Political Applications of Systems Theory in the Twentieth Century:
From Cybernetic Control to Spontaneous Emergence

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ABSTRACT

This dissertation is a realist intellectual history of systems theory in the second half of the twentieth century. Systems theory can be defined as the study of the informatic patterns that are found within a variety of complex phenomena, both natural and social. The science behind systems theory emerged from wartime engineering projects, and was promoted by major philanthropic organizations such as the Rockefeller Foundation. Theoretical concepts from the nascent systems sciences, including the subfields of information science, cybernetics, and systems biology, migrated into social science fields including political theory and economics. The social applications of systems theory were heavily promoted by major figures within both America's counterculture, and America's neoliberal revolution. Systems theory injected strong elements of political thinking and political reasoning into natural and social scientific fields alike. The integration of systems theory into natural science fields such as biology was paired with an expanded understanding of the purposes of science. These purposes ranged from the attempt to capture sophisticated, systemic mechanisms of control within life processes, to the attempt to describe the spontaneous, creative, and free self-organization within living systems. Likewise, in economics and the social sciences, systems theory provided an apt conceptual terminology to imagine human society as either an intricately interwoven system of control and coercion, or as a spontaneously organizing source of human freedom. Systems approaches to economics rejected simplistic descriptions of human motivation and behavior, and emphasized the importance of collective processes that do not follow central direction. While Friedrich Hayek is the most well-known economist to utilize systems theory, other less known figures such as Kevin Kelly and George Gilder played a major role in the development of systems based, informatic approaches to social and economic thought. Hayek is often blamed for the development of speculative, systems approaches to economics that minimize the importance of material reality. Contradicting this consensus, I argue that Kelly and Gilder are better exemplars of this speculative rejection of materiality. I also challenge the dominant consensus within political theory scholarship that argues that systems theory can only be understood as a tool and modality of control. Instead, I show that freedom and control co-exist ambiguously in systems theory discourses, and that the lasting appeal and uptake of systems theory within American culture must be interpreted in this light.

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GENERAL AUDIENCE ABSTRACT

Systems theory describes a body of research that sought to represent the world through the language of the system. Systems theory was applied to diverse contexts, including engineering, biology, psychology, social science, and economics. Systems theorists believed that self-organizing forces could be found in many complex systems, both natural and man-made. Systems theory was a method by which the complexity of these processes could be described and understood. Specifically, systems theory relied on the concept of information. Information was the basic component from which any system was built. For systems theorists, however, information was not simply a unit or isolated measurement. Rather, information could also refer to a pattern or the characteristics of a process. Thus, systems theory was about being able to capture and describe repetitive processes found in the world. Systems theorists were interested in understanding how both natural and social processes could self-regulate themselves, maintain their basic integrity, and change over time. Thus, the emergence of order without centralized direction was a central preoccupation of systems theorists. In this dissertation, I argue that systems theory was more than a scientific theory; it was also a form of political reasoning. At times, systems theory was a way to conceptualize forms of systemic control, coercion, and homogenization. At other times, systems theory became a way to conceptualize how participation in spontaneous processes could support diversity and freedom. I show that systems theorists were divided between such portrayals of control and freedom. Furthermore, control and freedom often coexisted in the language, behavior, and political claims of systems theorists.

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Introduction

Systems theory is often remembered as a momentary fixation of America's mid-century, Cold War era scientific establishment. Historians of information technology typically recount the rise of systems theory through reference to a series of recognizable events: the interdisciplinary Macy Conferences, the publication of Norbert Wiener's surprisingly popular books on cybernetics, and the dissemination of Stewart Brand's eccentric odes to systems theory in the *Whole Earth Catalog*, a sprawling and experimental text which reached a surprisingly broad audience. It is indisputable that the concepts and cultural imaginaries associated with systems theory were, at one point in time, ubiquitous and powerfully influential within a particular vein of America's scientific, cultural, and intellectual life. Nonetheless, existing scholarship, especially in the field of political theory, has not acknowledged the comprehensive importance and lasting impact of systems theory on American political thought.

