1 A Global History of Cybernetics

I am thinking about something much more important than bombs. I am thinking about computers.

—John von Neumann, 1946

Cybernetics nursed early national computer network projects on both sides of the cold war. Cybernetics was a postwar systems science concerned with communication and control—and although its significance has been well documented in the history of science and technology, its implications as a carrier of early ideas about and language for computational communication have been largely neglected by communication and media scholars.[1] This chapter discusses how cybernetics became global early in the cold war, coalescing first in postwar America before diffusing to other parts of the world, especially Soviet Union after Stalin's death in 1953, as well as how Soviet cybernetics shaped the scientific regime for governing economics that eventually led to the nationwide network projects imagined in the late 1950s and early 1960s.

The term *cybernetics* evades easy definition. Today there are still more self-identified cyberneticists in the world than available definitions of the field, although the first tally is dropping as the second tally creeps slowly upward. In the English-speaking information science research environment, cybernetics failed to cohere as an institutionalized field, a fact that partially explains the inability of specialists to agree on a definition for the field. And yet the definitions are no easier in the territories of the former Soviet Union, where cybernetics did take root and still enjoys institutional recognition fifty years later. To this day, the definition puzzle holds: the postwar science remains a rich subject for critical inquiry precisely because it has escaped a clear-cut characterization.

Since the mid-1940s, cybernetics' themes of communication and control in computational biological, social, and symbolic systems have inspired and bedeviled researchers across the natural sciences, social sciences, and humanities. Accounts have identified cybernetics as a science of communication and control, a universal science, an umbrella discipline, a Manichean science, and a scientific farce founded on sloppy analogies between computers and human organisms.[2] Against its interdisciplinary backdrop of a computer-compatible formulation of communication, scores of scientists, philosophers, and policy makers advanced the midcentury computer as a tool for modeling systems and specifically for the regulation of information flows and behavior in the animal, the machine, and society. In addition to computer modeling, it gathered together preexisting concepts such as feedback loops in control systems, cooperative human-machine relations, and some foundations for the network design of digital computing. In the information sciences, it formalized midcentury mind-machine analogies that continue to animate some corners of contemporary artificial intelligence research. In the hands of polymaths such as Norbert Wiener, Warren McCulloch, and Donald MacKay, the technical and technocratic insights into a summary set of cybernetic sciences—operations research, systems theory, game theory, and information theory—presented themselves with seemingly cosmological force, delivering balance to a postwar world riven by rage.

Modern computing talk owes a fair amount to these cybernetic sciences as well. A visible contribution of cybernetics may be its consolidation and popularization of a robust vocabulary for computing, including words such as *information*, *control*, and *feedback*. In modern parlance, cybernetics also gave currency to the widely used and now slightly pejorative prefix *cyber* (*-bully*, *-café*, *-crime*, *-dating*, *-fraud*, *-law*, *-punk*, *-security*, *-sex*, *-space*, *-terrorism*, *-warfare*) as well as the phrase "in the loop." In popular culture, cybernetics also helped breathe life into the scientific fictional imagination of the cyborg—or cybernetic organism—as an ensemble of human and machinic parts, even though in practice formal cybernetics research rarely dealt with cyborg research.[3]

For the purposes of this project, cybernetics sets the scene and props up the intellectual scaffolding that is helpful for understanding the promises and problems of cold war computing initiatives and sciences, including the U.S. ARPANET, the Soviet OGAS, and OGAS's sibling network projects. In this chapter, I trace a brief global history of cybernetics, including its sources and consolidation in postwar America, its spread to other cold war climes and countries, and its adoption in post-Stalinist Soviet science.

Backlit by observations about how cybernetics, like most scientific discourse, expresses itself in variable international dialects as well as common metaphors (such as the human mind as a model information system for designing other systems), I then detail four major stages in the history of Soviet cybernetics in general and the rise of a peculiarly Soviet field—economic cybernetics—on which subsequent chapters build.

The American Consolidation of Cybernetics

Norbert Wiener, the MIT mathematician, inveterate polymath, and son of the founder of Slavic studies in America, is often credited with launching cybernetics with his 1948 book *Cybernetics, or Control and Communication in the Animal and the Machine*.[4] How much of any scientific event can be credited to one person is arguable, although we can at least credit Wiener for helping to consolidate and coin under one label a series of intellectual influences and sources. These sources were so complex and varied that perhaps his greatest accomplishment was not setting into motion a new field but synthesizing ideas from philosophy, mathematics, engineering, biology, and literary and social criticism in his masterwork. Wiener's input exceeded even his output, which was tremendous. During World War II, Wiener researched ways to integrate human gunner and analog computer agency in antiaircraft artillery fire-control systems, vaulting his wartime research on the feedback processes among humans and machines into a general science of communication and control, with the gun and gunner ensemble (the man and the antiaircraft gun cockpit) as the original image of the cyborg.[5]

To designate this new science of control and feedback mechanisms, Wiener coined the neologism *cybernetics* from the Greek word for *steersman*, which is a predecessor to the English term *governor* (there is a common consonant-vowel structure between *cybern*- and *govern*—*k/g* + vowel + *b/v* + *ern*). Wiener's popular masterworks ranged further still, commingling complex mathematical analysis (especially noise and stochastic processes), exposition on the promise and threat associated with automated information technology, and various speculations of social, political, and religious natures.[6] For Wiener, cybernetics was a working out of the implications of "the theory of messages" and the ways that information systems organized life, the world, and the cosmos. He found parallel structures in the communication and control systems operating in animal neural pathways, electromechanical circuits, and information flows in larger social systems.[7] The fact that his work speaks in general mathematical terms also sped his work's reception and eventual embrace by a wide range of readers, including Soviet philosopher-critics, as examined later. Wiener placed little faith in his scientific field to usher in peace—a social value disguised in his technical work on *homeostasis*, a near synonym for dynamic equilibrium that he borrowed from biology—into a world destabilized by mass violence. Nonetheless, his thesis of the 1950 second edition of his masterwork *Cybernetics* prophesied that "society can only be understood through a study of the messages and the communication facilities which belong to it; and that in the future development of these messages and communication facilities, messages between man and machines, between machines and man, and between machine and machine, are destined to play an ever-increasing part."[8]

A second strand of American cybernetic thought, led by neurophysiologist Warren McCulloch, took seriously the brain-computer analogy—that is, the now long-disputed notion that a brain can best be described as a complex information processor, transmitter, and site of memory storage.[9] McCulloch is remembered for his long white beard and contributions as the organizer of the Macy Conferences on Cybernetics, which consolidated the cybernetics movement in America. Researchers and historians of science remember his 1943 paper, coauthored with the enigmatic polymath Walter Pitts, "A Logical Calculus of the Ideas Immanent in Nervous Activity," which proposed models for neural networks in the brain that later became influential in the theory of automata, computation, and cybernetics. Their argument holds that the mind is, given certain reductions, equivalent to a Turing machine. In other words, with sufficient abstraction, it is possible to imagine the neural network in a mind as a logical circuit that is capable of carrying out any computable problem. In McCulloch's words, he sought "a theory in terms so general that the creations of God and men almost exemplify it."[10]

That "almost" packs much into its experimental epistemology. Although the conclusion that the mind functions as a computer has since been disputed and dismissed by several generations of neuroscience and cognitive science, the basic neurophysiological insights that McCulloch brought to cybernetics animated the midcentury cybernetic scene. These insights included some inspiration for the development of distributed communication networking behind the ARPANET and to this day continue to inform some contemporary artificial intelligence research. In what follows, I reintroduce his seminal but largely overlooked cybernetic notion of *heterarchy* to understand dynamic networks of competing actors.

If cybernetics in the United States sprang from the teams of researchers channeling Wiener and McCulloch, it took disciplinary shape at the

Macy Conferences on Cybernetics, a series of semiannual (1946–1947) and then annual (1948–1953) interdisciplinary gatherings chaired by Warren McCulloch and organized by the Josiah Macy, Jr. Foundation in New York City. The Macy Conferences, as they were informally known, staked out a spacious interdisciplinary purview for cybernetic research.[11] In addition to McCulloch, who directed the conferences, a few noted participants included Wiener himself, the mathematician and game theorist John von Neumann, leading anthropologist Margaret Mead and her then husband Gregory Bateson, founding information theorist and engineer Claude Shannon, sociologist-statistician and communication theorist Paul Lazarsfeld, psychologist and computer scientist J.C.R. Licklider, as well as influential psychiatrists, psychoanalysts, and philosophers such as Kurt Lewin, F.S.C. Northrop, Molly Harrower, and Lawrence Kubie, among others. Relying on mathematical and formal definitions of communication, participants rendered permeable the boundaries that distinguished humans, machines, and animals as information systems. The language of cybernetic and informatic analysis—including terms such as *encoding*, *decoding*, *signal*, *feedback*, *entropy*, *equilibrium*, *information*, *communication*, *control*—sustained the analogies that bound together ontologically distinct physical phenomena.[12]

The "invisible college" constituted by the Macy Conferences proved immensely influential:[13] Von Neumann pioneered much of the digital architecture for the computer as well as cold war game theory;[14] Shannon founded American information theory; Bateson facilitated the adaptation of cybernetics in anthropology and the American counterculture;[15] Lazarsfeld fashioned much of postwar American mass communication research;[16] and of special note here, Licklider went on to pioneer and manage the U.S. ARPANET (predecessor to the Internet) and its founding vision of human-computer interaction. The effects of World War II on the global research community shaped both the number of international participants in the group (for example, von Neumann was a Hungarian émigré and Lazarsfeld was Viennese) as well as the distinctly American approach that the Macy Conferences represented as a trading zone between private philanthropic institutions (the Macy Foundation) and academics with strong ties to U.S. military research (including von Neumann, Wiener, Bateson, and many others).[17] Cybernetics emerged as a discipline that consolidated distinctly international sources of inspiration in a distinctly postwar American setting.

The principles to emerge out of the Macy Conferences were many and far from consensual. "Our consensus has never been unanimous," McCulloch quipped in a summary of the proceedings: "Even had it been so, I see no reason why God should have agreed with us." Nonetheless, a few remarks help sketch out its conceptual pliability for later international interpretation. The first methodological hallmark of cybernetics is that it is not one thing but that its key concepts, especially human-machine interaction and feedback, outline a kind of vocabulary for working analogically across different systems—computational, mechanical, neurological, organic, social—that rendered its vocabulary fecund for other sibling fields embedded in U.S. military-industrial research.[18]

Take, for example, the contemporary fields of information theory and game theory. Mainstream American information theory, following Bell Labs engineer Claude E. Shannon's 1948 mathematical theory of communication, concentrates on the efficient and reliable measurement and transmission of data.[19] Perhaps its central seminal contribution is the theorizing of a statistical framework for understanding all data transmissions. All communication messages became a question of probabilities and stochastic analysis, and the term *information* abandoned its ordinary meaning of relevant facts and took on a new definition as a technical measure of the likelihood that a message contains something ordered or surprising. Such insights sped the theoretical development of computational communication systems, although Shannon's theories were not widely applied until the advent of affordable personal computers in the 1970s.

