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Catalyzing the Collapse: The Computer and the Fall of the Soviet Union

Introduction

Since the development of the first digital electronic computer by Atanasoff and Berry at Iowa State University in 1942, the United States of America has led the way in nearly every major development in computer technology. In the early days of the Cold War, both the United States and the Soviet Union developed computing technology to be used in their respective nations. In the early 1960s, the United States' development clearly surpassed that of the Soviet Union, resulting in the formation of an ever growing "computing gap," between the USA and the USSR. By 1985 the gap in computer technology was apparent across all levels of the Soviet economy from research to production. In that year, Mikhail Gorbachev assumed the mantle of the General Secretary of the Communist Party, marking the beginning of a period of reform which resulted in the collapse of communism and the breakup of the Soviet Union into its constituent republics.

While the fall of the Soviet Union cannot be attributed to any single cause, it is clear that computers and the computing gap had major effects on the economic, political, and social developments in the USSR during this important period of world history. By 1985, the Soviet Union had failed to capitalize on the economic benefits of the technology revolution which was sweeping through Western society—with the computer as its centerpiece. This meant that while Western countries greatly increased their standard of living, the Soviet Union remained largely stagnant. Such was the crisis Mikhail Gorbachev inherited from his Stalinist predecessors when

he took control in 1985. Gorbachev's *perestroika* reforms were intended to allow the USSR to rapidly exploit the benefits of the digital revolution by restructuring the Soviet economy and investing heavily in the stagnant Soviet technology sector. These efforts failed to increase Soviet economic performance appreciably despite the large diversion of resources. Simultaneously, the *glasnost* reforms allowed a highly committed reformist segment of the population to employ the information technology infrastructure that was available to crystallize resistance to communist rule among public opinion.

This paper will examine the development of the computing gap and its ramifications during the fall of the Soviet Union. While it was never Gorbachev's intention to bring about the fall of the USSR, the tensions from decades of repression of its citizenry and poor economic performance jarred Gorbachev's reformist agenda into a full-blown revolution. With computers playing a central role in Gorbachev's failed *perestroika* initiatives and arming the information-deprived dissidents with new communication methods, it can be safely said that computers and the computing gap contributed extensively to the breakup of the Soviet Union in 1991. Because computers and information technologies continue to play an important role on the global stage, an in-depth analysis of their role in both the economic and political collapse of the Soviet empire may provide important insights into how these technologies will continue to shape the world.

Background

The development of the computing gap is embedded in the scientific and technological apparatus of both the United States and the Soviet Union in the last half of the 20th century. The causes of the gap are varied and indicate that systematic features of the Soviet economy made it difficult for them to produce computer technology. However, it is not immediately apparent why computers in particular should be lagging when other areas of Soviet technology, such as the

development of weaponry, seemed to be capable of maintaining parity with the United States. Even more puzzling is the apparent Soviet strength in many areas of science throughout the Cold War.

Science played a prominent role in Soviet society, with full members of the Academy of Sciences enjoying more prestige than the top leaders of the Communist party or government.[1] In America, Congressional leaders are most often lawyers or businessmen, but in 1991 almost eleven percent of the members of the Supreme Soviet were scientists or engineers, and a much larger percentage had scientific or engineering degrees.[2] R&D expenditures were also characteristically high in Soviet society, with the central government providing most money for technology development.[3]

Science education was also very strong in the Soviet Union. In a series of interviews with Soviet scientist émigrés in the early 1980s, nearly all had a higher opinion of Soviet elementary and high school education than of American education. Some also believed that Soviet university education was superior to American education, especially in math and physics.[4] Soviet traditions in math and physics excellence go back over a century, but these same émigrés usually also believed that while Soviet scientists and engineers were better educated, their American counterparts were more productive and innovative.[5]

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[1] Loren R. Graham, "Science and Computers in Soviet Society," *Proceedings of the Academy of Political Science* 35 No. 3, The Soviet Union in the 1980s (1984): 127

[2] Paul R. Josephson, "Science and Technology as Panacea in Gorbachev's Russia," in *Technology, Culture, and Development: The Experience of the Soviet Model*, ed. James P. Scanlan (Armonk, New York: M. E. Sharp, 1992): 33

[3] Susan J. Linz, "Innovation Strategies in Centrally Planned and Transition Economies," in *Technology, Culture, and Development: The Experience of the Soviet Model*, ed. James P. Scanlan (Armonk, New York: M. E. Sharp, 1992): 65

[4] Graham (1984), 125

[5] Ibid, 127

In most aspects, the Soviet Union has been a follower of Western technology, rather than a leader. Computer technology was certainly no exception. Loren Graham summed up the story of American-Soviet competition this way: "…not a refrain from the old song 'Anything you can do, I can do better,' but 'Anything you can do, I can do a bit later.'"[6] The weaknesses of Soviet science mainly stemmed from the limitations of the centralized control of the research sector. Soviet émigrés explain the lack of innovation and creativity in Soviet Russia as a result of not always being able to choose their own research topics and also as a result of communication lags in the dissemination of new results and findings. Results published in Western journals were received late, and often went first to senior scientists instead of the more creative junior scientists who could make use of the results in their work.

