Items* and *Soviet Cybernetics Review,* a series that presented translated Soviet articles and other publications relating to the burgeoning field of Soviet cybernetics and computing development until 1973. Highlighting the importance and difficulty of translating Russian computer terminology for English-speaking audiences, Rand began work on a Russian–English technical glossary alongside its series on Soviet cybernetics and computing.[6]

The stated purpose behind the Rand cybernetics series was "to keep computer specialists who are interested in Soviet computing technology and cybernetics informed about Soviet publications and activities in these areas."[7] Rand's interest in Soviet cybernetics and computing capabilities reflected the concerns of other American agencies, such as the CIA and NSA, over the potential of Soviet computer science and cybernetics to overtake that of the West. An internal White House memo of 1962 warned that the apparent Soviet total commitment to cybernetics could result in disaster for the United States by 1970 if the US did not match that commitment. However, at Rand in the early 1960s, Willis Ware and Wade Holland raised questions as to the true nature of cybernetics in the Soviet Union and the Soviet scientific establishment's approach to the topic. Ware and Holland noted the existence of "wide divergences of opinion" found in Soviet sources discussing cybernetics, the apparent emotional bases for those divergences, and a vagueness about applications of cybernetic theory. For Ware and Holland, these questions and issues regarding Soviet cybernetics and computing invited further investigation and the need more sources of information, rather than extremes of speculation.[8]

Current knowledge about Soviet computing has expanded as new sources have became available following the end of the Soviet Union and as the passage of time has allowed for reflection on the consequences of computer development and of the Cold War in general. The interaction of science, technology, and political ideology had an enormous impact on the development of Soviet computing.[9] The sampling of trip reports examined in this article touch upon Western perceptions of and reactions to this interaction during the mid-1960s. The trip reports highlight Soviet cybernetics, a field that would encompass a broad range of disciplines and modes of thought in the Soviet Union.[10] The trip reports also feature the development of large-scale technological programs that the Soviet government commissioned in an attempt to reengineer complex systems, particularly the Soviet economy in the 1960s.[11]

Cybernetics in the Soviet Union

The broad definition of cybernetics as the study of communications and control within self-regulating systems, such as the human brain, parallels the equally broad interpretation of cybernetics that developed within Soviet computing and society.[12] The literature describing the rise and decline of Soviet cybernetics is well attuned to the key features and consequences of the Soviet cybernetic movement. Understanding this literature aids in placing the American trip reports in a greater context with respect to the Soviet computing they seek to describe.

Slava Gerovich described the changing Soviet attitude toward cybernetics beginning with the early 1950s Soviet science establishment discouraging its study, labeling cybernetics as incompatible with Marxist dialectical materialism, to its rehabilitation following the break with Stalinism. Cybernetics subsequently rose to prominence in Soviet computing, economics, life sciences, and even politics in the 1960s. This rapid, broad acceptance and use across Soviet science and society stood in contrast with its more tempered acceptance in the West, where cybernetics followed more closely Norbert Wiener's original concepts of feedback control and information theory, rather than the wide spectrum of control and communications-related fields, including the social sciences, in the Soviet Union.[13]

Benjamin Peters built upon Slava Gerovich's pioneering analysis of Soviet cybernetics to understand its meteoric rise in the Soviet Union. His work revealed that the conceptual framework underlying cybernetics, that of "controlling and regulating information systems," coincided with the changing post-Stalinist Soviet power structure. Peters argued that the promise of "control without violence" offered by cybernetics appealed to scientists who were tired of political oppression and to party officials who sought a means of maintaining control of the state without the endemic violence of the Stalinist era. The rise of Soviet cybernetics was, in this view, not an anomalous fascination among numerous strata of Soviet society, but a rational extension of the Soviet system of maintaining power through controlling the population via information control.[14]

Peters' description of cybernetics as a means of perpetuating state authority through information control resonates with discussions of traditional Soviet "vertical" communications structures. S. Frederick Starr outlined the deliberate Bolshevik policy of securing for state use the means of communication that extended vertically through all levels of society, such as newspapers, print, and radio, while impeding the development and use of "horizontal" means of communication, such as the telephone, the telegraph, and the automobile.[15] The Soviet state's control of information also bears on Walter D. Connor's assessment of the stability of the Soviet system, which he indicated was predicated on the Soviet state imposing three essential conditions on the population, including repression, fostering material dependence upon the state, and isolation from the outside world.[16] A more practical aspect of the expansion of Soviet cybernetics was, as Slava Gerovitch indicated, the ability of members of "previously marginalized" lines of research to gain acceptance by associating their work with increasingly popular cybernetic principles, no matter how far afield. As a result of these numerous ideological, political, and practical factors, Soviet cybernetics was not the defined field it was in United States, but an ongoing effort to bring computing principles into numerous scientific disciplines. This situation added to the curiosity and confusion of Westerners attempting to dissect Soviet cybernetics of its meanings and capabilities.[17]

