Introduction: Political and Technological Visions

In Chile, I know that I am making the maximum effort towards the devolution of power. The government made their revolution about it; I find it good cybernetics.

—Stafford Beer, February 1973

This book tells the history of two intersecting utopian visions, one political and one technological. The first was an attempt to implement socialist change peacefully and through existing democratic institutions. The second was an attempt to build a computer system for real-time economic control more than twenty years before the Internet became a feature of everyday life. Like all utopias, these visions were beautiful yet elusive. However, studying them brings to light how a South American government tried to take control of its destiny at the height of the cold war and how that same government made computer technology part of a political project for structural transformation. This book uses the confluence of these two utopian visions to address a central question in the history of technology: What is the relationship of technology and politics?

Cybernetics, the interdisciplinary postwar science of communication and control, plays a role in both utopian projects and links them together. Cybernetic ideas shaped the design of this ambitious computer system; they also shaped how the people who built it viewed processes of political change. However, this book is not concerned only with machines and ideas. At its core this is a study about a group of people who tried to create a new political and technological reality in the early 1970s, one that broke from the strategic ambitions of both the United States and Soviet Union.

The setting is Chile, the narrow sliver of the South American continent bordered by the Andean cordillera on one side and the Pacific Ocean on the other (figure I.1). In 1970 Chilean voters opted to pursue a democratic road to socialist change under the guidance of Salvador Allende Gossens. Chile's turn toward socialism came after a more moderate Christian Democratic reform failed to reach its goals in the 1960s.[1]

As Chile's first democratically elected Socialist president, Allende proposed a political third way, something different from the politics and ideology of either superpower.

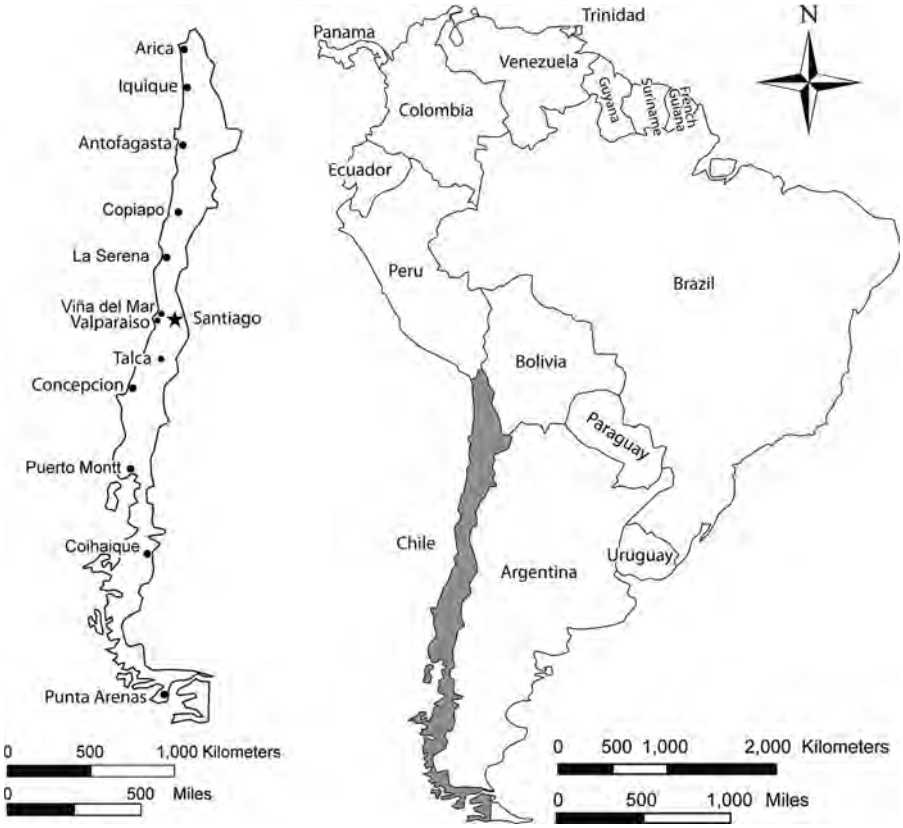

Figure I.1
Map of Chile.

Allende wanted to make Chile a socialist nation, but he also wanted change to occur peacefully and in a way that respected the nation's existing democratic processes and institutions. Moving property ownership from foreign multinationals and the Chilean oligarchy to the state, redistributing income, and creating mechanisms for worker participation were among the top priorities of the Allende government.[2] Among the democratic institutions that Allende wished to preserve were respect for election results, individual freedoms (such as the freedom of thought, speech, press, and assembly), and the rule of law. His commitment to socialist change through constitutional means set Chile's socialism apart from that of Cuba or the Soviet Union. His platform became known as the "Chilean road to socialism."

Chile was an exceptional nation within Latin America. From 1932 to 1973 Chile boasted the longest period of uninterrupted democratic rule in Latin America.[3]

Allende's outward commitment to peaceful socialist change and the free expression of ideas stood in sharp contrast to the political situation in neighboring countries such as Argentina and Brazil. In 1970 these two nations had repressive military governments that had seized control, ostensibly to stop the threat of communism. Chile was also a battleground in the global cold war and a focus of U.S. attention. From 1962 to 1969 Chile received more than a billion dollars in U.S. aid, more than any other nation in Latin America, as part of the Alliance for Progress.[4] The United States believed such levels of aid would help raise living standards for Chileans and thus stop members of the poor and working classes from turning to communism.

