Cybernetic Revolutionaries

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- Cybernetic Revolutionaries | Technology and Politics in Allende's Chile (http://www.cyberneticrevolutionaries.com/).
- Cybernetic Revolutionaries | The MIT Press (https://mitpress.mit.edu/books/cybernetic-revolutionaries).
- Further references here (https://links.fluxo.info/tags/cybersyn).

Control and descentralization

Beer's writings on management cybernetics differed from the contemporaneous work taking place in the U.S. military and think tanks such as RAND that led to the development of computer systems for top- down command and control. From the 1950s onward, Beer had drawn from his understanding of the human nervous system to propose a form of management that allowed businesses to adapt quickly to a changing environment. A major theme in Beer's writings was finding a balance between centralized and decentralized control, and in particular how to ensure the stability of the entire firm without sacrificing the autonomy of its component parts.

Similarly, the Popular Unity government confronted the challenge of how to implement substantial social, political, and economic changes without sacrificing Chile's preexisting constitutional framework of democracy. A distinguishing feature of Chile's socialist process was the determination to expand the reach of the state without sacrificing the nation's existing civil liberties and democratic institutions. Both Beer and Popular Unity were thus deeply interested in ways of maintaining organizational stability in the context of change and finding a balance between autonomy and cohesion.

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Adaptive Control

The idea of control is commonly associated with domination. Beer offered a different definition: he defined control as self- regulation, or the ability of a system to adapt to internal and external changes and survive. This alternative approach to control resulted in multiple misunderstandings of Beer's work, and he was repeatedly criticized for using computers to create top- down control systems that his detractors equated with authoritarianism and the loss of individual freedom. Such criticisms extended to the design of Project Cybersyn, but, as this book illustrates, they were to some extent ill- informed. To fully grasp how Beer approached the control problem requires a brief introduction to his cybernetic vocabulary.

Beer was primarily concerned with the study of "exceedingly complex systems," or "systems so involved that they are indescribable in detail." 52 He contrasted exceedingly complex systems with simple but dynamic systems such as a window catch, which has few components and interconnections, and complex systems, which have a greater number of components and connections but can be described in considerable detail

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In Beer's opinion, traditional science did a good job of handling simple and complex systems but fell short in its ability to describe, let alone regulate, exceedingly complex systems. Cybernetics, Beer argued, could provide tools for understanding and controlling these exceedingly complex systems and help these systems adapt to problems yet unknown. The trick was to "black- box" parts of the system without losing the key characteristics of the original. 53

The idea of the black box originated in electrical engineering and referred to a sealed box whose contents are hidden but that can receive an electrical input and whose output the engineer can observe. By varying the input and observing the output, the engineer can discern something about the contents of the box without ever seeing its inner workings. Black- boxing parts of an exceedingly complex system preserved the behavior of the original but did not require the observer to create an exact representation of how the system worked. Beer believed that it is possible to regulate exceedingly complex systems without fully understanding their inner workings, asserting, “It is not necessary to enter the black box to understand the nature of the function it performs” or to grasp the range of the subsystem’s behaviors. 54 In other words, it is more important to grasp what things do than to understand fully how they work. To regulate the behavior of such a system requires a regulator that has as much flexibility as the system it wishes to control and that can respond to and regulate all behaviors of subsystems that have been black- boxed.

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Controlling an exceedingly complex system with high variety therefore requires a regulator that can react to and govern every one of these potential states, or, to put it another way, respond to the variety of the system. “Often one hears the optimistic demand: ‘give me a simple control system; one that cannot go wrong,’ ” Beer writes. “The trouble with such ‘simple’ controls is that they have insufficient variety to cope with the variety in the environment. . . . Only variety in the control mechanism can deal successfully with variety in the system controlled.” 56 This last observation—that only variety can control variety—is the essence of Ashby’s Law of Requisite Variety and a fundamental principle in Beer’s cybernetic work. 57

The Law of Requisite Variety makes intuitive sense: it is impossible to truly control another unless you can respond to all attempts at subversion. This makes it extremely difficult, if not impossible, to control an exceedingly complex system if control is defined as domination. History is filled with instances of human beings’ trying to exert control over nature, biology, and other human beings—efforts that have failed because of their limited variety. Many of the most powerful medicines cannot adapt to all permutations of a disease. Recent work in the sociology of science has positioned Beer’s idea of control in contrast to the modernist ethos of many science and engineering endeavors, which have sought to govern ecosystems, bodily functions, and natural topographies. Despite the many successes associated with such projects, these efforts at control still have unexpected, and sometimes undesirable, results. 58

Beer challenged the common definition of control as domination, which he viewed as authoritarian and oppressive and therefore undesirable. It was also “naïve, primitive and ridden with an almost retributive idea of causality.” What people viewed as control, Beer continued, was nothing more than “a crude process of coercion,” an observation that emphasized the individual agency of the entity being controlled. 59 Instead of using science to dominate the outside world, scientists should focus on identifying the equilibrium conditions among subsystems and developing regulators to help the overall system reach its natural state of stability. Beer emphasized creating lateral communication channels among the different subsystems so that the changes in one subsystem could be absorbed by changes in the others. 60 This approach, he argued, took advantage of the flexibility of each subsystem. Instead of creating a regulator to fix the behavior of each subsystem, he found ways to couple subsystems together so that they could respond to each other and adapt. Such adaptive couplings helped maintain the stability of the overall system.