The Rehabilitation of Soviet Cybernetics

Cybernetics rose to prominence in Soviet science, society, and politics during the 1960s. Previously discouraged in Soviet computing circles as incompatible with Marxist dialectical materialism, cybernetics was "reformed" in the years following the break with Stalinism at the Twentieth Party Congress in 1956. Key figures in Soviet science, such as the academicians Aksel Berg and Victor Glushkov, espoused cybernetics as a means of control through the introduction of electronic machines capable of processing vast amounts of real-world information. Through the early 1960s, the influence of cybernetics spread from electrical engineering and computer science into biology, psychology, economics, and even to politics. Aksel Berg, director of the Scientific Council on Cybernetics, the council within the Academy of Sciences that attempted to coordinate cybernetic research in the Soviet Union, exploited the growing interest in cybernetics. Amid the burgeoning cybernetic fervor, Berg expanded the role of the Council on Cybernetics through his broad interpretation of what fell under the umbrella of cybernetics, which included almost any form of computing and systems of control, communication, or information. The Council on Cybernetics took over increasingly broad oversight and contributed to the wide adoption of cybernetic concepts in the Soviet Union. The rapid growth of and enthusiasm for cybernetics in the Soviet Union, which as Stanislav Klimenko indicated, took place amid an assortment of competing computer science "tribes" and lacked a discernible distinction in publications between what was under production and what was imagined, explains much of the Western concern and confusion about Soviet cybernetics—what it was and what its potential threat might have been.[18]

Between 1962 and 1964, the scope of the Council on Cybernetics grew from 170 to 374 projects under its direction, from 29 to 96 institutions under its purview, and from 14 to 22 agencies under its aegis. During this period of expansion, cybernetics appeared to offer a great many solutions to problems perceived as inherent to the Soviet system. Economic planning was one of the first and most popular applications of Soviet cybernetics. The first published model of cybernetic economic planning appeared in the Soviet Union in 1957, and within three years, 40 economics institutions were engaged in cybernetic modeling. As Martin Cave explained, a series of technical and political changes occurred in the Soviet Union between the late 1950s and early 1960s that helped marry state economic planning with computing. An important technical change was the successful Soviet transition to second-generation computing, developing transistorized computers that offered greater speed and reliability than their vacuum-tube counterparts. Another important change followed a 1957 management reform that enhanced the regional-level power of the Central Statistical Administration (TsSU), which allowed the TsSU to install a growing number of mechanical data-processing machines in a series of accounting stations across the Soviet Union, setting a precedent for the use and TsSU oversight of automated economic processing on the Soviet regional, rather than ministerial, level. Finally, the Soviet Union experienced a revival of mathematical formulation of planning in the early 1960s, providing a means of uniting economic planning with digital computing. By the mid-1960s, half of the 500 Soviet cybernetics research institutions were conducting economic modeling. Berg's Council on Cybernetics established its own Economic Section, which published an economics journal, *Cybernetics–In Service of Communism*. It was after mathematical economic planning embraced cybernetics in the early 1960s, combined with the enhanced power of second-generation computers, that the Soviet government began to take seriously the use of cybernetics to address a predicted economic management crisis.[19]

The growth of the postwar Soviet economy resulted in a commensurate growth in management complexity. As of 1962, official predictions for the future of Soviet economic management were not optimistic. One alarming prediction estimated that, by the mid-1980s, the growing volume of paperwork, coupled with the existing "archaic" data-processing system, would result in nearly the entire adult population of the Soviet Union employed in economic management. Less dire predictions still offered the grim assessment that, without reform, the Soviet Union would soon outstrip its capacity for processing the increasing amount of economic data within acceptable time limits, a disturbing prospect in a planned economy. Whatever the veracity of these predictions, the Soviet leadership took these arguments for economic management reform seriously. Prominent cyberneticists, like Victor Glushkov, founder of the influential Kiev Institute of Cybernetics (later called the Glushkov Institute of Cybernetics), answered Khrushchev's call for economic management reform through decentralization with a planned series of locally controlled computer centers. The writings of Glushkov, it should be noted, featured prominently in the Rand publications on Soviet cybernetics and demonstrated Glushkov's extremely broad interpretation of and future hopes for cybernetic principles and applications. His connection with the Kiev Institute, and its lack of reliance upon the state military or the atomic energy industry, often allowed Glushkov and his supporters opportunity to follow more speculative pursuits than his counterparts who were tied to more practical or short-term demands, which helps to explain the extremely ambitious nature of Glushkov's economic plans.[20]