Existing research on systems theory tends to offer either a historical account of specific scientific discoveries, research collaborations, and scientific funding decisions, or a more theoretical account of how specific political ideologies have been bolstered by systems theory. Much of this research is excellent and thorough, but systems theory itself is often portrayed as peripheral to other arguments about scientific ethics or modalities of political power. My dissertation contributes to the existing scholarly conversation in the fields of political theory and history of science by flipping the emphasis: I take systems theory as a worthy object of study on its own. Rather than mapping systems theory's influence on a specific cross-section of American scientific, political, or cultural life, I center the rise of systems theory itself, describing its broad influence across an array of institutions, disciplines, and cultural moments.

The goal of this more comprehensive account, spanning historical, cultural, political, and scientific discourses, is not simply to make the point that systems theory created a broadly popular and widely applicable framework for the analysis of complex phenomena. Certainly, it is not surprising to discover that an idea as broad and adaptable as the systems concept could be applied to both natural and social sciences, as well as popular culture. Further, it is certain that twentieth century observers were not the first to conceptualize the existence of systems with interacting components and emergent properties. What was significant about the uptake of systems theory in the mid to late twentieth century period is the way that the systems concept was attached to consistently grandiose pronouncements about interdisciplinary scientific collaborations, the invention of new forms of human culture, breakthrough technological developments, and rapid changes to economic and political structures. While specific points of emphasis differed, commentators writing within this time consistently emphasized that humanity was on the verge of a series of rapid changes that would far eclipse the speed of major transitions during any other period in thousands of years of human history.

This optimism was not entirely ill-founded. Systems theory and the related field of information technology provided powerful new techniques, technologies, and conceptual frameworks that were used to imagine new ways to act, intervene, design, and implement both social and scientific aims. Certainly, the invention and dissemination of the technology of the modern computer was a significant milestone in the effort to achieve various outcomes by way of the processing of information. However, by focusing on the systems concept itself, I draw the focus of my analysis to a political and cultural ferment within which information and data came to have a far more expansive meaning than simply computing.

For the purposes of this dissertation, I am defining systems theory as a conjoined scientific and cultural phenomenon. Systems theory emerged as a primarily scientific and mathematical methodology that allowed scientists to interpret reality through systems models. These models were frequently, although not always, based on statistical probability. The anticipation of systemic probabilities was particularly useful for the engineering applications of systems theory, whether in military or computing contexts. Systems theory was also inextricably linked with the concept of information. A commonly held empirical view among systems theorists was the claim that the complex, dynamic matter comprising the fabric of reality was inherently informatic. The writings of many of the systems theorists considered in this dissertation heavily imply that the informatic nature of reality is an ontological characteristic, preexisting human observation.

The implications of such ontological positions vary according to how information itself is defined. In contrast to common language definitions of information as an isolated measurement, unit, or bit, representing a specific moment in time and place, information within systems theory discourse has a much richer meaning. Specifically, information often refers to a pattern, a distribution, or a logic of systemic coherence. Further, systems theorists use information as a tool to capture complex, dynamic, continuously unfolding processes. The characterization of information as a pattern or process was conveyed by systems theorists through mathematical language. It is not insignificant that the two major founding figures of systems theory, Norbert Wiener and Claude Shannon, were both mathematicians. However, many of those who later appropriated systems theory for various cultural, political, and even scientific applications were not versed in the particularities of the mathematical equations representing information that had been crafted by Wiener and Shannon. In fact, even among the scientifically trained biologists who wished to apply systems theory to their field, most were not able to follow the mathematical intricacies of the founding texts of cybernetics.

Despite the loss of mathematical precision as systems theory and cybernetics travelled into various applied fields, one central mathematical concept was retained through this process of translation: the concept of entropy. Specifically, Norbert Wiener and Claude Shannon both independently discovered that information could be represented by the mathematical equation for entropy, or the tendency of the universe to move towards disorder. For Wiener, information was negative entropy—the movement away from disorder. For Shannon, information could be represented as positive entropy—the tendency towards disorder. This disagreement about positive and negative signs did not appear to trouble Wiener and Shannon, and the disagreement never became the subject of sustained inquiry. Rather, the discovery that information and entropy were mathematically linked was the relevant finding that quickly drew attention from scientists and nonscientists alike.