The Soviet Union also has had a long history of intense conflicts between scientists and the state. For example, in 1928, the leading engineer Peter Palchinsky was arrested and executed because of his prominent position in a group of engineers and scientists who tried to rectify the mistakes being made by the Soviet industrialization effort.[7] Equally well-known is the story of Andrei Sakharov, the father of the Soviet hydrogen bomb. He was thrown into the gulag system for speaking and writing about human rights abuses in the Soviet Union, only to be cleared by Gorbachev's glasnost several decades later.[8] While Soviet science and scientists held prestige in society, when push came to shove, the repressive and stagnating forces of the state won out every time.

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[6] Ibid, 133
[7] Loren R. Graham, *Ghost of the Executed Engineer: Technology and the Fall of the Soviet Union* (Cambridge: Harvard University Press, 1993): 1
[8] Graham (1993[1]), 168

The development of the computer in Soviet society encountered additional problems stemming from the limitations of the economic system. These problems were unique to the computer and can help explain why development of computing technology was so severely retarded in an otherwise lagging, but still mediocre technology sector.

The centrally-planned economy and lack of innovation hampered computer development much more severely than other sectors. In the United States, the computing industry was rapidly expanding into new markets and innovative new applications, which drove demand higher, driving American enterprise to further improve the technology. In contrast, the Soviet policy even into the late 1970s was to simply recreate the capabilities innovated in Western countries. While the administration was aware of the importance of these technologies, the essential economic and social framework of the Soviet Union was fundamentally opposed to the kind of high-risk high-reward industry that thrived in the United States.[9] Businesses in the planned economy revolved around fulfillment of specific goals, which often could not accurately reflect the actual needs of the economy. For example, a computer producer's most important index might be set by the state to be the number of central processing units (CPUs) produced. The production management would obviously try to maximize this performance index, at the expense of other products, like peripherals, even if demand for CPUs were to drop below the demand for peripherals. Furthermore, firms had a clear incentive not to overdo themselves producing goods one year, as they would benefit in the next year if the set quotas were as low as possible. They

[9] Goodman, 557

also had no clear incentive to develop new products and services unless they were specifically instructed by the state.[10] Seymour Goodman best summarizes the problems thus:

> The most basic and difficult problem of technology transfer has been that of taking a complicated, pervasive, and successful technology out of its original and nurturing environment, and attempting to transplant it into a fundamentally different one.[11]

Additionally, it has been observed that much of the innovation in computer hardware and software, especially early on, came from individual entrepreneurs and eccentric geniuses would have had a difficult time operating in the centrally planned economy of the Soviet Union.[12]

An important fundamental design shift also damaged the Soviet system's ability to support computer technology. Early computer development emphasized the creation of large "mainframe"-style computers which were, by necessity, centrally controlled and operated. These computers played well into Soviet ideology, centralized planning, and a Soviet tendency toward "gigantomania."[13] However, a shift in design philosophy of computer systems began in the late 1970s with the rise of minicomputers, and continued in the early 1980s, with the spread microcomputers. We now live in the era of the PC or personal computer, and the Soviet Union was not well prepared to undertake this shift toward decentralization.

The Soviet government had a particular issue with computers owned by individuals because of the fear that any computer connected to a printer was a potential printing press for *samizdat*, the Russian term for illegal anti-Soviet or subversive literature.[14] Even without printers, computers could be used to store and transmit data on media such as tapes or disks.

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[10] Goodman, 563
[11] Ibid, 561
[12] Loren R. Graham, *Science in Russian and the Soviet Union* (New York: Cambridge University Press, 1993): 201
[13] Graham (1984), 129
[14] Ibid, 130

Until the Gorbachev era, individuals were forbidden from owning personal computers or copier machines.[15] Because of these controls and the emphasis on theory in Soviet universities at the expense of practical applications, the "hacker culture" present in many American schools never developed in the USSR. The fear of hackers in the Soviet Union, while present, was turned on its end:

> …if American authorities worry about the teenagers in Milwaukee and Seattle who break *into* central data banks without authorization, the Soviet authorities have the opposite worry that an undergraduate in a Soviet technological institute may break *out* of the central computer surveying his activities. [16]