The computer centers Glushkov proposed were to automate much of the difficult task of processing vital economic data into actionable reports for local leaders, thus reducing the burden on Moscow of centralized processing and planning. Although the party and government leadership encouraged this plan, leaders of the various state-level ministries in Moscow fought to retain their centralized control. The opposition of ministries to perceived encroachments on their authority would remain a perpetual factor in the development of computerized economic controls in the Soviet Union. Although the ousting of Khrushchev in October 1964 eventually altered the direction of cybernetic economic reform, the projected reform remained in its early, Khrushchev-era planning stages for some time after his removal. This intense internal debate over cybernetics as it related to computing, economics, and politics would play an integral part in the experiences and perceptions of the Western visitors who witnessed this period in Soviet history.[21]

Edward Feigenbaum in the Soviet Union

In October 1964, at the same time as Khrushchev was being ousted, Edward A. Feigenbaum, a pioneer in artificial intelligence who became a founding member of the Stanford Computer Science Department the following year, visited the Soviet Union as a guest of the Soviet Academy of Sciences. Feigenbaum had traveled to the Soviet Union four years earlier as an American delegate to the First Congress of the International Federation of Automatic Control (IFAC) in Moscow, where he observed early Soviet efforts in cybernetics and artificial intelligence in the years immediately after the "rehabilitation" of Soviet cybernetics. Far from just a visitor, Feigenbaum maintained a long-running interest and connection with Soviet computing following his initial visit, including a correspondence and friendship with Andrei Petrovich Ershov, a programming language pioneer and the lead developer of the Alpha language. Personal connections made during visits, along with those made at international conferences, such as those through IFAC and the International Federation for Information Processing (IFIP), of which Ershov was a key contributing member, diminished some of the barriers between Western and Soviet colleagues during the Cold War and served as points of contact that helped shape and change perceptions on either side. They also proved valuable for making personal introductions that sometimes lead to visits to either the United States or Soviet Union.[22]

In 1964 Feigenbaum spent nearly a month traveling to various computing and technical centers in Moscow, Leningrad, Kiev, and the then-new Scientific Center in Novosibirsk.[23]

Reflecting the rising status of cybernetics in the Soviet Union, Feigenbaum's visit was arranged through Aksel Berg's Scientific Council on Cybernetics. Feigenbaum's 1960 report, "Soviet Computer Sciences and Cybernetics," was well read in Soviet computing circles and had left a favorable impression among Soviet cyberneticists. The secretive nature of scientific work in the Soviet Union, whether due to government control of information or Soviet scientists carefully guarding their work from competitors for fear of losing funding, meant that Western papers like Feigenbaum's were often the best sources of information Soviet scientists had on work being conducted elsewhere in the Soviet Union. This situation added to the appeal for Soviet computer scientists to meet their Western counterparts. One such scientist, Anatolii Viktorovich Napalkov, the head of an Academy of Sciences cybernetics lab, had personally orchestrated Feigenbaum's return visit to the Soviet Union. Feigenbaum himself was initially unclear as to the rationale for the invitation. However, it soon became apparent that Napalkov was seeking to leverage the notoriety that the American's report from 1960 had generated in Soviet computing circles to elicit greater support for Napalkov's own field of research, heuristic programming.[24]

Feigenbaum's 1964 trip report, transcribed from the audiotape he recorded at the American Embassy in Rome after he left the Soviet Union, begins with an overview of his itinerary, followed by a section discussing the scientific and technological insights he gained, and concludes with the individuals he encountered and the conversations he had with them. The report is not simply a listing of technologies, labs, and researchers that Feigenbaum deemed of likely interest to Western analysts. Feigenbaum also included a thoughtful collection of his impressions regarding their ambitions, competencies, management styles, and the likelihood of the projects and concepts he witnessed coming to fruition based on their technical merits and on the skills and personal drives of the individuals involved. Even though Feigenbaum took issue with Napalkov's abilities as an "organizer," Napalkov was one of the key individuals in Feigenbaum's narrative. As Feigenbaum described it, Napalkov was "completely sold" on heuristic programming, the concept of computers programming themselves through feedback mechanisms, where they effectively learned from experience and reduced the need for laborious, traditional programming by humans. Other key Soviet cyberneticists opposed, or were at least skeptical of, heuristic programming, viewing it as "not mathematical" and, therefore, suspect.[25]