Nonetheless, the systems theory tradition in American science and culture can be generally divided into two camps: those who drew inspiration and ideas from Norbert Wiener, and those drew upon the writings of Claude Shannon. In general, those who followed Shannon tended to focus on the communication of messages through channels, while those who were followers of Wiener tended to produce more generalist applications of systems theory that emphasized spontaneous organizational processes in a variety of contexts. However, other schools of systems theory did emerge, which will be relevant to the historical narrative of this dissertation. For instance, while economist Friedrich Hayek was familiar with the writings of Norbert Wiener, the original source of his interest in systems theory appears more likely to be the general system theory of German biologist Ludwig von Bertalanffy. In the American context, second order systems theory can also be considered a distinct tradition, although it emerged out of the earlier version of cybernetics that had been popularized by Wiener. Heinz von Foerster is often credited for the creation of second order systems theory, which sought to integrate the abstract representation of a system with the context of the environment of that system, as well as the context of observation of the system. According to second order systems theorists, Norbert Wiener's first order systems theory tradition failed to take these attributes of systems into consideration.

Rather than presenting these disparate traditions as a means towards the development of a unified representation of the systems theory tradition, my aim is rather to track the mutability of the systems concept, as well as the mutability of the concept of information. Thus, my working definition of systems theory throughout the dissertation is quite broad. Systems theory, in my view, should be understood as an approach to the study of reality that seeks to represent and understand the informatic components of a complex, systemic process. That process could include chemical systems, biological systems, psychological systems, social systems, or economic systems. The key unifying point is that systems theorists were interested in representations of information; for this reason, I will sometimes use systems theory and information theory interchangeably. However, just as the system that was being represented was quite variable, depending on whether the subject matter was social, biological, physical, or psychological, and whether the systems theorist was using first or second order systems theory, representations of information differed quite widely.

Based upon uses of the term in common parlance, it is often assumed that information refers to an abstract quantity or measurement, removed from context. For systems theorists, however, the pursuit of abstract information was not always the goal. Just as I will trace changing representations of the concept of a system, my dissertation will also trace changing representations of the concept of information. I will discuss how some biologists sought to represent the genetic components of the cell as messengers of abstract information, similar to a code, that preexisted human observation. However, other biologists represented information gathering as a more immanent and contingent choice to observe certain aspects of complex living phenomena, rather than others. For this second group of biologists, the context of observation mattered, and could fundamentally change the informatic depiction of a complex process. In the realm of social theory and economics, information also took on multiple meanings. For economist Friedrich Hayek, the informatic units of the pricing mechanism of the market had strong subjective components, due to the dependence of the market on human preferences. Thus, information relevant for the complex system of the market was not fully rooted in any particular material process. At the same time, it was not fully abstractable either: Hayek strongly resisted taking information out of the context in which it was created.

Other economists inspired by the systems theory tradition, such as George Gilder, leaned towards a more abstract representation of information.

My aim in this dissertation, however, is not simply to trace shifting signifiers and terms for the sake of historical interest. Rather, one of my central aims throughout the dissertation is to show that the tradition of systems theory contributed to the formation of political ideologies. More specifically, systems theory, in the mind of its adherents, had ontological effects: the world, under the terms of systems theory, was transformed into a field of emergent, informatic complexity. The claims of systems theorists frequently traversed beyond epistemology into such ontological terrain. Methodologically, my examination of how individuals and communities ontologically construct the experience of the "world" that they inhabit has been inspired by political theorist Laura Ephraim.

Laura Ephraim's (2017) book, *Who Speaks for Nature?*, explores the issue of world building in a way that I have found particularly helpful for my analysis. Ephraim centers her analysis on the construction of scientific authority. Ephraim argues that the social status and trust that are imparted to scientists and scientific institutions cannot be explained simply by epistemology. That is, while the empirical testing that occurs through the framework of the scientific method can explain why scientists achieve meaningful and reliable results, it cannot fully explain why the public values science and scientists. Instead of relying on an epistemological explanation of science's authority, Ephraim emphasizes the importance of ontology, arguing that:

> "natural scientists owe their prevalent role as spokespersons for nature to what I will call the politics of world-building. By "world-building politics," I mean the embodied practices through which scientists and citizens struggle with and against

> each other to engage the material reality of their environments and bodies and compose a common world from these heterogeneous elements. World-building practices instantiate relations of proximity, affinity, resemblance, or repulsion among disparate human and nonhuman beings, excluding some from the assemblages that secure the power, prestige, and visibility of others." (Ephraim, 2017, p. 4)

Thus, according to Ephraim, the work that scientists do has a far more significant function than simply informing the public. Instead, scientists are also involved in a process of actively negotiating how people experience the world.