Beer called the natural state of system stability homeostasis . 61 The term refers to the ability of a system to withstand disturbances in its external environment through its own dynamic self- regulation, such as that achieved by coupling subsystems to one another. Beer argued that reaching homeostasis is crucial to the survival of any system, whether it is mechanical, biological, or social. Control through homeostasis rather than through domination gives the system greater flexibility and facilitated adaptation, Beer argued. He therefore proposed an alternative idea of control, which he defined as “a homeostatic machine for regulating itself.” 62 In a 1969 speech before the United Nations Educational, Social, and Cultural Organization, Beer stated that the “sensible course for the manager is not to try to change the system’s internal behavior . . . but to change its structure —so that its natural systemic behavior becomes different. All of this says that management is not so much part of the system managed as it is the system’s own designer.” 63 In other words, cybernetic management as described by Beer looked for ways to redesign the structure of a company or state enterprise so that it would naturally tend toward stability and the desired behavior.

In addition, cybernetic management sought to create a balance between horizontal and vertical forms of communication and control. Because changes in one subsystem could be absorbed and adapted to by changes in others (via lateral communication), each subsystem retained the ability to change its behavior, within certain limits, without threatening the overall stability of the system and could do so without direction from the vertical chain of command. To look at it another way, cybernetic manage-

ment approached the control problem in a way that preserved a degree of freedom and autonomy for the parts without sacrificing the stability of the whole.
The first edition of Beer's 1959 book Cybernetics and Management did not make many

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The Liberty Machine

The Liberty Machine modeled a sociotechnical system that functioned as a disseminated network, not a hierarchy; it treated information, not authority, as the basis for action, and operated in close to real time to facilitate instant decision making and eschew bureaucratic protocols. Beer contended that this design promoted action over bureaucratic practice and prevented top- down tyranny by creating a distributed network of shared information. The Liberty Machine distributed decision making across different government offices, but it also required all subordinate offices to limit their actions so as not to threaten the survival of the overall organization, in this case, a government. The Liberty Machine thus achieved the balance between centralized control and individual freedom that had characterized Beer's earlier work.

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Beer posited that such a Liberty Machine could create a government where "competent information is free to act," meaning that once government officials become aware of a problem, they could address it quickly; expert knowledge, not bureaucratic politics, would guide policy. However, Beer did not critically explore what constitutes "competent information" or how cybernetics might resolve disagreements within the scientific community or within other communities of expertise. Moreover, it is not clear how he separated bureaucracy from a system of checks and balances that might slow action but prevent abuse.

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Viable System Model

The Viable System Model offered a management structure for the regulation of exceedingly complex systems. It was based on Beer’s understanding of how the human nervous system functioned, and it applied these insights more generally to the behavior of organizations such as a company, government, or factory. 81

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Beer maintained that the abstraction of the structure could be applied in numerous contexts, including the firm, the body, and the state. In keeping with Beer’s emphasis on performance rather than representation, it was not a model that accurately represented what these systems were; rather, it was a model that described how these systems behaved. The Viable System Model functioned recursively: the parts of a viable system were also viable, and their behavior could be described using the Viable System Model. Beer explains: “The whole is always encapsulated in each part. . . . This is a lesson learned from biology where we find the genetic blue- print of the whole organism in every cell.” 83 Thus, Beer maintained that the state, the company, the worker, and the cell all exhibit the same series of structural relationships.

The Viable System Model devised ways to promote vertical and lateral communication. It offered a balance between centralized and decentralized control that prevented both the tyranny of authoritarianism and the chaos of total freedom. Beer considered viable systems to be largely self- organizing. Therefore, the model sought to maximize the autonomy of its component parts so that they could organize themselves as they saw fit. At the same time, it retained channels for vertical control to maintain the stability of the whole system. These aspects of the Viable System Model shaped the design of Project Cybersyn and provide another illustration of how Beer and Popular Unity were exploring similar approaches to the problem of control.

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The Viable System Model did not impose a hierarchical form of management in a traditional sense. The dynamic communication between System One and System Two enabled a form of adaptive man-

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The Viable System Model draws a distinction between the bottom three levels of the system, which govern daily operations, and the upper two levels of management, which determine future development and the overall direction of the enterprise. Because the lower three levels manage day- to- day activities and filter upward only the most important information, the upper two levels are free to think about larger questions. In this sense, Beer’s model tackled the idea of information overload long before the Internet required us to wade into and make sense of an expanding sea of information.