The United States responded to Allende's election by adopting a "non-overt course" to prevent Chile from turning socialist. This included funding government opposition parties and opposition-owned media outlets and sabotaging the Chilean economy. For example, the United States established an invisible financial blockade and significantly reduced its aid to Chile. It also used its substantial influence to cut international and bilateral aid and private bank credit to Chile, prevented Allende from renegotiating the national debt he had inherited from his predecessor, and decreased the value of U.S. exports to Chile.[5] Allende's commitment to changing Chile's long-standing social and economic structures also met with strong opposition from members of Chile's privileged classes. Nevertheless, Chile's long and solid commitment to its democratic institutions led Chileans and onlookers from around the world to wonder whether Allende and his government might succeed in pioneering a new political model.

This political experiment set the stage for an ambitious technological experiment. Bringing Chile's most important industries under state control challenged the management capabilities of the Allende government.[6] The rapid pace of nationalization added to these challenges, as did the number of employees in the state-run enterprises, which was growing in concert with Allende's efforts to lower unemployment. Moreover, the government lacked sufficient numbers of qualified people to run the newly nationalized industries, and production was hindered by shortages of spare parts and raw materials. A small team of people in the Chilean government believed such problems could be addressed through the use of computer and communications technology, and set out to create a new system for industrial management in collaboration with a group of British technologists.

From 1971 to 1973 the transnational team worked on the creation of this new technological system, which they called Project Cybersyn in English or Proyecto Synco in Spanish. The system they envisioned pushed the boundaries of what was possible in the early 1970s and addressed difficult engineering problems such as real-time control, modeling the behavior of dynamic systems, and computer networking. More impressive, the team tackled these problems using Chile's limited technological resources and in the process proposed solutions that were different from those explored by other, more industrialized nations. The system they proposed used new communications

channels to transmit current production data to the government from the state-run factories. These data were fed into statistical software programs designed to predict future factory performance and thus to enable the Chilean government to identify and head off crises before they came to pass. The system included a computerized economic simulator, which would give government policy makers an opportunity to test their economic ideas before implementation. Finally, the proposed system called for the creation of a futuristic operations room where members of the government could convene, quickly grasp the state of the economy, and make rapid decisions informed by recent data.

Some members of the team even speculated that this technical system could be engineered in ways that would change Chilean social relationships and bring them in line with the goals of Chilean socialism. For example, some saw the system as presenting ways to increase worker participation in factory management. The statistical software evaluated factory performance using a model of production processes. Team members argued that workers should participate in the creation of these models and thus in the design of this technology and in economic management at the national level. In a little over a year the team built a prototype of the system and hoped that, once complete, it would help the government stay in power and improve the state of the Chilean economy.

In this book I study the intersection of these political and technological visions and the efforts made by historical actors to bring them into being. I use these intersections to understand the interplay of technology and politics in history. The book draws from important early work in the history and sociology of technology that has shown that technologies are the product not only of technical work but also of social negotiations.[7] However, this book does not seek to uncover the hidden politics of a technological project by breaking down a dichotomy of the social and the technical. Instead, I take the absence of such a dichotomy as my starting point. Politics touched almost every aspect of Chilean life during the Allende period, including science and engineering activities and the design and use of technologies such as Project Cybersyn. Politics also colored how outsiders reacted to Project Cybersyn in Chile and abroad. Politics are thus an explicit, not hidden, part of this history of technology.

In addition, this book is not centrally concerned with the question of whether technologies are neutral.[8] As earlier work in the history, sociology, and philosophy of technology has shown, technologies are not value-neutral but rather are a product of the historical contexts in which they are made.[9] As a case study, Project Cybersyn provides a clear example of how particular political and economic contexts support the creation of particular technologies.

This book is an attempt to understand (1) how governments have envisioned using computer and communications technology 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 technology can enhance our understanding of a historical moment. I use the term *political values* to refer to the particular concepts, ideas, and principles that are central to a political project, such as democracy, participation, liberty, and state control. I use the term *technologist* throughout the book to refer to white-collar professionals with technical expertise, such as cyberneticians, engineers, computer scientists, operations research scientists, statisticians, and, at times, industrial designers. I decided against using the more familiar word *technocrat* because of its pejorative connotation during Allende's presidency, when it was frequently used to refer to those who believed that technology and the empowerment of technical experts were more important than political change. The term *technocrat* is also associated with the Pinochet dictatorship, when experts in fields such as engineering, economics, or finance used it to signal their belief that they were apolitical and that they wanted to use their knowledge to advance the Chilean nation. Neither definition is an appropriate description of the technical experts involved in this history.[10]

This book addresses these questions by studying a historical moment when government technologists, administrators, politicians, and members of the general public were engaged in an explicit discussion of the relationships between technology and politics and how technologies could be designed or used to enact or embody a political goal. This book therefore builds on the pathbreaking work of historians such as Gabrielle Hecht, Paul Edwards, and Ken Alder who have used similar historical moments to show how goals of nationalism, command and control, and technocratic revolution led to the creation of particular technologies and, conversely, how technologies framed these goals, shaped power configurations, and became instrumental in political strategies.[11] Like these scholars, I use history to show the ways that technology and politics are deeply intertwined and mutually constitutive; however, I do so in a context outside of the United States or Europe.

I also push this observation further to show how technology can complicate our readings, and thus our understanding, of politics. Phrases such as "political goal" or "political project" suggest that a consensus exists about what needs to be achieved and how to achieve it. Yet reality is not so neat. Disagreements, inconsistencies, and controversies pervaded the Chilean road to socialism, and this plurality of views made it difficult, if not impossible, to create a technology that embodied a political ideal. There were many views on how to make Chile socialist within the governing coalition, within each member party, and among communities of technologists. Here I use the history of a technical system, Project Cybersyn, to illustrate the diversity of opinions present in Chile's socialist experiment and to show how technologists, government officials, factory managers, and workers struggled to define a course of action. I use the history of a technical system to open this black box of politics, just as I use politics to open this black box of technology.