Ephraim's observations deeply inform my assessment of the impact of cybernetic and systems sciences on society. Many systems scientists actively participated in and shaped conversations in popular culture and even politics. Further, the intense cultural popularity of systems theorists such as Norbert Wiener is difficult to explain if Wiener's contributions are understood as purely technical, mathematic, or scientific. Instead, I would argue that Wiener offered his readers a glimpse of a different world. Ephraim's theory of world building provides a language to explain why systems scientists and other academics who became proponents of systems thinking were able to draw such an enthusiastic response from the public. What they offered was a glimpse into a new world of futurity in which information flowed freely, resources could be manipulated, and human possibility could be unleashed. Furthermore, my approach aligns with Ephraim's observation that this world building is always political, and gives rise to political effects.

Thus, science is political because of the work that it does in contributing to how not just scientists, but also ordinary people and nonscientists, experience the real world.

Ephraim's claim goes far beyond the assertion that science is a political enterprise, or that scientists impact the actions and beliefs of lawmakers. Rather, Ephraim claims that scientists contribute towards the stabilization of a shared reality through which political claims and assertions are articulated. This argument is not meant to dismiss or minimize the specificity of the empirical processes behind the practice of science; rather, Ephraim argues that science has secondary, ontological effects beyond its empirical components that are not always sufficiently appreciated. My dissertation will build upon Ephraim's work by examining, in particular, how the twentieth century sciences of biology and economics had political effects that have not yet been sufficiently appreciated. Biological science is rarely appreciated as the site of formation of political ideologies, and I will claim that these political effects can in fact be found in discourses surrounding biological systems theory.

In contemporary language, the claim that I am making about the broad cultural and political effects of science is frequently described as a "paradigm shift." The concept of the paradigm shift, often traced to Thomas Kuhn's 1962 work *Structure of Scientific Revolutions*, originally was used to describe transformations in scientific practice. In the writings of systems theorists, the concept of a paradigm shift appears frequently, both with and without direct references to Kuhn. What systems theorists mean by this reference, however, extends beyond science itself. Instead, most systems theorists made claims indicating that they understood science and culture as co-constitutive. Thus, shifts in scientific thinking would lead to shifts in culture, beyond the uptake of any specific scientific concept or finding. One of the most common assertions, made by systems theorists, is the claim that systems theory was the successor to the Newtonian Revolution.

Systems theory, it was argued, was the set of tools by which humanity would finally overcome the linear, outdated Enlightenment era conceptions of reason, reality, action, and organization.

A similar observation has been made by theorist Sylvia Wynter (1984, 2003), whose writings about historical paradigm shifts have been influential in the field of political theory. Wynter discusses how shifts in scientific thinking are connected to shifts in culture, specifically the formation of genres of subjectivity. Wynter argues that each historical age has a characteristic genre of the human. Each genre of the human is linked to an ontological, or even cosmological, portrayal of the nature of reality more broadly. Much of Wynter's discussion focuses on the shift from religious to secular ways of thought in the context of medieval Europe. Wynter argues that the birth of the secular, rational mode of interpreting the world came into being through a historically specific negotiation with pre-existing religious worldviews. Wynter argues that religious worldviews were not simply relinquished; rather, the structure of the belief remained, while being replaced with the content of secularism. Thus, the enlightenment instituted a genre of the rational, secular human. Next, Wynter argues, the industrial revolution gave rise to a new genre of the human, defined in biological terms.