Von Neumann's game theory (still influential in contemporary economics, business, and policy) developed formal models for human behavior based on strategic and rational decision-making processes.[20] By presuming that the players in its games are rational actors seeking to make strategic decisions, game theory formalized approaches to mathematically describing, modeling, and proscribing the optimal behaviors in both competitive and cooperative multiplayer interactions that came to characterize the cold war as a whole.[21]

The founders of these fields disagreed about the limits and relationships between the three fields. Shannon insisted on keeping the technical principles of information theory separate from the more sweeping scope of cybernetics, Von Neumann did not rigorously distinguish between the three, and Wiener defended his grouping of the other two research fields under the cybernetics umbrella, even as (especially after mid-1950s) many information theorists and game theorists objected to any conflation of these fields.[22] All three fields presented overlapping rational and generalized models of communication, or a "theory of messages" fit for application, even though no one—not even the founders—knew the exact limits of these computation communication sciences. Shannon did not accept the label of cybernetics, and he also did not accept the label others had given to his own "information theory," preferring to the end of his life his original emphasis on "mathematical theory of *communication*." Each of these sciences sought to theorize the technical means by which communication could be controlled. The cybernetic sciences, especially but not exclusively in the Soviet case, emerge as a communication science in search of self-governing systems.

Although it has never been clear (perhaps even to cyberneticists) what cyberneticists could do exactly, it also never has been obvious what cybernetics *could not* do (perhaps even the definition of cybernetics is self-governing). For example, in 1943, Wiener and his coauthors succeeded in springing "feed-back"—a once obscure term on loan from control engineering and reclaimed in his antiaircraft research—into an umbrella concept that was fit for understanding any type of purposeful behavior, where the behavior of humans, animals, and machines is understood as "any change of an entity with respect to its surroundings."[23] At this philosophical height, feedback loops proved a generalizable tool that could stabilize all kinds of unsteady systems: feedback offers a process whereby information that leaves a system is brought back into the system with the intention of influencing that system's future behavior.

Feedback comes in at least two kinds—positive and negative. When positive, feedback amplifies a signal cyclically, much like a microphone that is set too close to a loudspeaker will cause painful audio feedback as the signal loops out of control. Negative feedback by contrast can serve as a stabilizing agent, an internal check or correction on a system seeking balance in an unstable environment. By working with feedback loops in communication systems, cybernetics sought a revolution in recognizing and operationalizing the nonlinear, self-recursive processes that abound in nature and technology. Whatever cybernetics is, it is not a straightforward worldview of Newtonian physics, Cartesian grids, Euclidian geometry, Aristotelian cause and effect, and arithmetic. Rather, cybernetics espouses a mathematical worldview that helps us understand the midcentury struggle to balance atop the tectonic shift in science toward pre-postmodern concepts such as quantum physics, curvilinear grids, non-Euclidian geometry, cyclical causalities, self-similar fractals, and modern probability theory.

The interpretive purchase of Wiener's cybernetics rests not on its clarity but on its synthetizing search for system self-regulation in the face of a topsy-turvy postwar world. That is, the basic cybernetic approach seeks to harness to the logical power of computing a wide range of scientific problems with circularities and feedback loops. In this search for a balance between the incongruities of material behavior and the sharp logic of computing, feedback—even more than the cybernetic watchwords *information*, *control*, and *equilibrium*—emerges as a clean concept for attempting to domesticate all kinds of unruly communication systems. In 1943, Warren McCulloch introduced the companion, although largely neglected, notion of *heterarchy*, which serves as a useful lens for focusing scrutiny on the Soviet case. This cybernetic concept helps describe some of the sources of conflict that beset Soviet cybernetic attempts to network their command economy.

Let us set up this argument with a glimpse into institutional networks of actors that are based on neither flat market nor hierarchical states but on this third or middle way of *heterarchy*. The cold war organizational tropes for self-regulation break down along that spectrum of economic order that conventionally opposes market and hierarchy. In this view, the *market* is understood as a flattened space for free interaction and efficient possibility discovery among varied economic actors, and the *hierarchy* is understood as a well-ordered, top-down pyramid of superiors over subordinates that is well suited for completing long-term and complex tasks. Etymologically, the English *market* is by far the newcomer of the two and can be traced back to the mid-thirteenth-century Italian term for a "public building or space for trading, buying, and selling." The term *market economy* is first noted in English only in 1948, centuries after the early modern capitalist revolution that gave it fame and that has since enjoyed a privileged if often misunderstood position in the Western vocabulary of modern politics, economics, and society. One reason for justifying the Pareto efficiency of the market rests on the transitivity of human preferences. For the market to be the ideal organizational mode, some economists assume that rational actors will rank the order of their preferences linearly: if rational actors prefer option A over B as well as option B over C, they also will prefer option A over C. Yet this view of the market has been challenged in recent decades. Markets hide transaction costs and information asymmetries. Behavioral economists have demonstrated how under a number of conditions (such as fear, regret, the threat of loss, cognitive dissonance, or peer pressure) the rational *homo economicus* is a fiction: a person may prefer apples to bananas, bananas to cantaloupes, and cantaloupes to apples, and there is no guarantee that there exists a rational solution to voting systems or daily choices involving three or more actors.[24]

By contrast, the concept of *hierarchy* (from the Greek term ἱεραρχία, "rule by priests") reaches back fifteen centuries to religious roots. As sociologist of economics David Stark shows, the term was first used by a Christian medieval theologian who is known today as the Pseudo-Dionysius the Areopagite.

He published in the late fifth century under the pseudonym Dionysius the Areopagite, a name first attributed to a first-century convert of Paul and the first bishop of Athens. The fifth-century Christian mystic theologian describes two far-reaching hierarchies in his *Heavenly and Ecclesiastical Hierarchies*: the first, which includes nine levels of celestial beings (extending from the supreme Godhead to the angels, who were just above humans), serves as a symmetrical reflection for the second, which includes nine levels of church leadership (seen in the current nine-tier Catholic ecclesiastical hierarchy descending from pope to bishop).[25] The concept of hierarchy has abounded in Western thought ever since—in the nine levels in Dante's *Inferno*; the organizational design of countless church, military, governmental organizations; and the conceptual imprint of information classification systems, computer sciences, mathematics, and categorical thought. These are all scalable approaches to bringing order in the modern world. Perhaps the strongest example of hierarchy and socialism in modern America is also its greatest bastion of patriotism—the U.S. armed forces, whose command-and-control silos deliver social services and benefits to its members.

The logic of hierarchy has faced many challenges. Most modern critical thought—epistemologists William James and Michel Foucault, critical theorists and feminists, Marxists and free-market theorists, liberation theorists and theologians on the radical left and right, digital media theorists and others—is organized *against* hierarchy.[26] Even though the cold war ideological division over planned and free-market economies preoccupies fewer social scientists today, modern organizational power and its resistance still organize along the coordinates of hierarchy and open system.

The cybernetic concept of *heterarchy* offers a third way and an alternative model between market and hierarchy that helps make sense of the Soviet cyberneticists and informs later network analysis of how Soviet cyberneticists tried to build computer networks to match the institutional networks running the command economy. In 1945, just before McCulloch took stewardship over the Macy Conferences, he published a five-page essay, "A Heterarchy of Values Determined by the Topology of Nervous Nets," in the *Bulletin of Mathematical Biophysics* that coined the term *heterarchy* and established how even the simplest systems can be subject to multiple competing regimes of evaluation.[27]

Heterarchies are neither ordered nor disordered but instead are ordered complexly in ways that cannot be described linearly. McCulloch takes as his simplest example a network of three neurons arranged into a hierarchy of transitive connections from neuron A to neuron B and from neuron B to neuron C in which there are no "diallels" or "cross-overs." His description references the hierarchy in “the sacerdotal structure of the Church” in which “the many ends are ordered by the right of each to inhibit all inferiors.” He then contrasts a hierarchical network with an intransitive neural network in which a crossover is introduced between neurons C and A. In this case, to model the network one needs to “map the network not on a plane, but on a three-dimensional Taurus (a donut-shaped topological space).” Instead of imagining such a network arrangement as inferior or inconsistent, he observes that “circularities in preference actually demonstrate consistency of a higher order than had been dreamed of in our philosophy. An organism possessed of this nervous system—six neurons—is sufficiently endowed to be unpredictable from any theory founded on a scale of values. It has a heterarchy of values, and is thus internectively too rich to submit to a *summum bonum*.”[28]

With the concept of neural *heterarchy*, McCulloch introduces the multidimensional possibilities for complex systems that cannot be mapped onto two-dimensional logics of either flat markets or tall hierarchies. This concept has since proven helpful in cybernetic-compatible research far beyond brain research, including self-organization, feedback loops, automata theory, and non-Turing and non-Euclidean computing for thinking about the superabundance of actual complex networked relations and also about the limits of traditional tools for accounting for these relations. As detailed later, similar cybernetic notions introduced both the terms and the network tools for describing and managing the heterarchical tensions at the heart of the Soviet command economy.

Cybernetics beyond the Cold War Superpowers

Between 1948 and the mid-1950s, cybernetics also enjoyed reception and development in a number of countries outside of the cold war superpower axis. For the purposes of this section, I focus on the postwar reception of cybernetics in England, France, and Chile, although the point of the section supersedes comparative local or national histories. The conditions of modern countries after World War II and during the cold war were ripe for an umbrella science of self-governance. Many scientists worldwide were rushing to find ways to stabilize and regulate the consequences of a torrent of new and disruptive technologies—and cybernetics modeled a technical mindset for how to grapple with and control the consequences of technology itself. The 1950s saw a dizzying number of potentially revolutionary technologies become popular—atomic and hydrogen bombs, nuclear power plants, *Sputnik*, the double helix, passenger jets, dishwashers, polio vaccines, the lobotomy (invented in the 1930s), television, and transistor radios—and other trends, such as rock & roll and suburban housing developments. The disruptive influences of modern science and technology continued to be felt in the 1960s as quarks, lasers, *Apollo*, nylon, Pampers, the pill, LSD, napalm, DDT, mutually assured destruction, and the ARPANET entered the world stage. The most disruptive and destructive of all was the development of computers around the work of John von Neumann at the Institute of Advanced Studies at Princeton to study and control the effects of nuclear bombs.[29] The technocratic promise of the computer seemed to promise both delivery and destruction. If computers could help civilize the terrible and awesome power of the atom bomb, thought the scientists of the day, then perhaps it might help stabilize lesser disruptions of modern science and technology. If not, what terrible consequences would follow? Or as von Neumann asked, taking the pulse of the moment in 1955: "Can We Survive Technology?"[30]

Von Neumann's question especially animated those who were engaged in the nuclear cold war. In postwar France, United Kingdom, and Chile, the potential of the computer to civilize awesome powers generated a "technology" of cybernetic interest in the 1950s and 1960s that was sometimes more disruptive than the atomic bomb that troubled von Neumann. It was the human mind imagined as an embodied machine. Might cybernetics and its heir in cognitive science, midcentury scientists wondered, crack the human mind and in turn spark new insights into how that most creative of technologies might be modeled elsewhere?[31]

In France, the intellectual contributions of cybernetics began with more analogies to politics than to the parietal lobe. Cybernetics had an early start and a long afterlife in postwar France for several reasons. The public debate about cybernetics turned the science into a bit of a political football between communist and anticommunist debates in postwar France; the local intellectuals helped ascribe a long French intellectual tradition to cybernetics, which softened its reception; and Norbert Wiener visited France repeatedly and promoted his science vocabulary in person. The imprint of cybernetics can still be seen in subsequent generations of French theorists.