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Management Cybernetics and Revolution

The tension inherent in Beer's model between individual autonomy and the welfare of the collective organism mirrors the struggle between competing ideologies found in Allende's democratic socialism. Allende's interpretation of Marx's writings emphasized the importance of respecting Chile's existing democratic processes in bringing about socialist reform, a possibility that Marx alluded to but never realized. 91 In contrast to the centralized planning found in the Soviet Union, Allende's articulation of socialism stressed a commitment to decentralized governance with worker participation in management, reinforcing his professed belief in individual freedoms. Yet he also acknowledged that in the face of political plurality the government would favor the "interest of those who made their living by their own work" and that revolution should be brought about from above with a "firm guiding hand." 92

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In October 1970, nine months before Beer heard from Flores, the cybernetician delivered an address in London titled "This Runaway World—Can Man Gain Control?" In this lecture Beer unknowingly foretold his coming involvement with the Allende government. Commenting that government in its present form could not adequately handle the complex challenges of modern society, Beer concluded: "What is needed is structural change. Nothing else will do. . . . The more I reflect on these facts, the more I perceive that the evolutionary approach to adaptation in social systems simply will not work any more. . . . It has therefore become clear to me over the years that I am advocating revolution." 94 Beer added, "Do not let us have our revolution the hard way, whereby all that mankind has successfully built may be destroyed. We do not need to embark on the revolutionary process, with bombs and fire. But we must start with a genuinely revolutionary intention: to devise wholly new methods for handling our problems." 95 Less than one year later, Beer would be in Chile helping a government accomplish exactly this.

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Cyberfolk

Thus Beer proposed building a new form of real- time communication, one that would allow the people to communicate their feelings directly to the government. He called this system Project Cyberfolk. In a handwritten report Beer describes how to build a series of "algedonic meters" capable of measuring how happy Chileans were with their government at any given time. 72 As noted in chapter 1, Beer used the word algedonic to describe a signal of pleasure or pain. An algedonic meter would allow the public to express its pleasure or pain, or its satisfaction or dissatisfaction with government actions.

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Constructing the Liberty Machine

As scientific director Beer created a work culture closer to the startup culture of the 1990s than to the chain- of- command bureaucracy that flourished in the 1960s and 1970s and was characteristic of Chilean government agencies. He viewed his position as scientific director more as that of a "free agent" than a micromanager. After establishing offices at the State Technology Institute (INTEC) and the Sheraton, he informed the team that he would work at either location at his discretion and call on project team members as required. Moreover, he refused to stick to a traditional nine- to- five work schedule. Team members often found themselves working alongside the bearded cybernetician into the wee hours of the morning. This schedule enabled them to attend to other projects at their regular jobs during the day and helped create an informal camaraderie among team members that bolstered their enthusiasm for the project.

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In a memo to the Cybersyn team, Beer explains that he broke Cybersyn into clearly defined subprojects that small teams could address intensively. This arrangement allowed for a "meeting of the minds" within the smaller group, and because the small team did not need approval from the larger group, it could progress quickly. At the same time Beer insisted that each team keep the others informed of its progress. He arranged large brainstorming sessions that brought together the members of different subteams. In these sessions, he instructed, "sniping and bickering are OUT. Brain- storming is essentially CREATIVE. . . . At least everyone gets to know everyone else, and how their minds work. This activity is essentially FUN: fun generates friendship, and drags us all out of our personal holes- in- the- ground." Project leaders could then take ideas from the brainstorming sessions and use them to improve their part of the project, thus incorporating the suggestions of others. Beer contrasted this "fun" style of management with the more common practice of bringing all interested parties together to make project decisions. That approach, he felt, eventually led to bickering, sniping, or sleeping. It "masquerades as 'democratic,' [but] is very wasteful," he observed. 12 In addition, he required all project leaders to write a progress report at the end of each month and distribute it to the other team leaders. Beer viewed the brainstorming sessions and the written project reports as serving a function similar to the signals passed between the different organs of the body: they kept members of the team aware of activities elsewhere. They also allowed the different subteams to adapt to progress or setbacks elsewhere and helped Cybersyn maintain its viability as a coordinated project while it advanced toward completion.

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The October Strike

Flores proposed setting up a central command center in the presidential palace that would bring together the president, the cabinet, the heads of the political parties in the Popular Unity coalition, and representatives from the National Labor Federation—approximately thirty- five people by Grandi's estimation. Once these key people were brought together in one place and apprised of the national situation, Flores reasoned, they could then reach out to the networks of decision makers in their home institutions and get things done. This human network would help the government make decisions quickly and thus allow it to adapt to a rapidly changing situation. "Forget technology," Flores said—this network consisted of "normal people," a point that is well taken but also oversimplistic. 21 The solution he proposed was social and technical, as it configured machines and human beings in a way that could help the government adapt and survive.

In addition to the central command hub in the presidential palace, Flores established a number of specialized command centers dedicated to transportation, industry, energy, banking, agriculture, health, and the supply of goods. Telex machines, many of which were already in place for Project Cybersyn, connected these specialized command centers to the presidential palace. 22 Flores also created a secret telephone network consisting of eighty- four numbers and linking some of the most important people in the government, including members of the Popular Unity coalition and the National Labor Federation. According to Grandi, this phone network remained active throughout the remainder of Allende's presidency. 23

Both the telex and the telephone network allowed the command centers to receive upward flows of current information from across the country and to disseminate government orders back down, bypassing the bureaucracy. Flores assembled a team at the presidential palace that would analyze the data sent over the network and compile these data into reports. High- ranking members of government used these reports to inform their decisions, which Flores's team then communicated using the telex and telephone networks. This arrangement gave the government the ability to make more dynamic decisions.