The Soviet economy also had significant problems creating a rich software writing industry, a primary driver of American innovation. In the 1970s and 80s, most software was written by individuals or small firms—a significant challenge to the centrally planned economy which discouraged small enterprise in general. Furthermore, the distinct lack of support and contact between the hardware and software segments of the computer industry crippled the development of new software because the software engineers needed to write all but the most basic utility programs themselves. In the United States, software development was accelerated because most computer hardware manufactures were eager to provide utility programs and example code to encourage developers to write software for their machines. Additionally, the lack of collaboration and support meant users were forced to maintain their hardware on their own. Because repair parts were in short supply, users often made custom modifications which made sharing programs difficult. In addition, hardware limitations forced Soviet programmers to

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[15] Felix Gilbert and David Clay Large, *The End of the European Era: 1890 to the Present,* Fifth Ed. (New York: Norton, 2002): 518

[16] Graham (1984), 130-1

write their programs in more archaic and difficult machine language, instead of the American trend of writing programs in a higher level assembly or procedural languages in which English-like commands are interpreted and converted to machine language automatically, greatly simplifying programming tasks. [17]

Finally, the United States and Western Europe had important advantages in cultural receptivity to computer technologies which the Soviets did not. These include a tradition that technologies be privately owned, a tradition of free access to information, widespread education in business and technological skills such as typing and programming, excellent phone lines which could be used for machine communication, and a reward system for innovation.[18] The Soviet system had none of these factors.

The computer technology industry was certainly not the only sector which suffered from the lack of efficiency and innovation in the centrally planned economy, but the damage appeared more severe because of the breakneck pace of innovation set by the American industry. In sectors where innovation was not such a key concern, some of the aspects of the centrally-planned economy may have even worked in the Soviet's favor, but for the computer industry nearly every fundamental difference between the American and Soviet model provided an impediment to development.

Economic Consequences of the Computing Gap

As a result of the difficulties inflicted by the centrally planned economy, the Soviet Union entered the Gorbachev era largely without the computer. In 1987 there were roughly

[17] Goodman, 550-1
[18] Graham (1984), 131

200,000 microcomputers in the USSR, compared with 25 million in the United States. These computers were distributed across the American economy and gave rise to marked improvement in productivity from fundamental research in which computer modeling and statistical analysis sped breakthroughs, all the way to production where computers aided managerial decision making about suppliers, finance, capital, and labor. In the West, the computer was seen as a metaphor for human communication and control[19], and Western researchers and managers increasingly considered themselves knowledge workers, whose productive contributions were gleaned from their interaction with information. Computers, then, were an extension of themselves—as natural as a builder's hammer or a machinist's wrench.

In capitalist economies, the so-called "invisible hand" of price is the fundamental indicator by which decisions are made on what, how, when and for whom to produce. Price is simply the most invaluable piece of information used for planning in capitalist economic theory. In centrally planned economies, this piece of information is removed from the picture. Because prices are set by the state, they no longer indicate the value of the goods they are assigned to. A centralized bureaucracy makes planning decisions based on sources of information other than price and based on the ideology of those in charge. It was estimated in 1991 that the underdevelopment of the computing industry accounted for the loss of 10% of the USSR's national income.[20] Thus, the Soviet Union was in an economic slump caused by two *different* crises of information: one from the backwardness of their computer infrastructure, and one from the nature of their economic system itself. Soviet authorities hoped that by investing heavily in

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[19] Slava Gerovitch, "'Mathematical Machines' of the Cold War: Soviet Computing, American Cybernetics and Ideological Disputes in the Early 1950s," *Social Studies of Science* 31 No. 2, Science in the Cold War (2001): 276

[20] I. Adirim, "Current Development and Dissemination of Computer Technology in the Soviet Economy," *Soviet Studies* 43 No. 4 (1991): 663

computer systems, decision makers would be able to access and analyze the information they needed to guide the economy to prosperity. As we shall see, it proved extremely difficult, if not impossible, to improve the infrastructure or the decision making without addressing the economic system itself.

Beginning in the late 1960s, the Communist party began an expansive program to introduce computer-based information systems into the Soviet economy all the way down to the enterprise level. Despite these efforts, by 1984 the majority of these systems had made little change in the way enterprises were actually managed.[21] Fundamental scientific research, despite being high on the Soviet's priority list, suffered extensively from the lack of a computer infrastructure. For example, the Soviet Space Program, while grand in its early accomplishments (the Soviets were the first to put a human in orbit around the earth), suffered extensively in later years because of sub-par onboard computer systems.[22] Mathematics and the physical sciences began to suffer from a lack of numerical and analysis applications and inadequate hardware to run them on.[23] Scott Shane, an American journalist for the Baltimore Sun who was in Moscow during the Gorbachev period commented:

> Scientists used slide rules. Cashiers used abacuses. I often thought, as some activist handed me a fuzzy carbon copy of a manifesto that looked like it had been ten layers of paper away from the typewriter keys, that this country seemed to have missed out on fifty years of technology.[24]

The reason that the Soviet Union did not see the full benefits of computer technologies was primarily and directly because there simply were not enough computers, but this not the

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[21] William K. McHenry and Seymour E. Goodman, "MIS in Soviet Industrial Enterprises: The Limits of Reform from Above," *Communications of the ACM* 29 No. 11 (1986): 1034
[22] Goodman, 547
[23] Graham (1993[1]), 214, 233
[24] Scott Shane, *Dismantling Utopia: How Information Ended the Soviet Union* (Chicago: Ivan R. Dee, 1994): 61

whole story. If it were that simple then the Soviets could have solved their problem by simply intensifying the production of computers.