Feigenbaum's first encounter with Napalkov occurred during his a car ride from the airport in Moscow, during which Napalkov warned Feigenbaum of the opposition the American might encounter from Soviet cyberneticists, such as Glushkov, toward heuristic programming. On more than one occasion, Napalkov coached the American on what he should say in response to potential arguments against Napalkov's position on heuristic programming. Napalkov attended many of the American's discussions and all of his lectures, afterward giving him a "kind of playback" of what he had said and instructing Feigenbaum on the important points he should focus upon. While bothered by Napalkov's coaching, according to Feigenbaum, the most disturbing part of his time in Moscow was being "pigeonholed as a biological-type cybernetic scientist." This was likely due to Feigenbaum's visit being arranged through Napalkov's Biology Section of the Council of Cybernetics. Because of this perception among organizers that Feigenbaum was a biological-type cyberneticist, the American had great difficulty finding discussions on computers and computer science. Feigenbaum confronted Napalkov over the issue, but to no avail. The problem diminished as Feigenbaum made his way through Leningrad and Kiev and then to Novosibirsk, where Napalkov had no further use of the American. Once in Novosibirsk, Feigenbaum was finally able to explore computer research facilities without Napalkov's interference.[26]

In his trip report, Feigenbaum expressed extreme displeasure at Napalkov's poor coordination with the labs and scientific centers where Feigenbaum was scheduled to visit and lecture. The lack of planning often left Feigenbaum uncertain where he was supposed to go and how to get there. Lectures were often arranged at the last minute. However, Feigenbaum's reputation, and the curiosity about American cybernetics among Soviet scientists, drew large crowds, even with little notification. This situation also improved where local planners, such as Glushkov in Kiev, took it upon themselves to handle the arrangements. While Napalkov had prepared the American for a strong negative response to the concept of heuristic programming among Soviet cyberneticists, Feigenbaum found that this was not the case. Indeed, Feigenbaum discovered a "considerable" interest in heuristic programming among Napalkov's colleagues. Although there were cyberneticists, including Glushkov, who were skeptical of the concept, the real issue in the Soviet Union, as the American perceived, was the lack of practical work being done in the field of heuristic programming. Feigenbaum observed that Napalkov and his lab personnel, which consisted of engineers, physiologists, and a mathematician, had a complete understanding of the concepts and exhibited great enthusiasm and interest in the field, but they had no practical means of moving beyond theory. There was no plan for moving their advanced theoretical work onto the computer, nor could the group even agree on the beginnings of such a plan. Feigenbaum's visit to a cybernetics lab in Leningrad, under the direction of Yuri Orfeev, Napalkov's acquaintance through the Council on Cybernetics, revealed a similar problem. Orfeev stated that there were no practical applications of heuristic programming in the Soviet Union at that time, including in his own lab.[27]

Although Feigenbaum noted a considerable expansion of cybernetics in Soviet science and society since 1960, many of the key features of Soviet computing that he had observed in 1960 remained in 1964. In 1960, Feigenbaum observed that Soviet computer research, and publications in the fledgling field of cybernetics, emphasized theory over practical applications. Feigenbaum had concluded in 1960 that the extreme dearth of computers likely contributed to this arrangement, as labs and individuals lacked the access to computers they needed to conduct practical work. Feigenbaum speculated that, if the Soviets of 1960 made accessibility to hardware a priority, the gaps he perceived between American and Soviet computer development would have diminished. Although the number of computers in use in the Soviet Union did increase in the four years between his visits, the number was still far from meeting demand, and the existing machines were typically small and best suited for work in mathematics. Another problem Feigenbaum noted in 1964 was the nature of cybernetic research in the Soviet Union.[28]

The broad interpretation of cybernetics meant that Soviet cybernetic research was extremely wide in scope and diffuse in focus and coordination. There were a multitude of labs across the Soviet Union pursuing a broad range of research projects under the nominal umbrella of cybernetics, but directing those projects for effectiveness and to reduce duplication was an onerous chore. Although the Council on Cybernetics aimed to coordinate cybernetic research in the Soviet Union, Feigenbaum discovered that, whatever its stated purpose, it was not a powerful directing body. Lacking a large budget or the authority to set the national agenda in cybernetics research, the Council on Cybernetics functioned in an advisory capacity and served mostly to exchange information among cyberneticists. The broad scope of Soviet cybernetics, however, severely reduced the council's effectiveness in even its limited capacities. Soviet cybernetics, as Feigenbaum discovered, was far from a unified or even coordinated effort.[29]