The Project Cybersyn telex room, housed in the State Development Corporation (CORFO), served as the industrial command center during the strike. In addition to transmitting the daily production data needed for the Cyberstride software, the CORFO telex machines now carried urgent messages about factory production. "There were enterprises that reported shortages of fuel," Espejo recalled. Using the network, those in the industrial command center could "distribute this message to the enterprises that could help." 24 The network also enabled the government to address distribution problems, such as locating trucks that were available to carry the raw materials and spare parts needed to maintain production in Chilean factories, or determining which roads remained clear of obstructionist strike activity. Espejo recalled, "The sector committees were able to ask the enterprises to send raw materials, transport vehicles, or whatever to another enterprise" that needed them. At the same time, enterprises could send requests to the sector committees and have these requests addressed immediately. "It was a very practical thing," Espejo continued, referring in particular to the state- appointed managers known as interventors. "You are the interventor of an enterprise, you are running out of fuel, you ask the corresponding sector committee. . . . Or [the interventors] know that the raw materials they need are available in Valparaíso and that they need a truck to go and get it. With bureaucratic procedures it would have been more difficult to resolve these situations." 25

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After the strike, Silva said, "two concepts stayed in our mind: that information helps you make decisions and, above all, that it [the telex machine] helps you keep a record of this information, which is different from making a telephone call. [Having this record] lets you correct your mistakes and see why things happened." Silva added that the energy command center relied primarily on the telex network because it gave up- to-

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The telex network thus extended the reach of the social network that Flores had assembled in the presidential command center and created a sociotechnical network in the most literal sense. Moreover, the network connected the vertical command of the government to the horizontal activities that were taking place on the shop floor. To put it another way, the network offered a communications infrastructure to link the revolution from above, led by Allende, to the revolution from below, led by Chilean workers and members of grassroots organizations, and helped coordinate the activities of both in a time of crisis.

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Automation, autonomy and worker participation

Beer was spinning ideas in "One Year of (Relative) Solitude," but he was aiming for a new technological approach to the worker participation question that would create a more democratic and less stratified workplace. And he concluded that giving workers control of technology, both its use and its design, could constitute a new form of worker empowerment.

This assertion differed substantially from how other industrial studies of the day approached the relationship of computer technology and labor in twentieth- century production. Such studies, especially those inspired by Marxist analysis, often presented computers and computer- controlled machinery as tools of capital that automated labor, led to worker deskilling, and gave management greater control of the shop floor. In Labor and Monopoly Capital (1974), Harry Braverman credits such machinery "as the prime means whereby production may be controlled not by the direct producer but by the owner and representatives of capital " and cites computer technology as routinizing even highly skilled professions such as engineering. 53

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In the 1950s Norbert Wiener, author of Cybernetics , believed computers would usher in a second industrial revolution and lead to the creation of an automatic factory. In The Human Use of Human Beings (1954), he worries that auto- mated machinery "is the precise economic equivalent of slave labor. Any labor which competes with slave labor must accept the economic conditions of slave labor.” 56

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Two factors explain the difference between Beer and Braverman, who were writing at about the same time. First, the computer system Beer designed did not automate labor. Given the Popular Unity commitment to raising employment levels, automating labor would not have made political sense. Second, Beer was writing and working in a different political context than Braverman. The context of Chilean socialism inspired Beer and gave him the freedom to envision new forms of worker participation that were more substantial than what Braverman saw in the United States. It also allowed Beer to see computer technology as something other than an abusive capitalist tool used by management to control labor. Beer’s approach also reflected his position as a hired science and technology consultant. His use of technology to address worker participation differed from the contemporaneous efforts of the Allende government on this issue, efforts that had focused on devising new governing committees within the industrial sector and electing worker representatives.

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Beer’s proposal bears a close resemblance to the work on participatory design that emerged from the social democratic governments in Scandinavia in the 1970s. The history of participatory design is often tied to Scandinavian trade union efforts to empower workers during that decade, and thus to create a more equitable power relationship between labor and capital in Scandinavian factories. 58 These efforts were either contemporaneous to Beer’s December report or began several years later, depending on historical interpretation. Like the aforementioned automation studies, early participatory design work viewed technologies such as computer systems as representing the interests of management, not labor. However, participatory design used the primacy of management as a starting point and then tried to change the dynamics of the labor-capital relationship by changing the social practices surrounding the design and use of technology.

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Furthermore, appointing worker representatives to control the use of Cybersyn would not guarantee that the system would be used in a way that represented the best interests of the rank and file. Studies of worker participation have shown that worker representatives often separate themselves from their co- workers on the shop floor and form a new group of administrators. As Juan Espinosa and Andrew Zimbalist write in their study of worker participation in Allende’s Chile, “It has been the historical experience, with a few exceptions, that those interpreting workers’ priorities and needs have grown apart from the workers they are supposed to represent. . . . [They] become a new class of privileged administrators.” 63 Simply put, it would be impossible to give “the workers” control of Cybersyn as Beer suggested, even if Chilean workers possessed the skills to use the technology or build the factory models.

