Rethinking algorithmic regulation

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Abstract

Purpose – The history of cybernetics holds important lessons for how we approach present-day problems in such areas as algorithmic regulation and big data. The purpose of this paper is to position Project Cybersyn as a historical form of algorithmic regulation and use this historical case study as a thought experiment for thinking about ways to improve discussions of algorithmic regulation and big data today.

Design/methodology/approach – The paper draws from the author's extensive research on Cybersyn's history to build an argument for how cybernetic history can enrich current discussions on algorithmic regulation and the use of big data for governance.

Findings – The paper identifies five lessons from the Cybersyn history that point to current data challenges and suggests a way forward. These lessons are: first, the state matters; second, older technologies have value; third, privacy protection prevents abuse and preserves human freedom; fourth, algorithmic transparency is important; and finally, thinking in terms of socio-technical systems instead of technology fixes results in better uses of technology.

Research limitations/implications – Project Cybersyn was a computer network built by the socialist government of Salvador Allende under the supervision of the British cybernetician Stafford Beer. It formed part of the government's program for economic nationalization. Work on the project ended when a military coup brought the Allende government to an early end on September 11, 1973. Since we do not know how the system would have functioned in the long term, parts of the argument are necessarily speculative.

Practical implications – The paper uses Cybersyn's history to suggest ways that the Chilean experience with cybernetic thinking might enhance, improve, and highlight shortcomings in current discussions of algorithmic regulation.

Originality/value – The paper provides an original argument that connects one of the most ambitious cybernetic projects in history to present day technological challenges in the area of algorithmic regulation.

Keywords Governance, History, Politics, Algorithms, Cybernetics, Citizenship

Paper type Conceptual paper

The history of computing is filled with attempts to make the world a better place by improving capabilities in data collection and data processing. Yet recent headlines about National Security Agency surveillance or data-driven marketing practices that track our online behavior in extensive and invisible ways remind us that initiatives that seem positive on their face – stopping terrorism, discounts for products we want – can undermine important societal values such as privacy. More troubling is that we often do not understand the consequences of enhanced data capabilities until such systems are already in place.

The history of cybernetics holds lessons for these present day imbroglios. In this essay I explore how a technological system built in Chile during the 1970s – Project Cybersyn – addressed issues similar to those we currently face in areas such as big data and algorithmic regulation.

Our data-driven present

There is no doubt that we are in a data-driven moment. According to the IT research firm Gartner, Inc., the Internet of Things has now replaced big data as the most hyped emerging technology (Press, 2014). The popularity of both terms illustrates that we are living in a moment of data-driven enthusiasm that has yet to wane. This is especially clear when we consider the investments being made by governments, universities, and the private sector to not only collect and store data but also to figure out ways to extract new knowledge from these growing data banks.

Technology pundits such as the publisher Tim O'Reilly (2013) argue that developments in data collection, storage, and computer power promise to make governments more efficient and adaptive and thus improve governance. In a recent essay, O'Reilly describes "algorithmic regulation," a form of improved data-driven governance. First, policy makers develop a clear sense of the outcome they desire; second, they take measurements in real time to see if the outcome is being achieved; third, they use algorithms to assess the new data and adjust government actions accordingly; and fourth, they conduct periodic assessments to see if the algorithms are performing as expected. He argues that such forms of regulation offer new possibilities for data-driven governance and could even provide a model for how to improve law.

Such optimism stems in part from the technological moment. For example, it has only recently been feasible to collect and process data on this scale. Technological innovations such as smart phones provide new data collection and transmission possibilities. Social media sites such as Twitter collect both spontaneous reactions to world events and celebrity photographs and store them for subsequent processing. Sensors embedded in our phones, refrigerators, thermostats, and cars can now generate a continuous stream of data documenting our activities in virtual and physical spaces. Police departments now use computerized management tools to allocate police resources based on past incidents of crime and the statistical prediction of where future criminal activity will take place. Data farms, too, have grown in capacity, from terabytes to petabytes to exabytes and now to speculations of zettabytes and yottabytes. Certainly these technological capabilities play a central part in our fascination with data-driven analytics.