These postwar happenings are described briefly below. In 1947, the year before he published *Cybernetics* with the MIT Press, Wiener attended Szolem Mandelbrot's congress on harmonic analysis in Nancy, France, which resulted in a French book contract for the book that, while initially resisted by the MIT Press, sold a sensational 21,000 copies over three reprints in six months after its release in 1948. Three years later, in 1951, at the invitation of Benoit Mandelbrot, the founder of fractals and Szolem's nephew, Wiener returned to lecture at Collège de France. Between 1947 and 1952, a flurry of press coverage and public controversy sprung up between two camps of anticybernetic communists and anticommunist cyberneticists.[32] (Jacques Lacan, who served in the French army, may very well have been among the anticommunists and early cyberneticists at the time.) These debates over the future of the governance of the French state were fueled by a slow and painful postwar recovery, with widespread poverty aiding popular communist and pro-Soviet sentiment. However, after Paul Ramadier's socialist party voted to accept the American Marshall Plan during the international Paris meeting in 1947, anticybernetic communists slowly fell out of public favor and with it, the debate about cybernetics. Similar to the initial Soviet rejection of cybernetics, the initial public reaction to cybernetics appears less about its science than about its status as an American import.[33]

At the same time, the public and implicitly pro-American defense of cybernetics in the French press also helped reclaim this foreign science as the heir to a distinctly French intellectual tradition that included the rational mind-body concerns of René Descartes' and Denis Diderot's rational encyclopedia, the physicist André-Marie Ampère's coining of the term *cybernétique* as a political science of peaceful governance in 1834, and the structural linguistics of Ferdinand Saussure. Although I currently know of no obvious direct connection between French cybernetics and the Minitel network that developed between 1980 and 1989, the situation nonetheless points to a generative and transnational intellectual exchange about the scientific self-governance of a nation. As recent interpreters have argued, many leading lights of postmodern French theory trace some of their basic insights to French postwar cybernetic sciences. These include Claude Lévi-Strauss's treatment of language as a technologically ordered series (after meeting with Macy Conference attendee Roman Jakobson in Paris in 1950); Jacques Lacan's turning to mathematical concepts; Roland Barthes's turn to schematic accounts of communication; Gilles Deleuze's abandonment of meaning, with Claude Shannon's information theory in hand; Felix Guattari's, Michel Foucault's, and other French theorists' experimentation with terms such as *encoding*, *decoding*, *information*, and *communication*.[34] Postmodern French theory owes a deep debt to postwar information theory and the cybernetic sciences.

In England, cybernetics took on a different character in the form of the Ratio Club, a small but potent gathering of British cybernetic figures who gathered regularly in the basement of the National Hospital for Nervous Diseases in London from 1949 through 1955. Notable figures include the computing pioneer Alan Turing, his Bletchey Park colleague and cryptographer mathematician I. J. Good, neuropsychologist Donald MacKay, and astrophysicist Tommy Gold. The historian of science Andrew Pickering chronicles the lives and work of six active and largely forgotten Britons who were preoccupied with what the brain does—neurologist W. Grey Walter, psychiatrist W. Ross Ashby, anthropologist, psychiatrist, and Macy Conference attendee Gregory Bateson, radical antipsychiatrist R. D. Laing, psychologist Gordon Pask, and management cyberneticist Stafford Beer (who also features prominently in the Chilean cybernetic situation described below). Interdisciplinary discussions ranged widely across themes such as information theory, probability, pattern recognition, artifacts that act (such as William Ross Ashby's homeostat and W. Grey Walter's robotic tortoises), and philosophy. Among their guests over the years were at least two Americans who later played roles in the development of the ARPANET—J.C.R. Licklider and Warren McCulloch.[35] According to Pickering, what each of these pioneering cyberneticists held in common was an interest in the brain as a machine that acts, not thinks—or communication systems that perform, not cogitate.[36] Cybernetics took root on its own terms in Britain—not the postmodern theory of France but what Pickering calls the "nonmodern" performances of neurological structures.

Chile and to a lesser extend Argentina also experienced the influx of cybernetic ideas that ended up framing the debate about national networks. In 1959, as a graduate student at Harvard, the Chilean biologist Humberto Maturana coauthored an important paper, "What the Frog's Eye Tells the Frog's Brain" with lead author Jerome Lettvin, Warren McCulloch, and Walter Pitts. In the early 1970s, Maturana and his student Francisco Valera secured their part in what has been called the "second wave" of cybernetics together with the editor of the Macy Conferences proceedings Heinz von Forester and Gordon Pask, among others, with their contribution of the idea of *autopoiesis*—a system that generates, maintains, and reproduces itself (such as a biological cell). The idea found resonance with the work on the Chilean socialist economy led by the British management cyberneticist Stafford Beer during the political rule of Salvador Allende between 1971 and the military coup in 1973.

During this period, Project Cybersyn took place, and it was perhaps the most prominent experiment in developing a national network intended for managing the socialist economy. As historian of science Eden Medina has recently revealed, the British management cyberneticist Stafford Beer served as principal architect for the rapid design, development, and partial deployment of this nationwide network of telex machines connected to a central mainframe computer. Beer, working with then finance minister and engineer Fernando Flores, imported and adapted his (British) emphasis on the brain as a model for managing organizations as published in the 1972 book *The Brain of the Firm*.[37] His overtly cybernetic idea of a viable system—a system that is designed to survive by adapting to its changing environment—took root in the design of the Project Cybersyn network and was reflected the political ideals of Allende's democratically elected socialism and the autonomy of the workers. Despite limited success in rerouting goods during a 1972 strike of truck drivers, the Cybersyn network, including its futuristic central operations room, were scrapped in the military coup of General Augusto Pinochet in 1973. In this Chilean case and perhaps in the larger Latin American scene, cybernetics dovetailed with a strong emphasis on embodied philosophy of mind.[38]

Before turning to the Soviet reception and translation of cybernetics, let us look briefly at the eastern European sources of the cybernetic tradition, some of which precede its consolidation in U.S. military research and the postwar Macy Conferences. The list of precybernetic promoters includes several notable figures. Aleksandr Bogdanov—old Bolshevik revolutionary, right-hand man to Vladimir Lenin, and philosopher—developed a wholesale theory that analogized between society and political economy, which he published in 1913 as *Tektology: A Universal Organizational Science*, a protocybernetics minus the mathematics, whose work Wiener may have seen in translation in the 1920s or 1930s.[39] Stefan Odobleja was a largely ignored Romanian whose pre–World War II work prefaced cybernetic thought.[40] John von Neumann, the architect of the modern computer, a founding game theorist, and a Macy Conference participant, was a Hungarian émigré. Szolem Mandelbrojt, a Jewish Polish scientist and uncle of fractal founder Benoit Mandelbrot, organized Wiener's collaboration on harmonic analysis and Brownian motion in 1950 in Nancy, France. Roman Jakobson, the aforementioned structural linguist, a collaborator in the Macy Conferences, and a Russian émigré, held the chair in Slavic studies at Harvard founded by Norbert Wiener's father. And finally, Wiener's own domineering and brilliant father, Leo Wiener, was a self-made polymath, the preeminent translator of Tolstoy into English in the twentieth-century, the founder of Slavic studies in America, an émigré from a Belarusian shtetl, and like his son, a humanist committed to uncovering methods for nearly universal communication.[41]

Although summarizing the intellectual and international sources for the consolidation of cybernetics as a midcentury science for self-governing systems is beyond the scope of this project, the following statement is probably not too far of a stretch. In each of the case studies examined here—Warren McCulloch's heterarchical neural networks, the French evolution of information theoretic and its turn to postmodern theory, the British Ratio Club's emphasis on performative models and agents, the Chilean building of a socialist national economic network after a model of the nation as an organized firm, and sundry competing eastern European forces—the midcentury cybernetic sciences are expressed in the local dialects of an intellectual milieu and share with cognitive science an impulse to think with the model of the mind. To a different effect, cyberneticists have been constructing system analogs to understanding the mind and using such mind models as analogs for reenvisioning new social, technological, and organic worlds. The fascination with the mind is not new to cybernetics. The millennia-long preoccupation with the inner workings of the mind, as one neuroscientist quipped, may be little more than our own brain's conceit about itself.[42]

Soviet Cybernetics

With the first Soviet test of the atomic bomb in 1949, the cold war conflict between capitalism and socialism slipped into the nuclear age. Soviet scientists, philosopher-critics, and journalists redoubled their search for real threats, as well as exciting possibilities, in the rapidly developing sphere of science and technology, including rumors about a new American field called *cybernetics*. Between 1947 (the year Norbert Wiener coined the term *cybernetics* at a Macy Conference in New York) and 1953 (the year after Joseph Stalin died), the state of Stalinist science, having proven itself as essential to winning the war, enjoyed a complicated improvement in social status, better funding, and uneven intellectual autonomy.[43] The Soviet Union stood out as a state that was committed to groundbreaking science.[44]

At the same time, certain fields of science, especially genetics in the wake of the Lysenko debates, experienced acute pressures and censorship.[45] And although cybernetics was not outright repressed during Stalin's rule, it was widely ridiculed in the press and did not flourish until after his death. The remainder of this chapter shows that even though post-Stalinist cybernetics seemed poised to remake the Soviet Union as an information society, the history of Soviet cybernetics, especially during the period of its rehabilitation and adoption, slouches in significant ways toward the normal patterns of Soviet history. In four overlapping sections below, I show that Soviet scientific discourse rejected, rehabilitated, adopted, and adapted cybernetics for historically expedient and changing purposes.

The Stalinist Campaign against Cybernetics: A "Normal" Pseudo-Science

Not all was rosy at the start. Amid abundant American accolades following the publication of Wiener's *Cybernetics, or Control and Communication in Animal and Machine* in 1948, the Soviet press poured on insults. In 1950, at the same time that the American *Saturday Review of Literature* was triumphantly proclaiming that it was "impossible for anyone seriously interested in our civilization to ignore [Wiener's *Cybernetics*]. This is a 'must' book for those in every branch of science," the leading literary Soviet journal *Literaturnaya gazeta* was calling Wiener one of those "charlatans and obscurantists, whom capitalists substitute for genuine scientists."[46] In a 1950 article titled after the computing machine developed by Howard Aiken, "Mark III, a Calculator," Soviet journalist Boris Agapov ridiculed the sensationalist American press for its exultations about the coming era of "thinking machines," styling Norbert Wiener as an unknown figure "except for the fact that he is already old (although still brisk), very fleshy, and smokes cigars." Commenting on a *Time* magazine cover of a computer dressed in a military uniform, Agapov continued, "it becomes immediately clear in whose service is employed this 'hero of the week,' this sensational machine, as well as all of science and technology in America!"[47] After Agapov's 1950 article, Wiener's *Cybernetics* was officially removed from regular circulation in Soviet research libraries; apparently only secret military libraries retained copies into the early 1950s.[48]

In 1951, a public campaign in the Soviet Union called the computer hype in the United States a "giant-scale campaign of mass delusion of ordinary people." The 1951 volume *Against the Philosophical Henchmen of American-English Imperialism* categorized cybernetics as part of a worrying fashion around "semantic idealism" and dubbed cyberneticists "semanticists-cannibals" for their recursive logics, especially self-informing feedback loops. In addition to American cyberneticist Norbert Wiener, the volume identified those belonging to the group of "semantic obscurantists" as including logician-pacifist Bertrand Russell, his Cambridge colleague Alfred North Whitehead, and Vienna Circle logical positivist Rudolf Carnap. Positivism, semiotics, and mathematical logic all appeared guilty of the cardinal cognitivist belief that "thinking was nothing else than operations with signs."[49] In 1952, *Literaturnaya gazeta* ran an article called "Cybernetics: A 'Science' of Obscurantists," which cleared the way for a deluge of popular titles: "Cybernetics: An American Pseudo-Science," "The Science of Modern Slaveholders," "Cybernetics: A Pseudo-Science of Machines, Animals, Men and Society," and so on.[50]