There are other reasons why it is extremely difficult to make a technology embody political values, even when governments expend substantial human, financial, and technological resources on the effort. Central to this discussion is the idea of sociotechnical engineering, my term for the designing of a technology, and the social and organizational relationships that surround it, to uphold a configuration of power congruent with the aims of a political project.[12] Through sociotechnical engineering practices, Chilean and British technologists tried to make Project Cybersyn implement and uphold principles of Chilean democratic socialism. For example, the system included mechanisms to preserve individual liberty within a context of greater state control. Some Cybersyn technologists also tried to use Project Cybersyn as a vehicle for increasing worker participation in economic management and proposed having workers collaborate with Chilean operations research scientists. I argue that, for the system to support values such as worker participation or decentralized control, Cybersyn needed to implement and maintain the social, organizational, and technical relationships specified by its designers. Yet the reverse was also true: changing these social, organizational, and technical relationships could cause the system to produce configurations of political power, including totalitarianism, that were very different from Chilean democratic socialism.

Finally, this book demonstrates that studying the development of technology can help scholars understand historical and political processes. Studying Project Cybersyn reveals the limitations of the Chilean revolution; the ongoing tension between the revolution from above and the revolution from below; the legacy of class prejudice, gender bias, and systematized bureaucracy; and the underlying assumptions about modernity that privileged foreign expertise and technology, even within the context of socialist revolution and increased nationalism. Technologies are historical texts. When we read them, we are able to read history.[13]

Chilean Cybernetics

Cybernetics plays a central role in this book. It is impossible to give a universal definition of this term, since members of the field have defined cybernetics in many ways over the years. However, the MIT mathematician Norbert Wiener, one of the originators of the field, offers one of the most-cited definitions. In 1948 he described cybernetics as the study of "control and communication in the animal and the machine."[14] Cybernetics often mixed metaphors from engineering and biology to describe the behavior of complex systems ranging from the electromechanical operation of a computer to the function of the human brain. Some members of the cybernetics community viewed cybernetics as a universal language for the scientific study of machines, organisms, and organizations. In the late 1940s and early 1950s, these insights and appeals to universality resonated with a number of distinguished researchers from

fields as diverse as physiology, psychology, anthropology, mathematics, and electrical engineering. Cybernetic thinking influenced subsequent work in information theory, computing, cognitive science, engineering, biology, and the social sciences. Cybernetics also spread outside academia and entered areas such as industrial management, the area explored in greatest depth here.

This book is in conversation with the growing literature on the history of cybernetics. It adds another national experience to this already rich area of scholarship, which includes studies of cybernetics in the United States, the Soviet Union, Britain, East Germany, China, and France.[15] In the context of these other national cybernetic histories, the Chilean experience provides evidence for the validity of the "disunity of cybernetics" thesis put forth by historian Ronald Kline. In contrast to earlier studies of cybernetics, which emphasized how members of the U.S. cybernetics community tried to build a universal science, Kline argues that cybernetics assumed a variety of forms depending on its national, historical, and disciplinary context.[16] This book builds on Kline's work by showing how Chile's political, economic, and historical context shaped the Chilean experience with cybernetics and set it apart from the experiences of other nations.

It also demonstrates that the history of cybernetics is more than a collection of different national experiences; it is a transnational story. Histories of science and technology often involve transnational collaborations and the movement of scientific ideas and technological artifacts from one national context to another. However, such movements are especially visible when we look at science and technology in areas of the global south where legacies of colonialism and economic dependency make the movement of scientific ideas and technological artifacts more pronounced and thus more visible. However, this book challenges simple models of technological diffusion that frame science and technology as flowing from north to south. Scientific ideas and technologies originate in many different places and travel in multiple directions, including from south to north.

The history of Chilean science and technology in the twentieth century is highly transnational, and so is its history of cybernetics. Chile was connected to the international cybernetics community almost from the outset. The archive of Norbert Wiener's papers, housed at the Massachusetts Institute of Technology, contains a 1949 letter that Wiener received from Chile a mere three months after the first printing of his book *Cybernetics*, the book widely credited for bringing the new interdisciplinary science to the attention of the public. The letter came from a Chilean named Raimundo Toledo Toledo, who asked the famed MIT mathematician for advice about a simple calculating machine Toledo was building. Toledo had learned of Wiener's work from an article in *Time* magazine, and he asked Wiener to send him a copy of *Cybernetics*.[17] As this correspondence shows, Chileans had learned of U.S. work on cybernetics from U.S. publications and were connecting with leading members of the U.S. cybernetics community,

engaging with cybernetic ideas, and trying to build their own computing machinery as early as 1949. That Chile's involvement in the history of cybernetics dates almost to the origin of the field suggests that the history of cybernetics played out over a far wider geography than the existing literature has thus far recognized and that these international stories are necessarily intertwined with one another.

This book tells the story of another transnational cybernetics connection, primarily between Chile and Britain. This connection is a good example of the historical contingency of technological development. Project Cybersyn was made possible because of a very specific confluence of ideas and people, as well as technological and political moments. In Chile in the early 1970s, national efforts to foment political change converged with the ideas of the British cybernetician Stafford Beer and the efforts the Chilean government had already made to increase its technological capabilities, especially in the area of computing. As this book shows, Chile's specific historical, political, and technological circumstances allowed the Allende government to use computers and apply cybernetic ideas in ways that were not, and arguably could not be, replicated in wealthier nations.