It is also characteristic of the kind of technological enthusiasm – ideology even – that is often found in high-tech culture. Such enthusiasm celebrates technology as a magic bullet for societal problems while also embracing such values as individuality, personal responsibility, and the superiority of the innovative power of the private sector to that of government. This stance has been characterized by Borsook (2000) and others as cyberlibertarianism.

Our cybernetic past

Yet, if we move beyond technology and ideology, it is clear that we have seen similar calls for data-driven dynamic regulation in the past. For example, algorithmic regulation is highly reminiscent of cybernetics, the interdisciplinary science that emerged in the aftermath of Second World War and brought together a diverse group of scholars, including Norbert Wiener, Margaret Meade, Gregory Bateson, Ross Ashby, Warren McCulloch, Heinz von Foerster, and Arturo Rosenblueth (Conway and Siegelman, 2006; Edwards, 1996; Heims, 1991; Light, 2005; Medina, 2011; Morozov, 2014). Cybernetics moved away from linear understandings of cause and effect and toward investigations of control through circular causality, or feedback. It influenced developments in areas as diverse as cognitive science, air defense, industrial management, and urban planning. It also shaped ideas about governance.

The content of cybernetics varied according to geography and historical period. In the USA early work on cybernetics was often associated with defense (Edwards, 1996); in Britain it was associated with understanding the brain (Pickering, 2010); in China cybernetic thinking influenced the development of the one child per family program (Greenhalgh, 2005); in the Soviet Union cybernetics became a way to make the social sciences more "scientific" and also contributed to the use of computers in a highly centralized economy (Gerovitch, 2002). In Chile cybernetics led to the creation of a computer system some thought would further socialist revolution (Medina, 2011).

This last example is of course a reference to Project Cybersyn and the work of the cybernetician Stafford Beer. Here I use Cybersyn's history to suggest ways that the Chilean experience with cybernetic thinking might enhance, improve, and highlight shortcomings in current discussions of algorithmic regulation. Indeed it is striking that a system built more than 40 years ago in a South American country as part of a socialist revolution continues to remain relevant today. I argue, and have argued throughout my work, that this is precisely the value of studying the relationship of political innovation and technological innovation in different parts of the world. Every political context produces its own ways of technological being that can inspire new possibilities for technological developments in other parts of the world.

A discussion of Project Cybersyn requires a discussion of Stafford Beer, whom Norbert Wiener described as "the father of management cybernetics." Beer conducted path breaking work on the application of cybernetic concepts to the regulation of the firm, which he published in such books as *Cybernetics and Management* (1967) and *The Brain of the Firm* (1981). He believed, strongly, that cybernetics and operations research should drive action, whether in the management of a firm or in governance on a national scale. Beer writes, “The company is certainly not alive, but it has to behave very much like a living organism. It is essential to the company that it develops techniques for survival in a changing environment: it must adapt itself to its economic, commercial, social and political surroundings and learn from experience” (1967, p. 17). Companies needed to be able to adapt in order to remain viable.

For Beer, computers in the 1960s and 1970s presented exciting new opportunities for regulation. In 1967 he observed that computers could bring about structural transformations within organizations if they were linked to new communications channels that enabled the generation and exchange of information and permitted dynamic decision making. His 1971 essay “The Liberty Machine” extended this thinking to the domain of government, which he uncharitably described as an “elaborate and ponderous machine” with “immense inertia” (p. 343). Ineffective organization, he believed, limited the ability of government to act in the present and prepare for the future.

Beer proposed the creation of a “liberty machine,” a sociotechnical system that operated in close to real time, facilitated instant decision making, and shunned bureaucracy. The liberty machine also prevented top-down tyranny by creating a distributed network of shared information. Expert knowledge would be grounded in data-guided policy, not bureaucratic politics. Indeed, the liberty machine sounds a lot like algorithmic regulation, as we understand it today. Examining Beer’s attempt to construct an actual liberty machine in the context of political revolution – Project Cybersyn – further strengthens this comparison.