In 1953, an author who wrote under the pseudonym "Materialist" published the infamous article "Whom Does Cybernetics Serve?" in a leading journal for ideological and intellectual battles, *Questions of Philosophy*. "Materialist" waxes poetic in his rebuke:

> the theory of cybernetics, trying to extend the principles of modern computing machines to a variety of natural and social phenomena without due regard for their qualitative peculiarities, is mechanicism turning into idealism. It is a sterile flower of the tree of knowledge arriving as a result of a one-sided and exaggerated blowing up of a particular trait of epistemology.[51]

Later in the article, Materialist contends that "in the depth of their despair, [those in the capitalist world] resort to the help of pseudo-sciences giving them some shadow of expectation to lengthen their survival."[52] With somewhat less vitriol, in 1954, the fourth edition of the *Concise Dictionary of Philosophy* cast cybernetics as a slightly ridiculous, although still harmful anti-Marxist "reactionary pseudo-science." The entry reads:

> Cybernetics: a reactionary pseudo-science that appeared in the U.S.A. after World War II and also spread through other capitalist countries. Cybernetics clearly reflects one of the basic features of the bourgeois worldview—its inhumanity, striving to transform workers into an extension of the machine, into a tool of production, and an instrument of war. At the same time, for cybernetics an imperialistic utopia is characteristic—replacing living, thinking man, fighting for his interests, by a machine, both in industry and in war. The instigators of a new world war use cybernetics in their dirty, practical affairs.[53]

The campaign continued in the popular and scholarly press more or less unabated through the 1950s, although the first public rehabilitation efforts, noted below, began in earnest as early as 1955.

The list of epithets reserved for cybernetics by the Soviet press should be put into perspective. The campaign against cybernetics, however mean-spirited and aggressive, appears far from the most vicious of campaigns that were organized by Soviet journalists and public commentators against American thought. Stalin, who was known to read widely across the scientific fields, seems to have known little to nothing about cybernetics; his fury against it appeared independent of "any essential features of cybernetics itself," according to Gerovitch.[54] Without any direct evidence of Stalin's involvement in the campaign against cybernetics, we can speculate that Stalin likely reviled cybernetics for the same reasons that he hated all imperialist "pseudo-sciences": ideological opposition was necessary to fuel and power his monumental state building and modernization projects. The campaign against cybernetics, which came in the wake of Stalin's personal affront against classical genetics, appeared more or less a "farce" to some philosopher-critics. These same philosopher-critics, according to information theorist Ilia Novik, "berated cybernetics with certain … indifference and even fatigue." In the late 1940s and early 1950s, as cybernetics was sweeping the United States, France, the United Kingdom, Chile, and other countries with the enthralling possibilities of self-organizing human-machine ensembles and predictive negative feedback loops, "cybernetics" in the Soviet Union had, to crib Novik's phrase, "emerged as a normal pseudo-science."[55]

The anti-American Soviet campaign against cybernetics was only one among a range of operations that were meant to repress the Soviet knowledge base, including but not limited to Stalinist science. A few other examples include the rise of Trofim Lysenko in Soviet biology, whose program on the heritability of acquired characteristics ousted the study of Mendeleev and classical genetics; the condemnation of Linus Pauling's structural resonance theory by Soviet chemists in 1951; the banning of Soviet Lev Vygotsky's work, now recognized as a foundation of cultural-historical psychology; the forestalling of structural linguistics pioneered by Ferdinand Saussure, Nikolai Trubetzkoi, and Roman Jakobson; and the excoriation of Albert Einstein's theories of general and special relativity, quantum mechanics, and Werner Heisenberg's principles of indeterminacy as distortions and corruptions of the true (that is, Marxist) objective and material nature of the universe.[56] In light of these and other examples, the public campaigns against cybernetics strike the contemporary observer as far from masterfully orchestrated or even normal in their regularity. The ground warfare of ideological critique was messy, full of ritual elements, political posturing, and routine debates. Not only did the enterprise of Soviet cybernetics prove to be diverse, but the anticybernetic campaigns that preceded it varied richly.

There was nothing particularly anticybernetic about the early anticybernetic campaigns. Rather, the early opposition to the science appears overwhelmingly anti-American in motivation. In the decade that followed, Soviet cybernetics transformed into an apparent harbinger of social reform and later into a normal Soviet science. Even the Soviet ideological resistance to cybernetics appears normal from the beginning.

The Post-Stalinist Rehabilitation of Cybernetics, 1954 to 1959

Natural Science will in time incorporate into itself the science of man, just as the science of man will incorporate into itself natural science: there will be *one* science.

—Karl Marx, *Economic and Philosophic Manuscripts of 1844*

Stalin's death in March 1953 made possible a watershed shift in public discourse in favor of Soviet cybernetics and gave root to the promise of cybernetic-led structural reform of the Soviet Union—and especially the promise of a new kind of self-governance in the wake of Stalin's bloody rule. After he seized power from his rivals in 1955, Nikita Khrushchev titled himself first secretary, not general secretary as Stalin had, in an effort to signal a clean break from the past and the launching of a new post-Stalinist era. Typically, the only thing remembered about the Twentieth Congress of the Communist Party of the Soviet Union, is Khrushchev's 1956 "secret speech," which he delivered to a carefully selected crowd and in which he became the first Soviet authority figure to denounce Stalin's crimes and the now infamous "cult of personality." The speech inaugurated the Khrushchev thaw, a period known for the easing of censorship and political repression and the partial de-Stalinization of Soviet policy, international relations, and society. These public revelations, combined with a sagging Soviet economy, compelled even those least likely to decry the terrible reality of Stalin's terror to admit that, in Khrushchev's terms, "serious excesses" and "abuses" had been committed.[57]

As part of this sweeping technical reform, the new first secretary also called for an ideological reappraisal of Marxism-Leninism:

> In this connection we will be forced to do much work in order to examine critically from the Marxist-Leninist viewpoint and to correct the widespread erroneous views connected with the cult of personality in the sphere of history, philosophy, economy, and other sciences, as well as in literature and the fine arts. It is especially necessary that in the immediate future we compile a serious textbook of the history of our Party, which will be edited with scientific Marxist objectivity.[58]

By 1959, Stalin's *Short History of the Communist Party of the Soviet Union*, once characterized as "the catechism of Communism," had been officially deemed full of errors and withdrawn under Khrushchev. It was replaced in 1961 by the 900-page *Fundamentals of Marxism-Leninism*.[59]

The time between Stalin's death and cybernetics' entrance into the favor of the press and Soviet public discourse on science was not great. In fact, in the same 1956 Congress that he gave his "secret speech," Khrushchev also promoted cybernetic-friendly principles for automating the Soviet economy: "The automation of machines and operations," he declared, "must be extended to the automation of factory departments and technological processes and to the construction of fully automatic plans."[60] With the passing of Stalin, cybernetics entered Soviet technical, scientific, and political discourse at a time that was particularly primed for reform.

Although Soviet science enjoyed reforms and looser ideological constraints under Khrushchev, Soviet science may have accomplished more under the fist of Stalin than it did under the loose umbrella of cybernetics. Under Stalin, Soviet physicists and chemists pioneered work for which chemist Nikolai Semyonov, physicist Igor Tamm, economist Leonid Kantorovich, and physicist Pyotr Kapitza received Nobel Prizes decades later. Other Soviet scientists—including Igor Kurchatov, Lev Landau, Yakov Frenkel, and Andrei Sakharov, and other world-renowned figures—also developed atomic and thermonuclear bombs, a lynchpin in Stalin's rapid and forceful industrialization of the remnants of the Russian empire from a backwater country into a global super power in the period of a few decades. Many Soviet scientists successfully employed dialectical materialism as a genuine source of inspiration, not a forced ideology, in their scientific work. The reality that the health of science depended more on funding than it did on freedom also sobers reflection on the contemporary state of science and public attitudes about it.[61]

Soviet cybernetics arrived at a time that was well suited for leveraging a post-Stalinist revision of scientific Marxist objectivity. It introduced its mind-machine analogies in a light that was friendly to Ivan Pavlov's celebrated notion of "conditioned reflexes" in psychology, which were based on the reflex-response analogy of a telephone electrical switchboard, the reactions of which depended on the programmable configuration of wires. Both Pavlov and, two generations later, cyberneticists worldwide imagined the mind as neural networks and electronic processors, a seminal metaphor for what philosopher Pierre Dupuy dubbed the "mechanization of mind" powering the subsequent rise of cognitive science.[62]

Soviet cybernetics also found the support of several world-famous mathematicians, which was a field in which the Soviets were internationally recognized. Figures including Andrei Kolmogorov, Sergei Sobolev, Aleksei Lyapunov, and Andrei Markov Jr., came together, despite significant differences, to form an early core of Soviet cybernetic mathematicians who were committed to advancing this new metamathematical science as a single science for Soviet thought. And just as cybernetics was mobilizing its intellectual defenses, it also found institutional fortification in the creation of Akademgorodok, a new "scientific township at Novosibirsk" in Siberia. Created in the spring of 1957, this city of science (formally part of the city of Novosibirsk) proved a refuge of privilege and relative intellectual freedom for over 65,000 Soviet scientists, including Aleksei Lyapunov, a pioneering cyberneticist.[63]

Before the Soviet scientific mainstream could adopt cybernetics, the attendant scholarly communities had to be prepared for an about-face in the official Soviet attitude toward an American-born discipline. The first sign of this turnaround came not from Moscow but from a neighbor in the near abroad: in 1954 in Warsaw, six "Dialogues on Cybernetics" surfaced, and they approached cybernetics in a critical dialectical tone that was serious enough to signify that the topic deserved real discussion.[64] In the meantime, three mathematicians and an unlikely philosopher-critic closer to Moscow set off on a mission to remake Soviet cybernetics from the inside out.

The First Soviet Cyberneticists: Kitov, Lyapunov, Sobolev

In 1955, two Russian-language articles appeared in the same issue of the Soviet journal *Voprosi Filosophii (Problems of Philosophy)*, where "Materialist" and others had railed against cybernetics in 1953. This signaled a watershed change in the official attitude toward cybernetics. A closer look at these two articles sheds light on this reversal. Sergei Sobolev, Aleksei Lyapunov, and Anatoly Kitov coauthored the article titled "The Main Features of Cybernetics" and began the process of rehabilitating cybernetics from positions of relative authority in the Moscow military-academy complex. Although Kitov was the youngest and the least influential of the three mathematician coauthors, he also appears to have been the first Soviet cyberneticist.

