Why the Soviet Internet Failed

Benjamin Peters
Bjp2108@columbia.edu

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Why wasn't there a Soviet equivalent to the US ARPANET? Building on fresh archival evidence, this paper examines several surprising leads: one, that the first person anywhere to conceive of and propose a national computer network for civilian use appears to have been the Soviet cyberneticist and Engineer Colonel Anatolii Kitov; two, that Soviet economic cybernetics tried repeatedly but did not succeed in building such a network; three, that the collective failure comes in part due to unregulated bureaucratic competition and infighting over resources within the Soviet state and academy (while the US ARPANET and French MINITEL networks initially benefited from centralized state subsidy) and in part due to the untenably comprehensive and hierarchically decentralized design in vogue among Soviet cybernetists in the 1960s. The fact that cybernetics was a discursive vehicle for reform-oriented science in the early 1960s makes its failed contributions that much more culturally poignant. These and other ironies are explored.

Introduction

Immanuel Kant once said that the significance of the French Revolution could be understood only by studying the international response to it. That particular French Revolution (1789-99) could not have become *the* French Revolution without the US Declaration of Independence (1776), the Spring of Nations (1848), or the Russian revolution (1917). In this sense, the importance of a historical event is a consequence, not a cause, of our constructed memory of it.S So it is with the rise of the computer network. Recognizing the international aspect of the computer revolution, this paper examines the rise and failure of Soviet attempts to invent and adopt computer network initiatives during the prehistory of the US ARPANET (1962-1969).

The US Defense Department's ARPANET has been showered with many accolades: it has been called not without much hyperbole, "the Mother of all nets," the predecessor to the Internet, and the first functioning non-military large-scale computer network in the world.[1] In a strong sense, it is all of those things. But as often the case, the story of the ARPANET is not enough to understand the impact of the ARPANET.

It should surprise some to note that the Soviets did not successfully develop an early Internet equivalent in the 1960s. After all, developing a military network to match the rise of the ARPANET of the US Defense Department was a top political, intellectual, and financial priority for the Soviets. Like in the United States, the highest levels of authority recognized that nationwide network could help secure the Soviet nation against nuclear attack. (Paul Baran's much heralded peer-to-peer distributed network design sprung in large part from the fact that the

[1] *Visions*, By Michio Kaku, p. 48.

US Defense Department was pressuring him to build a network that could simply “survive” a nuclear attack.) Moreover, Cold War spies ensured that both sides knew something of the others efforts to advance, computerize, and automate military technology and information science. The vast military-industrial state of the Soviet Union ensured sufficient resources were available for computer research. There was a surplus of intellectual talent and social interest in mathematics and computer theory driving the work of high-speed calculating machines. Given all this, why, then, did the Soviets not build an ARPANET?[2] Before addressing this epistemologically hazardous question, a closer look at what the Soviets *did* have may be in order.

The Soviet Military Context: Cybernetics and Computer Networks

While the United States maintained a well-document lead in terms of computer hardware development, the Soviet Union had clear advantages in terms of the deep intellectual reservoir of Soviet theoretical mathematicians and early programmers as well as—coinciding with the adoption and rise of cybernetics at the critical early design period of the networks the late 1950s and early 1960s—a broad societal interest in computers as "machines of Communism." Particularly during Nikita Khrushev's thaw, a sort of intoxication with computers spread through the body politic, from Communist party leaders to reform-minded intellectuals to the popular press and to public. This is not to say, of course, that America did not enjoy a related and similar rush of enthusiasm for cyber-culture in the 1960s and 1970s. Only that the character of the social interest was importantly different. On the one hand, while in America, cybernetics was broadly adopted in its original sense of a science of "communication and control in the animal and the machine," whereas in the Soviet Union, it was adapted and embraced at the highest levels as a more thoroughly comprehensive study of not only the animal and the machine but society as a whole.

And in the 1950s and 1960s, in fact, at least three cybernetically-inspired computer networks operated successfully in the Soviet Union: however, all of them were strictly controlled military networks built after the hierarchically organization of the US SAGE defense network. All of the military networks were closed to outside nodes and capitalized on the strategic value in the unilateral flow of orders from the command and control center to out-posts missile silos. Several of these early Soviet military networks, such as System A, an anti-ballistic missile defense network, which stretched from near Moscow to points east X and X, were successfully running fully automated controls over missile silos as early as the mid 1950s [specify date].

In the mid 1950s, the Soviet military planners responded to the development of the American air-defense system SAGE (Semi-Automatic Ground Environment) by deciding to build three systems--an air defense system, a missile defense system, and a space surveillance system--to coordinate a response to an American massive air offense. The three systems included, one, a national air defense system resembling SAGE--the task of the Scientific Research Insitute of Automatic Equipment created in 1956, which resulted in a network of eight

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[2] See preceding chapter of Peters’ working dissertation. When the late 1950s and early 1960s saw the full embrace and translation of Norbert Wiener's cybernetics, "kybernetika" quickly swept the Soviet sciences and society (although not always state) accompanied by a rosy vision of computer-supported socialism (1955-1967). This rosy vision was eventually supplanted by a vision of state-governed, computer-regulated socialism that reaffirmed instead of reformed Soviet structural power (roughly 1967-1985 until cybernetics was displaced by the keyword discipline *informatics*).

of the first Soviet transistor computers, the TETIVA; two, a prototype missile defense system 'System A' developed by the Moscow Institute of Precision Mechanics and Computer Technology in the late 1950s, which tested successfully in March 1961, leading Khrushchev to boast that Soviet anti-missiles could "hit a fly in outer space"[3]; and, three, a space surveillance system (tracking foreign spy satellites and friendly spacecraft), begun in 1962, which lead to the successful establishment of a full automated, distributed computer network between M4-2M transistor-based computers a command-and-control center near Moscow and two remote nodes in Sary-Shagan and near Irkutsk in Siberia. "System A," for example, a fully functional automated prototype missile defense system, was a hierarchically-structured, decentralized network that linked a command and control center in Moscow to remote specialized computers and radar installations in Sary-Shagan, Kazakhstan and near Irkutsk, Siberia. All three defense systems (air, space) were military-based networks, all of them enjoyed tremendous amounts of funding and at least a moderate degree of success. Khrushchev once boasted Soviet anti-missiles could "hit a fly in outer space".[4] Like the various military computer networks in the US, these were not coordinated and served only one particular purpose, the secure and automated transfer of military commands across great distances.

Non-military purpose, design, and management of the Soviet economic network made it subject to at least two higher standards of sharing resources than the military networks of the period. One, in order to be comprehensive enough to monitor and manage the entire socialist economy, the central processing node had to be built to open take in a massive amount of informational inputs. A lumber processing plant north of Mongolia had to be able to feed its data to the economic managers in Moscow. Military defense networks had only to monitor the skies for movement, and in turn send the launch code: the economic network had to take survey, adjust for, and deliver corrections to a massively complex Soviet economic five-year plan. Two, in order to be effective, the economic information network had to be encompassing enough that it would have required the pooling of financial and technical resources of many diverse ministries simply to build it. It had to unify the society economic behavior by layering the Soviet Union within a pyramid of computing power. In short, the civilian breadth and reach of the economic network required both a sophisticated mastery of information management as well as a comprehensive design.

Civilian and military work often intersected importantly. As Fred Turner's work demonstrates of the United States (and through the biographical lens of Stewart Brand), the emergence of Bay area cyberculture in the 1980s can be traced back through a fascinating set of twists and turns through West coast counterculture in the 1960s and 1970s, and even earlier back to US Defense Department work. On the Soviet side, in contrast, the liberal reform period was captured for a period by cybernetics, which poses a very official form of counterculture for a period. Soviet Union was a particularly fittingly structured society for the natural adoption and application of grand systems thought and information network technologies. This natural fit resonates, again, with a longer tradition of Soviet scientists and revolutionaries discussed earlier (e.g. Andrei Bodganov, Nikolai Bukharin, Leon Trotsky, and to some extent Vladimir Lenin) grappling to implement a decentralized, comprehensive social systems theory—that is, a theory

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[3] (Gerovitch, Internyet, fn 21: Malinovsky, Pioneers of Soviet Computing, ch 4; and Trogemann et al, Computing in Russia, 215-220; Pervov, Mikhail. Sistemy rakteno-kosmicheskoi oborony Rossii sozdavalis' tak, 2nd ed. Moscow: AVIARUS-XXI, 2004)

[4] (Ved Mehta, Comment, "Comment," The New Yorker, July 28, 1962, p. 15)

of social and scientific organization that balances at once the centralization of executive power with the need to implement control and commands over the immense expanses of Soviet Eurasia: a scientific worldview that was at its core decentralized.[5]

In Khrushchev period, the Soviet interest in cybernetic construction of social networks was particularly profound and widespread. The reformist-oriented movement surrounding computers fell to the wayside as official discourse about cybernetics shifted with the Leonid Brezhnev's political refreezing and emphasis on implementing strong top-down controls over press and public life. The mid 1960s did not bring a complete return to the repressive regime of Stalin however. Cybernetics as a science remained, although Stalin had originally declared it a hiss and a byword, and a chorus of nay-sayers had joined in calling it an imperialist reactionary pseudo-science before Stalin's death in 1953, and the early defense and ideological adoption of cybernetics beginning in 1953. However, under Brezhnev, cybernetics was neither imperialist (read American), nor reformists. Rather the official discourse on the social use of computers, something Gerovitch calls *cyberspeak*, had almost wholly lost any mention of the study of communication. What was once the mislead and ideologically wrong mission of the enemy, and later a reformist-oriented toolbox for networking socialist society, become an official state tool for the study of control.

On the whole, it stands to note the contrast that, while the early rise of American cyberculture was more or less limited to a certain, sometimes marginalized, sometimes exceptional set of, in this order, government, reformist-oriented countercultural, and corporate actors until personal computers themselves become widespread and interconnected in the 1980s, in the Soviet Union, the early proclivities and intellectual instincts for technologies capable of organizing societies were already long in place. In some sense, the trope holds that American cyberculture blossomed with the invention of the individual or personal computer, while the broader structural fit with a more socially-oriented sense of cyberculture has long been familiar territory in the Soviet Union. This dichotomy, whatever the danger of stereotypes, may help connect under-explored parts of the social comparison than to establish lasting and meaningful contrasts of these two societies as a whole: for instance, the intellectual affinities between the marginalized communalist and hippies segments of American society and the long-standing Soviet and Russian commitments to socialism and communalist political philosophy.[6]

The Soviets enjoyed a tradition of many of the world-class mathematicians, and certainly had the brain capital to design a network: theoretical work in abstracted symbols of theory and computers, it seems, was safe haven for intellectuals. (The trope about the US is pragmatic engineering application.) And as early as 1955, cybernetics—Norbert Wiener's field of precise analogy making between machines and animals—began sweeping Soviet society, and with it, a tremendous social interest in developing computers as comprehensive tools, as "machines of communism." This is worth stressing. Cybernetics (like several other earlier attempts to generalize science, general systems theory, Bogdanov's tektology touched upon in chapter two) may be understood at core as an attempt to make analogies precise. The analogies are almost

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[5] The Soviet history of cybernetics is developed in further detail in the preceding chapter.

[6] More on Gorbachev at Esalen, CA? See *Esalen*. On the other hand, hippies on the West coast of the US and liberalizing cyberneticists in the Soviet Union were not the only keeping the peace. In a counterintuitive game theory sense, spies may have been keeping the peace by defraying doomsday conspiracy theories with local knowledge.

always expansive and interdisciplinary: the comparison of engineering networks and nervous systems, the computer and the mind, servomechanisms (or machines that use negative feedback to correct their performance) and purposeful human behavior, machines and animals. Thus, in the critical period of early network building, the late 1950s and 1960s especially, the Soviet adoption and adaptation of cybernetics ushered in a culture of making analogies precise in a language of mathematical abstraction, an ecumenical code for all the sciences.

To repeat the central puzzle of this chapter: given that the more or less competitive computer resources between the superpowers, why did the Soviets fail to develop an equivalent to the US predecessor of the Internet? I answer that the failure is due in part to the particular confluence of historical circumstances developed below. Part of the answer is technical: the Soviet Union didn't have the digital computer technology that the US did. Part of the answer is personal: when Brezhnev replaced Khrushchev, and when Fedorenko replaced Nemchinov, the politics of economic networks in the Soviet Union and the Central Economic Mathematical Network shifted importantly. And lastly, part of that answer is also conceptual: namely that the cybernetic memes of hierarchical control occupying Soviet thought also contributed to the failure of design innovations. The reason the Internet is not based in Moscow is a function, in short, of both historical means and cultural memes.

It should also be noted that such counter-factual questions like "Why did the Soviet Internet fail?" are epistemologically hazardous. There is no right answer to the wrong project. Whatever use I hope to derive in shedding light on the possible political, social, and technical preconditions necessary to construct and sustain a nationwide computer project, I doubt that any amount of archival digging can provide a truly satisfactory answer. The historical record is at its best positivist in its empirical collections. It never discloses the cause or purpose of a particular path of history. Rather it, like a candle over an abyss, offers ample evidence foremost of our own ignorance about the past and little in way of certainty or comfort.[7]

The remainder of this chapter explores this question. One of the key assertions concerns the infrastructural character and layout of the Soviet Union for computer network building in the 1960s, and in particular the tension between computer networks designed to optimize information distribution and hierarchical bureaucracies that oversaw those networks. Namely, that in order to understand why the Soviet Union failed to establish nationwide means for the distribution of information (economic, scientific, military, or otherwise), it is essential to understand the Soviet Union first as a decentralized system, rather than as a centralized one--a small but, I believe, pregnant correction for critics of the Soviet Union. In other words, the best explanation for why the Soviet Union ended up trying to build multiple, deeply unsuccessful computer network projects has to do at core with the inefficiencies of power-sharing in the bureaucratic and managerial structure of the Soviet state as well as of the cybernetic principles of design resonating throughout Soviet society. Were the Soviet state in the 1960s truly centralized, there would be no systemic power-sharing problems, for indeed, one small body would control it all. Stalin was not just a strong man tyrant; he was the strong man tyrant that oversaw the expansion of the Soviet state from a small post-revolutionary government to a many-headed hydra.[8]

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[7] The case is compounded by the fact that military archives, which contain the best-funded attempts, remain closed to outside researchers.