Readers should be aware that several central characters and events in this story are highly controversial. Allende, for example, is a polarizing figure in Latin American history. He has been depicted as a martyr because he assumed the Chilean presidency with a dream of social justice and was deposed in a violent coup that brutally ended the Chilean road to socialism and resulted in his death. Yet Allende has also been portrayed as a villain who destroyed the Chilean economy and brought on widespread consumer shortages. Other interpretations have portrayed the former president as a conflicted and contradictory figure who loved women and bourgeois luxuries even as his political dream called for the creation of a more just society. Allende's presidency exacerbated political and class divisions already present in Chilean society, and members of these different groups experienced the Allende period, and the Pinochet dictatorship that followed, in different ways. The scars from these memories have yet to heal completely and continue to shape interpretations and understandings of Allende's presidency.

In recent years Project Cybersyn has also been the subject of radically different kinds of interpretations.[18] Chilean artists have variously portrayed the project as part of a socialist utopia, the result of Beer's drinking too much whiskey, and evidence that technical prowess is a part of Chilean culture.[19] A science fiction book published in 2008 cast the project as a tool for totalitarian control and evidence that socialist success has a dark side, whereas recent postings on Chilean technology blogs show that some Chileans view the system as an inspiration.[20] Yet several Chilean computer pioneers interviewed for this book believed that Project Cybersyn did not warrant historical attention because it never reached completion. However, as this book demonstrates, there is historical value in studying innovative technological systems, even if they are never fully realized.

Stafford Beer, the British cybernetician whose ideas were central to Cybersyn's design, was also no stranger to controversy. Beer's admirers view his intelligence, breadth of knowledge, and willingness to think in unconventional ways as signs of misunderstood genius. On the other hand, his detractors paint a picture of a self-promoter who made grandiose claims that were not backed by his actual accomplishments.[21]

Even cybernetics, the interdisciplinary study of communication and control, is the subject of conflicting interpretations. It is well documented that some of the top scientific minds of the postwar era were drawn to the field and its promise of universality, and that cybernetic ideas on feedback, control, systems analysis, and information transmission shaped work in a number of fields. For example, cybernetic thinking influenced the trajectory of operations research, computer engineering, control engineering, complex systems, psychology, and neuroscience.

Yet few scientists today identify themselves as cyberneticians first and foremost. Why this is the case is outside the scope of the book and, moreover, has been studied in depth by historians such as Kline.[22] Popular misunderstandings of cybernetics have led members of the scientific community to view the term with disdain, and cybernetics is not part of the lexicon used by government funding agencies. Even in the 1950s, arguably the heyday of the field, members of the scientific community viewed it as shallow because of its interdisciplinary reach, criticized it for lacking quantitative rigor, and claimed its methodology consisted of little more than making analogies. It did not help that in the popular imagination cybernetics was often linked to science fiction or fads such as Dianetics, the theory on the relationship of mind and body developed by L. Ron Hubbard in 1950.

In 1959 Beer wrote that "the new science [cybernetics] is often open to derision, and is not yet academically respectable." But Beer was optimistic and added, "Not very long ago, however, atom-splitting was derided; yet more recently space travel was not respectable."[23] He hoped that the scientific profile of cybernetics might improve as people recognized the value of this science of control. In 2010 the American Society for Cybernetics had only eighty-two members.[24] Although cybernetics continues to be an active field, it has not attained the widespread influence that Beer, and other members of the cybernetics community, had imagined.

Presenting a balanced picture of these people, technologies, and ideas, all while capturing the nuances of the period that brought them together, has constituted a central challenge in writing this book. The resulting text forms part of an ongoing conversation about defining cybernetics, the Allende government, Project Cybersyn, and the work of Stafford Beer and understanding their collective significance.[25] At the same time, the varied and often contradictory readings of these ideas, people, technologies, and historical moments are what make it possible to study the complicated and highly nuanced relationships of technology and politics that I explore in this book.

Structure

This book has six chapters that unfold chronologically and illuminate different facets of the relationship of technology and politics. Chapter 1 explores why a member of the Chilean government would decide to apply ideas from Stafford Beer's writings on management cybernetics to the regulation of the Chilean economy. I argue that this connection between cybernetics and Chilean socialism came about, in part, because Beer and Popular Unity, as Allende's governing coalition was called, were exploring similar concepts, albeit in the different domains of science and politics. For example, both were interested in developing ways to maintain system stability while facilitating structural change and striking a balance between autonomy and cohesion. In addition, the chapter explains some of the core concepts in Beer's work that later shaped the design of Project Cybersyn.

Chapter 2 describes the Popular Unity economic program and the challenges the government faced at the end of Allende's first year in office. It explains why a cybernetic approach to management would seem to address these challenges and thus why it would appeal to someone involved in leading Allende's nationalization program. I discuss how members of the Chilean government viewed computer and communications technology as a way to implement the structural changes associated with the Popular Unity platform. Moreover, I delineate how the design of this system differed from contemporaneous efforts to use computers for communication and control, yet was still representative of the Popular Unity stance on science and technology. By following how Chile's innovative political experiment with democratic socialism led to the creation of this innovative computer system, the chapter argues that political innovation can spur technological innovation.

Chapters 3 and 4 explore the ways that political goals, contexts, and ideologies shape the design of technological systems. Both chapters document how the Chilean ideas on democratic socialism influenced the design of Project Cybersyn and its goal of helping to raise production levels while creating a broadly participative, decentralizing, and antibureaucratic form of economic management. Both chapters also examine how technologists, British and Chilean, tried to embed political values in the design of this technology. In chapter 3, I also trace how Chile's limited technological resources, made worse by the U.S.-led economic blockade, forced Cybersyn technologists to engineer a new approach to computer networking that differed from the approaches used by other nations.