The origins of Project Cybersyn

Project Cybersyn was an ambitious technological project tied to an ambitious political project. It emerged in the context of Chile’s peaceful road to socialism. Salvador Allende had won the Chilean presidency in 1970 with a promise to build a fundamentally different society. His political program would make Chile a democratic socialist state, with respect for the country’s constitution and individual freedoms such a freedom of speech and freedom of the press.

Giving the state control of Chile’s most important industries constituted a central plank in Allende’s platform but created management difficulties. The government had limited experience in this area. Yet by the end of 1971 it had taken control of more than 150 enterprises, among them twelve of the twenty largest companies in Chile (Stallings, 1978, p. 131).

The problem of how to manage these newly socialized enterprises led a young Chilean engineer named Fernando Flores to contact Beer, the British cybernetician, and ask for advice. Flores worked for CORFO, the government agency charged with the nationalization effort. Beer was an international business consultant known for his work in the area of management cybernetics, which he defined as the “science of effective organization.”(Beer, 1974/1994, p. 13) Together Beer and Flores formed a team of Chilean and British engineers and developed a plan for a new technological system that would improve the government’s ability to coordinate the state-run economy.

The system would provide daily access to factory production data and a set of computer-based tools that the government could use to anticipate future economic behavior. It also included a futuristic operations room that would facilitate government decision making through conversation and better comprehension of data. Beer envisioned ways to both increase worker participation in the economy and preserve the autonomy of factory managers, even with the expansion of state influence.

Members of the Chilean government believed the system would bolster the success of Allende's economic program and, by extension, Chile's socialist revolution. Beer gave the system the name Cybersyn in recognition of "cybernetics," the scientific principles guiding its development, and of "synergy," the idea that the whole of the system was more than the sum of its technological parts.

The system worked by providing the government with up-to-date information on production activity within the nationalized sector. Factory managers transmitted data on the most important indices of production to the Chilean government on a daily basis. Typically this included data on raw materials and energy as well as data on worker satisfaction (as measured by the percentage of workers present on a given day). Operations research scientists conducted studies to determine the acceptable range of values for each index – what would be considered normal and what would be considered cause for alarm.

Engineers from Chile and Britain developed statistical software to track the fluctuations in the index data and signal if they were abnormal. The software also used statistical methods to predict the future behavior of the factory and thus give government planners an early opportunity to address a potential crisis.

In terms of hardware, the system relied on a national network of telex machines that connected the factories to the central mainframe computer. The computer processed the production data and alerted the government agency in charge of the nationalization effort (CORFO) if something was wrong. Project Cybersyn also included an economic simulator, intended to give government officials an opportunity to play with different policy alternatives and, through play, acquire a heightened sense of the relationship among the different economic variables. It also included a futuristic operations room, which was built in downtown Santiago.

In 2011, I published a book on the history of Project Cybersyn titled *Cybernetic Revolutionaries: Technology and Politics in Allende's Chile*. In it I made the argument that the system provided a compelling example of how different political contexts open up new possibilities for technical innovation. I also used the system to illustrate how technologists, workers, and members of government tried to instill political values in the form and function of a technological system, a process I refer to as sociotechnical engineering. I further show that the approach to decentralized control found in Project Cybersyn mirrored the approach to democratic socialism articulated by the Allende government. For example, both extended the reach of the state while still preserving individual freedoms, and both were centrally concerned with increasing participation in government.

Here, however, I will make a different argument. I begin with the assertion that Project Cybersyn provides a historical example of algorithmic regulation. If we return to O'Reilly's definition, for example, we see that the Chilean government had a clear purpose: increasing industrial production (step 1); it created a way to measure production in the nationalized sector as close to real time as was possible, given Chile's technological resources (step 2); it used computer algorithms to detect changes in factory behavior that could decrease production levels; these algorithms also alerted government officials and factory managers to make policy adjustments (step 3). Given that the system never made it past its initial stages – the project ended with the demise of the Allende government on September 11, 1973 – Cybersyn's creators did not have much of an opportunity to evaluate the correctness of their statistical algorithms (step 4), although it is easy to imagine this kind of activity taking place had Allende stayed in power and work on the project continued.