[8] Data on soviet state expansion under Stalin.

The Soviet "Patchwork" of Networks

Aside from military networks, there were multiple Soviet attempts to design and build a nationwide computer network for the management and monitoring of the socialist economy and by proxy Soviet society. Acronyms abound. Anatolii Kitov began developing the first "Economic Automatic Systems of Management" (or EASU for "ekonomicheskie avtomatizirovannie sistemi upravleniya") in 1959; Viktor Glushkov, a colleague of Kitov and a computer visionary at the Kiev Institute for Cybernetics, began work on the "All-State Automated System (OGAS for "obshche-gosudarstvennaya avtomatizirovannaya sistema) in 1962, a total economic management system. This system was reduced by 1963 to a basic network of computer systems called "the Unified State Network of Computing Centers" (EGSVTs for "edinaya gosudarstevennaya set' vyicheslitel'nikh tsentrov"). Lastly, Nikolai Fedorenko took up the charge in 1964 to build the System of Optimal Functioning of the Economy (SOFE for Sistema optimalizatitsia Functionirovaniya Ekonomiki).

1. 1959, Anatolii Kitov
   Dual-Purpose Military-Civilian Network
   (Unnamed: died in committee, spawned the rest.)

2. 1962, Viktor Glushkov
   All-State Automated System
   (OGAS: Planned, never realized.)

3. 1963, Viktor Glushkov
   Unified State Network of Computing Centers
   (EGSVTs: Planned, underfunded.)

4. 1964, Nikolai Fedorenko
   System of Optimal Functioning of the Economy
   (SOFE: Became optimal modeling, micro-level successes.)

These four projects will be touched upon below in the context of four factors common to the failed Soviet attempts to build economic networks:

1. Ideological entrenchment of the purpose of the project (basic research)
2. Unbalanced funding flows of the project
3. Pervasive cybernetic logic of hierarchical design
4. Unregulated competition for management power

To touch on each, one is ideological entrenchment of purposes, which argues that the standards for agreeing upon and advancing a non-military project in the Soviet Union were much higher—unworkably higher—than those necessary to secure resources for military projects. The process of internal political negotiation between the Academy of Sciences and attending State Ministries was, in a sense, too open to debate (carried out in committee); as a result, each division in the social science tended to carve out an autonomous zone in the political discourse at the time to justify their own self-existence. This practice, in turn, left little room for basic research in Soviet research funding apparatus, especially—as discussed below in the case of economic cybernetics—surrounding the burdensome political commitment Marxist-Leninist thought owes to the socialist economy.

The second factor is the unbalancing influence of funding surges, which may have distracted key Soviet institutions away from the early idea to build a nationwide non-military computer network. This will be explored especially in context of fourth example above, the early institutional history of the Central Economic Mathematical Institute run by Nikolai Fedorenko.

The third factor follows that the hierarchically decentralized technical design of the Soviet network itself carried with it an additional architectural burden implicit in most networks of its day, but not in distributed design of the ARPANET. Here, however, the success of the basically centralized Minitel network serves as a counter example to suggest that in fact the hierarchically decentralized Soviet design was less viable than even centralized network designs. I follow this over-determined logic of hierarchical design to its origins in Soviet cybernetics and suggest the Soviet case as cautionary tale for modern-day attempts to regulate and deregulate network innovations.

The fourth factor addresses that the fact that the decentralized institutional support of the Soviet network led to unregulated bureaucratic power-hoarding, resource bottlenecks, and managerial inefficiencies. This has counterintuitive implications for interpreting the early history of long-distance, large-scale cold war computer networks. Namely, the Soviet network, in large part, failed due to unregulated competition over funding among middle-level bureaucrats, while the ARPANet developed successfully in part thanks to stable subsidy and regulation from the US state. The ARPANET initially succeeded thanks to US state subsidies, and the Soviet networked floundered in unregulated competition between ministries. By recognizing the interactions of state, society, and science in these four factors, we find in the Soviet Union an amply rich opportunity for developing some nuanced conceptual framework to help understand how early decentralized organizations facilitated by information and communication technologies.

Each of the above listed factors and network proposals receive some attention below. However, before giving historical context to each network project, I wish to focus on some of the more conceptual similarities between these proposed networks. To this end, I propose a conceptual model for comparing early nationwide computer networks projects. As the statistician George Box declared in 1987, “all models are wrong, but some are useful.”[9] My model takes into account several values that shape each: the technical design, the arrangements of the supporting institutions, and the political dynamics of consensus building.

In 1964, Paul Baran, a key architect of the ARPANET, offered a continuum for describing the technical design of computer networks in the same seminal 1964 paper "On Distributed Communications" that launched the first wave of packet-switching work in America.[10] He writes "Although one can draw a wide variety of networks, they all factor into two components: centralized (or star) and distributed (or grid or mesh) (see Fig. 1)" (ARPANET Sourcebook, 12). In fact, one can place all possible network designs on a continuum between purely centralized and distributed designs. In practice, almost all communication networks lie somewhere between star and mesh networks and can thus be considered "decentralized" networks.

[9] Box, George E. P.; Norman R. Draper (1987). *Empirical Model-Building and Response Surfaces*, p. 424, Wiley.
[10] Abbate, pp. ?? distinguish packet-switching work of Baran from the British work.

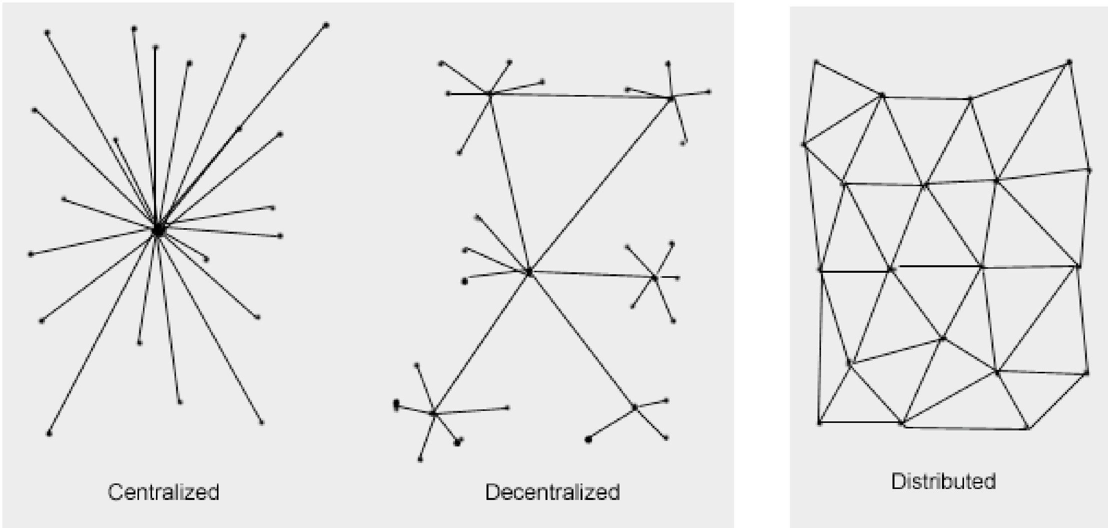

Figure 1: Paul Baran, “On Distributed Communications” 1964.

The ideal type of a centralized network can be described simply and comprehensively: connect all nodes to one master node. The ideal type of a distributed network can also be described simply: connect each node to all neighboring nodes. This, however, is a local, not a comprehensive, description. The perspective necessary to build a distributed network need extend no further than the perspective of any single node: "connect to all neighboring nodes" is a one-step algorithm that any user at any node can adopt and repeat ad infinitum. In other words, the distributed network can be designed from the ground, one node at a time, without a preconceived master plan. The centralized network, on the other hand, has its own type of simplicity in that its comprehensive plan requires adopting the perspective of only one single node, the master node: "connect all nodes to a master node," is also a one-step algorithm but, unlike the distributed network, only one single node can adopt and repeat it ad infinitum.

There's also an important difference in the function of these design ideals. The distributed network can endure change due to the redundancy of links (think packet switching). The link is the weakest part of a distributed network, but it is also the most important part provided there are many weak links and the relatively complex routing protocols are obeyed. The weakness of links is also the virtue of a distributed network: it does not require expensive and secure wiring. While the centralized command-and-control-style networks, on the other hand, emphasize few, strong links and simple routing instructions. In centralized systems, links make control possible; in distributed systems, links make communication possible.

The decentralized network is an important mixture of these two. It cannot necessarily be described simply, and has no single ideal type, consistency, or internal pattern. Instead, decentralized networks are build on uneven distributions of nodes link strength. They can have hierarchy and layers, pyramid shapes, and implied centers--sometimes multiple; they are theoretically impure and they are our practical reality. Decentralized networks can have well-ordered layers of centralized networks, with many layers of many connecting to one, or they can compose any constellation of random and incomplete connections. In the theoretical extreme, the varieties of decentralization make up a continuum of network design between all but the most idealized endpoints between centralized and distributed networks. Either any one broken link in a purely distributed network or any one additional link in a purely centralized network means some degree of local decentralization. Any plan to build a decentralized network, then, must include both comprehensive and local perspectives. It needs an architect's blueprint of the whole as well arbitrarily many levels of more detailed design.

The Soviets in the 1960s were particularly interested in one type of decentralized design: the hierarchically structured network. A hierarchically structured network follows a classic tree-like or pyramid structure arranged in multiple vertically-stacked layers, in which any node on the network is connected to exactly one node above it and any node can connect to multiple nodes beneath it. Namely, all four networks examined below were designed in a pyramid-like structure (illustrated in figure 2), with a master node in Moscow controlling and connecting all subsidiary nodes.

[Insert here: picture of pyramid with three levels: a single, centralized computer center at Moscow at the top, several dozen major urban computer centers, and 10,000s of regional centers. Original images from 1964 memo possibly?]

Figure 2: Example of Hierarchically Structured Decentralized Network

A hierarchically-structured network is a curiously cybernetic design: each part of it, including the whole, reflects elements of both distributed and centralized design. Moreover, a strictly hierarchical network reflects elements of both tight control and open communication. From a master engineer's perspective, a hierarchical network, like a purely centralized one, has the advantage of being ostensibly controllable from one single point. A hierarchical network, like a decentralized one, also has the advantages of spreading out actual control points throughout the network. By designing their networks to be hierarchically structured, the center offered the possibility of comprehensive controllability, while the multiple interconnected layers of computer connections allowed mid-level managers to enact actual and more intelligent control decisions that, when actually left to central planners in Moscow, would lead to substantial economic inefficiency.

The hierarchically-structured network model espouses a variety of cybernetic design logic in its combination of strict, comprehensive control at the meta-level and lower-level variable degrees of freedom and flexibility of action within the internal components of the network system. The complexity of the economic system and the pervasive logic of strict internal design characterize key elements of cybernetics.

The two-dimensional shape of cybernetic systems can be demonstrated in the example of the steel mill given by Pierre de Latil in his seminal popularization of cybernetics 1956 *Thinking with Machines*. For generations before the invention of feedback, engineers had struggled to build a machine capable of rolling out sheet metal in uniform thickness. There were, before feedback mechanisms, simply too many interrelated variables at regulate at once perfectly and simultaneously. Latil mentions at least seven factors: distance between the rolls, speed of the rolls, thickness of the metal, malleability, ductility, temperature, and traction on the sheet" as it rolls out. Increasing the speed of the roller would decrease the temperature; increasing the temperature would lower the traction; lowering traction increases the speed, and so on. Every part influenced every other part in ways that were too complicated to analyze, quantify, and accurately regulate in real production time.[11]

While Wiener's 1948 *Cybernetics* is perhaps too often given credit for generalizing and popularizing the invention of feedback mechanisms, the basic feedback insight was simple yet

[11] Latil, 1956, *Thinking with Machines*, p. 55-160; Kevin Kelly, *Out of Control*, p. 120-121.

critical in resolving, among other complex industrial applications, the steel rolling machine example. By adding what Latil calls a "feeler" gauge at the end of the finished sheet roller and by connecting that gauge to signal necessary adjustments in the exactly one original factors, the engineer could suddenly translate any deviations in the thickness into electronic information signal directly back into the steel rolling mill itself, creating a feedback loop that transforms the machine into a system that searches for equilibrium. Once the accounting of the change became a corrective part of that change itself, it was no longer important to gauge and synchronize every factor simultaneously. It was enough to have the system's inputs respond to its own output.