Chapter 4 documents how Cybersyn technologists attempted to embed political values not only in the design of the technology but also in the social and organizational relationships of its construction and use. I use these attempts at sociotechnical engineering to show that these historical actors held a limited view of revolution. In

particular, preexisting ideas about gender, class, and engineering practice constrained how Cybersyn technologists imagined political transformation as well as technological possibility.

Chapter 5 demonstrates that technology can shape the path of political history by making certain actions possible. In a moment of crisis—namely, a massive strike begun by Chilean truck drivers that threatened to end the Allende government—the communication network created for Project Cybersyn was used to connect the vertical command of the national government to the horizontal activities that were taking place on the shop floor of Chilean factories. This communications network gave the government access to current information on national activities that it used in its decision making. It then used the network to transmit its directives quickly and reliably the length of country. These abilities helped the government withstand and survive a crisis that is commonly viewed as a watershed moment in the Allende government. Chapter 5 is therefore the most important chapter in this book from the perspective of Chilean history. This chapter also documents the diverging views within the project team on how Project Cybersyn should be used to advance the Chilean road to socialism, and thus shows how historical readings of technology can make visible the complexities internal to a political project.

Chapter 6 analyzes how the cold war influenced the ways that journalists, members of the Chilean government, and members of the British scientific community viewed Project Cybersyn. Even though members of the project team tried to design the system to reflect and uphold the values of Chilean democratic socialism, outside observers frequently viewed Project Cybersyn as implementing a form of totalitarian control. These interpretations reflected British and Chilean fears of an all-powerful state, the ideological polarization of the cold war, and the opposition's attacks against Allende. Building on chapter 5, this chapter also traces the multiple, often conflicting views of how Cybersyn and, by extension, the Popular Unity government could best address Chile's mounting economic crises. On 11 September 1973, a military coup brought the Popular Unity government to a violent end. When the military cut short Chile's political experiment with socialism, it also ended the nation's technological experiment with cybernetic management. International geopolitics therefore can play a decisive role in technological development, regardless of the merits or shortcomings of the system under construction.

Chile was not able to implement its political dream of democratic socialism or its technological dream of real-time economic management. However, the story of Chile's attempt to create this unusual, ambitious, and in many ways futuristic technology sheds light on the ways that people have tried to use computer and communications technology to effect social, economic, and political change. It further shows how a country with limited technological resources used what resources it did have in creative

ways to push the boundaries of what was considered technically feasible at the time. Finally, it demonstrates that technological innovation in the area of computing has occurred across a broader geography than is typically recognized. This broader geography of innovation cannot be viewed as a discrete collection of national stories, for it is connected by the multidirectional and transnational flows of artifacts and expertise and the far-reaching effects of international geopolitics.

limited, but a small yet vibrant community of scholars is forming. In 2008 a group of Latin American computer scientists and historians began a project to document the history of computing in Chile, Brazil, and Argentina. This group continues to grow and now includes scholars throughout Latin America. See Jorge Vidart, "Latin American Conference of the History of Computer Science," *IEEE Annals of the History of Computing* 33, no. 1 (2011): 80–81. And, in the history of technology, scholars such as Michael Adas, Daniel Headrick, Gabrielle Hecht, Clapperton Mavhunga, and Suzanne Moon have conducted pathbreaking work on the history of technology in Africa and Asia.

4. Ramón C. Barquín, "Computation in Latin America," *Datamation* 20, no. 3 (1974): 74; Martin Campbell-Kelly, *From Airline Reservations to Sonic the Hedgehog: A History of the Software Industry* (Cambridge, Mass.: MIT Press, 2003), 90.

5. Chile's commemoration of the thirtieth anniversary of the military coup invited a national process of remembrance and reexamination. The series of events tied to the anniversary spurred Chileans to embrace a new willingness to talk about the past and deeply affected the scope and depth of my research. This public reevaluation of the Allende period changed the scope of Chilean history, allowing for a greater number of voices to be heard and the documentation of new objects of study, among them, studies of Chilean science and Chilean technology. Some of my findings appeared in the Chilean and international press, and brought Project Cybersyn back into the public eye for the first time in decades. See Juan Andrés Guzmán, "Proyecto Synco: El sueño cibernético de Allende," *Clinic*, 10 July 2003, 5–8.

Introduction

1. The Christian Democratic government of Eduardo Frei Montalva (1964–1970) did have some noteworthy successes. It resulted in significant improvements to education and welfare, the aggressive pursuit of a program of agrarian reform, majority ownership of the nation's copper mines (a process known as Chileanization), and major strides in creating local self-help organizations for women and the poor (*promoción popular*). During Frei's tenure, the state housing corporation, CORVI, built about 87,000 new houses. The government established three thousand new schools, and 95 percent of Chilean children received a primary school education by 1970, Frei's last year in office. See Simon Collier and William F. Sater, *A History of Chile, 1808–1994*, 2nd ed. (New York: Cambridge University Press, 2004), 312. Political scientist Arturo Valenzuela has written that during Frei's presidency public expenditures on health increased by 136 percent, on housing by 130 percent, and on education by 167 percent. See Arturo Valenzuela, *The Breakdown of Democratic Regimes: Chile* (Baltimore: Johns Hopkins University Press, 1978), 25. However, Frei's presidency also oversaw an increase in foreign investment, particularly from U.S. multinationals. By 1970 foreign interests controlled forty of the top one hundred Chilean companies. Twenty-four of the thirty leading U.S. multinationals had branches in Chile. As Chilean private investment declined, foreign firms came to control one-quarter of all Chilean industrial capital. Government attempts to increase foreign investment deepened Chile's economic dependence, failed to alleviate unemployment, and gave priority to the needs of foreign companies and international lending agencies over domestic policies. For this reason Brian Loveman opines that the Frei government was a "dismal failure" in its attempts to modernize by increasing the flow of foreign capital into Chile. Brian Loveman, *Chile: The Legacy of Hispanic Capitalism*, 3rd ed. (New York: Oxford University Press, 2001), 238.