A Soviet colonel engineer, Anatoly Kitov discovered in 1952 the single copy of Wiener's *Cybernetics* in a secret library of the Special Construction Bureau—SKB-245—at the Ministry of Machine and Instrument Building. Kitov had been sent there to research possible military applications for computers after graduating in 1950 from the military academy where Lyapunov taught with a gold medal, the highest award in the Soviet education system. After reading Wiener's *Cybernetics*, Kitov began to consider that cybernetics was, in his words, "not a bourgeois pseudo-science, as official publications considered it at the time, but the opposite—a serious, important science."[65]

After digesting *Cybernetics*, Kitov turned to share his newfound enthusiasm for the science with his former instructor, Aleksei Lyapunov. Lyapunov, who later was known as "the father of Soviet cybernetics," was a wide-ranging and luminous mathematician who taught at the Military Artillery Engineering Academy and in the department of computational mathematics at Moscow University. Recognized by biologists, geophysicists, and philosophers alike, Lyapunov took, according to Soviet historian of science M. G. Haase-Rapoport, an "integrating, non-dividing approach in natural science," which "became the rich soil [for] the sprout of cybernetic ideas."[66] Having heard his case, Lyapunov in turn encouraged Kitov to write an article explaining the essence of cybernetics, promising to coauthor it with him. Holed up in the secret military research library, Kitov wrote a draft for the article, after which Lyapunov recommended inviting as coauthor Sergei Sobolev, then chair of the department of computational mathematics at Moscow University. Sobolev also played a legitimizing role as deputy director of the Institute of Atomic Energy, in effect the mathematician with a hand on the atomic bomb. In 1933, at the age of twenty-five, Sobolev became the youngest corresponding member of the Soviet Academy of Sciences, and in 1939, the youngest full member (academician) of the Academy. After joining the Bolshevik Party in 1940, Sobolev was appointed as the deputy director of the Institute of Atomic Energy in 1943 and contributed to the construction of the first Soviet atomic and hydrogen bombs. With this in mind, Lyapunov and Kitov arranged to visit Sobolev at his dacha in Zvenigorod, an hour west of Moscow, where, after discussing the draft, Sobolev offered his name as coauthor. Although it is not known how much he contributed to the article, Sobolev repeatedly and publicly defended cybernetics in the late 1950s.[67]

Sometime in 1952, Kitov and Lyapunov visited the editorial staff of *Problems of Philosophy*. For unknown reasons, the editors agreed to publish the article, asking only that they receive permission from the Communist Party first. We may speculate on why the editors agreed to publish on a forbidden topic. *Voprosi Filosofii* continued to publish anticybernetic material for several years, so one might suppose that the editors thought permission would not be granted, thus shifting the blame for the rejection onto higher authorities. It is equally possible that the editors agreed to publish the article out of genuine enthusiasm to encourage intellectual debate during Khrushchev's thaw. Regardless, the editors sent Lyapunov and Kitov to meet with representatives in the science division of Staraya Square, an administrative wing for the Communist Party in downtown Moscow. The administrators heard their case, asked some questions, and then concluded: "We understand: it is necessary to change the relationship to cybernetics, but an instantaneous split is not possible: before the article can be published, it would make sense to do several public reports."[68] Lyapunov and Kitov spent 1953 and 1954 carrying out tacitly approved public lectures and private workshops, and Lyapunov began hosting in his home a circle of colleagues to discuss cybernetics that lasted over a decade.[69]

At once an introduction, a reclamation, and a creative translation of Wiener's *Cybernetics*, Kitov, Lyapunov, and Sobolev's feature article, "The Main Features of Cybernetics," danced a deliberate two-step. First, it attempted to upgrade cybernetics to parity with other natural sciences by basing an ambitiously comprehensive theory of control and communication almost exclusively on Wiener's 1948 book (although these early Soviet cybernetics made notably less of the field as an applied science and more of it as a universalizing theory than did Wiener). Second, it retooled Wiener's conceptual vocabulary into a Soviet language of science. Gerovitch details the translation of their terms: "What Wiener called 'the feedback mechanism' they called 'the theory of feedback' … 'basic principles of digital computing' became 'the theory of automatic high-speed electronic calculating machines'; 'cybernetic models of human thinking' became the 'theory of self-organizing logical processes.'"[70] In fact, the coauthors used the word *theory* six times in their definition of cybernetics to emphasize the theoretical nature of the new science, possibly as a way to avoid having to discuss the political implications of introducing a practical field of human-machine applications into a society well suited to adopt them.

The coauthors also integrated and expanded the stochastic analysis of Claude Shannon's information theory while simultaneously stripping Wiener's organism-machine analogy of its political potency.[71] Wiener's core analogies between animal and machine, machine and mind were stressed as analogies—or how "self-organizing logical processes [appeared] *similar* to the processes of human thought" but were not synonyms. At the same time, the article scripts his language of control, feedback, and automated systems in the machine and organism into the common language of *information*, or Shannon's mathematical theory of communication. For Kitov, this "doctrine of information" took on wholesale the task of universalizing statistical control in machines and minds. It did so by preferring the "automatic high-speed electronic calculating machine" (that is, computer) to Wiener's original base analogy for cybernetic comparisons—the servomechanism. The servomechanism is an automatic engineering device used in a larger mechanism to correct, using error-sensing negative feedback, that mechanism's performance: examples could include the steam engine governor, modern cruise control in cars, or, in Wiener's case, antiaircraft fire control mechanisms controlling a gun and its gunner.[72] Despite the coauthors' efforts to silence the social implications of the theory, computer algorithms added a further layer of technical complication to Wiener's feedback mechanisms, even as their neuronal analog to electronic switches quietly implied opening new research horizons in human-computer interaction, robotic prosthetics, and cyborgs. By formulating the science in terms of cutting-edge computers, not servomechanisms, the coauthors propelled the Soviet cyberneticist and his computer into the front lines of the escalating space and technology race. Thus, conceiving of the computer as a general regulating machine for any control systems, the Soviet formulation of cybernetics focused on computational systems from the start—a generalized step away from Wiener's interests in communication and control in concrete entities of "the animal and the machine."[73] Although computers were not common in the Soviet Union until decades later, to this day, the Russian word for *cybernetics*, *kibernetika*—together with its heir *informatics*, or *informatika*—remains a near synonym for the English field of computer science.

Computers at the time were new media in the sense that few people agreed how to talk about them: the computer in Russian in the 1950s and 1960s went by the bulky description "automatic high-speed electronic calculating machine."[74] Frequent use of the term mercifully introduced the abbreviation *EVM* (*electronnaya vyichislitel'naya mashchina*, or "electronic calculating machine"), which stuck through the 1960s and 1970s. Only under Gorbachev's *perestroika* in the 1980s did the now nearly ubiquitous English calque *komp'yuter* replace the term *EVM*.[75] The unwieldiness of the original Soviet term underscores the perennially renewable nature of the discursive contest that makes computers more or less new. Because the coauthors were sensitive to how language, especially foreign terms, packs in questions of international competition, the coauthors attempted to keep their language as technical and abstract as possible, reminding the reader that the cybernetic mind-machine analogy was central to the emerging science but should be understood only "from a functional point of view," not a philosophical one.[76]

The technical and abstract mathematical language of Wiener's cybernetics thus served as a political defense against Soviet philosopher-critics and as ballast for generalizing the coauthors' ambitions for scientists in other fields. They employed a full toolbox of cybernetic terminology, including signal words such as *homeostasis*, *feedback*, *entropy*, *reflex*, and *the binary digit*. They also repeated Wiener and Shannon's emphases on probabilistic, stochastic processes as the preferred mathematical medium for scripting behavioral patterns onto abstract logical systems, including a whole section that elaborated on the mind-machine analogy with special emphasis on the central processor as capable of memory, responsiveness, and learning.[77] Wiener's call for cyberneticists with "Leibnizian catholicity" of scientific interests was tempered into its negative form—a warning against disciplinary isolationism.[78]

On the last page of the article, the coauthors smoothed over the adoption of Wiener, an American, as foreign founder of Soviet cybernetics by summarizing and stylizing Wiener's "sharp critique of capitalist society," his pseudo-Marxist prediction of a "new industrial revolution" that would arise out of the "chaotic conditions of the capitalist market," and his widely publicized postwar fear of "the replacement of common workers with mechanical robots."[79] A word play in Russian animates this last phrase: the Russian word for *worker*, or *rabotnik*, differs only by a vowel transformation from *robot*, the nearly universal term coined in 1927 by the playwright Karel Capek from the Czech word for "forced labor."[80] The first industrial revolution replaced the hand with the machine, or the *rabotnik* with the *robot*, and Wiener's science, the coauthors dreamed, would help usher in a "second industrial revolution" in which the labor of the human mind could be carried out by intelligent machines, thus freeing, as Marx had intimated a century earlier, the mind to higher pursuits. "Automation in the socialist society," the coauthors wrote in anticipation of Khrushchev's declaration at the 1956 Congress, "will help facilitate and increase the productivity of human labor."[81] Although Stalin had found no use for Wiener's sounding of a "new industrial revolution," these mathematicians had found and refashioned in Wiener an American critic of capitalism, a founder of a science that was fit to sound the Soviet call for the "increased productivity of labor."[82]

Given this explicit adoption of Wiener into the Soviet scientific canon, it is surprising to note that the coauthors quoted only one line from any of his works. That line reads: "Information is information, not matter and not energy. Any materialism that cannot allow for this cannot exist in the present."[83] By distinguishing between information, energy, and matter, Wiener skips across two recent paradigm shifts in modern physics—first, from a Newtonian physics of matter to an era of thermodynamics and Bergson and second, from the thermodynamics of energy to a new but related paradigm of information science and Wiener's cybernetics. For many in the West, this quote meant that information is nothing but information, a value-neutral statistical measurement on which to rest objective science and the search for computable truth. The technical meaning was the same for their Soviet counterparts, but it also meant something more. By singling out Wiener's alliance of materialism and cybernetics, the coauthors implied that Wiener had in mind a position that was amendable to the official philosophy of Soviet science—the dialectical materialism of Marxism-Leninism. If dialectical materialism did not update itself for the information age, it could not exist. The same quote also leaves open the opportunity that the coauthors were lobbying for—that Soviet dialectical materialism *could* allow for information to be information in its fullest cybernetic or stochastic sense. The quote thus renders Wiener as a sort of foreign prophet announcing a dialectical materialist science of information science, a science whose present materialism could only be fully Soviet. With these ritual words, the coauthors wed cybernetics to Soviet ideology and dialectical materialism to the cybernetic information sciences. The success of this "important new field" of Marxist-Leninist information science, they contended, hung on the call to action that was voiced by its American originator.

The coauthors also buttressed Wiener's ideas of neural processing with reference to the great Soviet scientist Ivan Pavlov, whose original theory of conditioned reflexes in human psychology was derived from a telephone electrical switchboard, a communication machine with ideal cybernetic resonance.[84] Finally, the coauthors concluded the article in a ritual flourish of Orwellian newspeak that was common to academic writing at the time, calling for a battle against the capitalists who "strive to humiliate the activity of the working masses that fight against capitalist exploitation. We must decisively unmask this hostile ideology."[85] After years of anti-American, anticybernetic positions, they were the first to voice an anti-American, procybernetic position in the Soviet press. In the mid-1950s, the tone of subsequent arguments began to distinguish between the capitalist use of cybernetics, which was flatly condemned, and cybernetics in general, thus creating space for the argument that the socialist use of cybernetics might not only be possible but even preferable.

"The Dark Angel": Ernest Kolman's "What Is Cybernetics?"