This example of a simple cybernetic rolling mill, in turn, illustrates how the Soviets understood hierarchically structured networks to be the analogous cybernetic network model. Like the rolling mill, a strictly hierarchical network has a single point through which all other information in the system passes and is verified. For the rolling mill, it is the "feeler" gauge just at the end of the production; for the hierarchical network, it is the master node, or the centralized computer center in Moscow, that acts as the all-seeing check on the rest of the system, which for the purposes of this chapter, are the entire socialist economy. Moscow will be charged with checking for and correcting any deviation, just as the feeler gauge oversees all outputs. Similarly, and ironically, however, is the obvious fact that a command and control economy programmed from Moscow would require—unlike the feedback feeler—direct intervention into specific portions of the economy. Unlike the rolling mill, where the regulator is unconcerned with causes, and can detect and correct deviation in the final output by controlling a single variable, a national economy has many outputs that cannot be so simply controlled. Grain shortages could not be compensated for by increasing lumber production. The conceptualization of the socialist economy as a cybernetic entity—and certainly the field of economic cybernetics—seems a thoroughly Soviet invention. It is wrought with curious tensions that will be explored below.

Distributed Network Design

Unlike the dual military and civilian uses of both Soviet economic networks and American ARPANET, the Minitel was not for military use. Unlike the ARPANET and the Minitel network, the Soviet economic attempts did not only not succeed—they never got beyond the proposal stage The cutting-edge theoretical work of American engineers and psychologists, such as Paul Baran work on survivable computer networks at RAND begun in 1959 and J.C.R. Licklider's 1960 paper "Man-Computer Symbiosis," a topic begun in 1957 and seminal for the peculiar place of the human user in the ARPANET—combined to bring to light the principles and techniques necessary to build such an open, flexible computer network. The ARPANET (1969-1990) is considered the predecessor to the Internet because it was, at core, a dual-use technology. It was not the first network to use TCP/IP nor the first network to go commercial (in fact, it only lost its partial military purposes late in 1983 well after other networks like the Computer Science Research Network (CSNET), the CDnet (Canadian Network), and the National Science Foundation Network (NSFnet) were using TCP/IP and being made available for public use) but because it was the first dual-use network to be used by research universities for non-military purposes.

The ARPANET discovery of distributed networking lay the ballast for the founding of that classic trope of TCP/IP Protocol, the end-to-end principle—which internet enthusiasts and techies, cyber lawyers and business managers, and scholars alike have yet to tire of repeating: that is, moments of intelligence and control should ideally appear only at the ends of a transmission, or between the sender and receiver terminals. What the terms "intelligence" and "control" mean have varied over time. As noted computer scientist and teacher, J.H. Saltzer and colleagues wrote in the 1984 articulation of the end-to-end principle: "The function in question can completely and correctly be implemented only with the knowledge and help of the application standing at the end points of the communication system" [Saltzer, et. al., 1984]. Applications, protocol execution responsibility, and a host of other computer functions have been since been assigned to the end points in computer networks, the solid ground in an otherwise effervescent and flexible entity. Distributed networks gave us an ideal against which we could imagine a world of communication in which computers connected any human to any other human. It was a dramatic, foundational shift for the imagination of computerized communication, the ideological infectiousness of the Internet--the supposed replacement of hierarchy with interface, and the flattening of organizational power. And it remains the driving inspiration for many modern cyber-enthusiasts.

The caution for such distributed networking designs is also the lesson of the Soviet economic networks. That is, the Soviet economy were culturally and institutionally committed to decentralized hierarchical structures: it is not a surprise that their networks followed suit. However, it is the unintended spillover of a design principle that in large part led to the unworkable tangle of hierarchically structured ministries unwilling to cooperative sufficiently to build a comprehensive hierarchically structured network. This commitment bias to hiearchy, or as Barry Staw first called it in 1976 “the escalation of commitment,” ensured an overdetermined hierarchical design that, while resonant across actual functioning Soviet economic institutions and power structures, proved not to be workable in the present as well as a distraction from the innovation in distributed network design happening contemporaneously in the United States.

Toward a Conceptual Framework for Comparing Nationwide Networks

I adapt Baran's conceptual distinction between centralized and distributed network designs into a classificatory scheme for organizing early national computer network projects according to technical design, institutional support, and purpose. While I choose, for some context, only the Soviet, American ARPANET, and the French Minitel network, it stands that each computer network was shaped by a unique set of technical designs, political arrangements, and social uses.

Fig. 2.

	Centralized	Hierarchical	Distributed
Technical Design	Minitel?	Soviet Networks	ARPANET
Institutional Support	ARPANET Minitel	Soviet Networks	
Purposes	Soviet Networks	Minitel (1970s)=======➔ ARPANET (1960s) ===➔	(1980s) (1980s)

By “technical design,” I follow Baran’s model in outlining the different ways engineers have of connecting computers. Were they directly united to a common master node (MINITEL?)? Were they dispersed in a hierarchical arrangement of connections, all leading to a common master node (Soviet networks)? Or was each computer connected only to its neighboring computers (distributed like Baran's ARPANET)?

By "institutional support," I mean to touch on the organizational structure of the institutions that supported and designed those networks. If the technical design refers to how engineers have organized the computer networks, the institutional support refers to how human institutions—like ministries, governments, corporations, private entrepreneurs—organize themselves around computer networks.

Lastly, by including "purposes" in this schematic, I mean to capture something of the clarity of the arrangement of the ideas behind the creation of the network itself. Of course, purposes are never strictly "centralized" "hierarchical" or "distributed" themselves, but the stated reasons for building a network can be, in turn, all bound to one common idea (centralized), multiple in form but eventually bound to one common idea (hierarchical), or multiple, unorganized, and without a clear single structure (distributed). In this analysis, it is necessary to note that both the Minitel and ARPANET began as state supported projects but later opened up to a variety of individual entrepreneurial purposes. While the Soviet economic networks were developed with the singular purpose of monitoring and managing the Soviet economy, the ARPANET and Minitel networks begun as proposed technical solutions to a single problem (many possible uses are hierarchically arranged under a common purpose), that purposes was given up as soon as others began to see alternative uses for the networks (shifting a more distributed "use it if you can" model), which included the software that made the Internet possible. In both the ARPANET and Minitel cases, unauthorized innovations were tolerated and then encouraged. Ray Tomlinson, for example, had been hired in 1971 to discover uses for the ARPANET (which began functioning in 1969): his answer was email, which he invented because "mostly it seemed like a neat idea" (Tomlinson).[12] The lesson of open-ended purposes is to approach problems less committed to solving a single given problem than seeing what other problems a single given innovation may be able to solve?

A Patchwork of Networks: a Dual-Use Network, EGSVTs, OGAS, SOFE

In the late 1950s and early 1960s, a number of Soviet cyberneticists began dreaming up a nationwide information network for monitoring and managing the Soviet economy. And a patchwork of acronyms followed: The "Unified State Network of Computing Centers" (EGSVTs for "edinoi gocudarstvennoi seti byichislitel'nikh tsentrov") was to provide the technical hardware on which the following networked economic systems would operate. Building on Kitov's work around a "unified information network," Viktor Glushkov, a visionary computer scientist from Kyiv, began publishing about computers in 1957 and then proposed and lead the "All-State Automated System" in the mid 1960s. Nikolai Fedorenko, a young, rising academic (43), was appointed in 1963 to direct the newly formed Central Economic and Mathematics Institute (TsEMI): Fedorenko and his TsEMI developed the "System for the Optimal Functioning of the Economy" (SOFE, for "sistema optimalizatsia funktsionirovaniya ekonomiki" [check??]) which would essentially provide the theory and design behind the software necessary for mathematically optimize the modeling and monitoring and management of the national economy. Each receives a moment of historical context below.

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[12] Ray Tomlinson, "The First Network Email." 2009 Feb 16, http://openmap.bbn.com/~tomlinso/ray/firstemailframe.html

Anatolii Kitov, the Soviet Colonel Who Proposed the First Civilian-Use Network Anywhere

Records suggest that the first person to propose a nation-wide computer network for civilian use anywhere was the Soviet cyberneticist and Engineer Colonel, Anatolii Kitov. In other words, what makes the ARPANET foundational to the Internet—civilian access—is exactly that which Kitov first proposed in the Fall of 1959. It seems, at least, that this wider vision of computer networks were not unique to the US ARPANET.

On January 7, 1959, Anatolii Kitov then a 39-year old Soviet Egineer colonel sent a developed proposal for a comprehensive unified automated system for the management of the national economy based on a general network, or "large complexes," of computer centers run by the Soviet Ministry of Defense, plus a brochure for his recently published book on digital computer programming, to the General (then First) Secretary Nikita Khrushchev.[13]

Later in the Fall of 1959, Kitov developed a proposal for a nationwide dual-use network of computer centers between military and civilian (economic) facilities. He argued that this would streamline bureaucratic management of information and reduce vast intra-administrative inefficiencies. Two notes are key to Kitov proposal: one, Kitov proposed first a network for the management and monitoring of the socialist economy and then, later in 1959, a dual-use network shared by the leaders of both the Soviets military and the socialist economy. This basic proposal would go onto to inspire Soviet cyberneticians to develop three major national economic networks projects including the EVGTS under Kitov, SOFE under Nikolai Fedorenko, and OGAS under Viktor Glushkov. Two, Kitov, then still a bright star among the Soviet military engineering community, would be temporarily suspended from the Communist party for the critical tone and procedural misstep of his proposal to Khrushchev. But to understand the evolution of these events, one should begin at the beginning of Kitov's life,.

The tension between military and public service was lifelong in the case of Anatolii Ivanovich Kitov. In 1921, Anatolii Ivanovich Kitov's mother and father fled with him, at the age of one, from Kyibishchev (now Samara), Russia to Tashkent, Uzbekistan to avoid repression from Bolsheviks due to his father, Ivan Staponovich Kitov's, former career as a junior officer in the White Army and to pursue a new quiet life as an accountant. Kitov himself rose as a star pupil in mathematics and engineering, earning in 1939 a gold star for his exemplary performance while in high school, an award begun in 1939 meant to confer public "hero" status to the recipient. Three months into his undergraduate education in Tashkent, Kitov was drafted into the army and then transferred to the prestigious Leningrad Artillery Academy, where he graduated prematurely in 1941 to serve as an artillery platoon commander on the south front of World War II. For the following four years, Kitov lived anti-aircraft artillery, studying mathematics in every spare moment. On the other side of the front, there was a well known parallel, the path of Norbert Wiener and his young engineer assistant Julian Bigelow (and later physician and colleague Arturo Rosenblueth) on the human-machine interactions necessary for the world war II anti-aircraft gunner and gun to probabilistically predict the flight of approaching enemy aircraft in the heat of battle ("Purpose, Behavior, Teleology" 1943).

[13] (Kitov to Khrushchev, 7 January 1959; Kitov papers, Moscow Polytechnic Museum, from Gerovitch, InterNyet, fn. 25. See also http://www.viperson.ru/wind.php?ID=8390, January 12, 2009)

At the end of the war, Kitov entered the Artillery Engineering Academy in Moscow, where he took courses with, among others brilliant mathematicians, the future Soviet cybernetic luminaries Aleksandr Lyupunov and Andrei Kolomogorov at Moscow State University, and also managed to patent a jet cannon reported on directly to Stalin and graduated in 1950 with a second gold star. In 1952 he submitted a dissertation on programming for ballistic problems of the long-range rockets and encountered in the secret library of the Special Design Bureau - 245 (SDB-245) Wiener's 1948 book Cybernetics and began the process of recuperating the study of cybernetics for Soviet adoption and adaptation discussed in detail in the previous chapter. In 1954 Kitov helped found and was appointed Chief of the Computer Center No. 1 at the Soviet Ministry of Defense, a scientific research position he occupied at the equivalent military rank of General. In 1956, Sovietskoye Radio press published his monograph, Digital Computing Machines, the first Soviet book in cybernetics, and in 1958 Sovetskoye Radio published the first edition of his textbook with N. A. Kritinsky, Electronic Digital Computers and Programming, a textbook that would be widely used and translated in the Soviet sphere of influence. An English translation appeared in 1962. Throughout his successes in science were intimately tied to his military service.

Such a dual-purpose career may help explain why Kitov conceived of a unified information network in the Fall of 1959 for both military and economic managements. (Russian sources remain quiet on the subject, saying only that "the idea came into his head" http://www.viperson.ru/wind.php?ID=8390.) The dual-purpose design of the network, Slava Gerovitch writes, is a natural product of Kitov's belief that the supply of computer processing power would outpace the demand, a belief that was "typical for the time." He also reasoned the entire system could be hid in secret underground locations and connected by hidden communication lines, with civilian computer portals and information stations in large cities.

In fact, it should be noted that the practice of redistributing excess processing power has since grown into a motivating force and leading idea among cyber scholars committed to the sometimes communalist study of social and economic production online. The most recent example of this trend is Yochai Benkler's seminal *The Wealth of Networks*, which sets the sociological and legal foundation for thinking about how peer-to-peer communication technologies--from file-sharing networks to interested user communities--can at once speed and spread out the basic patterns of wealth creation and distribution. From humans, Benkler asks for "time and interest" and from computers, "processing, storage, and communication capacity" (2006, pp. 100).[14] Together, Benkler argues at length, that the efficient harnessing and allocation of the "excess capacity" emerging out of the symbiosis of digital communications and human productivity can result in at once a capitalist profit-creation and a socialist, more egalitarian distribution of that value (see pp. 85-88, 167-182, 222-225, 298, 621-623). What the details of Benkler's argument are discussed elsewhere (footnote here), it is worth noting the strong resonance between the shared tenets of their arguments.