2. On Allende's economic program, see J. Ann Zammit, *The Chilean Road to Socialism: Proceedings of an ODEPLAN—IDS Round Table, March 1972* (Austin: University of Texas Press, 1973); Sergio Bitar, *Chile: Experiment in Democracy*, translated by Sam Sherman, vol. 6 (Philadelphia: Institute for the Study of Human Issues, 1986); Barbara Stallings, *Class Conflict and Economic Development in Chile, 1958–1973* (Stanford, Calif.: Stanford University Press, 1978); Valenzuela, *The Breakdown of Democratic Regimes*; Peter Winn, *Weavers of Revolution: The Yarur Workers and Chile's Road to Socialism* (New York: Oxford University Press, 1986). On worker participation, see Juan G. Espinosa and Andrew S. Zimbalist, *Economic Democracy: Workers' Participation in Chilean Industry, 1970–1973* (New York: Academic Press, 1978), and Peter Winn, "Workers into Managers: Worker Participation in the Chilean Textile Industry," in June Nash, Jorge Dandler, and Nicholas Hopkins, eds., *Popular Participation in Social Change: Cooperatives, Collectives, and Nationalized Industry* (Chicago: Mouton, 1976), 577–601.

3. From 1932 to 1973 Chilean presidents were elected by popular vote to serve single six-year terms (their immediate reelection was barred by law), and the transition from one administration to the next was peaceful. Chile also had a competitive and contentious tradition of party politics spanning the ideological spectrum. Parties often formed coalitions to win elections, a necessity given the number of active parties—ten in 1970, down from more than thirty in 1930. This fraught political environment posed a substantial challenge to the governing abilities of both the executive branch and the legislature, especially when internal disagreements within coalitions prevented consensus.

Although Chile's political parties have changed their names over time, several main players were influential by 1970. The National Party was formed in 1966 through the fusion of the traditional conservative and liberal parties and became the largest party of the Chilean right. The anticlerical Radical Party held the political center, as well as the presidential office, from 1938 to 1952. The Radicals were later removed as the dominant centrist party by the Christian Democratic Party (PDC), formed in 1957. The Communist and Socialist parties are the mainstays of the Chilean left. The Chilean Communist Party formed in 1922 and remained active in Chilean democratic politics until a 1948 law made the party illegal for ten years. The Socialist Party began in 1933, bringing together several small leftist movements that had long been active in Chile. Party leaders operated within the constitutional framework and respected democratic institutions. Many Socialist leaders were members of the middle class, and some were affluent. Among the founding members of the Socialist Party was a medical doctor from Valparaíso named Salvador Allende.

4. This figure includes grants and loans. See U.S. Senate, *Covert Action in Chile, 1964–1973: Staff Report of the Select Committee to Study Governmental Operation with Respect to Intelligence Activities* (Washington, D.C.: U.S. Government Printing Office, 1975), 151.

5. Peter Kornbluh, director of the National Security Archive's Chile Documentation Project, meticulously follows the paper trail left by the Nixon administration on U.S. intervention in Chile. See Peter Kornbluh, *The Pinochet File: A Declassified Dossier on Atrocity and Accountability* (New York: New Press, 2003).

6. By the end of Allende's presidency the manufacturing enterprises in the state-run sector constituted approximately 40 percent of Chile's total industrial production in terms of sales. Espinosa and Zimbalist, *Economic Democracy*, 50.

7. For example, see Donald Mackenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance* (Cambridge, Mass.: MIT Press, 1990).

8. Langdon Winner engages with this debate in his classic article "Do Artifacts Have Politics?" in Winner, *The Whale and the Reactor: A Search for Limits in an Age of High Technology* (Chicago: University of Chicago Press, 1986), 19–39.

9. For example, see Andrew Feenberg, *Questioning Technology* (New York: Routledge, 1999).

10. For an extended discussion of technocracy in Chilean history, see Patricio Silva, *In the Name of Reason: Technocrats and Politics in Chile* (University Park: Pennsylvania State University Press, 2008). Theodore Roszak argues that negative views of technocracy helped give rise to the U.S. counterculture during the sixties, a period he contextualizes by looking at the years 1942 to 1972. Theodore Roszak, *The Making of a Counterculture* (Berkeley: University of California Press, 1995). Fred Turner offers a different reading of the story of technocracy and the counterculture by showing how counterculture and computer expertise came together from the 1960s to the 1990s to produce the high-tech cyberculture exemplified by *Wired* magazine. Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006).

11. See Gabrielle Hecht, *The Radiance of France: Nuclear Power and National Identity after World War II* (Cambridge, Mass.: MIT Press, 1998); Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, Mass.: MIT Press, 1996); and Ken Alder, *Engineering the Revolution: Arms and Enlightenment in France, 1763–1815* (Princeton: Princeton University Press, 1997).

12. I am not the first to use the term *sociotechnical engineering*. For example, John Law and Michel Callon used the term in a 1988 article to describe how people, organizations, machines, and scientific findings are mobilized in engineering practice. Law also used the term in a 1987 review article, but he does not provide a definition of the term in that text. More recently the term has been used to refer to the practice of having systems designers work with stakeholders in designing computer systems that take into account the social context in which they will be used. See John Law and Michel Callon, "Engineering and Sociology in a Military Aircraft Project: A Network Analysis of Technological Change," *Social Problems* 35, no. 3 (1988): 284–297; John Law, "The Structure of Sociotechnical Engineering: A Review of the New Sociology of Technology," *Sociological Review* 35, no. 1–2 (1987): 404–425; Alexis Morris, "Socio-Technical Systems in ICT: A Comprehensive Survey," Technical Report #DISI-090-054, University of Trento, Italy, September 2009.