Lacking the resources and experience to develop his theoretical models of heuristic programming into a working system, Napalkov wanted to use Feigenbaum, and trumped-up suggestions of American superiority in the field, to pressure his colleagues into pursuing practical applications for heuristic programming. Suggesting that the Americans were finding successful, practical applications for heuristic programming, Napalkov hoped, would counter Soviet skepticism about heuristic programming and would stimulate increased support and coordinated research out of Cold War fears of falling behind the Americans. Lacking the ability to steer or coordinate the broad field of cybernetics in the Soviet Union, Napalkov had little hope of gaining the large-scale support required to put theory into practice. Although Napalkov's gambit did not fully succeed, the role and importance of cybernetics in the Soviet Union would continue to grow through the decade, even as it became less cohesive. Somewhat paradoxically, the greater the expansion of cybernetics, the less the Council on Cybernetics could fulfill its already overtaxed capacity as an advisory and coordinating body.[30]

Feigenbaum's 1964 visit to the Soviet Union served several purposes. For Napalkov, the American was a means of invoking Cold War anxieties to spark a new level of support for his particular field of interest. For other Soviet cyberneticists and computer scientists, Feigenbaum's visit gave live access to information normally found only in translated journal articles, and it provided not only evidence of work being done abroad, but also insights into other Soviet efforts that were typically obscured through various layers of secrecy. In the United States, Feigenbaum used the experiences described in his trip report to intervene in an American attempt to stoke unwarranted fears of Soviet cybernetics.

Feigenbaum Encounters American Fears

Shortly after his return from the Soviet Union, Feigenbaum encountered a draft publication intended to instigate an American fear of Soviet cybernetics. Richard Bellman, an American applied mathematician, the inventor of dynamic programming in 1953, and a Rand employee, published "Russian Progress in Cybernetics and Its Relevance to Military Power" for the United States Air Force. In his report, Bellman claimed that Soviet cybernetics "represented a definite threat to USA supremacy" in industrial development and, more seriously, in American military development. Bellman argued that rapid expansion of cybernetics in the Soviet Union would, within 10 years, probably result in a breakthrough that would spur rapid Soviet advancements in industrial management and in weapons systems development. As evidence of the total Soviet commitment to cybernetics, Bellman cited the expanding influence of cybernetic theory in Soviet sciences, society, and politics, the rapid growth of Aksel Berg's Council on Cybernetics, the development of numerous cybernetics institutes, such as Glushkov's in Kiev, and the ambitious plans for cybernetic economic management begun under Khrushchev. Bellman estimated that, without a "concerted cybernetics effort" in the United States, the Soviets would surpass American capabilities in less than a decade. The ultimate fear Bellman roused in his estimate was the incorporation of advanced cybernetic artificial intelligence into Soviet nuclear and anti-ICBM systems, which might have tipped the nuclear balance to favor the Soviet Union.[31]

In a March 1965 letter to Paul Armer, the head of Rand's Computer Sciences Department, Feigenbaum presented a scathing critique of Bellman's draft report to the Air Force. Feigenbaum described Bellman's presentation as an "emotional and unbalanced view of the Soviet Cybernetics scene," which "distorts by the introduction of unsupported evidence and questionable judgments and interpretations." In Feigenbaum's assessment, Bellman based his interpretation on insufficient real-world information and a distortion of the evidence at hand. Feigenbaum argued that the evidence he directly observed during his visit to the Soviet Union entirely dispelled Bellman's sensationalist estimates of impending Soviet superiority in cybernetics. First, Feigenbaum deflated the fear of the great size of the Soviet cybernetics effort, stating that because the Soviets had adopted such a broad definition, almost any field or endeavor relating to communication, control, computing, and associated topics fell under the umbrella of cybernetics. When using the more limited American definition of cybernetics, the Soviet effort was far less expansive. The second major issue was that Bellman insinuated that the wide-scale adoption of cybernetics was a unified Soviet endeavor, whereas Feigenbaum's own experience indicated that Soviet cybernetics was made up of diffuse and disorganized labs working on their own projects, usually with little communication between them. Feigenbaum argued there was no central guiding authority for Soviet cybernetics beyond the Council on Cybernetics' modest advisory capacity. Bellman's claim that the Soviet Union had overcome its deficiency in high-speed computers ran counter to Feigenbaum's direct observation of labs running old or small machines due to the persisting shortage of high-speed computers. This deficiency of machines supported Feigenbaum's most notable observation of Soviet cybernetics, the continuing focus on theory over practical applications. That problem frustrated Napalkov's efforts in heuristic programming and marked most Soviet efforts in cybernetics, including the planned system for cybernetic economic management, ever since Feigenbaum's visit in 1960. Bellman's argument relied upon the Soviets making a unified "breakthrough" from theory to practice, when the Soviets were in fact still struggling to move beyond cybernetics theory.[32]

When using a more limited American definition of cybernetics, the Soviet effort appeared far less expansive.