Wynter argues that every paradigm shift in human history has been driven by a desire to institute order and avoid chaos. Medieval religious systems located heavenly order in the stars, and saw unruly chaos in the earthly realm. The rational secular mentality that replaced medieval religious sensibilities similarly sought to divide the sensible realm into a chaos/order binary. The secular, rational view was built upon the belief that the world could be interpreted and known through human reason. Wynter argues that all science functions this way: it creates and reinforces the concept of order, as a tool to overcome the inherent chaos of nature. Wynter claims that each scientific paradigm has a different emphasis: rationality for the enlightenment, energy for the industrial revolution, and, finally, information for the new age of systems theory. As Wynter argues, human cognition inherently seeks these basic paradigms in order to stabilize the world. These cognitive processes, which have culturally specific associations, have the ability to mutate and change over time, but while they are ascendent they produce the appearance of a stable external world. These cognitive apparatuses have such a compelling effect that "their constitution of world is as real to us as is physical reality" (Wynter, 1984, p. 50). It is this stabilization effect that my analysis of systems theory throughout the dissertation seeks to capture.

Thus, the purpose of this dissertation is to show how the systems concept spurred fundamental transformations in belief systems, phenomenological experiences, and political ideologies in American culture. These transformations encompassed shifts in perception that went beyond the simple uptake of new ideas. Specifically, the order/chaos binary which Wynter mentions as central to human perception occurs again and again in systems theory discourses, despite the ambiguity about whether information should be understood as order or chaos, and the ambiguity about how exactly order should be defined. As discussed, the association of information with the order/chaos distinction can be linked to two figures: Norbert Wiener and Claude Shannon. Norbert Wiener described information as a pattern that could be analyzed through statistics, while Claude Shannon described information as the amount of uncertainty in a communicational system. Both Wiener and Shannon agreed that information could be represented by the mathematical equation for entropy, though they disagreed about whether information was best described as positive or negative entropy. Shannon, whose research was based on electrical engineering, viewed information as the disordered noise that occurs when a message travels through a communication system, and thus favored defining information as positive entropy. Wiener, on the other hand, whose writings emphasized themes such as control and communication within systems, chose to depict information as negative entropy—the reduction of disorder.

The implications of Wiener and Shannon's decision to link information and entropy were not simply scientific. Defining information through the language of entropy, a foundational concept within science, helped to bolster the legitimacy of the new field of cybernetics, Wiener's term for systems theory (Kline, 2015). It also helped to fuel speculation about the transformative possibilities of the new information technologies, which enabled increasingly sophisticated ways to design and control feedback mechanisms. The discovery of machines which could process vast amounts of information was presented as a breakthrough, equivalent to the discovery of industrial age machines that could transmit energy. Many observers, including Wiener himself, argued that society was thus hurtling towards rapid technological and political change, driven by scientific developments in the study of complex systems (Wiener, 1961). Just as the discovery of technology to generate and channel energy had birthed the age of the steam engine and the first industrial revolution, many believed that the discovery of techniques to manipulate, channel, and control information would lead to equally rapid and comprehensive economic, political, and social change heralding a second industrial revolution.

Further, if information was negative entropy, a claim which Wiener popularized, the implication was that information was the opposite of disorder. Thus, designing technological and social systems through the manipulation of information was to align with an almost cosmic principle of order. Information was portrayed by many technologists as a generative force which, though neither fully material nor energetic, could nonetheless drive, direct, and shape processes in the physical and social realms. The concept of spontaneous order, which referred to patterned changes that occur without centralized direction, became the basis for many of the political and economic applications of systems theory. Proponents of the concept believed that a society that was designed and managed through the systems concept would have drastically better resource management, more efficient and dynamic decision-making, and greater adaptability and resilience.

Many political theorists and historians of science have described and catalogued the utopian pronouncements of systems theorists. Excellent existing scholarship has described many of the various social movements and scientific enterprises that were spawned from the new systems sciences. However, existing research on this topic often stays within a narrow scope, either approaching the rise of systems science and cybernetics as a temporary if widespread fixation of the Cold War scientific establishment, or as the guiding premise of pathways within which specific political ideologies fermented. The second trend, scholarship on political ideologies inspired by systems theory, generally takes one of two forms: an analysis of the self-described 1960s counterculture, or an analysis of the so-called neoliberal revolution. Generally, such arguments tend to focus on either the counterculture or neoliberalism, and do not consider the two topics side by side. While such scholarly approaches have made important contributions to our understanding of specific aspects of systems discourses, this dissertation attempts a more integrated analysis that highlights crossovers between academic disciplines, political ideologies, and seemingly unrelated cultural trends.