Despite these oversights, Beer did realize that the October Strike was a transformative event for Chilean workers. Their self- organization and improvisation during the strike played a central role in maintaining production, transportation, and distribution across the country. During the strike, workers organized to defend their factories from paramilitary attacks, retooled their machines to perform new tasks, and set up new community networks to distribute essential goods directly to the Chilean people. Members of larger industrial belts collaborated with other groups of workers to seize private- sector enterprises that had stopped production during the strike. Historian Peter Winn notes that during the strike workers came together regardless of politics, industrial sector, factory, or status, thus “generating the dynamism, organization, and will to stalemate the counterrevolutionary offensive and transform it into an opportunity for revolutionary advance.” 64 In short, the strike transformed the mindset of the Chilean working class and showed that workers could take control of their destiny and accelerate the revolutionary process.

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Self-organization

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Although his information was limited, Beer was aware of workers’ activities during the strike, and was excited by them. In fact, the ideas he presented in his December report, “One Year of (Relative) Solitude,” were designed to support the “people’s autonomy.” Beer wrote, “The new task [outlined in the report] is to try and get all this, plus the spontaneous things that I know are happening [such as the cordones industriales] together.” 65 From his perspective, it looked as if Chilean workers were self- organizing to keep the larger revolutionary project viable. It is important to stress, especially given the criticism he would receive in the months that followed, that Beer viewed his role as using science and technology to help support these bottom- up initiatives.

Although Beer’s take on participatory design was inspired by the events of the October Strike, it also came from his understandings of cybernetics. “The basic answer of cybernetics to the question of how the system should be organized is that it ought to organize itself,” Beer writes in the pages of Decision and Control . 66 In his writings Beer often cited nature as a complex system that remains viable through its self- organization. He argued that such systems do not need to be designed because they already exist. To modify the behavior of such a system, one need not control its every aspect but rather change one subsystem so that the overall system naturally drifts toward the desired goal. Perhaps the injection of worker action could drive Chile toward a new point of homeostatic equilibrium, one that was congruent with the overall goal of socialist transformation.

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Cybernetics

Increasingly, Cybersyn was becoming a technological project divorced from its cybernetic and political origins. The best- known component of the project, the telex network, was not even associ- ated with the overall Cybersyn system, let alone with Beer’s ideas about management cybernetics.

In contrast, members of the core group had become serious students of cybernetics. Several months earlier they had formed a small study group known as the Group of 14 and tasked themselves with learning more about cybernetics and related scientific work in psychology, biology, computer science, and information theory. They read the work of Warren Weaver, Claude Shannon, Heinz von Foerster, and Herbert Simon and invited Chilean biologists Humberto Maturana and Francisco Varela to speak to the group (both accepted). Maturana was arguably the first substantial connection between Chile and the international cybernetics community. In 1959, while a graduate student at Harvard, he had coauthored an important paper, “What the Frog’s Eye Tells the Frog’s Brain,” with Warren McCulloch, Jerome Lettvin, and Walter Pitts, all of whom were important figures in the growing field of cybernetics. 76

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Cybersyn Goes Public

These initial press accounts illustrate a finding from science studies research, namely, that for a technology to be successful it must be taken up by people other than the inventors. What Bruno Latour, a sociologist of science, writes of scientific ideas also holds true for technologies: “You need them , to make your [scientific] paper a decisive one.” 16 However, this appropriation creates a dangerous situation. Engineers need others to support their technologies so that the technology will be successful, but in the process the engineers lose control of their invention. Latour warns, “The total movement . . . of a statement, of an artefact, will depend to some extent on your action but to a much greater extent on that of a crowd over which you have little control.” 17 As Latour observes, others may decide to accept the technology as it is, but they could also dismiss, appropriate, or change the technology in fundamental ways.

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Simple technologies

To these criticisms, Beer responded that the system used simple technologies such as telex machines, drew from excellent programming talent in London and Santiago, and relied on many “human interfaces,” meaning it was not automated. He also said that he was tired of hearing the assertion that such a system could be built only in the United States, and stressed that building the futuristic control room required only “the managerial acceptance of the idea, plus the will to see it realized.” 18 But, he added, “I finally found both the acceptance and the will—on the other side of the world.” 19 This final comment was a not- so- subtle jab at his British compatriots, who over the years had questioned the legitimacy and feasibility of his cybernetic ideas.

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Necessary instability; power and control

The comments Espejo, Flores, and Schwember telexed to Beer show that they objected to other facets of the speech as drafted. They wrote that, while they agreed that cybernetic thinking might help the government increase social stability, they also wondered whether instability might be an important part of social progress. “Historical development is a succession of equilibriums and unequilibriums [sic],” Espejo telexed. Disequilibrium “might be indispensable.” This is an interesting observation, although it was not raised as an objection to Cybersyn in subsequent press accounts. The Chileans also challenged Beer’s framing of the Chilean revolution as a control problem. “The social phenomena goes [sic] further than the control problem,” Espejo wrote; “there is for instance the problem of power.” If cybernetics looked only at control and ignored power relationships, “there is the danger that cybernetics might be used for social repression,” Espejo continued, echoing the fears that had already appeared in the press. Beer responded: “I cannot write the next book in this one lecture.” 30 But perhaps Beer would have given greater thought to this issue had he known that his critics would be most concerned with whether Cybersyn facilitated social repression.