In contrast, I use the term to refer to the practice of engineering a technological artifact and to the social and organizational relationships that surround its construction and use. This type of sociotechnical engineering aims to produce a sociotechnical system capable of upholding a configuration of power that is consistent with the goals and values of a political project. My use of the term *sociotechnical engineering* is related to the idea of technopolitics proposed by Gabrielle Hecht, which she defines as "the strategic practice of designing or using technology to constitute, embody, or enact political goals." Hecht, *The Radiance of France*, 15. It would be accurate to view parts of this book as a case study of Chilean technopolitics. However, *sociotechnical engineering*

provides a more appropriate framework for this study because it conceptually emphasizes the role of social and organizational design in the coproduction of technology and politics.

13. Previous works in the history of technology have also equated technologies and texts. For example, Larry Owens remarks that "machines could be read as weighty 'texts' embodying a variety of idioms—technical, intellectual, and ethical" (66). Owens uses the history of the analyzer to show how machines can embody the language of engineering and become "a catalog of [an engineer's] technical universe, lessons on the nature of mathematics and its instruments, and even expressions of the ethos which pervaded engineering education" (95). See Larry Owens, "Vannevar Bush and the Differential Analyzer: The Text and Context of an Early Computer," *Technology and Culture* 27, no. 1 (1986): 63–95. In contrast, I compare machines with texts to show how both are source materials for understanding processes of historical change.

14. Norbert Wiener, *Cybernetics: Or Control and Communication in the Animal and the Machine*, 2nd ed. (Cambridge, Mass.: MIT Press, 1965).

15. On cybernetics in the United States, see Flo Conway and Jim Siegelman, *Dark Hero of the Information Age: In Search of Norbert Wiener, the Father of Cybernetics* (New York: Basic Books, 2005); Peter Galison, "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision," *Critical Inquiry* 21, no. 1 (1994): 228–266; Geoffrey C. Bowker, "How to Be Universal: Some Cybernetic Strategies, 1943–70," *Social Studies of Science* 23 (1993): 107–127; Steve J. Heims, *John von Neumann and Norbert Wiener: From Mathematics to the Technologies of Life and Death* (Cambridge, Mass.: MIT Press, 1982); Steve J. Heims, *The Cybernetics Group* (Cambridge, Mass: MIT Press, 1991); Lily E. Kay, "Cybernetics, Information, Life: The Emergence of Scriptural Representations of Heredity," *Configurations* 5, no. 1 (1997): 23–91; and Paul N. Edwards, *The Closed World*. On cybernetics in the Soviet Union, see Slava Gerovitch, *From Newspeak to Cyberspeak: A History of Soviet Cybernetics* (Cambridge, Mass.: MIT Press, 2002). On cybernetics in Britain, see Andrew Pickering, "Cybernetics and the Mangle: Ashby, Beer, and Pask," *Social Studies of Science* 32, no. 3 (2002): 413–437; Andrew Pickering, "The Science of the Unknowable: Stafford Beer's Cybernetic Informatics," *Kybernetes* 33, no. 3–4 (2004): 499–521; Andrew Pickering, *The Cybernetic Brain: Sketches of Another Future* (Chicago: University of Chicago Press, 2010). On cybernetics in France, see David A. Mindell, Jérôme Segal, and Slava Gerovitch, "Cybernetics and Information Theory in the United States, France, and the Soviet Union," in Mark Walker, ed., *Science and Ideology: A Comparative History* (New York: Routledge, 2003). On cybernetics in East Germany, see Jérôme Segal, "L'introduction de la cybernétique en R.D.A. rencontres avec l'idéologie marxiste," *Science, Technology and Political Change: Proceedings of the XXth International Congress of History of Science (Liège, 20–26 July 1997)* (Brepols: Turnhout, 1999), 1:67–80. On cybernetics in China, see Susan Greenhalgh, "Missile Science, Population Science: The Origins of China's One-Child Policy," *China Quarterly* 182 (2005): 253–276.

16. Ronald Kline, "The Disunity of Cybernetics," paper prepared for the Annual Meeting of the Society for the History of Technology, Lisbon, 11–14 October 2008.

17. Raimundo Toledo described his own calculating machine to Wiener as simple, lightweight, and inexpensive. He boasted that the mathematical principles he worked out while building the device might improve the construction of electronic computers such as the ENIAC (Electronic

Numerical Integrator and Computer), the massive machine engineers at the University of Pennsylvania's Moore School of Electrical Engineering unveiled in 1946. Toledo hoped Wiener might help him bring his device from Chile to Western markets so that it might contribute to these computing efforts. In asking for a copy of *Cybernetics*, Toledo explained that he did not have much money and said that it was impossible for him to acquire technical literature on computing in Chile. Wiener's reply was short and condescending: "I do not think it is impossible that you may have made some progress in the direction of a computing machine." He refused to send Toledo a copy of *Cybernetics* because "I cannot afford to dispose of them freely to unknown strangers, no matter how deserving their cases may be." Yet Wiener promised Toledo that he would forward his letter to "an important designer of computing machines." And he did. He sent the letter on to Princeton mathematician John von Neumann, arguably the most important designer of computer architecture at that time. Having access to such a distinguished audience would have been a boon to Toledo if Wiener had not opened his cover letter to von Neumann by saying, "Here is an amusing letter I got from Chile." Raimundo Toledo Toledo, letter to Norbert Wiener, 14 January 1949, MC 22, box 6, Norbert Wiener Papers, Institute Archives and Special Collections, MIT Libraries, Cambridge, Massachusetts; Wiener to Toledo, 21 January 1949, MC 22, box 7, Wiener Papers; Wiener to John von Neumann, 21 January 1949, MC 22, box 7, Wiener Papers. I thank Bernard Geoghegan for bringing this correspondence to my attention.