Because the existing literature tends to focus on either the counterculture or neoliberalism in isolation, conceptual and historical crossovers between seemingly disparate conversations are often ignored, and the nature of political claims that emerged through engagement with systems theory are often oversimplified. On the one hand, the counterculture, associated with ecology, futuristic technological speculation, egalitarian language, and radical pronouncements about rapid social change, is generally portrayed by contemporary scholars as a movement with perhaps naïve or unrealistic hopes, but also compelling and even prophetic insights about how to build a society based on principles of freedom. Through engagement with diverse sources, I will show that the 1960s American counterculture was more complex than such portrayals indicate. The ubiquitous language of egalitarianism, liberty, sustainability, and justice within the movement was not always reflected in the concrete organizational, political, and philosophical commitments of countercultural figures.

My dissertation will also challenge what I will argue are overly simplistic portrayals of the impact of the systems sciences on the neoliberal revolution. The existing scholarly literature on how systems theory has influenced neoliberalism is quite significant, and has had a far greater influence on the field of political theory than the scholarship that discusses systems theory in the counterculture. Perhaps one of the reasons for the proliferation of writing on the topic of the so-called neoliberal revolution is that political theorists have struggled to explain the rise of a political movement that many have argued was primarily beneficial to owners of capital, and harmful to workers. In this vein of scholarship, systems theory provides a convenient explanation of why so many people became enamored with spontaneous organizing forces. Capitalism was envisioned by defenders of free markets as a creative, information processing system through which mysterious organizing forces flowed, bringing striking new innovations to persistent social problems.

There is clear historical evidence that systems theory influenced economists who contributed to the intellectual foundations of the neoliberal revolution, the most notable of whom is Friedrich Hayek. Systems theory also provided theoretical scaffolding for the concept of resilience, which was promoted heavily by the Stockholm Resilience Centre and countless international development agencies. Political theorists have argued that resilience was captured by the neoliberal, Hayekian dictates of self-reliance through adversity, thus naturalizing conditions of political inequality and severe environmental disruption as normal market perturbations (Walker and Cooper, 2011; Watts, 2014). I will show that many of these critiques oversimplify the specific arguments made by Hayek. By drawing attention to elements of Hayek's work that are often missed in the scholarly literature, I show that the trajectory towards increasingly speculative political proclamations that unfolded in twentieth century economic history was not inevitable. Hayek's philosophy of political decentralization could have been applied to political projects with more grounded ecological and social aims. I will argue that the most problematic applications of the concept of spontaneous order to problems in economics stem not from Hayek himself, but from later figures who sought to use systems theory and an ethos of spontaneity to imagine magical or even miraculous solutions to complex social problems.

This dissertation will analyze these different economic claims, and how these claims reflected the influences of cybernetics, systems thinking, and information technology. I will show that while many theories of economic decentralization led to a failure to acknowledge basic material conditions such as political injustice or environmental resource limits, it was not inevitable that these theories would have this outcome. Furthermore, I draw attention to often neglected counter-majoritarian arguments from the systems theory counterculture, including arguments that economic decentralization and political equality were in fact compatible. For example, many countercultural economic theorists argued that decentralization was in fact necessary for true environmental sustainability and political equality (Bookchin, 1982; Schumacher, 1975).

Organization of Chapters

This dissertation will unfold in the form of four chapters, which will support my main thesis argument. I will argue that systems theory is a powerful conceptual resource that has, historically, always carried ambiguous associations with both control and freedom when applied to political contexts. This ambiguity, which I will show runs through the so-called systems theory counterculture as well as through the writings of the systems enthusiasts of the neoliberal revolution, has not been adequately captured by the existing scholarship, which tends to focus on either control or freedom in exclusion.

The first chapter introduces the topic of systems theory, discusses relevant scholarly literature, and includes an analytical case study of theorist of information and cybernetic systems, Norbert Wiener. I show how the research activities, writings, and cultural influence of Wiener exemplify the tendency of systems theory to straddle an ambiguous divide between control and freedom, and between domination and equality. I will show that while Wiener's utopian hopes are not completely eclipsed by the shortcomings of his understanding of power, inequality, and political history, these flaws are not easily erased.