Both Benkler in 2006 and Kitov in 1959 argue that distributed network communications can produce more with less while reducing inefficiencies. In 1960, in fact, Kitov published an article with the Aksel' Berg and Aleksei Lyupanov in the leading Party journal Communist promised huge, sometimes fantastic, savings and reductions in planning periods through the development of an automated system for managing the national economy, based on a unified network of computer centers. Management would be halved, installation and overhead expenses

[14] Benkler (2006), p. 100.

would be made up within two years, and the more efficient economic management would remedy and quicken the nation's economic growth. Supply management costs, in particular, would be reduced to a fifth its previous size and the required planning time would reduce from several months to several days.[15]

Such bold claims, however, were never given the opportunity to be proven wrong. Speeding management productivity and reducing the costs of planning the five-year plans in terms of both time and resources should have struck home with the Soviet leaders, except that Soviet economic productivity ratings were peaking in the late 1950s and early 1960s. The system seemed to be working better than ever: bureaucrats had no incentive to change it and more importantly, many middle-level managers in the accounting and planning ministries felt as an automated information system would threaten their positions, power, and livelihood.

These structural disincentives against economic reform combined with the personal offense of Kitov submitted his letter directly to the Central Committee, namely the Nikita Khrushchev, and in the process violated the required submission procedure through a subsidiary committee and enraged his seniors. Unfortunately, Aksel' Berg was no longer in power to defend Kitov. And Kitov’s “insubordination” earned him a temporary suspension from the Communist Party in 1961.

Although none of the proposed automated information systems for managing the Soviet economy ever were even in part realized, the attempts to do so are still instructive. For example, consider how Kitov wrote about computer networks in strictly Soviet cybernetic terms. Kitov opens his second book, *Programming Economic and Management Tasks* (1971 Sovetskoe Radio), with a discussion of Soviet cybernetic in economics (the EVM/EASU of which is only one) that exemplifies an earlier vocabulary for talking about computer networks. To mercifully paraphrase Kitov, all cybernetic systems share the following seven characteristics:

1. a large quantity of interrelated elements connected by information channels. The traits of the elements, as a rule, do not determine the traits of the entire system.
2. “hierarchical structure” allows for multiple layers of management, each controlling the one underneath it.
3. all managing systems have both general goals and particular goals at every level of the hierarchy: the particular goals are subordinate to general goals.
4. each managing system has functional subsystems, goals, and tasks.
5. every system interacts with its surrounding environment, which it treats as a larger system and from which it extracts information.
6. flexible structures and managing algorithms make such systems stable and reliable.
7. people are management and control elements at all levels of the hierarchy.[16]

These characteristics are notable at once for their contradictoriness and forward-thinking. The first point is a basic restatement of Shannon information: namely, that the sum of a complex number of components in a system (or message) do not determine the system (or message). It is rather the structure—hierarchical in Kitov’s case and logarithmic in Shannon’s—that shape its behavior. The final point about people being “management and control elements” is also interesting for the fact that it asks for micro-level attention to individual people in the very act of articulating principles for a large complex potentially nationwide computer system. Moreover the

[15] Gerovitch, pg. (2??) footnote 27 (?).

[16] Kitov, Programmirovanie ekonomicheskikh I upravlencheskikh zadach, 1971, sovetskoe radio, p. 5-6, chapter “kibernetika v ekonomike”

mention of people as "control" elements suggests—unlike say the American tradition in Human Relations movement wrought by Ernest Mayo and Barnard[17]—the Soviets still actively conceived of individuals as Taylorist mechanisms for control.

The subordination of lower levels to higher levels in the systems hierarchy—be they people, goals, or subsystems—may help to explain one critical difference between all known attempts of Soviet cyberneticists to build large-scale computer networks and the ARPANET. Namely, that in its internal inspiration and its fit with larger society, Soviet computer networks were hierarchically decentralized, while the ARPANET was the first to be distributed in design. A hierarchically decentralized network design is not outlandish or outmoded. Most of modern-day networks between humans and computers express some elements of hierarchical design. The key, I argue, to understanding the failure of the Soviet computer networks begins with noting the overdetermined fit between the design of the networks and the organization of society at large. Namely, the universalizing scope of cybernetic principles—namely that all systems participated in larger systems, and were thus subject to an infinite regress to influence from outside (a sort of fractal expansion of hierarchically nested power relations)—prohibited network engineers and visionaries from actively imagining or advancing any alternative design. While it remains an open question whether the cybernetic organization of Soviet science or of Soviet society drove computer networks to hierarchical design, it is clear that the sound fit across of cybernetic thought in the Soviet Union may have overreached its usefulness. Several related case studies will be examined in more detail below.

Viktor Glushkov, the "Unified Network" (EGSVTs), the "All-State Automated System" (OGAS)

Viktor Glushkov (1923-1982) was a visionary computer scientists based in Kiev, Ukraine. In November 1962, the director of the Academy of Sciences M.V. Keldyish appointed Glushkov about the creation of the "all-state automated system of management" (for Obshchegosudarstvennoi Avtomatizirovannoi Sistemi (OGAS) Upravleniya."

In his memoirs, Glushkov notes that "the conception of a unified system of calculating centers for the development of economic information" had been present since the economist Vasilli Nemchinov (discussed below) "basically copied a proposal prepared in 1955 by the Academy of Sciences" for a system that would allow scientific reports to be compiled and exchanged over computers, but not over long distances—a task he had been working on with colleagues at the Institute of Cybernetics in Kiev, which enjoyed some fame abroad. The economists, Nemchiniov proposed, would do the same: build large but unconnected state computer centers in Moscow, Kiev, Novosibirsk, Rige, Kharkov, and other cities, where regional economists could come and calculate results to local problems but no more.[18] Glushkov wanted more: namely, he wanted computer networks to sustain exchange of information over long distances and he wanted to design and build a comprehensive nationwide network of computer centers that could effectively oversee the monitoring and management of the socialist economy in the whole of the Soviet Union. The result is the never realized project called OGAS (or all-state automated system of management), a comprehensive, hierarchically decentralized computer network design spanning all major industries and cities in the Soviet Union. Proposed in 1962, it remained secret until 1977.

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[17] Perrow, Charles. Complex Organizations, HR chapter, pp.??
[18] "Shto skazhet istoriya," Glushkov, p. 2.

It is telling to note that the first privilege Glushkov received from President Keldyish was the opportunity to enter any cabinet or office (such as at Gosplan, the planning ministry), "to ask questions, or simply sit in the corner and watch how they work: what he decides, how he decides it, according to what principles, etc. And naturally I received permission to acquaint myself with any industrial object—corporations, organizations—that I wanted." In 1963, Glushkov reports that he had visited over 100 objects (and in ten years probably over a thousand) of every variety from factories to agrarian communities and considers that "he, perhaps better than anyone else, has a complete pictures of the socialist economy." Throughout this recounting, a key moment appears to be the immediate inclination of both President Keldyish and Glushkov to understand the economy—or any other system for that matter—as a comprehensive whole. The keys to the kingdom, as it were, lay in the access, mapping, and conception of all economic activity as a coherent whole system.

Glushkov proposed with V.S. Mikhaelvich and A. I. Nikitin the underlying technical network (called EGCVTs, for Edinoi Gosudarstvennoi seti vyichiclitel'nikh tsentrov) upon which the software of OGAS and other related economic management projects could rely. It proposed around 100 computer centers in prominent industrial cities and centers of economic regions, unified by underground thick electrical wires. Thick wires and strong connections between nodes were characteristic of decentralized networks, whereas thinner, weaker connections were sufficient for distributed networks. The detail is not innocent either: for, weaker links were evidence of Baran's distributed network strategy to emphasize routing protocol instead of the durability of links themselves. These 100 computer centers, according to Glushkov, would in turn need to be attached to nearly 20,000 smaller portals for gathering and receiving economic information. Although Glushkov does not forefront the point in later recollections, the 100 computer centers would likely be connected to a master computer center in Moscow, thus completing the pyramid structure.

In either case, Glushkov's proposal in the scope of both his vision and the authorities permitted him were radically comprehensive. His receiving approval to attend and observe any facility was, in short, a type and a shadow of the functions his all-state automated system (OGAS) would provide. His vision was to conceive of the socialist economy as a whole, and to graft upon it the informational infrastructure, or nervous system, the economy would need to rise as a functioning, coherent body.

Glushkov formulated in his draft proposals a comprehensive vision of the organized structure of the socialist economy serving as a basis for a large-scale network that would systematically oversee all inputs and outputs of labor, production, and consumption—from agricultural output to waste management. But Keldyish had Glushkov strike from his original OGAS proposal the racial suggestion of building a "moneyless system of receipts," out of fear that it would raise "unneeded emotions," something, Keldyish wisely thought, should not be allowed to interfere with planning (Glushkov, "Sto skazhet istoria," 3).

In this edited form, Glushkov's 1962 proposal survived a number of Soviet government agencies until, in 1963, it was reviewed by the Party Central Committee and the Council of Ministers. These Committees at first rejected and burned Glushkov's papers—standard protocol for "secret materials"—before eventually accepting a modified and simplified form of Glushkov's proposal. The committees approved a joint decree titled "On Improving the Supervision of Work on the Introduction of Computer Technology and Automated Management Systems into the National Economy." After revision, Glushkov's proposal had been reduced to building the technical network, not the whole system, for nationwide economic management.

Here of course the presence of the word "supervision" in the title of the decree is telling. The government agreed to improve the supervision of the work of automated management, not to improve the work of automated management itself.

The decree sped at least two new orders of "supervision." One, major agencies that took up the problem of economic information systems did so by enlarged themselves by building prominent institutions under their purviews. The Academy of Sciences set up the Central Economic Mathematical Institute (hereafter CEMI), the State Planning Committee organized the Main Computation Center, and the Central Statistical Administration created the Scientific Research Institute for Design of Computation Centers and Economic Information Systems. To coordinate all the new work springing up in this area, the state launched the Chief Administration for the Introduction of Computer Technology into the National Economy.

Two, this official new sphere of work—begun under the title "economic cybernetics"—was devoted to, in the end, a surveillance system, and the further formalization of a Soviet surveillance state. Only this time, somehow, the shift in surveillance from the political stranglehold under Stalin to the economic management under Khrushchev should be understood as a primarily politically reformist act. Many of these institutes—indeed, much of the whole field of early Soviet cybernetics—were occupied by reform-minded scientists at the outset. The ultimate fate of that reform, however, is a different matter.

Glushkov's proposal for a nationwide unified information network is tellingly decentralized, not distributed, in its three-tier (regional, territorial, and central) set up. Although it originally conceived of radical means for reforming and streamlining the Soviet national economy, the decentralized structure of the OGAS, were it ever to have been realized, would more likely than not have confirmed and reaffirmed the core hierarchical arrangements of political power. And in 1964, Glushkov's Institute for Cybernetics cooperated with Nikolai Fedorenko's Central Economic Mathematical Institute in issuing a joint proposal for a common economic information management network. As Gerovitch writes, "the[ir] joint proposal [was] for a unified system of optimal planning and management on the basis of a three-tier unified nationwide network of computer centers. The proposed network included tens of thousands of local computer centers to collect 'primary information,' 30-50 mid-level computer centers in major cities, and one top-level center controlling the entire network and serving the government" (Gerovitch, unpublished, 8; see also Gerovitch, Cyberspeak, p. 273). Glushkov and Fedorenko's proposed that all economic information would be collected, stored, and made available only once--a vast simplification and improvement on existing procedures in which different planning, defense, and financial ministries systems independently processed their own data.

The many problems implicit in actually centralizing all information processing never came up, however, because almost no middle-level (or otherwise) administrators were willing to give up control of their own jurisdiction. That is, the bureaucratic pyramid, or decentralization of political power, ensured that would never happen for human reasons. Other scholars have argued how interpersonal trust networks were very tight in Soviet culture: that is, links made were both few and intense. Western critics have also theorized that without personal profit to maximize, socialist administrators tend to maximize personal power, in this case, by refusing to relinquish control over their domestic or local flows of information. (That is, as anyone living through the moment of economic downturn at the time of this writing may agree, we may agree that although profit-maximizing may lead to unjust or undesirable situations, at least it does so more efficiently than power-maximizing. Efficiency-driven sciences cut both ways.)

It may also be worth note that the preexisting patterns of decentralized power explain something of the Soviet academic insistence upon theory-driven work (as opposed to project- or case-driven work which was supposed to typify pragmatic American scholarship): theory is easily and infinitely scaleable, while the administrative or applied institutions charged with seeing out practical reform are importantly and understandably resistant to change. So too do ideas travel more easily than institutions, and the imbalance between center and periphery, between Moscow and Siberia (as well as the 14 satellite countries), may have played a role in undermining early initiatives to build and theorize a nation-wide information network capable of addressing both military, civilian, and economic concerns.

This combination of extant decentralized control and theory helps explain why the first attempts to theorize a computer planned economy took place in Siberia, not Moscow. Communist party leaders test drove Nemchinov and Kantorovich's theories at the regional level before deciding to apply them more fundamentally to the whole of the centralized Soviet economy, the very task Glushkov and Fedorenko were proposing; two, it also illustrates that while orders passed from Moscow to periphery, the currents of intellectual reform often flowed in the reverse direction. This practice allowed the Soviet center to sustain apparent power sharing with more peripheral city centers while retaining system-level control among the Moscow nomenklatura. However, this imbalance of power relationships between the core and the periphery also had clear disadvantages for the Soviet power elite. Namely, that were the center to ever decide to incorporate a successful project from the periphery, the sheer difference of structural logics between the center and periphery guarantees that any project developed in the periphery will have to undergo a substantial and often debilitating transformation before it can operate at the nationwide level. Moscow has no testable equivalent within the Soviet Union.