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Beer writes that “the polarity between centralization and decentralization—one masquerading as oppression and the other as freedom—is a myth. Even if the homeostatic balance point turns out not to be always computable, it surely exists. The poles are two absurdities for any viable system, as our own bodies will tell us.” 31 The algedonic, or warning, signals that Cybersyn sent to alert higher management constituted a threat to factory freedom but it was a necessary one, for not alerting higher management might pose a greater threat to system survival. “The body politic cannot sustain the risk of autonomic inac- tion any more than we can as human beings,” Beer observed. 32 In proposing the idea of effective freedom, Beer was arguing (1) that freedom was something that could be calculated and (2) that freedom should be quantitatively circumscribed to ensure the stability of the overall system. For those who had followed Beer’s work over the years, effective freedom was a new term to describe the balance of centralized and decentral- ized control that Beer had advocated for more than a decade. It also reflected the same principles as Allende’s democratic socialism, which increased state power but preserved civil liberties. But for the uninitiated, the claim that a control system that explicitly limited freedom actually preserved and promoted freedom must have seemed like a political slogan straight out of 1984 . 33

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In fact, Hanlon was not alone in recognizing Cybersyn’s potential for centralized control. On 1 March Beer telexed to Espejo, “Accusations come from Britain and the USA. Invitations [to build comparable systems] come from Brazil and South Africa.” Considering the repressive governments that were in power in Brazil and South Africa in the early 1970s, it is easy to sympathize with Beer’s lament: “You can see what a false position I am in.” 46 Beer was understandably frustrated with these international misinterpretations of his cybernetic work.

However, it took little political imagination to see how putting Cybersyn in a different social, political, and organizational context could make the system an instrument of centralized control. Beer had tried to embed political values in Cybersyn’s design, but he engineered them in the social and organizational aspects of the Cybersyn system, in addition to the technology itself. As safeguards, these social and organizational arrangements were not very strong. Archived telexes from the project team show that if the Cyberstride software detected a production indicator outside the accepted range of values, a member of the National Computer Corporation (ECOM) alerted the affected enterprise, those in the central telex room in CORFO, and Espejo in the CORFO informatics directorate—all at the same time.

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Feasibility

Grosch's letter to the editor underlines the assumption that industrialized nations, such as the United States and the nations of Western Europe, pioneered modern computer capabilities; nations of the developing world, such as Chile, did not. In his letter Grosch wrote that Project Cybersyn could not be built in a "strange and primitive hardware and software environment," such as that found in Chile, and in such a short time.

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For the system to function, human beings also needed to be disciplined and brought into line. In the case of Cybersyn, integrating human beings into the system, and thus changing their behavior, proved just as difficult as building the telex network or programming the software—or perhaps even more difficult. While the Cybersyn team could exert some degree of control over the computer resources, construction of the operations room, or installation of a telex machine, they had very little control over what was taking place within the factories, including levels of management participation or whether Cybersyn would be integrated into existing management practices. Espejo and Benadof lacked the authority to force the state- run factories to implement Cybersyn, and industrial managers remained unconvinced that it warranted their total compliance.

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Conclusions

This history is a case study for better understanding the multifaceted relationship of technology and politics. In particular, I have used this history to address (1) how governments have envisioned using computer and communications technologies to bring about structural change in society; (2) the ways technologists have tried to embed political values in the design of technical systems; (3) the challenges associated with such efforts; and (4) how studying the relationship of technology and politics can reveal the important but often hidden role of technology in history and enhance our understanding of historical processes. Forty years later, this little- known story also has much to say about the importance of transnational collaboration, technological innovation, and the ways in which geopolitics influences technology.

Computer and communications technologies have often been linked to processes of political, economic, and social transformation. But claims that these technologies can bring about structural change in society—like the frequent assertion that computers will bring democracy or greater social equality—are often made in the absence of historical analysis.

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Project Cybersyn is an example of the difficulty of creating a sociotechnical system designed to change existing social relationships and power configurations and then enforce the new patterns over time. Scientific techniques may conceal biases with a veneer of neutrality and thus lead to undesirable results. For example, Allende charged the Project Cybersyn team with building a system that supported worker participation. Yet the scientific techniques Chilean engineers used to model the state- controlled factories resembled Taylorism, a rationalized approach to factory production that disempowered workers and gave management greater control over labor. Time analysis, for example, emerged in the context of capitalist production, prioritizing efficiency and productivity over other values, such as the quality of shop floor life. By using time-analysis techniques, Cybersyn engineers could have inadvertently created production relationships that were counter to the Popular Unity platform and then solidified them in the form of a computer model.