Whatever rhetorical flourishes Kitov, Lyapunov, and Sobolev mustered, the strongest ideological support for their newfound procybernetic position lay in the article that immediately followed their publication in the same journal, Ernest Kolman's piece "What Is Cybernetics?" ("Chto takoe kibernetika?"). A loyal Bolshevik, an active ideologue-philosopher, and a failed mathematician with a long and bloody personal history of attacking nonorthodox mathematicians, Kolman makes a somewhat surprising candidate for the first ideological defender of Soviet cybernetics.[86] Among other ideological offenses that he appears to have committed, he seems to have done the most harm to the founders of the Moscow School of Mathematics, a powerful school in imperial Russia and the Soviet Union. He excoriated them for their nonatheistic commitment to a fascinating intellectual alliance between French set theory and a Russian Orthodox name-worshipping mysticism. (Their scandalously religious observation began by noting that both infinity and God could be named but not counted.)[87] Kolman was once dubbed "one of the most savage Stalinists on the front of science and technology" for his tireless defense of Lysenko's biology (which is now remembered as the Soviet pseudo-scientific alternative to classical genetics).[88] Some Soviet commentators feel that Kolman's diatribes kept the mathematician Andrei Kolmogorov in the 1940s from beating Wiener—the two are often compared as intellectual peers—to formalizing the link between biology and mathematics. Kolman was sensitive to political attacks and had a genuine interest in the history of science and a knowledge of four or five languages. A formidable opponent, he was sometimes known among his detractors and victims as the "dark angel."[89]

Despite such a body count, Kolman's role as self-elected guardian of cybernetics was not the first time he had deviated from an ideologically orthodox line of philosophy. He had spent time in a Stalinist labor camp after World War II for straying from the party line in his interpretation of Marxism. Just before he died in 1982, he published the book *We Should Not Have Lived That Way*, in which he reflected on his own past transgressions: "In my time I evaluated many things, including the most important facts, extremely incorrectly. Sincerely deluded, I was nourished by illusions which later deceived me, but at that time I struggled for their realization, sacrificing everyone."[90] This context makes Kolman's defense of cybernetics more surprising: why would an embittered former mathematician with a track record of decimating pseudo-scientific mathematical theories come to the defense of cybernetics in 1953? Was his role as the first ideologue to defend Soviet cybernetics an act of penitence or another cardinal sin?

Kolman began his eleven-page promotional history by outlining over a century of international cybernetics, beginning with the French mathematician, physicist, and philosopher André-Marie Ampère in 1843 and moving to "Russian and Soviet scientists, [such as] Chernishwev, Shorin, Andropov, Kulebakin, and others."[91] Kolman called Wiener "one of the most visible American mathematicians and professor of mathematics at Columbia University" and the one who "definitively" formalized cybernetics "as a scientific sphere," in a veritable shout of praise for the time.[92] In fact, Wiener had been appointed at MIT, not Columbia, since 1919, but Kolman may have introduced the mistake on purpose: Columbia University stood out to Soviet observers among American universities at the time for its Russian studies center, the Harriman Institute, which had been a favorite target of McCarthy, so by connecting Wiener to Columbia, not MIT, perhaps he softened his image in the eyes of Kolman's peer philosopher-critics.[93] In any case, Wiener occupies the sixth through the ninth paragraphs of Kolman's ideological support piece, which signals a second witness of Wiener's adoption into the vanguard of Soviet cybernetic historiography.

Having set up Wiener as the foreign founder of Soviet cybernetics in the article, Kolman promptly invented a Soviet prehistory to the science that broadened and colored the ambition of cybernetics to match Marxism-Leninism. Sensitive to the many eastern European origins of cybernetic-style thinking, Kolman's narrative assimilates cybernetics into a longer history of computational machines, including Ramon Llull in 1235, Pascal in the mid-1600s, the engineer Wilgott "Odhner of St. Petersburg" (and not Stockholm, Wilgott's native city), and the late nineteenth-century mathematicians A. N. Krilov and P. L. Chebishev. He then discussed how the Soviet mathematicians Andrei Markov Jr. (a constructivist mathematician who later became a leading cyberneticist), N. C. Novikov, N. A. Shanin, and others advanced the last hundred years' worth of precybernetic work in Russian.[94] Kolman's internationalism allowed two people west of Berlin to slip into his history—Norbert Wiener and Nikolai Rashevsky, the first Pavlov-inspired biomathematician and a Russian émigré at the University of Chicago.

Thus, the battle to legitimize Soviet cybernetics began internally and was fought against by and among Soviet philosopher-critics, the vanguard and police of ideological debate in Soviet discourse. Both procybernetic articles (especially Kolman's) were loaded with discursive tactics that were meant to protect cybernetics from counterattacks, so much so that, even in pronouncing it, the first act of Soviet cybernetics partook in cold war game-theoretic strategies. In the first public defense of cybernetics, which was a lecture given at Moscow State University in 1954, Kolman notes that "it is, of course, very easy and simple to defame cybernetics as mystifying and unscientific. In my opinion, however, it would be a mistake to assume that our enemies are busy with nonsensical things, that they waste enormous means, create institutes, arrange national conferences and international congresses, publish magazines—and all this only for the purpose of discrediting the teachings of Pavlov and dragging idealism and metaphysics into psychology and sociology." By imagining enemies as rational actors, not pseudoscientific bourgeois, a cybernetic worldview provides its own first defense: "There are more effective and less expensive means than the occupation with cybernetics," Kolman the philosopher-critic continues, "if one intends to pursue idealistic and military propaganda.[95]

Kolman employed the logic of reversing the rational enemy that was implicit in all Soviet cybernetic strategy to save the fledgling movement from future Soviet critics. Kolman invites his Soviet listeners to consider cybernetics from the perspective of an economically rational American scientist.[96] We should imitate the enemy, Kolman reasoned, because we can infer that the enemy knows something we do not, for he is occupied with something we do not understand. To its participants, cybernetics took initial shape in a militarized discourse of the postwar and cold war.

Like Kolman, the coauthors Sobolev, Lyapunov, and Kitov also preempted the reactions of the Soviet philosophers, rebuffing them for "misinterpreting cybernetics, suppressing cybernetic works, and ignoring the practical achievements in this field."[97] The coauthors flipped the reactionary argument that was sure to follow (that Soviet cybernetic defenders were "'kowtowing' before the West") by insisting that "some of our philosophers have made a serious mistake: without understanding the issue, they began by denying the validity of a new scientific trend largely because of the sensational noise made about it abroad."[98] In a concluding flourish, the coauthors conspired:

> One cannot exclude the possibility that the hardened reactionary and idealistic interpretation of cybernetics in the popular reactionary literature was especially organized to disorient Soviet scientists and engineers in order to slow down the development of this new important scientific trend in our country.[99]

Thus, the coauthors held, the critics of cybernetics, not its proponents, should be suspected of having fallen under the spell of the cold war enemy. To recognize the contributions of the enemy without opening themselves to attack, they heaped suspicion on suspicion, insinuating that instigators abroad had somehow organized the ideological critique of cybernetics within the Soviet Union. Although it is unlikely that the coauthors genuinely believed that their discovery of cybernetics came in spite of the efforts of American spies and agents, this kind of argument nonetheless won internal wars of words.

Soviet cyberneticists were not alone in employing this strained logic. If Wiener was right in arguing that information arms all its possessors equally, double heaps of suspicion may support an ultrarational strategy that strains toward the irrationality found across cold war discourse. Kolman's counterdefense of cybernetics against other Soviet critics, for example, resembles a game-theoretic scenario in which (like the policy of mutually assured destruction) both parties seek to settle their disagreements in order to avoid a larger collective loss.[100] The basic logic of this cybernetic worldview, asserts historian Peter Galison, is to adopt the logic of the "enemy Other" and to preempt and predict the behavior of the intelligent and rational foe to the point where the positions are reversed and foe and friend become indistinguishable.[101]

Cybernetics—like its sister disciplines of game theory, information theory, and others—appears as a method for rationalizing the enemy, distributing structural strategy evenly across opponents and flattening the chances that an enemy will have to take strategic or logical advantage over an ally. Perhaps nowhere is this as clear as in the Soviet defense of cybernetics itself, except that in Kolman's case, the enemy to defend cybernetics against was his own kind. At first rejected for its American sources, Soviet cybernetics took shape not as a Soviet reaction against the American enemy but as a circular defense of Soviet mathematicians against their own philosopher-critics.

A "Complete Cybernetics": Toward a Totalizing Plurality

The efforts of Sobolev, Lyapunov, Kitov, and Kolman in print and in public lecture, combined with the intellectual weight of preeminent mathematician Andrey Kolmogorov and high-ranking administrator and engineer Aksel' Berg, led to the establishment of the statewide Council for Cybernetics in 1959, which in turn promised cybernetics a base for significant growth as an institutional field in the early 1960s. By 1965, however, it was still not clear in which direction this new science would lead. Would it distribute the powers of the Soviet state among its participants more equitably and flexibly? Or would it consolidate power still further? In 1965, an American visitor feared the worst: after visiting a facility with an evident generation gap between "all the young, recent graduates of technical higher schools" who were interested in computers and "the older bureaucrats," he prophesied that "a turnover in generations in the Soviet administration" could lead to a "computer revolution" that "may enormously increase the effectiveness of formal communication channels." The "modernization of communication may have the paradoxical effects," the American observer fretted, "of actually enhance[ing] totalitarian control by making a fully centralized network of administrative communications channels really feasible."[102]

Between 1960 and 1961, the popular press began heralding computers as "machines of communism" and engineer admiral Aksel' Berg, then director of the Council of Cybernetics, launched the first of a series of volumes entitled *Cybernetics: In the Service of Communism*.[103] This series stirred emotions among Western observers. One American reviewer noted with concern in 1963, "If any country were to achieve a completely integrated and controlled economy in which 'cybernetic' principles were applied to achieve various goals, the Soviet Union would be ahead of the United States in reaching such a state." The reviewer also picked up on the burgeoning interest in economic cybernetics, stating that "a significantly more efficient and productive Soviet economy would pose a major threat to the economic and political objectives of the Western World.… Cybernetics, in the broad meaning given it in the Soviet Union," he concluded with a flare, "may be one of the weapons Khrushchev had in mind when he threatened to 'bury' the West."[104]

The Central Committee began publicly promoting cybernetics along similar lines in 1961 at the Twenty-second Party Congress as "one of the major tools of the creation of a communist society."[105] First Secretary Nikita Khrushchev himself promoted a far-reaching application of cybernetics: "it is imperative," he declared to the Congress, "to organize wider application of cybernetics, electronic computing, and control installations in production, research work, drafting and designing, planning, accounting, statistics, and management."[106] Central Intelligence Agency (CIA) sources noted similar enthusiasm at an All-Union Conference on the Philosophical Problems of Cybernetics held in June 1962 in Moscow, which included "approximately 1000 specialists, mathematicians, philosophers, physicists, economists, psychologists, biologists, engineers, linguistics, physicians."[107] The conference adopted an official, if vague, definition of *cybernetics* as "the science which deals with the purposeful control of complex dynamic systems."[108] The most ambitious of these complex dynamic systems, the Party leadership's support seemed to imply, would be the Soviet Union itself.