Project Cybersyn allows us to consider what algorithmic governance would have looked like in a political, geographic, and historical context other than that of the USA in 2015. That the system was developed in Chile, which at the time was considered part of the Third World, during a moment when politicians and technologists made political values an explicit part of technological design and construction, increases its value as a historical case study with a potential to shed light on present-day forms of computerized governance. It therefore offers a provocation to think about the alternative forms algorithmic regulation might take. Although the system never reached completion – the project was cut short by the military coup that took place on September 11, 1973 – it nonetheless stands as one of the most ambitious attempts to apply cybernetic ideas to government and thus warrants our further attention to see what lessons might be learned.

Lesson no. 1: the state matters

The state plays an important role in shaping the relationship of labor and technology. While the history of computing in the US context has been filled with couplings of machines and human expertise (Mindell, 2008), it has also been tightly linked to government command, control, and automation efforts (Edwards, 1996). The Allende government's approach to the technology-labor question in the design of Project Cybersyn provides an important counterexample. It illustrates how the state can encourage the design of computer systems that benefit the broader citizenry, including members of marginalized groups.

Allende made raising employment central to both his economic plan and his overall strategy for helping Chileans. His government pushed for new forms of worker participation on the shop floor and the integration of worker knowledge in economic decision making.

This political environment allowed Beer to view computer technology as a way to empower workers. In 1972 he published a report for the Chilean government that proposed giving Chilean workers, not Chilean managers or government technocrats, control of Project Cybersyn. More radically Beer envisioned a way for Chile's workers to participate in Cybersyn's design itself. He recommended that the government allow workers – and not engineers – to build the models of the state-controlled factories because they were best qualified to understand operations on the shop floor. Workers would thus help design the system that they would then run and use. Allowing workers to use both their head and their hands would limit their feelings of alienation from their labor (Beer, 1972).

Beer's idea for democratic participation had its flaws. For example, he did not consider how coding worker knowledge into the software of a computer system might result in the eventual disempowerment of workers, especially if the political context changed. But Beer showed an ability to envision how computerization in a factory setting might work toward an end other than speed-ups and deskilling – the results that labor scholars such as Harry Braverman witnessed in the USA, where the government did not have the same commitment to actively limiting unemployment or encouraging worker participation.

Braverman published his classic text, Labor and Monopoly Capital, in 1974, at about the time Beer was working for the Allende government. In it, Braverman observed how technologies such as computer-controlled machinery contribute to the automation of labor and lead to the deskilling of workers, even in highly specialized fields such as engineering. He found the same process at work in the context of office computer use. Computers make office work increasingly routinized and give management an easy way to monitor the amount of labor each operator has put in. The increased speed of work would result in more layoffs [1].

Beer saw computerization differently, not least because the Chilean state insisted that its socialist computer system would be designed for different ends than the ones that Braverman described. This in turn gave Beer the freedom to reconceptualize how technologies might shape work on the shop floor and see computers as a means of empowering workers.

In the case of Project Cybersyn, the state created the conditions for new directions in design thinking by making social justice a priority and providing financial and human resources to push technological innovation in this direction. It shows that the state can require (and inspire) technologists to consider how systems benefit the interests of the broader citizenry, which may or may not align with profit, market success, efficiency, technical elegance, or coolness in system design. Computer innovation can thrive by taking on design considerations that fall outside the scope of the market. Since the state has historically acted as a powerful motivator for thinking about technology in new and challenging ways, its continued involvement in the design of new data-driven systems and deciding how such technologies should be regulated offers an important counterbalance to the private sector.

Lesson no. 2 older technologies have value

When Project Cybersyn was built during the 1970s, Chile had approximately 50 computers in the entire country, and most were outdated. Nor could Chile ask IBM for help. IBM decreased its operations in Chile following Allende's election because the company feared the Chilean government would nationalize Big Blue (Medina, 2008).