Feigenbaum was not claiming the Soviet effort posed absolutely no threat, and he supported continued monitoring of Soviet progress. However, he opposed Bellman's unsupported and inflammatory claims about Soviet cybernetics. Feigenbaum's trip report revealed one attempt at manipulating Cold War anxieties abroad, while his letter to Paul Armer serves as a rebuttal to a similar attempt at home. Far from a simple collection of technical specifications, trip reports on Soviet computing provide a glimpse into the complex relationships between technology, politics, and individual ambitions on both sides of the Cold War.[33]

Time-Sharing, Technology Transfer, and National Security

Soviet developments in computing remained of keen interest in the West in the second half of the 1960s. One development after 1964 was the expansion of the proposed cybernetic economic management system under Brezhnev. Originally intended as a means of decentralizing management of the Soviet economy under Khrushchev, Brezhnev's government altered this goal, planning to use networks of powerful computers to re-centralize economic management. In the new plan, economic data from across the Soviet Union would converge in Moscow, where the processed data would offer central economic planners actionable reports on the state of the economy, allowing rapid responses and adjustments as well as more accurate planning and forecasting of economic goals. This plan, on its own, drew interest from Western computer experts and policy makers because such a system could have dramatically increased the efficiency (and thus the potential threat) of the Soviet planned economy. However, the expanded economic plan was not the only development in Soviet computing that prompted concern for the Americans.[34]

Soviet computer design labs, the most famous being that of Sergei Lebedev, began to introduce powerful transistorized machines, such as the BESM-6, in the mid-1960s. The BESM-6, a supercomputer with 60,000 transistors, was comparable to the American Control Data Corporation's 3600 computer in performance. Although not a match for the most powerful American machines, such as the CDC 6600, the BESM-6, first tested in 1965, marked significant advancements in power and design over previous Soviet machines. It was described as the first Soviet supercomputer to enter production with a complete software package. The BESM-6 was one of the first Soviet machines advanced enough to support time-sharing, the simultaneous use of one computer by multiple users. The existence of powerful machines, like the BESM-6, although still in small numbers in the mid-1960s, indicated to Western computer experts that the Soviets were making strides to increase access to computers and to move into more practical stages of development. The cybernetic economic management project, for example, depended on the projected availability of powerful, large-scale computers capable of processing large amounts of economic data and transmitting that data across a nationwide computer network. That necessitated machines with hardware and software capable of supporting multiple users simultaneously across networked connections. The BESM-6 appeared to be a significant step toward those goals.[35]

The interest Western computer experts took in these developments is reflected in the Rand trip reports of the mid- to late-1960s. Two reports, from 1966 and 1967, by a corporate technical manager and an economics and computer science professor, offer assessments of how the Soviet computers and projects compared with Western systems and capabilities. These personal impressions and comparative assessments, which were useful in their original context of advising policy, also provide a perspective on American conceptions of the Cold War.

In September 1966, Sol Zasloff, the technical manager of computer manufacturer Scientific Data Systems, visited an international technology exhibit in Moscow, where his firm had a display of its equipment. Zasloff used the opportunity to go on tours of the Academy of Sciences' Computing Center in Moscow and the Institute of Cybernetics in Kiev. Most of his time at the Moscow exhibit consisted of assessing the specifications of the Soviet computers on display, including the BESM-6. Zasloff added his interpretation of differences in technical definitions, such as the Russian "mathematical" addresses likely being the equivalent of virtual memory in the West, relating to the persistent difficulty with translating technical terminology from Russian to English. With the BESM-6, Zasloff reported its capabilities, with a particular interest in its capacity for time-sharing and on the Soviets using their first-hand knowledge of the CDC 6600 at Cern in Switzerland as a guide for their performance and software feature goals for the BESM-6. Sergei Lebedev's computer lab, which designed the BESM-6, appeared to be succeeding in those goals. By the mid-1960s, the Soviets appeared capable of making functional assessments of Western hardware and software and able to adapt those concepts to their own design and production methods.[36]