Soviet computers at the top of the line were inferior to their Western counterparts, and the military directed some of the best products away from the general economy.[25] Indigenous computer production was low, and in 1988 an estimated 40% of Soviet computers were imports, with most software derived from "pirated" Western programs.[26] Imported computers are undesirable because, although they might offer superior performance to Soviet designs, depending on the model, there was no structure in place to support the users with software, peripherals, or repairs. Printers, plotters, and external memories were particularly difficult to obtain.[27]

Furthermore, simply putting computer equipment in the hands of a Soviet manager does not mean that he or she will use it. The Soviet computer program was planned and orchestrated to fit the goals of top level bureaucrats, and as William McHenry & Seymour Goodman observed in 1986, "Perhaps the greatest failing of the Soviet infrastructure was its ignoring the ordinary user." Users were insufficiently trained in both computing and management science, meaning they were largely unable to use the computer systems when they arrived. They were also insulated from the computer designers, who were employed by top-level officials. Party officials saw computers as a way to increase the productivity of enterprises, and computers were designed, as well as they were able, to meet rational goals in this area such as optimizing production, minimizing inventory, and realistically evaluating the capacity and performance of an enterprise. Such systems were met with heavy resistance because managers saw these in

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[25] McHenry, 1036
[26] Adirim, 662-663
[27] Ibid, 664

direct conflict with their own goals, which was to minimize their own risk within the Soviet system. This often meant that the manager's goal was simply to fulfill planned targets, rather than maximize production because exceeding the plan is tantamount to asking for targets to be increased in future years. Managers often sought to hoard supplies, understate capacity, and overstate performance to maintain their position and rewards within the Soviet economy. "In short," observed McHenry & Goodman, "enterprises that play by the rules in the Soviet economy risk cutting their own throats; computerized management information systems are designed to help enterprises play by the rules." As a result, while optimization was the primary purpose of computer systems from the Party's view, it represented only 1-5% of all tasks executed on computer based information systems in the mid 1980s. Instead computers were largely used only for accounting and statistical functions. [28]

Regardless of whether top party officials were aware of the causes of the computing gap, and more generally, the technology gap, they were certainly aware of its effects. Gorbachev moved quickly to attempt to solve the problems of the Soviet economy by increased reliance on information and computer technologies. In June of 1985, only months after his ascension to the Secretariat, he convened a Central Committee conference on science and technology where he told the conference, "Microelectronics, computer technology, instrument making, and the entire information-science industry are the catalysts of progress."[29] In March of 1986 he announced the creation of the State Committee for Computer Technology and Informatics (GKVTI), with Nikolay Gorschkov as its chairman. Gorschkov stated that the Committee's mission was to bring about significant improvements in service, development and use of computer

[28] McHenry, 1038-9
[29] Shane, 67

technologies.[30] Also in that year, at the XXVII Party Congress, the Communist Party of the Soviet Union (CPSU) adopted a revised Program which called for an acceleration of scientific and technical progress, calling it the "Main lever for raising efficiency in production."[31] Gorbachev's plan also included a decree for a computer literacy campaign for all Soviet students.[32]

In early 1987, Gorbachev introduced perestroika, an economic reform initiative which included a relaxation of the central control of the economy to allow the formation of partially-independent cooperatives and the opening of the Soviet economy to foreign investment, joint ventures, and Western consumer goods.[33] The result was the splitting of the computer industry into two sectors: an old, state-run sector which consistently ignored the needs of the user community; and the newer "mixed-sector" which included cooperatives, foreign and joint ventures, and black-market activities.[34] Despite the removal of many of the obstacles to innovation created by centrally decreed control of the computer industry, there still remained many significant factors to retard its success. The cooperatives were hampered by both official regulation and public resentment. Cooperative work was limited to essentially "moonlighting" operations where employees worked at regular jobs during the workday, and many members of the Soviet society viewed entrepreneurial activity, with its unregulated rewards, to be a serious injustice.[35] Furthermore, all the computer problems which were not a direct result of central control still existed: poor software, lack of expertise and available components for repairs, etc.