The looming menace of a well-organized, cybernetic self-governing socialist enemy worried some American observers as well. During the John F. Kennedy administration, members of the intelligence community agitated against the perceived looming peril of Soviet cybernetics. John J. Ford, then a Russian specialist in the CIA and a future president of the American Society for Cybernetics, was responsible for several alarm-generating reports on Soviet cybernetics, which had already grabbed Attorney General Robert F. Kennedy's attention. One fateful evening in the fall of 1962, Ford gathered with President John F. Kennedy's top men to discuss the impending peril of Soviet cybernetics, only to have his meeting interrupted by the announcement that surveillance satellites had just uncovered photos of Soviet missiles in Cuba.[109] By the time the dust settled after the Cuban missile crisis, Soviet cybernetics no longer agitated the administration, which had reviewed the science and did not deem it an urgent threat. It is a strange twist of history, then, that the international crisis that is considered the zenith of cold war hostility (the Cuban missile crisis) also defused and derailed mounting American anxieties about the "Soviet cybernetic menace."[110]

Although U.S. and Soviet intelligence officers alternately fretted about or enthused over the possibilities of a cybernetically coordinated Soviet power, the facts about the practical debates among Soviet scientists point in a very different direction. Soviet cybernetics, for all its talk about self-governance, was anything but. Berg's series *Cybernetics: In the Service of Communism* produced heated debate and fierce divisions among prominent mathematicians in the Soviet Union.[111] In contrast to the CIA's fear of a mounting, unified platform of Soviet cybernetics, cybernetic talk swelled the internal discord among mathematical cyberneticists, painting a picture instead of an intellectually fractured front. Leading Soviet cyberneticists defined the field in dramatically different terms: Kolmogorov fought to claim information as the base of cybernetics, Markov preferred probabilistic causal networks, Lyapunov set theory, and Iablonsky algebraic logic. In 1958, only three years after their initial article, Kitov, Lyapunov, and Sobolev published an article outlining four new definitions of cybernetics in the Soviet Union, emphasizing the dominant study of "control systems," Wiener's interest in "governance and control in machines, living organisms, and human society," Kolmogorov's "processes of transmission, processing, and storing information," and Lyapunov's methods for manipulating the "structure of algorithms."[112] According to researchers, loose groups of cybernetic thought consolidated around leading cyberneticists such as Lebedev, Berg, Lyapunov, Glushkov, Ershov, and others.[113]

Although some scientists contended that the virtue of cybernetics lay in its capacious tent of competing foundations, not everyone felt that the new field should contain multitudes. Igor Poletaev, a leading Soviet information theorist and author of the 1958 book *Signal*, an early work on Soviet cybernetics, argued in 1964 against any plastic understanding of cybernetics. He legitimated his call for disciplinary coherence by invoking its foreign founder, Norbert Wiener, claiming that "'terminological inaccuracy' is unacceptable, for it leads and (has already led) to a departure from Wiener's original vision of cybernetics toward an inappropriate and irrational expansion of its subject."[114] "As a result," Poletaev continued, "the specificity of the cybernetic subject matter completely disappears, and cybernetics turns into an 'all-encompassing science of sciences,' which is against its true nature."[115] The geneticist Nikolai Timofeef-Ressovsky, whose life and work was praised and persecuted under the regimes of both Hitler and Stalin, once put the same sentiment in lighter terms. In correspondence with Lyapunov, he replaced the Russian word for *confusion* or *mess* with the term *cybernetics*, joking about his having once placed a letter in the wrong envelope as a "complete cybernetics."[116] In Timofeef-Ressovsky's witticism, we uncover a fitting rejoinder to those enthused and worried that a complete cybernetics might mean a unified Soviet information science and society.

To put it both precisely and audaciously, the term *cybernetics* should be used in the plural, and perhaps the only stable sense of cybernetics is the adjectival form, *cybernetic*, an adjunct to anything that its users see fit to apply it. From the point of view of the central committee that organized cybernetics institutionally, Soviet cybernetics, at the peak of its reach, appears both comprehensive and pluralist. It was a complete mess, as Timofeef-Ressovsky jested. In the late 1960s, the Academy of Sciences of the USSR promoted cybernetics into an entire division, one of four divisions comprising all Soviet science.[117] The remaining three (noncybernetic) divisions—"the physico-technical and mathematical sciences, chemico-technical and biological sciences, and social sciences"—could without much conceptual violence be read as subfields of the Siberian-sized Soviet cybernetic science.

The Soviets were not alone in the instinct to universalize science, although the ideological organs of the state excelled at promoting such discourse. The ecumenical commitment and a totalizing mission to stitch together the mechanical, the organic, and the social often were attributed to their foreign founder. In 1948, Wiener attempted to analogize (in the subtitle to his 1948 *Cybernetics*) "the animal and the machine" and concluded with a comment about the insufficiency of cybernetic methods for social sciences. Nonetheless, two years later, in 1950, Wiener published a popular version called *The Human Use of Human Beings*, whose subtitle belies his earlier caution: "cybernetics and society."[118] Still, the instinct to institutionalize his intellectual catholicity was clearly native to the Academy of Science, which originally categorized cybernetics into eight sections, including mathematics, engineering, economics, mathematical machines, biology, linguistics, reliability theory, and a "special" military section.[119] With Aksel' Berg's sway over the Council on Cybernetics, the number of recognized subfields then grew to envelop "geological cybernetics," "agricultural cybernetics," "geographical cybernetics," "theoretical cybernetics" (mathematics), "biocybernetics" (sometimes "bionics" or biological sciences), and, the most prominent of the Soviet cybernetic social sciences, "economic cybernetics" (discussed in later chapters).[120]

By 1967, the range of cybernetic sections enveloped information theory, information systems, bionics, chemistry, psychology, energy systems, transportation, and justice, with semiotics joining the linguistic section and medicine uniting with biology. Sheltering a huddling crowd of unorthodox sciences, including "non-Pavlovian physiology ('psychological cybernetics'), structural linguistics ('cybernetic linguistics'), and new approaches in experiment planning ('chemical cybernetics') and legal studies ('legal cybernetics')," cybernetics in the mid-1960s grew to an almost all-encompassing size.

Nonetheless, the runaway institutional success of cybernetics in the Soviet Union also meant that, by the time Leonid Brezhnev came to power in 1964, Soviet cybernetics could not help but slouch toward the intellectual mainstream.[121] It had to: its territory had grown so large it could not help but take up the middle of the road. The institutional growth of cybernetics outran the intellectual legs supporting it: the failure of cybernetics to cohere intellectually actually rested on the runaway growth of the discipline institutionally. Sloughing reformist ambitions to the side, by the 1970s, *kibernetika* signaled little more than a common interest in computer modeling that held together a loose patchwork of institutions, disciplines, fields, and topics. By the 1980s, the term *cybernetics* marked a nearly empty signifier for all the plural things to which the adjective could be attached. By the rise of Gorbachev in 1984, Soviet cybernetics had successfully accompanied and slowly integrated into a host of parallel developments. The inheritor field "informatics," the parallel revolution in military affairs, the scientific-technical revolution, and the first three generations of computer hardware (vacuum tubes, transistors, and integrated circuits) had rolled forward under the fading banner of Soviet cybernetics.[122]

Conclusion: Wiener in Moscow

This brief history of early Soviet cybernetics ends where it began, with Norbert Wiener and the foreign founding of cybernetics. In the early 1960s, travel restrictions for Americans in the Soviet Union began to slacken, and a trickle of chaperoned scientific and cultural exchanges began to flow between the two superpowers. Early among this generation of guests was Wiener, then an aging omnibus professor at MIT. In June 1960, Soviet officials warmly welcomed this American founder of cybernetics for a several-week visit to Moscow, St. Petersburg, and Kiev (figure 1.1.) After his arrival, Wiener, whose translated books were popular (albeit in edited form) in the Soviet Union, was paid royalties in cheap caviar and champagne (which apparently sat untouched in his basement) and gave invited lectures at prestigious institutes in those three cities.[123] For Wiener, it was a chance to issue a stirring warning against societies that would adopt cybernetics without the fundamental ability to correct themselves, decrying that "science must be free from the narrow restraints of political ideology." For his Soviet hosts, the visit allowed the cybernetic knowledge base to go about the regular ideological work of welcoming and canonizing a socialist saint in public memory of Soviet society and technology.[124] The effect among his colleagues in the Soviet Union and in Cambridge was electric. Reflecting on his public reception, Wiener's friend Dirk Struik, a Dutch mathematician and Marxist theoretician, captured the moment for many Soviet cyberneticists with his overstatement, "Wiener is the only man I know who conquered Russia, and single-handed at that."[125] We may claim that by this process Wiener became known as a foreign founder of Soviet cybernetics. In *Democracy and the Foreigner*, political theorist Bonnie Honig introduces the idea that an iconic "foreign founder," or an alien recruited for a project that he or she unsettled, often plays a role in the many political narratives of identity formation: the kingdom of Oz has its Dorothy of Kansas; the House of David has a Moabite grandmother, Ruth; the American colonies were united by the belief that they were no longer British; Europe now traces its origins to ancient Greece, which was first a Roman idea. Eastern Europe abounds in similar stories: Russia originates in ancient Rus', now in Ukraine; the Ukrainian national anthem claims brotherhood with the Cossack; and the Polish national anthem praises Lithuania.[126] That Soviet cybernetics identified Wiener as foreign founder is in context nothing new. After all, no native can found his or her identity. There is no identity

Figure 1.1
Norbert Wiener with Aleksei A. Lyapunov in Moscow, 1960.
Courtesy of Boris Malinovsky.

without a founder, and because founders precede identities, all foundations must be laid by what must appear post fact as foreigners.

Wiener's renown in the former Soviet territories has outlasted his memory in the English-speaking world. When Aksel' Berg became chair of the Council on Cybernetics in 1959, he made sure that among the first supporting works translated were Wiener's. Over fifty years later, nearly all of Wiener's major works have since been translated into Russian and retain their relative popularity, long after his legacy has faded in the English-speaking world, except recently among historians of science.[127] Wiener's 1948 *Cybernetics, or Control and Communication in the Animal and the Machine* was translated into Russian in 1958 and reissued in 1968 and again in 1983, one more printing than in English. In 1958, his *Human Use of Human Beings: Cybernetics and Society* was abridged and translated as *Kibernetika i obscheshtvo* (*Cybernetics and Society*). Based on the lectures he gave while visiting Moscow, he published a 1962 article "Science and Society" in the preeminent journal *Problemy Philosophii* (*Problems of Philosophy*). His autobiographies *Ex-Prodigy* (1953) and *I Am a Mathematician* (1956) were translated in 1967. And his final collection of lectures, *God and Golem, Inc.: A Comment on Certain Points in Which Cybernetics Impinges on Religion* (1964), was translated as *Tvorets i robot* (*Creator and Robot*) in 1966 and reissued in 2003.

As a testament to the staying power of Wiener as an iconic foreign founder figure, Wiener's semiautobiographical novel *The Tempter* was translated in 1972, eight years after his death. His short piece of fiction, "The Brain," which is hard to find in English, was translated in 1988. And his 1951 article "Homeostasis in the Individual and Society" appeared in Russian in 1992, just after the turbulent collapse of Soviet society. Bookstores in Moscow continue to offer new editions of Wiener's works to this day. His oeuvre has also migrated online unevenly: all aforementioned works in Russian are freely available for download online, compared to only one work in English, *God and Golem, Inc.* Given all this, it may not be a stretch to assert that, with the visit of an American founder of cybernetics, the son of Leo Wiener, an émigré from Byelostock and founder of Slavic studies in America, Norbert Wiener was christened no less than a Soviet prophet returning home.[128]

Yet if Wiener were a prophet, he would be the kind whose stinging calls to repentance went ignored both at home and abroad. He pressed for removing ideology from science just as the political winds, in the early 1960s, were shifting toward ideological reconsolidation and recentralization under Brezhnev. The case of Wiener in Moscow is interesting, then, not merely for biographical or historiographical reasons but also as a synecdoche for the larger Soviet experience with cybernetics. The cybernetic technological apparatus brought with it a promise of systemwide structural reform, and although that reform was never fully realized, the technological apparatus was. Cybernetics accompanied the transformation of Soviet society into an already networked information society, although it did so without bringing about the intended social, organization, and technological reforms and self-governance. The early nationwide cybernetworks explored in subsequent chapters are central to understanding the Soviet experience and the unintended political consequences of sociotechnical and technocratic reforms.