Sociotechnical relationships must also remain intact for the system to maintain the desired configuration of power. Changing these technical, social, and organizational relationships may also change the distribution of power within the system. As I have shown, in some cases it is much easier to change a sociotechnical system than to hold it static. The history of Project Cybersyn suggests that the interpretation of sociotechnical relationships is especially malleable when a system is new, forms part of a controversial political project, or requires existing social, technical, and organizational relationships to change in substantial ways.

This malleability makes it extremely difficult to marry a sociotechnical system to a specific set of political values, especially if the goal is to create dramatic changes in the status quo. In the case of Cybersyn, journalists, scientists, and government officials all

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Once separated from the social and organizational relations that Beer imagined, the technology of Project Cybersyn could support many different forms of government, including totalitarianism. If Project Cybersyn had been implemented as Beer imagined, it might have become a system that supported such values as democracy, participation, and autonomy. But as its critics perceived, it would have been easy to circumvent the technological and organizational safeguards the team designed; therefore, it would have been easy for the system to support a different set of political values, especially in different social, organizational, and geographic settings. Value- centered design is a complicated and challenging endeavor. Even if technolo-

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Even if technologists attempt to build certain relationships into the design of a technological system, which itself is a fraught and socially negotiated process, they have no guarantee that others will adopt the system in the desired way—or that they will adopt the system at all.

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This history further reveals that different nations have very different experiences with computer technology and that these experiences are connected to the political, economic, and geographic contexts of these nations. Chilean democratic socialism prompted the creation of a computer technology that furthered the specific aims of the Chilean revolution and would not have made sense in the United States. The Chil- ean context also differed from that of the Soviet Union in fundamental ways. Because Chile was significantly smaller than the Soviet Union in its geography, population, and industrial output, building a computer system to help regulate the Chilean economy was a more manageable affair. In addition, the Soviet solution used computers for cen- tralized top- down control and collected a wealth of data about industrial production activities with the goal of improving state planning. In contrast, the Cybersyn team used Beer's view of management cybernetics to create a system that emphasized action as well as planning; and the system sent limited quantities of information up the gov- ernment hierarchy, and tried to maximize factory self- management without sacrificing the health of the entire economy. As this contrast shows, technologies are the product of the people involved in their creation and the political and economic moments in which they are built.

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This particular transnational collaboration sheds light on processes of technologi- cal innovation in differently situated world contexts. Project Cybersyn, a case study of technological innovation, was a cutting- edge system using technologies that were far from the most technologically sophisticated. A network of telex machines trans- formed a middle- of- the- road mainframe computer into a new form of economic com- munication. Slide projectors presented new visual representations of economic data. Hand- drawn graphs showing data collected on a daily basis gave the government a macroscopic view of economic activity and identified the areas of the economy most in need of attention. Project Cybersyn thus challenges the assumption that advanced technologies need to be complex. Sophisticated systems can be built using simple tech- nologies, provided that particular attention is paid to how humans interact and the ways that technology can change the dynamics of these interactions. Project Cybersyn may be a useful example for thinking about sustainable design or the creation of tech- nologies for regions of the world with limited resources. 3

This story of technological innovation also challenges the assumption that innova- tion results from private- sector competition in an open marketplace. Disconnection from the global marketplace, as occurred in Chile, can also lead to technological in- novation and even make it a necessity. This history has shown that the state, as well as the private sector, can support innovation. The history of technology also backs this finding; for example, in the United States the state played a central role in funding high- risk research in important areas such as computing and aviation. However, this lesson is often forgotten. As we recover from the effects of a financial crisis, brought on in large part by our extraordinary faith in the logic of the free market, it is a lesson that is worth remembering.

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Geopolitics also shapes our understandings of technological development and technological change. If historians, technologists, designers, educators, and policy makers continue to give substantial and disproportionate attention to the technologies that triumph, a disproportionate number of which were built in the industrial centers of the world, they miss seeing the richness of the transnational cross- fertilization that occurs outside the industrial centers and the complex ways that people, ideas, and artifacts move and evolve in the course of their travels. Technological innovation is the result of complex social, political, and economic relationships that span nations and cultures. To understand the dynamics of technological development—and perhaps thereby do a better job of encouraging it—we must broaden our view of where technological innovation occurs and give greater attention to the areas of the world marginalized by these studies in the past.

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Epilogue

While on Dawson Island, Flores and the other prisoners reflected on their experiences during the previous three years and, as a group, tried to understand the complexities of Chilean socialism and what had gone wrong. Flores offered the group a cybernetic interpretation of events, which resonated with Allende's former minister of mining, Sergio Bitar. When Bitar published a detailed history of the Allende government in 1986, he used cybernetics to explain in part what happened during Allende's presidency. Bitar writes, "In the present case [the Allende government], systemic variety grew because of structural alterations and disturbance of the existing self- regulatory mechanisms (principally those of the market). But the directing center (the government) did not expand its variety controls with the necessary speed; nor could it replace the existing self- regulatory mechanism with new ones." Bitar concludes that "when a complex system [the Chilean nation] is subject to transformation it is essential to master systemic variety at every moment." 17 This choice of language, seemingly out of place in a study of political history, shows that Chile's encounter with cybernetics not only led to the creation of Project Cybersyn but also shaped how some members of the Allende government made sense of the history they had lived.