The computer manufacturer Burroughs similarly closed up shop in Chile during the Allende period. Additionally, the Nixon administration had instituted an “invisible blockade” to destabilize the Chilean economy and prevent Latin America from becoming a “red sandwich,” with Cuba on one side and Chile on the other. This further limited Chile’s ability to import US technology. The National Computer Corporation, or ECOM, controlled most of the computer resources owned by the Chilean government.

In 1971 ECOM had access to four mainframe machines. Three were IBM System/360 mainframes and one was a Burroughs 3500 mainframe. All were low- to mid-range machines (Medina, 2011).

As a result, Beer and the Chilean team came up with an ingenious way to create the data-processing network they needed to link the country’s factories to the central command center: they would connect the one computer they had for the project – and it was not even top of the line – to another technology that was not state of the art: the telex machine or, rather, several hundred of them. And it worked.

In 1972, a national strike that grew to include 40,000 truck drivers threw the country into a state of emergency and disrupted the distribution of food, fuel, and raw materials for factory production. The government used the telex network created for Project Cybersyn to determine which roads were open, coordinate the distribution of key resources, and maintain factory production.

The Cybersyn network improved government communication and substantially increased the speed and frequency by which the government could send and receive messages along the length of the country (Medina, 2011). It lacked the technological sophistication of the ARPANET, the US military communications system that was the forerunner of the internet and a contemporary of Chile’s telex system. In 1971, the ARPANET had 15 nodes, spanned the continental USA, and had e-mail capability (Abbate, 1999). But the Chilean network also used fewer technical resources at a lower cost and proved highly functional nonetheless. Older technologies were creatively reenvisioned and combined with other forms of organizational and social innovation. We can use older equipment in effective and novel ways, although it may require highly creative thinking and an openness to reframing the problem under study.

The operations room provides another example of how Project Cybersyn reenvisioned the possibilities for older technologies. For example, the room simulated television display screens by placing a series of slide projectors behind one wall of the room. These projectors back-projected slides of economic data onto the acrylic screens to improve the visualization of national economic activity and simulate a high-tech display. Project Cybersyn thus challenges the assumption that advanced technologies need to be complex and cutting edge.

New technologies come with significant environmental costs in terms of the consumption and disposal of electronic devices. Sales of electronic devices in the USA doubled between 1997 and 2009. According to the Environmental Protection Agency, in 2009 people in the USA disposed of 29.4 million computers and 129 million mobile devices (US Environmental Protection Agency, 2011). The USA had the highest amount of e-waste in the world in 2012, with a reported 9.4 million metric tons generated (StEP,

2014) [2]. Much of this waste is handled in places like China, India, and Pakistan, where the recovery of valuable materials such as gold can expose workers to lead and other toxic metals.

The current market for electronic products depends on planned obsolescence: old products quickly become outdated and unfashionable. But extending the life of our electronic devices helps to address the e-waste problem. Project Cybersyn shows that it is possible to create an advanced system using technologies and equipment that are not state of the art. It demonstrates that the future can be tied to the technological past.

New technology is not actually as “immaterial” as many would think. We often speak of our data’s being stored “in the cloud” – a phrase that implies a lack of physicality. However, such scholars as John Durham Peters (2015), Nathan Ensmenger (2012), and Tung-Hui Hu (2014) challenge the accuracy of this metaphor. Data farms depend on substantial quantities of natural resources. A 15 MW data center can use up to 360,000 gallons of water per day (Miller, 2009), and the recently completed NSA Utah Data Center requires a million gallons of water per day and 65 MW of power (Wilson, 2014).