Zasloff's visit to the Soviet Academy of Sciences' Computation Center in Moscow noted the administrative structure of pure and applied research labs. Three computers were in use. Two were older vacuum-tube machines, but one was a new BESM-6, which had just entered experimental use. His examination of the computers themselves was not as in-depth as Richard Judy's examination the following year (described shortly), but Zasloff's visit to the Kiev Institute of Cybernetics proved more instructive. While two years earlier Feigenbaum had noted the largely theoretical nature of cybernetic research in the Soviet Union, Zasloff saw what appeared to be the stirrings of practical applications of cybernetic principles. One such application was the optical scanning of documents and the recognition of the scanned characters on the page. Zasloff described the complex mechanism that picked up and moved the documents, the prism system that scanned each page, and the computer that detected analog patterns that were converted into digital information. Zasloff noted the lab's overall emphasis on the reliability of scanning and storing information over speed, stating that reliable peripherals appeared to be scarce in the Soviet Union.[37]

Zasloff observed that, during his presentations and discussions, the people at the Kiev cybernetics institute were generally friendlier and more open than in Moscow. In fact, their candor in supplying information about their work and professional ideas forced Zasloff to admit that it was "difficult to assess precisely what was happening." The Institute of Cybernetics staff had detailed knowledge of Western computer theory and developments, largely due to the institute library having "a very complete array of English language computer periodicals, including *Communications of the ACM* and *Datamation*." Zasloff was surprised to learn that English periodicals appeared with only a one month delay and Russian translations only a few months after that. Most of the staff, however, worked with the original English-language sources.[38]

Zasloff's visit provided several potential points of interest for Western computer experts. While the BESM-6 was not a secret outside the Soviet Union, Zasloff's examination of it suggested that the Soviets were not only developing supercomputers with advanced features like time-sharing, but also were capable of applying their experience with Western systems with some measure of success. The Kiev Institute of Cybernetics further demonstrated that Soviet computer scientists were thoroughly engaged with the latest in Western computer developments and were beginning to expand, despite some persisting limitations, into practical applications. These factors had significant implications for the West. It appeared that the Soviets were, in small measures, developing some of the capacities found lacking in earlier assessments of Soviet computer technology and may have been aided, or at least partly advised, through access to Western machines and publications.

The February 1967 trip report by Richard W. Judy, a professor of economics and computer science at the University of Toronto, would address similar points of Western curiosity and concern. Judy's focus on the traditional Soviet weak points of software development and the integration of cybernetic economic theory into real-world practice would temper the somewhat alarming suggestions made in Zasloff's more cursory examinations. Like Zasloff, Judy visited the BESM-6 computer at the Academy of Sciences Computation Center in Moscow. However, Judy's inspection was in far greater detail than Zasloff was permitted at the exhibit. Judy paid particular attention to programming and software, which were traditional areas of Soviet weakness. Judy discovered that the BESM-6 at the Computation Center was the first to become operational, and having been the experimental model, it required approximately two years to construct, following various design changes. Judy made note of the machine's hardware specifications, including its peripheral equipment, such as printers, card punchers, paper tape readers, and teletype units. Soviet peripherals, as Zasloff noted, were known for poor reliability and debilitating scarcity. Therefore, the evident quality of the BESM-6's peripherals was notable. Academician Dorodnitsyn, who had taken time out from a meeting of the Presidium of the Academy of Sciences to guide Judy's tour, stated that, despite the traditional Soviet difficulty with producing reliable peripheral equipment, he was optimistic that those issues had been overcome. Judy simply stated that other Soviet computer scientists did not share Dorodnitsyn's optimism.[39]

Although the system hardware was deemed to be complete, Judy discovered that the BESM-6 had not yet been accepted by the

The contrasting discoveries of Sol Zasloff and Richard Judy highlighted the disparate and fragmented nature of computing research done across the Soviet Union.

State Commission because its software was still under development. The incomplete software, Judy would learn, included compilers for several programming languages, including Cobol and Fortran, both of which were slated for development at the Institute of Cybernetics in Kiev. Judy also discovered that the executive and monitor programs remained in rudimentary form. Responsibilities for the system software were scattered across numerous labs in the Soviet Union, with few specifics about when those software projects were going to be complete. Dorodnitsyn did admit that the BESM-6 time-sharing system was in the testing stage and could only estimate it being ready in "a year or more." One of the obstacles was "the total absence of adequate terminal facilities." Judy's in-depth examination of the BESM-6 revealed that software and peripheral equipment still posed significant problems in Soviet computer development.[40]