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[30] McHenry, 1040
[31] *Program of the Communist Party of the Soviet Union, A New Edition, 1986* (Amsterdam, EURODOS: 1998) http://www.xs4all.nl/~eurodos/docu/cpsu-texts/cpsu86-0.htm
[32] Stephen T. Kerr, "Educational Reform and Technological Change: Computing Literacy in the Soviet Union," *Computer Education Review* 35 No. 2 (1991): 223
[33] Gilbert, 527-8
[34] Seymour E. Goodman and William K. McHenry, "The Soviet Computer Industry: A Tale of Two Sectors," *Communications of the ACM* 34 No. 6 (1991): 25
[35] Graham, 1993, 187

This was combined with the reality that the Soviets were not well prepared to operate under the conditions of a free market, especially one which was only first defining itself at the time. These cooperatives remained a small segment, dominated by the much larger state-run sector of the industry.

Despite the unprecedented importance assigned to computer technology in Gorbachev's policy, the new policy failed to live up the official expectations. Worse still, the Soviets were no closer to closing the computing gap between themselves and the Western world, and had even slipped further back in some areas relative to the enormous progress being made in the United States and their allies during this period. The large expenditures made in attempts to close the computing gap, combined with poor results, proved a major burden on the already strained Soviet economy. The Soviet economy was unable to bear the costs of the program. In his 1991 assessment of the state of Soviet computer technology, I. Adirim remarked,

> It can be said with confidence that the ambitious and exaggerated programme of computerization has made a substantial contribution to the deterioration of the Soviet economy and is therefore one of the reasons for the failure of Gorbachev's economic reform programme.[36]

Political Consequences of the Computing Gap

Although Gorbachev's vision for the *economic* system in the Soviet Union included extensive reform, his vision for the political system was relatively unchanged from the Stalinist leaders that preceded him. In light of this, how do we explain the role of the computer and computing gap amid the radical political events of this period? The answer requires an examination of the effects of both the *glasnost* and *perestroika* thrusts of Gorbachev's reform program. The *glasnost* reforms centered around a lifting of the repressive features of Soviet

[36] Adirim, 656

social control and an airing of the truth of state-run terror and purges of the Stalin period. Gorbachev attempted to distance himself and his government from the "abusive excesses" of Stalin and more recent, restrictive administrations. However, once the floodgates of freedom of expression were opened, the current Communist leadership was far from being above criticism. Gorbachev found himself facing vehement opposition from both sides: from conservative Party leaders who felt he was betraying Marxism-Leninism with his reforms and from previously silenced reformers who felt he had not gone far enough.

It was in this environment that Gorbachev introduced and advocated the economic *perestroika* reforms. As argued above, the enormous diversion of resources toward the goals of increasing computer and information technology resulted in little, if any tangible benefit to the Soviet economy, significantly contributing to the failure of *perestroika* to live up to its promises about increased productivity and higher quality goods. In the eyes of Gorbachev and his supporters, the main instrument for modernizing the Soviet economy was science and technology, most notably computer technology. The fact that *perestroika* was an attempt to restructure this main instrument, while simultaneously attempting to intensify production is a telling sign of how serious the Party leaders perceived the situation to be.[37] However, the expectations for how quickly the science and technology sector could reform, and how quickly these benefits could be passed on to the general economy were simply unrealistic. By 1989, Gorschkov, Chairman of the GVTKI, had been sacked, indicating a failure to fulfill the expectations for the Committee. *Perestroika* failed to identify and address the root causes of the computing gap, and instead attempted to effect increased output via the same top-down planned methods of the Soviet economy.

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[37] Peter Kneen, "Soviet Science Policy Under Gorbachev," *Soviet Studies* 41 No. 1 (1989): 67

Certainly this was not the first time that the Party program had failed to reach the officially stated objectives. Since the time of Stalin the Party's Five Year Plans were routinely not met by the Soviet economy, but this was the first time that Soviet citizens were allowed to hear about or talk about it. The *glasnost* reforms had shattered the illusion of an infallible Soviet leadership for many people, and the lifting of repressive policies on speech and expression allowed open debate and political conflict to reach the general populace. In this political landscape of disillusionment caused by the revelations of the Stalinist past, the open failure of Gorbachev to live up to his promises about increased production and prosperity would have been a major political liability. The failure of *perestroika* represented the first mistake of the Soviet leadership that the citizenry could see as it was unfolding. Computers were seen by the Soviet leadership and preached to the masses as a kind of panacea for the economic difficulties, and when this failed to produce results, Gorbachev's government lost a significant amount of credibility.

Soviet computer hardware, software, and paradigms for their integration into business were extensively based on Western designs. Ever since the early development of computers, the primary goal of Soviet scientists and engineers was to replicate the functionality of Western machines, rather than pursue their own needs and ideas. What developed was a computer "catch-up" culture in the ministries responsible for their development within the Soviet Union. Soviet computer designers never "struck out on their own" to see what they could get computers to do, they simply, and to the best of their abilities, replicated already complete Western advances. For example, a computer series which was highly successful by Soviet standards was the RIAD series. The RIAD series of computers was essentially a functional duplicate of the

IBM 360 series of computers developed several years before in the United States.[38] Such a culture implicitly admits to a Western superiority in the development of computer systems, and the lack of indigenous ideas and ventures similarly admits an unimportance of truly Soviet products in this sector. What mattered wasn't what Soviet people where using computers for, but what the Americans were doing.