Big data have costs. One way to lessen these costs is to think not only about new smart devices but also about ways to extend the life of older devices through repair and maintenance. Project Cybersyn provides a valuable of example of how older technologies can be reenvisioned – recycled even – to create new cutting-edge systems. However, Project Cybersyn also demonstrates that more can be done with less. The Chilean project did not, for example, try to copy the Soviets’ form of economic cybernetics, which collected a wealth of factory data and sent it to a centralized hierarchy of computer centers for further processing. Cybersyn accomplished the same task by transmitting only ten to 12 indices of production daily from each factory and having factory modelers spend more time thoughtfully identifying which indices were most important. In the 1970s, technological limitations made this a necessity. Today we can choose to encourage greater selectivity in data collection and challenge the uncritical storing of vast amounts of data simply because we can.

Lesson no. 3 privacy protection is necessary for decentralized control

New technological innovations such as smart phones, the increased use of data-driven analytics, and the push to create smart cities and an Internet of Things all make the collection of data easier and permit the recording of increasing volumes of human and nonhuman activity. Often we adopt these data-gathering technologies before understanding their full ramifications. For example, the data from activity trackers such as the fitness app Fitbit may become an accepted form of evidence in legal disputes (Olson, 2011). Such developments raise important questions about privacy and the extent to which we should expect to forfeit our privacy so that an increasingly data-driven environment can function. Project Cybersyn illustrates that privacy protection can mean the difference between a system that is centralized and abusive and one that can protect and promote human freedom.

In the 1970s, critics often likened Project Cybersyn to a form of authoritarian, centralized control because it collected data on factory activities and channeled them to the Chilean government. *New Scientist*, for example, ran an editorial that declared, “If this [Project Cybersyn] is successful, Beer will have created one of the most powerful weapons in history” (Hanlon, 1973, 347). Such critiques were overstated given the limitations of what Cybersyn could accomplish and often stemmed from Cold War anxieties.

In Chile the criticisms were tied to more general condemnations of the Allende government by the right-wing political opposition, which claimed that the Allende government was destroying Chilean civil liberties. In other cases, criticisms resulted, in part, from failure to fully understand the nuances of Beer’s cybernetic ideas or the system’s design. In at least one case, such criticisms stemmed from a disconnect perceived by members of the British Left regarding Beer’s work for a socialist government and the luxuries of his life as an international business consultant (Medina, 2011).

Beer overstated Cybersyn’s ability to promote freedom in Chile, but he did take pains to counteract the system's potential for abuse by including mechanisms to protect and preserve factory autonomy. This protection was engineered into the system’s design. The government, for example, could intervene in shop-floor activities only after the software detected a production anomaly and the factory failed to resolve the anomaly within a set period of time [3].

Human and technological limitations placed an additional check on government intervention. Operators in the factory, for example, could not monitor thousands of production indices a day, but they could track ten to 12 of the most important. Limiting the number of indicators also made it easier for the software to detect the most pressing emergencies in need of government action. However, it required Chilean engineers to make decisions about which data the government truly required.

Such limitations made much of the factory’s activity invisible to the Chilean government, preserved freedom, and protected Chilean workers from Orwellian abuse. The limitations created a layer of privacy that could have allowed workers to participate in economic management without the overbearing control of outside state bureaucrats.

Today, data collection is much easier and more complete. We are no longer constrained by humans typing numbers into telex machines or the processing power of computers run by punched cards. Since technology no longer provides a form of built-in protection, we need to be more vigilant about privacy. We must continually ask ourselves: What data do we need to perform a certain action? While it may be easy to collect more data than we need, we should also reflect on how such collection might constitute an invasion of privacy.

In 2013, we learned of NSA activities to collect cell phone metadata within the USA as a way to identify terrorist activity. Such revelations generated outrage within the United States, and internationally, and were widely seen as an egregious violation of personal privacy. In the aftermath of these revelations, President Obama formed a Review Group on Communications and Intelligence Technologies and charged the group with making recommendations for reform. The group concluded that the government should not be able to store bulk telephone metadata for domestic surveillance. Its members recommended instead that the data reside with the telecommunications companies and that the government have access only to specific data once it demonstrated need and acquired a court order.