Judy's visit to the Central Economics Institute of the Academy of Sciences uncovered similar issues with the proposed nationwide economic network. Meeting with several representatives of the Central Economics Institute, Judy learned that Soviet cybernetic economic modeling was still largely theoretical in nature and that there was "no prospect of early implementation" on the practical level. V.F. Pugachev, who was working on the project, assured Judy that considerable progress had been made on the algorithms required for large programming problems. However, specifics were not forthcoming. When Judy asked about the nationwide economic network that had received coverage in the Soviet press and had commanded much speculation in the West, Pugachev's answers were vague, giving Judy the impression that such a network was slated for "far in the speculative future." This discovery stood in striking contrast with the impressions of and the enthusiasm for cybernetic economics and the nationwide network in the world beyond the Economics Institute. Coupled with the realization that, although Soviet computer hardware was making advances, software and programming remained perennial weaknesses, Judy's visit tempered the wilder speculations about Soviet computing development moving beyond a largely theoretical pursuit anytime in the near future.[41]

The contrasting discoveries of Zasloff and Judy highlighted several important factors within Soviet computing and cybernetics that would characterize the 1960s and much of the remaining Soviet era. Not the least of these factors was the disparate and fragmented nature of computing research done across the Soviet Union. Work on nominally unified projects progressed at varied, and often seemingly incompatible, rates in several, sometimes competing labs. Western visits to the Soviet Union highlight the differing impressions Westerners could acquire of the same Soviet projects and technologies, depending on the Westerner's focus during the visit, with whom he spoke, and how closely he examined the official line presented to the public and to foreigners. The nationwide economic network, while officially lauded and drawing the interest of Western analysts and computer experts, remained a largely abstract, theoretical concept. The hardware capable of moving Soviet cybernetic theory into practical applications, aside from small-scale forays into analog-to-digital conversion, was still waiting for the software required to use it. Although the development of Soviet computing was not static, it still contended with issues that Feigenbaum had noted in his previous visits. These Western visitors offered perspectives on how the forces of Soviet ambitions with computing interacted with the realities on the ground and how Westerners might have interpreted those complex forces differently.

In the late 1960s, dissatisfied with the domestic computer industry's progress in developing economic computers and software, the Soviet leadership opted to pursue reverse engineering of Western computers, hoping to reduce expensive development time and avoid the uncertainties of unproven technologies. The focus in Soviet computing shifted from finding native solutions to reverse engineering Western technology.[42] In addition, the cybernetics movement fell out of favor among Soviet computer scientists in the early 1970s. Former cybernetics proponents became disillusioned with the high-level theory and supposed "omnipotence" of cybernetics in light of the lack of success in implementing the cybernetic grand schemes of the 1960s. As a result, they advocated a return to "concrete problems." Soviet cybernetics, already fragmented into competing schools of thought, polarized into two antagonistic factions, based largely on political allegiances, which further weakening its former broad-level support. A satire written in the mid-1970s mocked the use of cybernetic terminology among Soviet leaders and noted the disparity between the grand promises of cybernetic reforms in the economy and the modest real-world results. The scaled-back plan for a nationwide computer network resulted in a small collection of non-intercompatible computer systems for information management and production control spread across the various industries. However, the party leadership did not miss the lessons of cybernetics in the re-centralization of control. The party recast the system for economic management into a specialized political information gathering tool, developing a series of secret computer centers that collected political dossiers on Soviet citizens and supplied that data to party elites. Although computers were gradually introduced into the Soviet economy through the 1970s, they typically augmented and extended established systems of management and production control, rather than replacing them.[43]

Conclusion

The trip reports represented in this article give new insights into Western perceptions and reactions to a period of rapid changes in computer use and development on either side of the Cold War. The growing importance of computer technology and the asymmetrical flow of information between East and West invited Western curiosity and speculation. Not alone in their desire for pertinent data, individuals at Rand sought to develop a solid base of information surrounding Soviet computing, which included translating the limited sources published in the Soviet Union and collecting of expert intelligence, as found in Willis Ware's collection of trip reports. The trip reports Rand collected now serve to highlight the multitude of perceptions, motivations, and concerns that shaped Western reactions to Soviet computing during the Cold War as well as to provide insights into Western computer experts' interpretations of the issues confronting their Soviet counterparts. The trip reports provide not only an examination, through the lens of contemporaneous outsider encounters, of the Soviet government's belief in information technology as a means of solving the Soviet state's most intractable problems, but also a glimpse into Western reactions to the Soviet relationship and potential capabilities with computer technologies. The follow up to this article will draw upon trip reports from the 1980s, which after the failure of cybernetic economic reforms in the 1960s, trace an American group's investigation of Gorbachev's attempt at education reform through large-scale computerization.

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