William Conyngham provides three explanations for the impediment of OGAS form 1965 to 1980: one, trouble securing the design and financing of the network, two, unresolved conflicts over the management of its construction, and three, the tensions between the very place of computers in the existing system of Soviet planning and management (Technology and Decision Making: Some Aspects of the Development of OGAS, 1980). In a 1975 *Izvestiia* article, Viktor Glushkov called for the transition to a new "technology" of management, by which he seems to have meant a thorough overhaul and rationalization of Soviet-style management and decision-making procedures. The process of establishing the protocol, standards, and codes for even theoretical compatibility between ministries and industries, it seems, would tax the financial and managerial resources of any technically advanced society. Problems abounded: the Ministry of Wood and Wood-Processing, for instance, attempted several times to unify and streamline the procedural notation for the industry--the resulting code was over eighteen hundred pages and incompatible with other industries' codes.[19] The underlying goal to reduce and rationalize a "paperless" information network resulted in the opposite effect, while attempts in the 1976 to centralize computer memory capacity into a single data bank containing some 500 billion bits (about 58 gigabytes) of information proved untenable—and a series of regionally decentralized data banks were build instead.

In all, the Marxist conception of bureaucracy proved as flawed as that of the late capitalists: once stripped of its bourgeois excess and self-interest, the bureaucracy in the Soviet state, instead of becoming reduced to optimally minimal technical entity, proved an insurmountable obstacle to the advancement of the exact science that was meant to provide the

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[19] N. chesnenko, "'Obshchii iazyk' elektronnykh mashin: Problemy kodirovaniia dannykh," in Ekonomiceskaia gazeta, 1973, no. 47, p. 10)

technical streamlining and simplification of organizational power.

Soviet Economic Cybernetics

The flexible vocabulary of cybernetics allowed for the ideology of Marxian economics to be stretched, at times unrecognizably thin, over specific mechanisms and concepts capable of conceiving of the national economy in abstract terms of mathematical models and predictable social interaction. The planned economy fit cyberneticians' toolbox of control techniques well with the notion of "steering mechanisms" and "steered" parameters that allowed management and state planning institutions to target economic "subsystems" and activities to numerically represent a larger model of the national economy rather than relying on traditional statistical prognostication.[20] Horizontal coupling between enterprises were likened unto parallel circuits and hierarchical relationships, to serial circuitry.[21] Soviet researchers such as A.I. Katsenelinboigen, E.Z. Maiminas, V. A. Vokhov, Iu. R. Leibkind, A.L. Vainshtein, K.L. Gorfan, V.A. Volkonskii, and Iu. N. Gavrilets focused in particular on the connections between and within "organizational structure, communication, steering, growth, and uncertainty." Unlike the capitalist economy, which is organized by "elemental" principles, Lange argues, the socialist economy could be planned on rational principles—and, with its ideological acceptance, cybernetics became the preferred means of economic rationality.

However, rationality was certainly not the only impulse behind the turn to cybernetics. Escape from the ideological rhetoric of Soviet academic discourse was an important motivator behind the early explosion of interest in cybernetics generally, and economic cybernetics in particular. Rather the cybernetic rendering of Marxian reproduction scheme, socialist insurance analysis, input and output tables resemble the Western neoclassical economics of the day, whose mathematical language immunized economists on both sides of the Atlantic from the ideologically explosive issues inherent to the socio-economic injustices of both capitalist and Soviet systems. The early days of economic cybernetics were thrilling for the veiled attempt to work out a compromise of free market equilibria principles and socialist egalitarian ethics.[22]

The mathematical script of cybernetics provided rhetoric of disinterested rationality behind which the work of the enemy could put to use in the disinterested language of ciphers and computer code. Cybernetic tools, namely economic programming models, could be used to reaffirm pre-existing ideological and power structures in the Soviet Union just as easily as it could be to reform them—and they were put to both uses, often at the same time: by 1956, L.S. Pontryagin, a blind topologist, was promulgating the "Maximum principle," a fundamental of modern control theory originally used to show how beneficial equations of dynamic systems can be maximized under given conditions. According to Gavrilets, who joined the then nascent faculty group in 1959 the preceded and seeded the creation of the CEMI in 1963, early efforts to incorporate mathematical methods into the optimal planning of the socialist economy attempted to work out a middle-ground between Marxist principles of social justice with capitalist free market equilibria. By 1965 Janos Kornai, a Hungarian economist who would later become a noted critic of centralized economic planning at Harvard, had published *Mathematical Planning*

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20 (Review by Spulber of Hardt's Mathematics and Computers in Soviet Economic Planning, p. 999)

21 (Review of Lange's Introduction to Economic Cybernetics, 697)

22 Personal interview with Gavrilets

of Structural Decisions which began the corrective work of replacing traditional Soviet "balances" work with input-output analysis.

Out of these attempts grew a great scientific interest in the optimal planning of the national economy: namely, state planners would have influence over what variables and conditions are included in the complex formula for describing and predicting multi-sector market performance, while the formula themselves would do the troublesome work that eluded the bureaucrat, i.e. fixing optimal equilibria of social demand and state supply in the Soviet national marketplace (interview with author, ?? May 2008). The attraction to economic cybernetics as a reformist-oriented, market-sympathetic approach to reforming the flagging Soviet economy was particularly strong, moreover, given the fact that cybernetics provided something else to talk about than the Marxist-Leninist emphasis on the material economy as the philosophical foundation of the rest of Soviet social thought. While cybernetics provided a universalizing language of numbers to all countries, it also provided a particularly refreshing break from the predominance of dialectical materialism for social scientists in the Eastern bloc.

Soviet Cybernetics is Plural for Computer-Compatible Science

The three main characters in the narrative so far—Anatolii Kitov, Viktor Glushkov, and Nikolai Fedorenko—were self-pronounced cyberneticists, and in the 1960s, self-proclaimed economic cyberneticists. Kitov, as discussed earlier, was arguably the first Soviet cyberneticist: he discovered Wiener’s *Cybernetics* and introduced the work into Soviet science, bridging the division between military and academic thought. And after his temporary suspension from the Communist Party in 1961, he ended up spending the remainder of his productive career as a research scientist between economic and biological cybernetics. Glushkov, on the other hand, was an internationally recognized broad-minded cyberneticist at large: the long-time Director of the Institute for Cybernetics in Kiev, he was a founding theoretical cyberneticist, mathematician (he proposed solutions to Hilbert’s fifth problem in graduate school), and information technologist. Ever-the politically savvy academic, however, Nikolai Fedorenko came to distance himself from cybernetics in his later career, but not without first co-writing with Glushkov the seminal 1964 proposal for a nationwide economic information network. For a time he even considered naming the Central Economical Mathematical Institute with Vasilli Nemchinov the Central Institute of Economic Cybernetics.

That there was never was a Centralized Institute of Cybernetics is structurally fitting: what one, unified, coherent body of cybernetic study would look like remains a mystery. And while "economic cybernetics" remains the focus of this section, it is worth noting that cybernetics in the 1960s Soviet Union—and elsewhere—were importantly in the plural. Instead of a centralized institute of cybernetics—an institution that might have guaranteed the creation of a centralized top-down computer network, the Soviet Union primed with sub fields such as "geological cybernetics," "agricultural cybernetics," "geographical cybernetics," and others but there was never a single institution of cybernetic studies.

As evidence that the Soviet term *cybernetics* was a floating signifier for ideological scientific discourse, rather than a strictly defined single science, consider the curious fact that in throughout most of the 1960s, the Academy of Sciences, USSR, classified “cybernetics”—seemingly without precedent anywhere—as an entire one of four divisions comprising the whole of Soviet science: the other three were “the physico-technical and mathematical sciences, chemico-technical and biological sciences, and social sciences."[23] The fact that cybernetics is the only single term label to apply to these divisions strengthens this work's larger argument that cybernetics served as a scientific method for combining analogous studies under one roof. In fact, it is incoherent to conceptualize cybernetics as one coherent with another field that occupies one of the other fields, such as "theoretical cybernetics" (mathematics) or "technical cybernetics" (technical sciences), "biocybernetics," or frequently in English "bionics" (biological sciences), and, of special note here, "economic cybernetics" (social sciences).

In short, Soviet cybernetics is plural for computer-compatible science. It seems cybernetics research was not only fittingly decentralized for Soviet society—it was unavoidably so. Like the term *media* or *physics*, cybernetics may best be understood as means, not any single thing. Cybernetics *are*, not *is*. Were cybernetics in practice a singular science, it would not nearly have enjoyed the same rhetorical reflexivity and decentralized fit with the Soviet society.

The evidence of the Soviet widespread, diffusive embrace of cybernetics is widespread. Nikolai Fedorenko notes in his memoir that when a delegation of mathematicians led by A. A. Markov Jr. approached the head of Soviet Academy of Sciences, M.V. Keldish, about creating a cybernetics institute, Keldish, who himself practiced "cosmological cybernetics" (or basically, mathematical astronomy) promised to consider their proposal provided they could first formulate an exact definition of cybernetics (Fedorenko, p. 176). Needless to say, they never returned and a centralized Institute of Cybernetics was never built in Moscow. Instead, at least two major institutions in Moscow were devoted to specifically cybernetic work, namely, the Institute of Automation and Remote Control (1939-the present) and the Central Economic Mathematical Institute (1963-the present).

The Institute of Automation and Remote Control

The Institute of Automation and Remote Control (renamed the Institute of Control Sciences in 1969) was involved in an impressive range of activities, ranging from the theories of invariance, the synthesis of optimal systems, based on Lyupunov and Pontryagin's maximal principles, the theory of discrete automatic systems applied to pulse systems and digital computers, theories of control theory, learning automata, adaptive systems, large systems (seemingly a predecessor to complexity theory in which a large number of interrelated systems and control parameters are integrated), and bionics.[24]

The Institute also designed computers to "promote modular design principles, industry-wide standardization, and interchangeability of parts" in effort to advance the nationwide move toward a computerized, programmed economy.[25] Part of this effort involved trying to bridge analog and digital work. In fact, the Soviet computers even in the late 1960s were predominantly analog based, whereas digital computer and control elements in the United States were dominant. This led to transatlantic incompatibilities in which foreign computer hardware spoke, in essence, a different language. The Institute thus provided the means for technical translation between superior digital parts and larger analogy systems. Nonetheless, it was likely politically uncomfortable for the Institute to consider a full scale switch over to digital computer systems, given that the Institute itself, among others, the very active Director of the Institute (1947-1951),

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[23] Kassel, preface v.
[24] Kassel, Simon. Soviet Cybernetics Research: a prelimnary study of organizations and personalities, Santa Monica, CA, RAND, 1971, Pp. 3-5.
[25] Kassel, p. 5, 1971.

B. N. Petrov, was largely responsible for pioneering work in analog systems in the Soviet Union. For instance, although the TsM-1 Special-purpose computer stands for "digital computer (Tsifrovaya mashina, or digital computer, in Russian), in fact it was a hybrid system with an analog-digital central processor, a theory of so-called "dual control."[26] In the end, it may have been the momentum of early Soviet successes in analog computing that prohibited the institutions responsible from adapting to the later exponential successes of digital computing.

Central Economic Mathematical Institute: From Economic Cybernetics to Optimal Planning

The main website for the Central Economic Mathematical Institute reads (as of the date of publication) "When the Institute was founded in 1963, its main goal was to elaborate the theory of optimal management of the economy, applying mathematical methods and the use of computers to the task of practical planning." In other words, CEMI is remembered today for its spearheading the charge toward optimally planning with computerized and mathematical models the Soviet socialist economy.

Yet, the claim on the website is not historically true. In fact, according to its founding documents, the Central Economic Mathematical Institute (CEMI) was established in 1963 by the Communist Party, and a year later was designated by the Academy of Sciences, USSR as the primary agency charged with the "theoretical and practical implementation of a single, automated, nationwide system of economic control."[27]

The theoretical element consisted of designing a comprehensive mathematical model for the whole of the Soviet economy, while the practical element including leading the creation and integration of nationwide lattice of economic information networks connecting computer centers. Such a "unified information network" would allow project managers, industrial leaders, local accountants, virtually anyone with the technical training within the reach of the network to submit and receive economic directives. It was a "bold, romantic" founding vision, as the Institute's Scientific Secretary Aleksandr Stavchikov, (Uchyoniyi Sekretar', СТАВЧИКОВ Александр Иванович) put it in interview forty years later.

An Economist's Vision of Communist Self-Government

The actual person responsible for that bold, romantic vision seems to have been, at least in the case of CEMI, the mathematical economist Vasilly Sergeevich Nemchinov who—after founding a small laboratory in Novosibirsk in 1958 called the Laboratory of Economical Mathematical Methods—appealed to the Ministry of Finances in January of 1962.

In his proposal letter, Nemchinov wrote that the transformation of the Soviet economy from socialism to communism now depended on, "optimal plans for the nation's economy." But what he meant by "plans" was less "optimal planning" than an ideal plan for connecting the economy by computers itself. He wrote, "the modern mathematical methods and the means of mechanization and automation" were necessary to manage the complexity of a massive nationally economy. His letter appealed to the fact that, earlier in 1962, the President of the Soviet Academy of Sciences, A.N. (sp?) had called for "the transformation of economics into an exact science in the full sense of the word." It also underscored an interpretation of cybernetics

[26] Kassel, p. 5-6, "dual control," 18,

[27] Kassel, p. 86.

as means for governing a society by noting that "after World War II these methods were reopened in the West and were applied extremely widely to monopolistic government planning." He continues to mark that cybernetic methods have been applied "in the internal planning of the most developed capitalistic countries," creating in the process a competition void out of thin rhetoric. (In fact, the evidence that the United States used cybernetics to plan any part of its internal government is thin.) He proposed that at the present day "not a single scientific point"—which he replaced with "center"—stood ready to "guide and coordinate research in their field" in all of the Soviet Union. A Central Economic Mathematical Institute, Nemchinov concluded, would fill such a hole.