This approach can also applied to the private sector. Indeed the private sector should not be able to collect broad swaths of data simply because it can or because such data might be useful in the future. In 2014 MIT announced a system called openPDS, which stores all the data from your digital devices in one location. This system changes the ecology of data sharing in a fundamental way. As of now, you have little control over how the applications on your phone collect and store personal data. In fact, applications often collect data about your activities that are not essential to the service they provide. OpenPDS shifts the dynamics of control so that instead of sending your data to each application, each application instead needs to send a query to your central repository. The repository then provides access to the information the application absolutely requires. As one openPDS designer noted, the music program Pandora requires a list of the last ten songs you listened to in order to make a recommendation. It does not “need the list of all the songs you’ve been listening to” (Hardesty, 2014).

As Project Cybersyn illustrates, asking what data we need does not necessarily limit our ability to produce systems that improve management capabilities. Instead this question can serve to bring privacy to the forefront of system design and increase our recognition that the lack of privacy protection in our technological devices is a design decision.

Lesson no. 4 opening the algorithmic black box is important

Companies and government offices often couple large data sets with forms of algorithmic decision making whose inner workings are shielded from public view. We have limited knowledge of how Facebook chooses the posts that appear on our newsfeed or how Google constructs our personal “filter bubble” of search results (Pariser, 2012). We have a general – but not a complete – understanding of the factors that go into our credit score.

Yet forms of data analytics are entering domains that are less visible in everyday life and that create forms of regulation that are potentially more troubling. As the legal scholar Sonja B. Starr (2014) has shown, data-driven analytics are now entering the world of criminal sentencing. These tools compare such factors as an offender’s gender, place of residence, level of education, and socioeconomic status to existing data sets to calculate an offender’s risk of recidivism and shape sentencing practices in ways that are discriminatory and perhaps raise constitutional concerns. For example, recidivism predictions based on whether a defendant resides in an urban area or has a lower socioeconomic status may result in sentencing that has a racially disparate impact. Such practices are reminiscent of redlining. Moreover, these data-driven techniques often make use of proprietary software that is not open to public scrutiny.

Here, too, Project Cybersyn offers important insights. Beer believed Project Cybersyn would increase worker participation by having workers create the factory models that formed the basis of the Cybersyn software. This served to connect workers intellectually to their labors, as Beer explicitly wrote. However, it also did something else, which he did not acknowledge. It gave them a way to understand how this form of data-driven regulation worked. Theoretically it allowed them to open up the black box of the computer and understand the operation of the analytical processing taking place within it.

I say theoretically because the Allende government was cut short by a military coup that resulted in the death of President Allende and ended Chilean democracy for the next 17 years. Military dictatorship and economic policies often described as neoliberal shock treatments ended work on Project Cybersyn before it reached completion. In this context it no longer made sense to have a computer system that helped the state regulate national industrial production.

Nevertheless, Beer's framing is useful because it reminds us of the importance of not just computational transparency but democratic control. If code is law, as Lawrence Lessig famously proposed, then the code used in the new technologies that are shaping our lives should not be the exclusive domain of engineers and programmers. Algorithmic regulators with the potential to affect self-determination, democratic self-governance, and civil liberties should be designed alongside mechanisms that safeguard these principles.

Lesson no. 5 we need to think in terms of sociotechnical systems, not technological fixes

Throughout the Cybersyn Project, Beer repeatedly expressed frustration that Cybersyn was viewed as a suite of technological fixes – an operations room, a network of telex machines, an economic simulator, software to track production data – rather than a way to restructure Chilean economic management. Beer was interested in understanding the system of Chilean economic management and how government institutions might be changed to improve coordination. He viewed technology as a way to change the internal organization of Chile's government.

I always think of Stafford Beer when I hear of e-government projects that aim to put existing forms online or computerize existing processes. He would undoubtedly lament that these kinds of projects miss opportunities to make organizations themselves more effective.

We must resist the kind of apolitical "innovation determinism" that sees the creation of the next app, online service, or networked device as the best way to move society forward. Instead we should push ourselves to think creatively of ways to change the structure of our organizations, political processes, and societies for the better and how new technologies might contribute to such efforts. Thinking in terms of sociotechnical systems – or even ecosystems – would also help us do a better job of keeping humans in the loop. When we think of algorithmic regulation, we have a tendency to envision sluggish human processes being replaced with the faster, more efficient, and more analytically robust machines. The attention, therefore, goes to the machines. Yet machines are often poor regulators, especially in complicated situations (Leonard, 2014).