Such an implicit declaration of Soviet-communist inferiority to Western-capitalist industry seems likely to have had the effect of bolstering support for economic reform (perhaps to even further extremes than Gorbachev) among workers in that industry. Additionally, with the lifting of bans of expression of anti-soviet ideas, these feelings could have spread much farther.

Socio-Political Consequences of Computing

The Soviet computer industry was perhaps too small to affect macroscopic changes to the Soviet economy, but just large enough to have substantive influence on the social and political events in the Eastern bloc during the final years of the collapse of communism. In fact, the small size of the computing sector facilitated its neglect by Communist authorities, allowing it to have a much broader impact than might have occurred if they were able to ensnare it in their net of information control. In some cases, it appears that reformist groups were able to use computer-based information technologies to weaken Communist control in the USSR and satellite governments in Eastern Europe.

A key assumption is that authoritarian regimes inherently derive their power and control from a monopoly on the dissemination of information through a society, especially in news,

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[38] Loren R. Graham, "The Fits and Starts of Russian and Soviet Technology," in *Technology, Culture, and Development: The Experience of the Soviet Model*, ed. James P. Scanlan (Armonk, New York: M. E. Sharp, 1992): 18

history, and political commentary. The authoritarian ideal is that of complete domination of all sources of information, including people's ability to freely express ideas with others. Certainly, this phenomenon occurs both in real life examples, such as communist China, and in works of popular fiction, such as *1984*, which was penned by George Orwell and based on Soviet Russia. In his 1997 dissertation[39], Christopher Kedzie demonstrated a positive correlation between the democratization of societies and the development of networked communications, such as fax machines and computer networks. He has theorized that recent advances in communication technologies inherently favor *individual* control of the dissemination of information over control by sovereign governments. By empowering individuals to play a role in information dissemination, networked communications preferentially favor democratic governments over authoritarian ones. Kedzie explains his hypothesis on how networked communication benefits democracy in what he calls "the Dictator's Dilemma," which is succinctly summarized in the words of George Schulz, Secretary of State during the Reagan administration:

> Totalitarian societies face a dilemma: either they try to stifle these [information and communication] technologies and thereby fall further behind in the new industrial revolution, or else they permit these technologies and see their totalitarian control inevitably eroded. In fact, they do not have a choice, because they will never be able entirely to block the tide of technological advance.[40]

For these purposes, I shall use "computing" and "information processing" interchangeably to mean the storage, manipulation, and communication of information on digital electronic hardware. Kedzie proposes the analysis of communication technologies on two different axes to demonstrate the fundamental difference between computer networks and older

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[39] Christopher Kedzie, *Communication and Democracy: Coincident Revolutions and the Emergent Dictators*, dissertation (Santa Monica, RAND Corporation: 1997) http://www.rand.org/pubs/rgs_dissertations/RGSD127/

[40] Ibid, Ch. 2 (http://www.rand.org/pubs/rgs_dissertations/RGSD127/sec2.html)

technologies. The axes are those of the number of message recipients (influence) and number of message originators (autonomy). The dictators of authoritarian societies are comfortable with technologies which have high influence, but low autonomy, because it is assumed that they can most effectively control a small number of message originators. Technologies such as radio and television fit well into their comfort zone because the costs to transmit information is much higher than to receive, thus the dictator can control the dissemination of information by dominating the relatively small number of transmission stations. Technologies such as the telephone, which have high autonomy, but low influence, while not ideal, do not pose much of a threat because they cannot be used to "broadcast" information to many recipients, and thus remain low-influence. Computer networks share autonomy of telephones because every computer is capable of both sending and receiving messages, but they are not constrained to a single message recipient. Even with only a few recipients per message, dissemination tends to proceed exponentially since each recipient can quickly pass the message on to several more recipients, and so on. This makes it extremely difficult for authorities to contain "undesirable" messages. Thus the computer and network technologies, such as email, which can be used to autonomously and rapidly spread messages, pose an extensive threat to the information monopoly desired by the dictator.