The first known draft of this letter dates back to only several days after First Secretary Nikita Khrushchev spoke at the twenty-second Union of the Communist Party on the 18th of October 1961. (In his speech, Khrushchev issued a clear reversal of Stalinist anti-mathematical economics policy, and in turn, a call for economic cybernetics, in stating that "life itself requires planning and managerial leadership by means of scientific foundations and economic calculations.") In the first draft, Nemchinov proposed that the title of the Institute should be (not the present "Central Economic Mathematical Institute" but the "Institute of Economic Cybernetics." Although the term "cybernetics" did not make it to the final draft, the term appears very frequently in Nemchinov's official explanation of the Institutes' proposed research responsibilities, namely, "the wide application of cybernetics, electronic calculating machines and the regulating devices in production processes of industry, construction industry and transport, in scientific research, in the planning and project construction of calculations, in the sphere of accounting and management" (1959, 1, 7, 125, 11, December 1961).

By the "wide application of cybernetics" Nemchinov envisions something more than just working with "electronic calculating machines." He seems to have in mind a totalizing vision for the regulation of society. In a letter dated 17 November 1961 (one month following the XXII CP congress), for instance, Nemchinov declares with confidence that the Institute engage the following four projects:

1. "The development of a unified system of planned economic information, which work aims to improve planned information and documentation companies and (? Sovnarkhozakh)..., including work on "vnedrenie of modern calculating machines"
2. "The development of the algorithms for planned calculations based on the unified system of information.
3. "Dynamic modeling for developing the national economy."
4. Mathematical work to best construct "unified, centralized national economic plan" which in turn would developing "the communist form of self-government of the production units, the optimal composition of general governmental interests, every company, and every worker."[28]

These declarations by Nemchinov wed the second known (Kitov's was the first) Soviet proposal for a "unified system of economic information" and a declaration about the "unified, centralized national economic plan" as a means of developing a "communist form of self-government." It were as if, in the Nemchinov's Marxist-Leninist narrative, the computer and its scientists would be able to provide control and a common plan. Consider, for instance, that for Marx the

[28] RAN Archives: 1959, 1, 6, 106, "dokladnaya zapiska v Otdelenii", XXII s"ezd KPSS, 17 November 1961, by Nemchinov.

possibility of Communism in *The Civil War in France* would require "united co-operative societies…regulat[ing] national production upon a common plan, thus taking it under their own control, and putting an end to the constant anarchy and periodical convulsions which are the fatality of capitalist production."[29] "If such a society were to supercede capitalist societies" Marx continues, "what else would it be – gentlemen – except Communism, 'possible' Communism?" Drawing on powerful rhetoric of yet unaccomplished Communist self-government, Nemchinov foresaw in cybernetics the future of the Soviet economic state.

It is impossible to know whether the history of Soviet nationwide information networks would have been any different had Nemchinov continued to lead the Laboratory become Institute. We may never know, for he grew too sick to continue to his work in late 1962 and deferred in letter to the irrepressible Nikolai Fedorenko, a chemist and recent rising Academician, as the new Director of the Institute. Nemchinov died November 5, 1964, aged 70.

The Successes of a Failed Project: CEMI

Nemchinov's network project only made it as far as the first couple years into the lifespan of the Central Economic Mathematical Institute, and the plans behind that network proposal failed to develop to any significant degree. By 1966, three years after Nemchinov's laboratory became Fedorenko's Central Institute, the "unified information network" project had disappeared from the Institutes' stated research directives and goals. What began as a small laboratory devoted to the realization of a preconceived idea became, according to a RAND report, an "operational support agency" for the Gosplan, the Soviet ministry charged with planning the Soviet economy.[30] On the other hand, the capstone work of all CEMI work culminated in the ten-volume work published between 197? and 198? Titled "??[optimal planning something]??" and clearly reflects some early tendencies toward synthesizing capitalist neoclassical equilibrium theory with automated planning with the socialist aims of promoting equitable distribution of resources and socio-economic justice. It would be unfair to dismiss the entire Institute on the grounds of its failure to realize its founding network vision. Instead, I look to understand the Institute as an experiment in negotiating conflicting, and at times over-determined, logics of design, ideology, and institutional circumstances.

There are many reasons for the failure to realize this project: personalities, politics, cultural and design arrangements, and others. But in order to avoid some of the epistemological hazards of studying failure—namely, that wrong projects cannot produce right answers—some prehistory may be in instructive.[31] Fresh archival evidence helps fill a lacuna in the early history (1963-1973) and prehistory (1959-1963) of the Institute—and address questions of not only what inspired the Soviet imagination to apply cybernetics to socialist mathematical and management economics, as well as to address another aspect of the overarching theme of this chapter: why the attending network projects—Glushkov's OGAS, Fedorenko's SOFE, etc.—never came to fruition.

On May 21, 1963, following the 1962 XXII Congress heralding cybernetics in the service of communism, the Communist party decided to promote the small laboratory belonging to the Academician Vasilii Nemchinov, a friend of Glushkov, into a full-fledged academic Institute, to

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[29] Marx, the Civil war in France, pp. ??
[30] Kassel, p. 87.
[31] Gerovitch, cyberspeak, pp. on economic cybernetics;

relocate it from Novosibirsk (??check??) to Moscow as a result of the partial approval of Glushkov's 1963 proposal to build an economic network (OGAS) (Fedorenkno, 178). Nemchinov was already late in noted career as a mathematical economist known for his earlier work on mathematical optimization, and had run a small, innovative laboratory of researchers in Novosibirsk called the Laboratory for Economic-Mathematical Modeling.

The Laboratory begun in 1957 consolidated itself around the study of computer-assisted economic cybernetics. Or, as their yearly report shows, they purported to advance research fields in "mathematical programming," "dynamic model of balancing capital investment," and "economic cybernetics, or theoretical research in the region of the system of economic information as well as practical questions."[32] In other words, computers combined with a mixture of capitalistic and socialist terms, e.g. dynamic model for balancing capital investments.

The small group, included only a handful of researchers, including the younger Yuri Chernyak who Fedorenko cites as having some influence on persuading Nemchinov to adopt the economic cybernetics label (from which Fedorenko later regrets and distances himself).[33] Other staff grew to include by 1960 one academic (Nemchinov), three candidates of science, fourteen younger scientific collaborators, and six laboratory works. (In demographic terms, this translates almost as a rule into one older male, three tenured males, fourteen male doctoral candidates, and six female graduate students.)

The laboratory names its raison de entre (sp?) with a citation to the then President of Soviet Academy of Sciences, A.N. Nestomeyanovim calling for the transformation of economic sciences into "an exact sense in the full sense of the word."[34] Already by 1960 the small laboratory had the core cybernetic economic terms that would be transformed, and eventually drop the label "cybernetic," over the lifespan of the Institute until the collapse of the Soviet Union. There was work of "mechanized, digital receipts" being received by network, although not over long distances; of "balancing capital investment," "optimal schemes of stimulation," and "intersector balancing" through "optimal calculations" of "information and documentation." Throughout "balance" is a distinctly decentralized keyword the Laboratory (1957-1963) used to understand the dynamic processes and tensions involved in planning an economy nationwide. Balance is not a centralized keyword: it allows for other independent parts to hang from a dominant center, but given that balance is only possible given a fixed center, the term is clearly not a distributed keyword, either.

A visible error in an archival document illustrates this point about the dynamic difference between a purely centralized system and a decentralized system viewed from the perspective of the center. In 1960, the Laboratory report replaces the word "point" with the word "center." This by itself is not revealing until placed in context:

> In recent years these methods [of mathematical, computer-assisted planning] began to develop widely in the USSR and in other countries of the people's

[32] RAN Archive: 1960, : V Byuro otdeleniya ekonomicheskikh, filosophskikh I provavikh nauk AN CCCP, Sept 17, 1960.

[33] Fedorenko, p. 167. See also RAN Archive above.

[34] XXII Union of the KPCC. Nestomeyanovim. : "vyistupaya na XX s'esda KPSS, president Akademii nauk SSSR akademik nesmeyanov A.H. vidvinul zadachu prevrashcheniya eknomiki v tochnyu nauku v podlinnom smyisle etogo slova. Takovoi ona mozhet stat' tol'ko pri uslovii ispol'zovaniya matematicheskikh metodov I sovremennoi vychislitel'noi tekhniki."

> democracy. However, although hundreds of various types of economists and mathematicians from varying academic and practical organizations are already working in this field, in the USSR there is still not a single academic ~~point~~ center which would be able to lead and coordinate research.

The decentralized term, a *center*, can lead and coordinate research; strictly speaking, the singularly centralized equivalent, a point cannot. A "center" is also, more often than not, an academic euphemism in both the United States and in the former Soviet Union, for a single scholar with a plan, a number of listed contacts, and maybe an assistant.

When the Communist Party decided in May 1963 to promote the laboratory into the full-fledged Central Economic Mathematical Institute (CEMI), it did so by bringing under its aegis of influence faculty members, staff, and resources from the economic mathematical the Laboratory of Programming at the Computational Center for Mathematical Groups, the division of Trasnportational Cybernetics, the Institute of Complex Transportational Problems, and others divisions under the Soviet Academy of Sciences. In all, the Institute had, from its beginning, six divisions, including 26 laboratories and one shared off-site computer center. That same Spring, the young rising academician Nikolai Fedorenko replaced Vasillii Nemchinov as the prospective candidate for the directorship of CEMI to be opened that Fall. Nemchinov's health was failing after 69 years of life, and he died the next year.

In the first couple years, 1963-1966, the Institute proudly proclaimed that among its many tasks, "one of the most important" was, according to Nemchinov, "developing the theoretical foundations of opimtal planning and management in the aim of guiding the unified mathematical model of socialist economy" (edinoi matematicheskoi modeli nardonogo khozaistva).[35] Fedorenko went on to explain how the goal of such a model should be to provide the "maximal udovletvoreniya" on every level of the socialist economy. The modeling of the economy had to be "optimal" by being "tightly bound by constant perspectival and current planning." [36]

What happened? Why did Nemchinov's plans and Fedorenko's proposal in 1964 never come to fruition? One partial explanation is simply the change in leadership. Nemchinov (????-196?) carried with him a career expertise of leading work on the mathematical optimization of the economy and, subsequently, a naturally bright vision of a "unified information network," while Fedorenko, who became the dominating personality and considerable influence as the first Director of the Institute for decades after, was in fact by training a chemist and had no visible education or experience in computer technology or automation. He had, in short, everything but the cybernetics part. Much of Fedorenko's work at the Institute—he co-authored over 150 scientific papers in the first few years of the Institute—bore directly on optimizing the economics in the chemistry industry. Fedorenko was many things: a very young Academician (appointed at the tender age of 43), the career Director who kept CEMI at the cutting-edge of research (regardless of its costs), a director of the chair of Mathematical Analysis in Economics at Moscow State University, professor of the chair of the Economics of the Chemical Industry,

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[35] RAN archival notes, p. 5-6, red text. New document: 1959, 1, 101, index 170, "istoricheskaya spravka o geyatel'nosti instituta s 1963 po 1966 g. by director akad. Fedorenko, writing in 1966 for the 50 years of Soviet power academy celebration.

[36] See RAN fn. 13 above.

Chairman of the USSR Academy of Sciences' Scientific Councils on the Complex Problems of "Optimal Planning and Management of the National Economy" (as of 1967) and "Economic Problems in the Introduction of Chemical Processes into the National Economy," Deputy Academic Secretary of the Depatment of Economics of the USSR Academy of Sciences, Editor-in-Chief of the journal *Economics and Mathematical Methods* and on the boards of journals pertaining to the Chemical Industries, as well as a member of the following institutes in Moscow: the Rezinoproyekt Design Institute (which deals with rubber technology), M. V. Lomonosov Institute of Fine Chemical Technology, and the Scientific Council on the Complex Problems of Cybernetics.

Yet for all that Fedorenko clearly was—a natural leader, an attractive personality, a practiced over-exaggerator, a political negotiator, and self-promoting survivor in challenging times—he never seemed fully persuaded by the value or fundamental interest in computer networks as a means for organizing or regulating the economy or society. In characteristic self-promoting stride, Fedorenko recalls in his 1998 memoir the whole importance of the Institute's early work on networks, namely:

> [By 1965] we had already carried out a whole row of experiments, having connected our Moscow-based "Ural-14" with the powerful computer "BESM-6" which stood in the Leningrad Division of CEMI, but then that fell through. Observing today the development of electronic information networks, including the intercontinental ones like the "Internet" and others, I remember with melancholy the first developments we undertook—I emphasize—*first in the world*.[37]

Unfortunately, Fedorenko adds no detail to the claim, so it remains unsure what exactly they attempted, let alone accomplished. It is clear, at least, that his claim to being first is wholly unfounded, given the fact that AT&T developed in 1960 its Dataphone modem for transmitting digital computer information across pre-existing long-distance telephone national and global networks. By 1964, IBM's Sabre reservation system built for American Airlines was connecting consoles in 65 different cities to a pair of IBM 7090 computers. Early conceptual innovations also took place in the early 1960s at Bell Labs, which, according to an internal history, began applying the data bus approach for transmitting information among the subunits within a common computer to larger computer systems and computer-output equipment and interfaces between computers. E.H. Cook-Yarborough, who was visiting Bell Labs from the Atomic Energy Research Establishment at Harwell England initiated this approach seemingly before Fedorenko's Institute tried to connect computers over long-distances in 1964 and 1965.[38] In either case, Fedorenko's claim testifies to both the incredulity of his self-reporting and the irrepressibility of his enthusiasm for the Institute.