18. See my earlier work for a historical perspective: Eden Medina, "Designing Freedom, Regulating a Nation: Socialist Cybernetics in Allende's Chile," *Journal of Latin American Studies* 38, no. 3 (2006): 571–606; Eden Medina, "Democratic Socialism, Cybernetic Socialism: Making the Chilean Economy Public," in Bruno Latour and Peter Weibel, eds., *Making Things Public: Atmospheres of Democracy* (Cambridge, Mass.: MIT Press, 2005), 708–721; Eden Medina, "Secret Plan Cybersyn," in Stephen Kovats and Thomas Munz, eds., *Conspire: Transmediale Parcours 1* (Frankfurt, Germany: Revolver Press, 2008), 65–80. A brief discussion of Project Cybersyn appears in Andrew Pickering's book *The Cybernetic Brain,* but he uses the system to explain a central concept in Stafford Beer's work, namely, the Viable System Model, and does not interpret the system's significance in the context of Chile's socialist project.

19. In 2006 the Brainworks Gallery based in Santiago, Chile, put together a series of events in connection with a show called "Utopias in Process: Space, Technology, and Representation" and invited me to talk about the history of Project Cybersyn as a form of technological utopia. Chilean artist Mario Navarro assumed a more critical perspective in his 2006 work *Whiskey in Opsroom*. Navarro's project put a bottle of whiskey in an image of the Cybersyn operations room to portray the project as a drunken fancy of Stafford Beer. In 2007 the media artist group Or-Am created an installation about Project Cybersyn at the Cultural Center La Moneda, located below the Chilean presidential palace. It put Chilean technology history on display next to exhibits about Gabriela Mistral and the Selk'nam Indians, a now-extinct tribe indigenous to Tierra del Fuego. This juxtaposition linked Project Cybersyn to these exemplars of Chilean culture and implicitly made the point that technological prowess is as much a part of Chilean history as its poet laureates or indigenous peoples.

20. Jorge Bardit, *Synco* (Santiago: Ediciones B, 2008).

21. As one person who saw Beer lecture on Project Cybersyn put it: "There was this very large, rather voluble person [Beer] whose mannerisms gave the impression that he was sort of boasting about something, but one wasn't quite sure what the substance was behind it. . . . It seemed to me a bit like the machinations of a very clever, maybe self-important, even eccentric person." Ann Zammit, telephone interview by author, 27 January 2010.

22. Ronald Kline, "The Fate of Cybernetics in the United States: Decline, Revival, and Transformation in the 1960s and 1970s," unpublished manuscript, June 21, 2010, in the personal files of Ronald Kline.

23. Stafford Beer, *Cybernetics and Management*, 2nd ed. (London: English Universities Press, 1967), viii.

24. I thank Phillip Guddemi, vice president for membership of the American Society for Cybernetics, for supplying me with this information.

25. Readers interested in learning more about the technical aspects of Project Cybersyn should consult the accounts published by project participants. For example, see Raúl Espejo, "Cybernetic Praxis in Government: The Management of Industry in Chile, 1970–1973," *Cybernetics and Systems: An International Journal* 11 (1980): 325–338; Raúl Espejo, "Performance Management, the Nature of Regulation and the Cybersyn Project," *Kybernetes* 38, no. 1–2 (2009): 65–82; Raúl Espejo, "Complexity and Change: Reflections upon the Cybernetic Intervention in Chile, 1970–1973," *Cybernetics and Systems* 22, no. 4 (1991): 443–457; Herman Schwember, "Cybernetics in Government: Experience with New Tools for Management in Chile, 1971–1973," in Hartmut Bossel, ed., *Concepts and Tools of Computer-Assisted Policy Analysis* (Basel: Birkhäuser, 1977), 79–138; Roberto Cañete, "The Brain of the Government: An Application of Cybernetic Principles to the Management of a National Industrial Economy," paper presented at the 22nd Annual North American Meeting on Avoiding Social Catastrophes and Maximizing Social Opportunities: The General Systems Challenge, Washington, D.C., 13–15 February 1978; Stafford Beer, *Brain of the Firm: The Managerial Cybernetics of Organization*, 2nd ed. (New York: J. Wiley, 1981); Gui Bonsiepe, *Entwurfskultur und Gesellschaft: Gestaltung zwischen Zentrum und Peripherie* (Basel: Birkhäuser-Verlag, 2009); Stafford Beer, Raúl Espejo, Mario Grandi, and Herman Schwember, *Il Progetto Cybersyn: Cibernetica per la democrazia* (Milan: CLUP-CLUED, 1980).

Chapter 1

1. Fernando Flores, letter to Stafford Beer, 13 July 1971, box 55, Stafford Beer Collection.

2. Salvador Allende, quoted in Régis Debray, *Conversations with Allende: Socialism in Chile* (London: N.L.B., 1971), 85.

3. Salvador Allende, "The Purpose of Our Victory: Inaugural Address in the National Stadium, 5 November 1970," in Allende, *Chile's Road to Socialism*, ed. Joan E. Garcés, trans. J. Darling (Baltimore: Penguin, 1973), 59.

4. Sergio Bitar, *Chile: Experiment in Democracy* (Philadelphia: Institute for the Study of Human Issues, 1986).