A second, related technology which played a role in the USSR was the fax machine. A fax machine is a computer technology which can digitize written documents, transmit them electronically, and produce a duplicate copy (a facsimile) at a distant location. Compared with networked personal computers, the fax machine has the disadvantage of being only able to send to one recipient at a time, thus it is tempting to consider it to be of lower influence—being perhaps, only as disruptive to dictatorships as the telephone. However, the information

throughput is many times higher with a fax machine than the telephone. With a fax machine, detailed, multi-page news articles and communiqués can be transmitted in a number of seconds, compared with a relatively long and error prone process of telling some one about the news over the phone. Also, the fax machine actually creates new copies of documents which can be examined by multiple people, increasing the effective number of recipients considerably beyond one-to-one. Finally, in the Soviet context, the fax machine was poised to be perhaps a higher influence technology than even the networked computer because it had the advantage of being a much easier technology to deploy due to its low cost (relative to personal computers) and operation over existing telephone infrastructure.

Better access to information allows citizens to understand and judge a government, solidifying resistance if people do not like what they see. The *glasnost*-era revelations about Stalin's reign of terror in Soviet Russia gave Soviet citizens a chance to see the true face of the Communist regime.[41] Furthermore, information from foreign sources allowed Soviet citizens to see what the Western countries were like,[42] helping to persuade them that things might be better in a free and democratic society.

Prior to Gorbachev, the Soviet leadership was acutely aware of the potential risk that computer technologies posed to their control on information. Private citizens were outlawed from possessing personal computers during the Brezhnev period, when they were just starting to appear in Western markets. The practice of *samizdat*, or self-publishing of materials, proved particularly thorny for the Soviet leadership: self-published materials were not reviewed by the censors at publishing houses, and were therefore dangerous. Reformers who did engage in *samizdat* were forced to operate underground because of the danger of being discovered by the

[41] Shane, 261
[42] Kedzie, Ch. 5 (http://www.rand.org/pubs/rgs_dissertations/RGSD127/sec5.html)

KGB and thrown into the Gulag prison system. When Gorbachev took the reigns of the Soviet Union, he steered the Party into an about-face on both of the major obstacles to *samizdat*. He first lifted restrictions on publishing materials, calling off the KGB's crusade against reformers. He followed this with an intensive drive to develop the Soviet Union's information infrastructure—the very technologies Brezhnev had feared would destabilize the Party's control. Suddenly, reformers could operate out in the open, and the Soviet government was driving the production of the tools of their trade.

In August of 1991, the hardliner Soviet leadership discovered that once the floodgates of communication were opened, the new technologies made it much more difficult to shut them. During the coup, they moved quickly to take control of the media. In 1917, one of the Bolsheviks' first moves in the October Revolution was to seize control of St. Petersburg's Central Telegraph Office. The coup plotters did the modern equivalent—they surrounded the Moscow telephone exchange with tanks, sent soldiers to take control of the various broadcast facilities, shut down newspapers, and arrested key media figures. However, the smaller, newer, and more distributed communications technologies—all products of the computing revolution—escaped their control. Although having gained popularity only a few years before the coup, fax machines had become widespread enough to allow Yeltsin to fax his appeals for opposition to the coup to newspapers, other republics, foreign embassies, and other cities. Other top men in Yeltsin's Russian Federation government did the same, as did editors of banned newspapers who were able to transmit, in some cases, entire editions of their papers to outside sources to have them published.[43] In addition, electronic mail networks also played an important role in allowing the opposition to break the information blockade attempted by the coup plotters. Relcom, which

[43] Shane, 261-3

came online in 1989, was Russia's first privately owned computer network to support commercial activity. Relcom's president remarked that the system had been used to answer the call to break the information blockade by transmitting over 46,000 pieces of news during the three-day-long coup attempt.[44] These successes in getting news out helped to turn public opinion against the coup, eroding its support in the military and convincing large groups of Muscovites to take to the streets to protest.

Finally, it is important to realize that while certain communication technologies may inherently favor the democratic ideal by being autonomous and influential, these designations are meaningless without the context in which they are placed. For example, the wide-area computer networks which were eventually assembled into the Internet in America were explicitly designed without the need for centralized control. This decentralization was a design decision, not an inherent feature of computing. Networked computers could be, in principle, made much less autonomous if authoritarian controls were built in. Similarly, the distribution model for television and radio stations is that of a few large transmitters with many, distributed receivers. There is no reason, in principle, why transmitters could not be operated by individuals, as indeed were and still are in the case of CB and amateur radio. However, it should be noted that much of the economic benefits come from technologies which are, in practice, highly autonomous. A telephone, fax machine, or computer network would not be of much use to a manager if he or she could never initiate outgoing communications. Current network technologies are very difficult to adequately censor because of the decentralized structure and large variety of message formats. This means that regimes which allow these technologies must either accept some loosening of

[44] Kedzie, Ch. 2 (http://www.rand.org/pubs/rgs_dissertations/RGSD127/sec2.html)

their control on information or sink increasing portions of their resources into censoring initiatives.