While discussions of Project Cybersyn may have often reduced the project to its technological components, at bottom the project was about how to change the structure of Chilean economic management. It was about the social, organizational, political, and the technological. It was about understanding the phenomenon of economic management as a system. As Cybersyn's designers soon learned, the technological aspects of the problem were often the easiest to address.

Conclusion

Project Cybersyn was far from perfect. At the time it was built, critics called the system overly technocratic (Hanlon, 1973), unrealistic (Grosch, 1973), and overcentralizing (Adams, 1973). Nearly a decade later, Ulrich (1981) argued that the system limited the idea of worker participation, benefitted the state more than the workers, and equated "important information" to what computers could identify. In my own historical research (Medina, 2011), I have shown that the design of the system reinforced forms of gender bias, was divorced from many of Chile's political challenges, and may have disempowered workers in the long term by coding their knowledge into the system's software. There are lessons to be learned from the limitations of the system that are highly relevant to the critical assessment of today's data-driven information systems.

At the same time, it is important to think constructively as well as critically. This entails asking what positive things we might learn from historical examples, such as Project Cybersyn, and how they might help us improve future technologies. For that reason, I have chosen to reflect on how the Cybersyn case might help us build better algorithmic regulators. I will leave a more critical analysis for subsequent work.

Our immediate future will surely bring more forms of data collection, data generation, and algorithmic governance. Project Cybersyn suggests alternative forms that data collection and algorithmic governance might take. It is a thought experiment as well as a historical example.

In this paper I presented five considerations that should receive greater attention in these discussions:

1. the state matters if we want to create technologies that benefit the wider citizenry;
2. more thought should be given to data economy and how we might extend the life of older technologies;
3. privacy protection must be a focus of technological design if we want to build systems that protect human freedom – the lack of privacy protection in our current systems is a choice;
4. we need to develop mechanisms not only for greater algorithmic transparency but also for democratic control; and

5. we should move away from a technology-centered idea of social change and instead think in terms of sociotechnical systems.

These considerations are important because technological infrastructure is unique. Simply put, it endures. As historians of technology say, it has momentum (Hughes, 1994). And this should make us deeply concerned about the form our increasingly data-driven world will take.

The good news is that we have another infrastructure: law. This infrastructure has developed over time and through the democratic process. I will conclude by proposing that instead of trying to make law behave more like an algorithm, as O'Reilly (2013) has suggested, perhaps we should be theorizing ways to make our algorithms function more like law. This means we would need to not only think of algorithms as regulators but also pay attention to the process of their development and adoption. We also need to develop organizational infrastructures that can oversee and ensure that data collection, and data use, do not infringe upon civil rights and civil liberties.

Cybernetic scholarship – in particular certain areas such as those associated with Stafford Beer – has been centrally concerned with how to make regulators more democratic. This essay, I hope, is a provocation to continue this line of research, not only to correct interpretations that view cybernetics as simplistically advocating for data-driven control but also to bring these cybernetic and political insights into discussions of big data, the Internet of Things, and algorithmic regulation and, ultimately, improve their functionality.

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Notes

1. Norbert Wiener made a similar observation in the Human Use of Human Beings (1954). He projected that computers would usher in a second industrial revolution and lead to the creation of an automatic factory.

2. StEP is a project of the United Nations University, which is the academic arm of the UN; it is located in Bonn.

3. Although as Ulrich (1981) notes the system, not the factory, determined what constituted an actionable emergency and at what point the government should intervene. Beer wanted the workers to play an active role in setting the values for when the system emitted alert signals. However, my research has shown that engineers and operations research scientists almost exclusively set these values in practice. On the flip side, since the system only collected ten to 12 production indices, it would make very few factory activities visible to the government.

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