In 1964, Fedorenko delivered a comprehensive report on the activities of the Institute since it's founding one year earlier. In it, he emphasized that "while in capitalistic economies the development of industry is regulated by the market, the Soviet economy should be regulated by a scientifically based plan and not by arbitrary decisions, even if submitted by experienced specialists." The implementation of automated economic information processing would reduce

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[37] Fedorenko, N. P. *Vspominaya proshloe, zaglyadyivayiu v budushchee*, Moskva: Nauka, 1999, P. 179

[38] *A History of Engineering and Science in the Bell System*, S. Millman, ed., AT&T Bell Laboratories, 1983, p. 293

the planning periods, increase accuracy, and will not proliferate the number of clerical workers in industrial management, which he (over-)estimated as occupying over 12 million people, nearly six percent of the entire Soviet population. He also claimed that in a report to the Presidium of the Academy of Sciences, USSR, that since its founding the previous year, "the Institute also conducts work on the creation of methods of optimal planning and management of transportation in the country. Over 1000 optimal plans for transporting freight, using various means of transportation, have been computed. The savings of this work have already reached about half a billion rubles."[39] This seems unlikely, to say the least. In his memoir, Fedorenko reports a stark difference between CEMI's successes at planning macro- and micro-level economic objects. The number of total successes planning and analyzing any economic actor larger than a single firm, he writes, "can be counted on one hand" (which one wonders is not in fact a euphemism for zero). On the other hand, CEMI produced, Fedorenko claims, scores of optimally planned models for individual firms.

While these hyper-heated claims may be suspect, they can also be revealing in how they change over time. To wit, the overriding research directives of the Institute decreased in number in the first few years of growth, 1964-1969. In 1964, they were six:

1. The development of a theory of optimal planning and management to a unified mathematical model of national economy
2. Development of a unified system of economic information
3. Standarization and algorithmization of the planning and management processes
4. Development of mathematical methods for solving economic problems.
5. Design and creation of a unified state network of computer centers
6. Derivation of specialized planning and management system based on mathematical methods and computer technology.

However, by 1969, five short years later, Fedorenko had paired down the number of research directives at the Institute to three:

1. Development of systems theory for optimal national economic planning
2. Development of automated systems of planning and management
3. Analysis of a specific set of problems of national economic development for 1971-1975, and forecasting economic growth for a longer period of time.[40]

Although the match is not perfect, it is clear that three components of the 1964 initiatives are missing. Most notably, there is no mention of any unified state network of computer centers. As one analyst noted in 1971, "the most conspicuous feature of the latest version is the absense of any reference to the unified state network of computer centers. Also also is the proposed system of economic information. The projects, representing research on the methodology of economic analysis and organization of new operational systems, are replaced by work on economic projects, a much less innovative and more conventional activity."[41]

The "unified information network" was in fact romantically global, to paraphrase the Secretary of the CEMI in 2008: it is easy to dismiss CEMI's failure to design and build a

[39] Fedorenko, N. P. Vestnik Akademii Nauk, SSSR 10, 3-14, 1964.
[40] Ek. Gaz. 7, 15, 1969. See also Kassel, fn. 51, pages 97-98, fn 51. page 196.
[41] Kasel, p. 98

nationwide network as a natural consequence of a restrained financial and cooperative budget, in favor of CEMI's later specialization in industry-specific theoretical optimal planning work (CEMI research, as of the late 1960s, settled into tracks devoted to planning work in mixture of chemical, automated economic planning, agriculture, production control, transportation, radiobiology, and mathematical disciplines and industries).[42] More easily missed, however, is also the lack of any mention in 1969 of mathematics, methods, modeling, algorithms, standardization, or any of the other computer-theoretical work. In short, in 1969, all traces of cybernetics had left the very fledgling Institute that, just five years earlier, was being considered for the title, "Central Institute for Economic Cybernetics."

One should not be too quick to judge Fedorenko for his early ebullience, after all the Presidium of the Academy of Sciences, USSR, officially approved and even enhanced the first listed avenue of research—"the development of a theory of optimal planning and management to a unified mathematical model of national economy" was, the Presidium added, "one of the main directions of developments in modern economic science."[43] In the first few years, his annual reports conclude with unqualified claims about the "development" of theory and "experimental verification" of work in all areas described. Yet, as the unified network project became less and less feasible, and attempts to collaborate across ministries were beached against the rocky shores, Fedorenko does take some responsibility for keeping his Institute afloat, even at the cost of cutting all ties with the project that originally gave it wind.

The distinction is interesting, for, in principle, Soviet cyberneticists did not expect the cybernetic modeling to perform any differently for macro- and micro-level analyses. If the varying substrata are parts of an integrated system, the theory holds, then any success enjoyed in understanding one part should apply to the other. The theory thus pacifies the realities of unequal and unfair resource distribution by offering the psychological comfort that, in theory, the system is seeking a balance of justice, or social equilibrium. In fact, the system was perhaps never as functionally cybernetic as both its staid planners and reformers hoped. The cybernetic impulse is both the good fit and the source of failure of the design of Soviet experiments in moving from a planned to a programmed socialist economy between the 1960s and the 1980s. This impulse beats strong in the larger design of the economic networks themselves: economic cyberneticists systematically attempted to comprehensively plan a hierarchically organized economy presumably based on the popular belief that the symbolic tools of cybernetics allowed Soviet cyberneticists to translate up and down through various substrata of the hierarchical economy with theoretical easy. This trouble with totalizing system logics will be explored below.

The Unbalance Funding of the Central Economic Mathematical Institute

Patterns of financing and funding also play an important role in the history of the Central Economic Mathematical Institute as well as the stillborn project that was its Soviet economic network. Neither personalities nor conceptual tensions can fairly bear the burden of blame for the failure of the Soviet cybernetics to develop civilian-use computer networks. One more fundamental fact is that of unbalanced funding. It is a fitting problem to note that the unified nationwide economic network, which would be charged with regulating the transfers of financial information, was never founded, in large part, due to the recursive fact that the financial actors at

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[42] Kassel, p. 103-106
[43] Kassel, p. 94-96.

the time never agreed on how to divide up the responsibility for funding the common network itself. We may call it the self-fulfilling problem of establishing economic protocol.

In short, every ministry wanted competitive control over the network, and thus refused to share its resources with the other ministries responsible for developing and using the network basis. Ministries were, without a governing central body to enforce cooperation or to set the standards of interaction, simply unwilling to cooperate with their neighbors.

Particularly and oddly, economics enjoyed less prestige than other departments in the military. When Fedorenko approached the Ministry of Defense in 1965 to discuss the possibility of combining their potentially compatible (i.e. hierarchically organized, large-scale) computer networks projects, an hour of conversation passed before the Minister of Defense Bagramyanu replied with the following:

> "You are good men, and you are doing right by concerning yourself with the economy of the people's money. But I cannot help you." He explained, "my friends, the state gives me as much money as I ask for to build the technical basis [of the network]. As far as I understand, they give you nothing. If I were to cooperate with you, they would give money to neither me nor you, since there is that opinion, that economics is a scab on the healthy body of the governmental mechanism for planning and management."

Other Soviet leaders also proved uncomfortable with algorithm-planned economics, which introduced the idea of automating equilibria (be they capitalist free market-driven, or in this case the algorithm-driven balancing of inputs and outputs), and a clear challenge to that Marxian ideal of social justice that the state oversee, predict, and proscribe the economic needs of its people. Glushkov's original proposal draft even suggested that currency itself could be done away with--luckily for him, an adviser instructed him to submit that part of the proposal to the Communist Party separately. The proposal was approved, but the funding never followed.

In the early years the Central Economical Mathematical Institute, on the other hand, enjoyed a destabilizing flush of funding. It is disingenuous to ascribe the failure of CEMI to develop the economic network purely to the lack of funding. In fact, the Institute originally charged with seeing through Glushkov's proposal suffered from a sudden massive influx of funding devoted to optimal planning in the early years.

1959-1963	1963-1973
Novosibirsk (Siberia)	Moscow
18 employees	1000 + employees
4 laboratories	40 laboratories
0 computers	1 computer center
1 stated project (the economic net)	100+ projects (absent: an economic net)

By August 1963, the Nemchinov's (a colleague of Glushkov and Kantarovich, who won the only Soviet Nobel in economics for his equilibria-related work) small laboratory from Novosibirsk charged with building the network had formally relocated its four laboratories and 23 employees to Moscow, where it quickly multiplied into an institute with 700 employees and 40 internal divisions (six departments, 30 labs, and a computer center with three labs shared with the Soviet Academy of Sciences in Moscow). The Institute did not get its own computer until the late 1960s, when the Institute also occupied a 22-story building built for it (Fedorenko, p. 260-9). At the beginning of the 1960s, the average age of its full-time faculty was about 26, and ten years later when the Institute reached a 1000 employees in 1973, the average age was still a youthful 34--most of the staff was still intellectually flexible—and ready for new ideas, even when the original ones had more potential. As personal correspondence suggests, in the beginning the Institute was a lively and energetic place, full of critical-aligned, yet hopeful young economists and scholars. The workplace spirit was creative and collaborative, enthusiastic and ultimately shortsighted. In ten years, it had grown to nearly 40 times the size of the original laboratory (from Nemchinov, Kantarovich, and 16 candidates, to 1 academic, 1 corresponding member, over 40 doctors, 170 candidates of science, and hundreds of graduate students and supporting staff); and most of that growth took place in the few couple years.

As archival digging confirms, the Institute was designed in 1962 and 1963 on the early vision to create a nationwide computer network necessary for sustaining the national economy, however, as soon as 1964 and certainly by 1966, it had already shifted gears, and there is little to no evidence in their files of self-consciously going about building a network project. Instead, the bulk of the work had switched to not the network but the theoretical modeling necessary to compute and manage such massive economic data flows.

Herein lies the irony of sudden funding, for not only can its absence make projects impossible but its presence can also distract. What began as a technical problem in need of funding--a network--became an ideologically driven solution--a programmed (not planned) socialist economy; in a sense, the channeling of funding through specific, politically-shaped ministries and institutes ensured that the network project to bridge them would ever be overlooked.

The historical content of this chapter aims to reinforce, expand, and reframe Slava Gerovitch's original and forthcoming work on the subject. He reminds us that, like the US and the UK, the Soviet state envisioned computers as a "policy instrument" for casting military purposes and projects. However, unlike the US state, which supported only the technologies, and left the innovation of new uses to private companies, the Soviet state--lead by cyberneticists--insisted on building "an organic, feedback-controlled system" "by decree from above" (Gerovitch, conclusion). Arguing that the political struggle between ministries to secure funding and to preserve personal power, Gerovitch points out the paradox that, "[Soviet leaders] argued against gradual growth from below, since individual parts would not function efficiently without a comprehensive nationwide system, and a piecemeal approach would only conserve existing practices. But a nationwide management system, any individual part of which was not viable, could not be viable itself." What could have been a "network," he argues, ended up a "patchwork" (Gerovitch, unpublished draft, p. 12, 13).

By focusing on the hierarchically decentralized nature of the Soviet political and technical structures--and how that may bear out in terms of power-maximizing bottlenecks between administrators, and structural biases against power sharing projects between ministries, to say nothing of the sheer demands of designing compatible levels within a system that is both hierarchically designed and comprehensive across the largest country in the world. In short, the attempt to construct a viable whole out of summary of inviable parts, or to build an organic whole from above--as the natural result of decentralized perspective adopted (and structurally implicit) in both the politics and the design of the Soviet Internet project—was folly.

The prevalence of cybernetic analogy making, I argue, helps backlight the other administrative and political reasons the Soviet computer networks were decentralized. According to unpublished notes of the TsEMI historian, whose institutional beginnings we will touch on below, “the romanticism” of the Institute charged with realizing the first non-military Soviet network, was the “globality” of its first scientific plans and inventions. Because it was clear from the beginning that any attempt to plan every detail of the national economy would be “doomed to failure,” the TsEMI historian continues, “it was decided to plan the country’s unified information network hierarchically—just as the economy was planned in those days.” The explanation to our question--why the hierarchical structure--ends there, with nothing more than an analogy, a precise analogy, between the hierarchical structure of the economy and the information system that would someday support it.

What then went wrong? Why did a non-military nationwide network never get built? My answer today frames two obvious reasons--the power hoarding of both funding and information (data) within ministries--under one larger frame: the alignment of decentralized politics and power-sharing in both the design of the network and Soviet state and society itself. Both the ideologicalization of the network project, and of the administrative conflicts of interests that failed to fund the project, I suggest, can be understood as a function of decentralization power structures.