Conclusions

The development of computer technology was primarily driven by organizations external to the Soviet Union, forcing the Soviet industry to be reactionary in its decision making. The development of a computing infrastructure was a gradual process, even for global leaders such as the United States, but the comparatively slow uptake of computer technology and a 'computer culture' in productive units of the Soviet economy set the stage for the explosive pace of events in 1985-1991. By some standards, such as the production of weaponry, heavy industry, and the space race, the Soviet economy arguably maintained parity with the Western world as late as 1985, but the Soviet economy was extremely unresponsive to the wants of ordinary Russians. This was not primarily caused by the computing gap; and in fact, it was perhaps exactly the opposite: the computing gap was a particularly glaring example of the overall weakness of the centrally-planned economy in fulfilling the desires of its consumers. The Soviet Union did not become more inefficient; instead, Western countries, fueled by the information revolution, increased their efficiency on a grand scale. This poses no particular threat to an isolated society because the expectations of Soviet citizens would remain low. However, advances in communication (both computer and non) were giving rise to an overall globalization of economic enterprises in the industrialized world, and the Soviet Union grudgingly accepted that it could not remain isolated. Western goods and Western culture penetrated the Soviet Union via these new communication mediums. The Soviet Union was then forced into direct competition in developing an industry which played to Western strengths and to Soviet weaknesses. These increased expectations turned a purely economic problem into a political one.

Still, it took a very large jolt to send the Soviet Union on its course to dissolution. That jolt was provided by Mikhail Gorbachev, and not by computers or the computing gap. The time scale of this "information revolution" is on the order of decades (and indeed, some say it is not yet over), and not the mere months and years required to dismantle the communist bloc. Gorbachev and his government correctly identified the computing gap as a primary feature of the consumer-economic crisis which the Soviet Union was in the midst of, but failed to draw the appropriate conclusion on the role it played in the crisis. The computing gap was a complication, albeit a significant one, of the more fundamental issues of incentive and feedback deeply seated in the Soviet economic system. Treating it as a root cause and attempting to address it within the systemic framework that created it was an attempt doomed to fail. The transition toward addressing the fundamental issues in the Soviet economy was not one that could be done quickly or smoothly, yet the Party's plan called for unrealistic, immediate improvement in conditions. When these improvements failed to materialize, this further fostered unrest coinciding with the airing of the government's dirty secrets from its repressive past.

Gorbachev's opposition within the Communist Party was right to consider a move toward freedom of speech and the press to be a threat to the Party's control. However, the increased freedoms did allow computer technology to take hold at a much faster rate with the lifting of restrictions on personal computers, printers, photocopiers, and fax machines. This infrastructure sprang up quickly and was connected in an ad-hoc fashion across the nation, and as a result, when the hardliners sprang their putsch in 1991, their power was sufficiently weakened and the communications network too dispersed to be ensnared in their net of information control. Computer technology contributed greatly to the channels which broke their attempted blockade.

Without Gorbachev's reforms in the last half of the 1980s, it is doubtful that the pressure of the economic consequences of the computing gap alone could have toppled the Soviet Union. Rather, computer technology simply served as a catalyst for collapse through complications such as the failure of perestroika and the rapid spread of ideas via digital electronics. The events were so rapid, and causes so varied that it is difficult to sort out the relative importance of various factors. It can be said with some confidence that computer technology and the computing gap did contribute to the acceleration of the process and in greatly aided reformers in preventing the halting of the process.

Some of the ways in which the computer played a role in the collapse of the Soviet Union appear to be direct results of intrinsic characteristics of computers, while others seem to be highly circumstantial. The economic consequences of the computing gap which had manifest in the Soviet Union prior to 1985 fit well into the theory that information systems bring about economic benefit at a cost to centralized control over information dissemination. It might, in principle, be possible to carefully control these systems such that the information disseminated is only used for economically productive purposes and not for political gain by opposition groups. Looking to the Soviet example seems to suggest, however, that such controls can severely retard to development of such technologies, putting a society that employs them at an unavoidable economic disadvantage. The Soviet leaders, however, choose to attempt to close the computing gap by rapid reform to their system, with disastrous results. It was this initiative on the part of Soviet leadership that allowed computers to play such an active role in the unraveling of the Soviet system, and thus the roles that computers played during this period as a failed panacea to the Soviet economic crisis and a distributed communications system for dissidents could very well be unique to the Soviet situation.

Examples of a more gradual introduction of computer technologies, such as the People's Republic of China, illustrate that computers do not inherently lead to revolution. The Communist Party still maintains a tight grip on information flows via computers into and within the country, however, relative to China's population, the demand for computers are low, and censorship efforts can be expected to increase in cost and difficulty as the user base continues to grow. Communism in China has also been forced to slowly retreat from the economic sphere to the political sphere only, and it is extremely unlikely that Chinese authorities would be able to "turn back the clock," any more effectively than the botched Soviet putsch of 1991. With nowhere else to go but forward, it may only be a matter of time before modern communication technologies force additional concessions to democracy.