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But the more Flores read, the more he began to see the limitations of cybernetic thinking. While Flores still felt that the Law of Requisite Variety and the Viable System Model were useful concepts, he believed they were insufficient for the situations he had encountered while in Allende's cabinet. "My problem [in Allende's cabinet] was not variety; my problem was the configuration of reality, persuading other people," Flores said. 20 Understanding the configuration of reality became a driving intellectual pursuit for Flores, and he found the work of the Chilean biologists Maturana and Varela especially useful toward this end. In addition to developing the theory of autopoiesis with Varela, Maturana had conducted extensive work on optics. His 1959 work with Jerry Lettvin, Warren McCulloch, and Walter Pitts analyzed the frog's optical system and concluded that what a frog sees is not reality per se but rather a construction assembled by the frog's visual system. What the frog sees is therefore a product of its biological structure. This distinction formed the foundation for much of Maturana and Varela's later work in biology and cognition during the 1960s and 1970s, and later inspired the two biologists to break with traditional claims of scientific objectivity and emphasize the role of the observer. One of Maturana's best- known claims—"Anything said is said by an observer"—illustrates this point. 21

Flores's dissatisfaction with cybernetics paralleled a similar dissatisfaction within the cybernetics community. Heinz von Foerster, who had worked with Maturana, Varela, and the Group of 14 in Chile, found it problematic that cybernetics claimed to create objective representations of real- world phenomena that were independent of an observer. 22 Von Foerster described this approach as "first- order cybernetics," which he defined as "the cybernetics of observed systems." However, von Foerster was influenced by Maturana's work and, like Maturana, became convinced that the observer plays a central role in the construction of cybernetic models. In the fall of 1973 von Foerester taught a yearlong course at the University of Illinois on the "cybernetics of cybernetics," or what became known as second- order cybernetics, "the cybernetics of observing systems." 23 Although von Foerster was not the only person involved in the development of second- order cybernetics, studies of this intellectual transition have credited von Foerster for bridging the gap between first- order and second- order cybernetic thinking. 24 Not surprisingly, Flores also took to the idea of second- order cybernetics, and in his later writing he would cite von Foerster's edited volume Cybernetics of Cybernetics . 25

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Flores credits Maturana for leading him to the work of Martin Heidegger. Like Maturana, Heidegger rejected the existence of an objective external world and saw objects/texts as coexisting with their observers/interpreters. Heidegger's idea of "thrownness" also resonated with Flores—the idea that in everyday life we are thrown into the world and forced to act without the benefit of reflection, rational planning, or objective assessment. Looking back, Flores saw his time in the Allende cabinet as an example of thrownness rather than rational decision making. "My job was so demanding that I did not have the time to perfect [what I was doing]. I only had time to feel it. It was something I felt." 29 In the context of emergency, he had no time to study the laws of control laid down by cybernetics in order to determine how best to resolve government crises. Flores often had to lead with his gut, and his previous experiences and the traditions of Chilean society implicitly shaped his decisions. Flores also realized that "when you are minister and you say something, no matter what you say, it has consequences." 30 It was therefore important to use words deliberately. Flores found that management through variety control did not allow intuitive forms of decision making, nor did it account for the previous experiences and cultural situation of decision makers or accommodate the importance of communicating effectively and with intention.

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Understanding Computers and Cognition begins by critiquing the rationalist assumption that an objective, external world exists. The critique builds on the ideas of Heidegger, Searle, Maturana, J. L. Austin, and Hans- Georg Gadamer to show that knowledge is the result of interpretation and depends on the past experiences of the interpreter and his or her situatedness in tradition. Winograd and Flores then argue that because computers lack such experiences and traditions, they cannot replace human beings as knowledge makers. "The ideal of an objectively knowledgeable expert must be replaced with a recognition of the importance of background," Winograd and Flores write. "This can lead to the design of tools that facilitate a dialog of evolving understanding among a knowledgeable community." 32 Building on this observation, the authors propose that computers should not make decisions for us but rather should assist human actions, especially human "communicative acts that create requests and commitments that serve to link us to others." 33 Moreover, computer designers should not focus on creating an artifact but should view their labors as a form of "ontological design." Computers should reflect who we are and how we interact in the world, as well as shape what we can do and who we will become. The American Society for Information Science named

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To some he was brusque, intimidating, direct to the point of rudeness, and off-putting. Yet his message and his success in both the academic and business communities transformed him into a cult figure for others.

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"A civil democracy with a market economy is the best political construction so far because it allows people to be history makers," the authors declare. 41 Flores's transformation from socialist minister was now complete: he had wholly remade himself in the image of neoliberalism.

Thus, by the end of the 1990s, Flores and Beer had switched places. Flores had morphed into a wealthy international consultant driven by the conviction that organization, communication, and action all were central to making businesses successful. Meanwhile, Beer had become increasingly interested in societal problems and changing the world for the better. His last book, Beyond Dispute (1994), proposed a new method for problem solving based on the geometric configurations of the icosahedron, a polygon with twenty equilateral triangle faces. He called this new method "syntegrity" and argued that it could serve as a new approach to conflict resolution in areas of the world such as the Middle East.

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