A glance at the history of early Soviet cybernetics might at first steer readers to think that technocratic sciences are politically neutral, capable of adapting to whatever the political discourse of the day is, whether Stalin's rejection, Khrushchev's reform, or Brezhnev's reconsolidation of technocratic science. Yet this is not the case: claiming technocratic neutrality itself is a consequential political posture that often is filled by whatever the politics of status quo at the time and place are. The nationwide networks created to save the flagging economy and technical data infrastructures discussed in later chapters are presented as socially neutral technocratic solutions to social problems—and yet that position of neutrality proved to be a veiled form of ideational investment. Considered generally, the cybernetic goal of controlling and regulating information systems in abstract and supposedly neutral mathematical terms appealed to post-Stalinist scientists who were fed up with political oppression. Cybernetics struck Moscow-based bureaucrats and party officials as a politically feasible way forward in preserving the centralized state as an information system without the abuses of Stalinism.[129] Behold the promise of control without violence and of a socialist information society liberated from its stained past by the neutralizing politics of computation.

Others promised technological improvements without politics long before the onset of computers and digital media. Soviet discourse of what James Carey called the "electric sublime" begins with Lenin's famous 1920 statement that "Communism is Soviet power plus the electrification of the whole country," perhaps the highpoint of the Soviet reputation in the West as well as a memorable declaration of the Soviet Union's commitment to achieve social progress through technological modernization.[130] Soviet cybernetic discourse built actively on that tradition—particularly that of the Soviet digital economic network projects, which, like Lenin's electrification (or GOERLO) project, promised to rework the technological infrastructure of the whole country—the factories, the grids that united them, and the giant hydroelectric and computer stations that powered them. The cybernetwork projects integrated and updated a longer tradition of the industrialist, Taylorist megaprojects that marked the Soviet electrical age.

The cybernetic lexicon also resonates richly with native Soviet discourse. Before Wiener cemented that hardy word as central to cybernetic systems, *feedback* occupied a prominent position in the Soviet political imagination of itself as a "socialist democracy," a kind of complex social entity sustained by Pavlovian mechanisms of stimulus and response and control and cooperation between rulers and masses.[131] With little work, the term *noise reduction* came to stand for a technical synonym for continuing political censorship in the Soviet Union. Moreover, Wiener's twinning of the modern laborer with an automaton echoed of Stalin's attempts to make Soviet labor and industry efficient with the scientific management techniques of Taylorism. Wiener's theories of systematic information control and communication, once translated into Russian, appeared to be a recuperation of ideas that already were well understood.[132]

Perhaps this history of Soviet cybernetics is most helpful not for what it says about cybernetics but for what the discursive pliancy of cybernetics allows us to see in Soviet society. As a term, *cybernetics* served as a flexible semantic placeholder for a more widely held article of faith about the promise of technocratic governance aided by computer in post-Stalinist science and society. As a history, the several-step process of the Soviet rejection, rehabilitation, adoption, and adaptation of a new foreign discipline reveals less about cybernetics than it recapitulates the preexisting political dynamics of Soviet discourse—the debate patterns, rituals of discourse, strategies for intellectual defense, alliance forging, institution building, the political whims of Moscow, and other everyday dynamics. Backlit with fascinating twists, turns, and figures, the story of Soviet cybernetics presented here signals not particularly well-defined intellectual contributions but rather shows the ways that the lack of them allowed Soviet cybernetic discourse to mold to and reflect longer transformations and trends in the Soviet state's attempts to manage and control science, technology, and society.

Soviet cybernetics thus appears to be a normal science in the sense that it reveals the conflicting dynamics of underlying political, economic, and institutional practices and structures. These dynamics—the echoes of anticapitalistic public campaigns, the ritual aspects of intellectual debates and duels, the political machinations and strategies, the institutional diffusion of the computer as a specialized tool, the history of spikes of invention followed by downward-sloping plateaus of innovation and development characterizing the history of science in Russia, and the stubborn fact that the work of science takes place in prolific dialects and varied trading zones subject to the punishing pleasures of contest, prestige, and competition[133]—appeared par for the course. As the next chapter attempts to illustrate, the case of Soviet economic cybernetics challenges historians and other agent-observers of change with the suggestion that perhaps the ordinary, overlooked elements of actors, ideas, practices, and policies—including those governing everyday life in the command economy—best describe the circuitous historical course of science and social reform.

In one important sector, however, Soviet cybernetics and other information sciences were not obviously subjected to a confusion of competing motives—the Soviet military. The Red Army adopted cybernetic research methods and vocabulary, usually coded in public simply as "special research"; successfully theorized the military-technical revolution spurred by computers and associated long-range, specific-target military innovations; and maintained a competitive space and nuclear and long-range conventional warfare armaments without the internal incoherence and competition that was found in civilian sectors. So although the Soviet cybernetic-lit military technology revolution of the 1970s did not lead to application due to the political and economic incapacities of the Soviet state, the key distinction from the civilian economic sectors is that, inside the centralized military administration, real cybernetic reform was both possible and carried out in theory.[134]

In conclusion, having outlined a few sources that led to the consolidation of cybernetics in Wiener's 1948 masterwork, the Macy Conferences on Cybernetics (1946–1953), its postwar spread through France, England, Chile, and a vignette of how cybernetics became a loose techno-ideological framework for thinking through information sciences in post-Stalinist Soviet Union, I now comment on the idiosyncratic development of cybernetics across these moments in the early cold war global history. Several comparisons and contrasts draw connections to other postwar climates where cybernetics came to roost. The Soviet translation and adoption of cybernetics share with the other case studies glossed here an underlying fascination with the relationship of the mind to the machine, especially as seen in the biology and neurology of the British and Chilean cyberneticists. The mind-machine analog is a politically charged two-way street. Not only does cybernetics prompt us to think about how a logic machine (computer circuits or any other Turing machine) may function like a mind (a neural network), but it also raises McCulloch's potent possibility that subsequent neuroscience has soundly rejected: the mind (neural network) might function like a logic machine (computer circuits). This reverse comparison (that a mind is like a machine) proves particularly enduring in later discussions of the design and development of national networks. The designers of major early cold war national networks in the Soviet Union, the United States, and Chile sought, implicitly or explicitly, to model their own self-governing national networks after cybernetic neural networks. In the comparative network designs (including distributed, hierarchical, and participatory), early network scientists proposed differing images of the relationship between a network and the living body politic of the nation.

The mind analogies all share a common cybernetic impulse to analogize between information systems underlying organisms, machines, and societies. (The organizing itch of cybernetics is simply that a better-understood system can inform a less well-understood system.) Analogies are neither right nor wrong: they should be judged by their interpretive use rather than their epistemic weight. (Or as Evelyn Fox Keller once noted, the word *simulation* meant *deception* before it meant *analogical likeness*.) Given this, it is striking that each of the network architect teams at hand (Glushkov's OGAS, Beer's Cybersyn, and Baran's ARPANET) chose to analogize or model its national network project after the same basic image—the human mind, or an organic nervous system. But each of these national networks expressed the basic design analogy differently.

These early national networks projects—OGAS, Cybersyn, and ARPANET—were designed after different models of the (human) mind. Even though Beer and the Cybersyn project rejected previous and ongoing Soviet attempts to manage the command economy, the OGAS and Cybersyn projects pursued a national model in which the nation is likened to the body of an organism and the computer network to the nervous system that incorporates that nation's communication.[134] The ARPANET, by contrast, inspired by McCulloch's neural network research, is analogized to a disembodied brain itself. In this case, the nation is like the brain itself: whatever organization the network serves constitutes its own neural network. To oversimplify, Baran foresaw a national state network simulating a brain *without* a body, while Glushkov (and Beer) anticipated a network nation simulating a body *with* a brain—a government in touch with its people.

As cognitive philosophers have submitted, analogies of (a nation as) an embodied mind and a disembodied brain work very differently. Although Soviet scientists were understandably wary of overbold political proclamations, the OGAS design reaffirmed the self-conception of the Soviet state as a decentralized hierarchical heart of the Soviet nation. In a colossal nation, workers were to be incorporated and animated by planning that emanated from the central processing unit, or social brain, in Moscow. That state would not be simply centralized and top-down. In the OGAS design, the network would serve as a nationwide nervous system that responded to and adjusted in real time to local events and maintained dynamic balance through complex feedback loops with its internal and international information environment. This metaphor was both materialist and idealist—materialist in that it grounded the nation in the industrial and economic realities already on the ground and idealist in that it ignored the fact that the economy did not behave like a healthy or single body (but instead like an environment for nonsymbiotic competition over bureaucratic positioning).

Also consider how the U.S. ARPANET analogy of the nation as a disembodied brain, although articulated here for the first time to my knowledge, has already been inscribed many times. Most often the interpretations smack of triumphalist political overtones. Seeing the nation (network) as a brain, not a body, signifies that the United States is conceived as an organ for knowledge work, not physical labor; that its civilian communication networks imagine its citizens, not the state, as the democratic decision-making mechanism for the nation; that those citizens exist in peer-to-peer relationships where, like nodes in a distributed network, each may act and interact with her neighbor as equals; and that (particularly common in digital libertarian discourse) the computer network itself constitutes the higher order of technological freedom that is necessary for the natural emergence of a more robust political order. (When Baran described distributed networking, his word was not *robust* but *survivable* because his network was to survive nuclear attack, which puts a less optimistic spin on things.) Baran, we might assert, was acting in the libertarian tradition by espousing the organic nation as a marketplace of individuals dating back to Herbert Spencer.[136] Or perhaps Baran designed the ARPANET after the image of the state as an enlightened social brain, channeling the American progressive notion of the state (or any other depository of organized intelligence, including the news-reading public, schools, universities, and scientific laboratories) as a "social sensorium" dating back to John Dewey and Charles Horton Cooley.[137]

With enough imagination, the analogy of the national network to a human mind can serve almost any end, such as the engine of a sensing being interacting in a mediated environment, a nervous system animating a living body, or the gray matter filling a skull. Perhaps the reason that these cyberneticists populated their analogies with the human mind was (to paraphrase a leading neuroscientist) simply the fact that humans like to believe that the human mind is the most complicated thing in the universe, even though this idea is probably no more than the brain's opinion about itself.[138] The point is that this analog, like all others, is contentless. It has no right or wrong, and the work that it does for us is work that we do to ourselves. The stories we tell ourselves about our networks reveal more about us—the spinners of modern-day network rhetoric—than it does about the network itself.

Finally, this chapter summarizes how, in its early adoption period, early Soviet cybernetics muted but did not erase politically potent mind-nation-network questions with language that was deliberately more technocratic and theoretical perhaps than that of cyberneticists in other countries. Although no surprise, talk about cybernetics and society took on the technical discourse of what Gerovitch calls Soviet "cyberspeak," or an ideological and discursive strategy for embedding public discussion about society in the language of technical expertise. The postwar and cold war debates about cybernetics in the Soviet Union impinged on the social implications of the new science. Perhaps the most obvious example of a technocratic approach bearing out social implications is the focus of the next chapter—the case of economic cybernetics. How, if at all, might cybernetics—or the study of communication systems that organize our bodies, machines, and societies—improve the current social, political, and economic order? How, as Stafford Beer developed in Chile, might cybernetic insights be applied to the networking of the Soviet nation in need of an economic boost? How might concerns with communication and control that were central to both the larger Soviet state and cybernetic projects play out in the crucial practice and policies of command economies? The following chapter discusses these and other questions.