Why, then, did a decentralized design fail the Soviets in both technical and political senses? the basic difference lies in the scale and position of one's perspective necessary to plan, build, and carry out a hierarchically decentralized and a distributed network project: to build a decentralized network, one needs both a comprehensive and a local blueprint of the project. Purely distributed networks, on the other hand, can be perceived and built locally. In the Soviet case, the proposed nationwide economic network (SOFE and OGAS) failed to work due to both the technically and the politically comprehensive perspectives its designers adopted. From the outset, the project was to build a grand network for collecting, managing, and programming the whole of the Soviet socialist economy. Similarly, the network was designed from step one as a collective, multi-tier, hierarchical whole, rather than, as in the case of the ARPANET, a localized, arbitrarily expandable network of packet-switching neighborhoods. Both US and Soviet (UK and Chile as well) used computer networks as policy tools. In the US case, the invention of packet-switching and distributed networking was, as Paul Baran emphasizes, a technical solution to a simple motivation: to make a computer network that would survive. The Soviets, in contrast, held in mind a grand political ambition: to design a comprehensive information network capable of monitoring and managing the whole of the socialist economy.

The Unregulated Competition for Bureaucratic Power

[Insert section about unregulated competition for power between ministries. Information networks are powerful. Theorize the soviet state as an internal quasi-market, in which individual actors attempt to maximize power, not profit. Compare to military successes, and internal competition. Speculate on why the military internal markets succeeded, and the economic internal markets failed. Map the widespread (i.e. decentralized) responsibilities for managing of the political economy of multiple ministries and Academic Institutes. Compare that to the closed (i.e. centralized) management of military projects.]

Conclusion

This chapter has examined how the Soviet economic networks differed from the ARPANET. It has suggested four fundamental factors at play in explaining the failure of the Soviet Union to develop an independent computer network contemporary to the ARPANET. The factors advanced in the preceding chapter include:

1. Ideological entrenchment of purposes
2. Unbalanced funding flows
3. Pervasive cybernetic logic of hierarchical design
4. Unregulated competition for management power

[Restate and develop each here.]

The chapter's comparison would be incomplete, however, without stressing ways in which the Soviet economic network and the early ARPANET period (1959-1969) were similar:

1. The motivation of long-distance communication,
2. The need to optimize the group advantages of networks (net effects)
3. The need to meet external military mandates.

Scientists at both sides of the Atlantic began to conceive of the problem of establishing a national computer network as a fundamental communication problem as early as the late 1950s. In a recently published 1963 memo, for instance, J.C.R. Licklider, the Director of Behavioral Sciences Command & Control Research and head of ARPANET finds himself plunged into "the middle of complexity" in discussing the problem of intra-network computer language compatibility. "Is it not desirable, or even necessary for all the centers to agree upon some language or, at least, upon some conventions for asking such questions as "What language do you speak?" He continues, "At this extreme, the problem is essentially the one discussed by science fiction writers: 'how do you get communications started among totally uncorrelated 'sapient' beings?'"[44] Communication implies some agreed upon standards for organizing and correlating interaction between intelligences, but how does one set standards without some common code for communication in the first place? The recursiveness of signal confirmation--one has to assume that the confirmation means the same thing to you as it does to its sender--is an ancient problem of knowledge-sharing, one exemplified by the analogy of the computers as sentient but alien species and the network as the site of first contact. Unsure what to name the larger intellectual problem at hand, Licklider jokingly titled the memo, "Memorandum for Members and Affiliates of the Intergalactic Computer Network" and in a few key strokes gave it immortal place in the halls of computer fame.

A common solution to the intractable problem of network communication standards common facing both the Soviets and the American engineers was a default privileging of the advantages of the group over the individual. Licklider refers to the initiative of "group advantage"--although he readily admits it is difficult to determine what that might constitute (Licklider, 2). "Group advantage," however, is the natural ideological bedrock of socialist society, and the Soviets were much better prepared to perceive and praise the collective advantages of a computer network. The difference lies not in the advantages of socialist thought, however, but in the selection of the perspective from which to view and design the network. Licklider suggests in his memo that the work begin from the individual user's point of view. "It seems easiest to approach this matter from the individual user's point of view--to see what he

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[44] Licklider, "Memorandum for Members and Affiliates of the Intergalactic Computer Network," 1963.

would like to have, what he might like to do, and then to try to figure out how to make a system within which his requirements can be met" (Licklider, memo). All available record of the attempts to build a Soviet Internet, or a nationwide computer network, however, share one common approach: the God-like view of the whole network. The network design began for the Soviets, beginning with the architectural vision of Glushkov, adopt the most extreme perspective a group can have: that of the total network constituted by the group. [Soviet quotes of Glushkov on two or three-tiered systems here.]

It is essential to note, however, that Licklider and his company did not set the foundations of the Internet in complete contrast with the Soviet Union: the American design began not only with the user or individual in mind and the Soviet design did not begin only with the Soviet Union or collective in mind. For Licklider, rather, the progression proceeds from the individual user's point of view until all major obstacles are resolved, and then it switches to what calls, with a tip of his hat to William H. Whyte's 1956 bestseller and sociological critique of corporate America, the concerns of the "conscientious 'organization man' (Licklider, 5 of 7, memo)." The view point of such a conscientious organization man, according to Licklider, is one that favors "the general guidelines of the network for naming programs" and "matters of program libraries and public files of useful data." It was the eventual invention and adoption of a minimum unit of network communication--in this case the packet and packet-switching controlling protocol, or Transmission Control Protocol, or TCP/IP--that has standardized modern complex network communication.

As cyber scholar Jonathan Zittrain notes, the bottleneck in modern network data transmission is also the source of its interoperability, a well-understood term he more or less renames "generativity." The TCP Internet Protocol itself generates degrees of transmission freedom by ensuring all data transfers conform to its rules. It is the gatekeeper; no data in a TCP/IP network can pass through it without conforming to its constraints. It should be noted that packet-switching and TCP/IP are importantly neither open or closed models of communication: in fact, it is both at different points along the network. In terms of pathway selection, information packets flow freely, while at the ends of the networks manage the packets very closely. Control, on the one hand, exists at the ends of the network and within the uniformity of packet protocol; packets are uniform, dispensible, and cheap: receiving nodes are constantly requesting missing packets and discarding redundant packets; and any recurrent deviation or failure to properly distribute or receive packets disables the whole node. "An ideal electrical communication system," network innovator Paul Baran describes in the introduction of his report written for the US Air Force, "should effectively allow the illusion that those in communication with one another are all within the same soundproofed room—and that the door is locked" (ARPANET, 51).[45]

The Soviet Union and United States also built their first networks under military mandates. While recent researchers have emphasized the open, collaborative, and flexible nature of the early 1960s DARPA (Hauben), it is hard to underemphasize the important role the US military mandate for a computer network capable of surviving a single enemy missile strike had

[45] The science that enabled a network to manage chaotic sending and receiving of packets between nodes while still maintaining order within the packets is touched upon in the optimization modeling and stochastic (or probabilistic) sequencing in chapter 2.

on the very early insights—namely how to transmit very little data between two distant computers—that shaped the ARPANET.

Network single-strike "survivability"—not to be confused, as often is, with long-term network "robustness"—was a driving concern for RAND network scientists in the early 1960s. Of all the criteria for addressing military communication, Baran writes in 1964, "Survivability was placed at the top of our list" (ARPANET, 55). The task was to build a network that could withstand heavy and nuclear attacks. "It was the height of the Cold War," Baran recalled in interview, referring to the motivations of his research at the time: "There were threats going back and forth, and we were entering the Cuban missile crisis (October 1962). They were crazy times." He then added that he did not consider packet switching "as any great achievement" but rather "the only solution I could think of for survivability" (ARPANET, 3, from Philadelphia Inquirer, 5 May 1999).

Baran writes "since destruction of a small number of nodes in a decentralized network can destroy communications, the properties problems, and hopes of building 'distributed' communication networks are of paramount interest" (ARPANET, 14). Node destruction was an acute Cold War research problem, for while hardware failure could cause "noise" randomly throughout any network structure, defensive strategies against "worst case" enemy targeting of nodes required a more robust network than the decentralized model offered; in early 1960s DARPA research, this meant that researchers assumed from the outset that 40% of the nodes and links (rented telephone lines) would be destroyed. The need for "survivable communications" was a base order working assumption of early 1960s engineering (Abbate, 9).

In the early 1960s, the motivations at RAND were to secure the transmission of "the go code," a brief and encrypted order to annihilate the enemy sent to all nuclear forces on land, air, and sea, as a requirement of the (shared) national policy of mutual assured destruction—a Nash equilibrium deterrence strategy meant to ensure that neither side would attack in order to avoiding worst case scenarios. The "go-code" requirement, liked the packet-switching innovation that made it possible, emphasized dissemination across distances; the network was not originally intended for dialogue, or even sending a reply message. "There was no return path for communications from the forces to the command structure" remarks Willis War, a senior RAND computer scientist, "there was no intent to use the arrangement to prosecute a lengthy war" (ARPANET, 71). Thus, while the eventual development of the network led to grander scales of endurable digital message transmission, what was to become the Internet began as little more than the national policy goal to get a short message out: "Go." (The actual message would have also included a brief timetable for attack.)

In 1959 Paul Baran, then a young engineer at Rand's computer science department, began developing a system that could survive long enough to deter preemptive military first strikes. In 1990, he reflected that "a more stable position" was not "a wholly feasible concept, because long-distance communications networks at that time were extremely vulnerable and not able to survive attack" (Baran 1990, p. 11). As Janet Abbate notes, although Baran in 1990 justifies the concept as part of his community's concern to avoid war--writing "I never encountered anyone who deserved the Dr. Strangelove war monger image so often unfairly ascribed to the military"--he began his 1960 paper by, Abbate writes, "explicitly characteriz[ing] his proposed network as a tool for recovering from--rather than forestalling--a nuclear war." Baran wrote "The cloud-of-doom attitude that nuclear war spells the end of the earth is slowly lifting from the minds of the many.... It follows that we should... do all those things necessary to permit the survivors of the holocaust to shuck their ashes and reconstruct teh economy swiftly" (Baran, Paul. 1990. Interview by Judy O'Neill, Menlo Park, California, 5 March. Charles Babbage Institute).

It should be noted that flexible communication networks--and the central innovation of packet-switching--seems a natural outgrowth of a low-content communications system, however it is not a necessary feature of network evolution. Paul Edwards documents "Flexible-response strategy required that political leaders continue to communicate during an escalating nuclear exchange.... Therefore, preserving central command and control--political leadership, but also reconnaissance, data, and communication links--achieved the highest military priority" (Edwards, 1996, 133). Moreover the innovations of combining survivability with high capacity into what he called "distributed communications" came through more specific set of circumstances. In non-distributed communications systems, such as telegraphy or telephony systems, the nodes at which information switching occurs are organized in centralized and hierarchical fashion. Calls or signals are placed from one local sender to one and only one other local center, or switching node, which in turn passes the message to one and only one other regional office, and the signal proceeds in a directed singular fashion until it reaches its intended destination. Each possible message sender-receiver relationship possesses one unique pathway. The conventional signal routing, however, was very vulnerable to disruption.

Thus, the irony is thick that Paul Baran's inspiration behind seminal innovation of packet-switching that gave birth to the moderns flexible, open-ended ideals of computer network communication such as the end-to-end principle was based on the military strategy of mutually assured destruction. The problem was malicious: how do we build a network that can ensure the total annihilation of humanity in the event of a first enemy strike? The solution was magical: make the network flexible. In short, the reasonably titled MAD is not only the mid-century expression of complete rationalistic vengeance (even in the absence of the strategists behind the system)--it is also partially responsible for inspiring what the technological innovation that openly connects the modern networked society. Although it is convenient to forget the malice that inspired the magic, the refresher is worthwhile as it draws out two important sides of the historical unpredictability of innovation and policy demands: one, that technical solutions to political problems do not need to have any of the same class, character, or consequences--brilliant technologically dependent principles have been raised on the backs of malicious military strategies--and two, that the technologists and policymakers themselves involved in the construction of the network may not have been openly or even willfully committed to forward the military strategies.

In summary, what does the Soviet story teach us, if anything? So what? The Soviet story corrects (at least the vocabulary of) the conventional critique of the Soviet Union as a centralized (rather than decentralized) entity. Traditional Western Russian specialists theories--strong man theories, political centralization, Russian conservatism, etc.--do not sufficiently recognize that those arguments are only possible assuming that a purely centralized system, state, or society in Russia is impossible. The argument for decentralization to be the baseline assumption about Russia, if anything, credits the other truism about Russia: that it is big. True centralization is a geographic impossibility and this suggests that the multiple layers of periphery in the decentralized architecture (from the privilege of Akademgorodok, St. Petersburg, or Kiev, to the quietly interesting corners of Tartu, Estonia, to the utter exile of farther east Siberia) will continue to matter as long as Russia remains big. To understand its history, we must think like Russia did and pay attention to the overlapping layers of periphery and power.

This chapter also corrects, or at least begins to suggest reason to suspect, present-day enthusiasm for any residual hierarchically decentralized (rather than vertically distributed) power structures and organizations. To learn not to think like the Soviets did, however, we might begin to think of systems at a local level to discover insights such of packet-switch routing as neighborhoods. Interestingly, Fedorenko stated the number of successes TsEMI enjoyed at programming economies at the macro-level "could be counted on one hand"—while at the firm-level of analysis of smaller, he reports hundreds of successes over several decades of work. Networks based not on decentralized or centralized distances and direction between nodes, centers, and borders but instead expressed in terms of a local action that can be repeated anywhere within that system may stand to enjoy more success in a world of digital communications.

It may be useful in closing to note that all naturally or man-made systems are, to some degree, hierarchically decentralized (centralized and distributed networks are static, ideal types, asymptotically unreachable endpoints on a continuum of natural reality). Those in the twentieth-first century West, then, have much to learn from the failure of the Soviet Internet because we are bound, despite the obvious and extreme differences, to recognize the same structural conditions of hierarchical decentralization about us all.