The second chapter discusses two interrelated trajectories within twentieth century biological research, and discusses why the utopian hopes of countercultural systems theorists were never fully realized. The first trajectory I trace is the development of the field of molecular biology. Molecular biology rose to prominence starting in the 1930s through funding from the Rockefeller Foundation. The field sought to represent life as reducible to isolated cellular mechanisms that could be reproduced in laboratories and manipulated by technology. Molecular biology, which developed closely in tandem with systems theory and cybernetic research, promoted a view that life could be described as a form of code, and the field's technical aspirations became attached to technocratic, reformist programs of social uplift through rational expertise. Many contemporary scholars have described these research programs as sophisticated attempts to build systems of control (Geoghegan, 2023). However, even within molecular biology, the goals of control shifted as scientists began envisioning alternative narratives about the social significance of science.

Additionally, a group of systems biologists, notably Humberto Maturana, Francisco Varela, James Lovelock, and Lynn Margulis, sought to use cybernetics, systems theory, and informational language to craft a methodological and normative framework for the field of biology that was strikingly different from values of the early field. They believed that their attempts to represent life informationally avoided the reductive, technocratic, and overly simplistic approaches to the representation of life that had been developed in molecular biology. Instead, they sought to emphasize the context of observation, the interrelatedness of levels of organization, and even a more normative orientation toward ecological goals. This second trajectory failed to achieve widespread implementation, but it did have a lasting influence as a minoritarian tradition of ecological theory, and deeply affected the pronouncements of various individuals and communities in the self-described counterculture.

This second trajectory had a marked impact on the American counterculture because it provided a language to reimagine the role of the individual as a participant in ecological processes. I discuss how systems biology, ecology, and cybernetic thought influenced major countercultural figures, notably William Irwin Thompson and Stewart Brand. I then discuss how despite the intention of these thinkers to overcome the military, philanthropic, and bureaucratic associations of early research on cybernetics and systems theory, their attempt to rebrand systems theory as a route to authentic freedom and cultural innovation was never fully successful. I will show that the historical and philosophical shortsightedness of these figures partially explains why the utopian hopes of the systems theory counterculture were never fully realized.

The third chapter, which turns towards the theorist of free markets Friedrich Hayek, shows that Hayek's claims about the ontological nature of systems and the complexity of psychological perception are in fact strikingly similar to claims made by the systems biologists discussed in chapter two, complicating dominant scholarly portrayals of Hayek. I also discuss how exposure to systems theories and cybernetics influenced Hayek's theory of spontaneous order and evolutionary change within societies. I argue that these conceptual crossovers complicate dominant portrayals of Hayek in the political theory literature, which has often over-simplified Hayek's claims, or portrayed his theories of economic decentralization as applicable only to the further entrenchment of political inequality and the domination of nature.

The fourth chapter is a discussion of techno-utopian claims in the late 20th century. I discuss speculative claims about information theory and autonomous systems that were made by Kevin Kelly, the first editor of *Wired* magazine, and George Gilder, an economist who had broad cultural and political influence. Kelly argued that the machines that were being created through the information revolution operated through lifelike principles, and that the creative capacity of such machines could solve almost all resource scarcity problems. Figures such as Kelly and Gilder drew upon currents in systems theory and the budding information revolution to argue that technology and social design could be mobilized to create self-organizing societies which could overcome physical resource limits. I will argue that ultimately, Kelly and Gilder's claims about the power of information and the mutability of ecological limits were far more radical than those of Hayek. I will show how free market economic theory changed over the later decades of the twentieth century, becoming more proclamatory and speculative as the information revolution gained an increasingly influential role in American culture.

The conclusion discusses how such speculative, utopian imaginaries associated with systems theory have held back meaningful political action on behalf of the environment. I will then return to the minoritarian tradition within political theory that has argued that systems theories can in fact be a route towards genuine freedom. I will argue that systems theory does in fact contain powerful resources for imagining how individual and collective human creativity can be channeled towards major political change. Nonetheless, the drawbacks of systems theory, most notably tendencies found in many of these writings to empower excessive speculation, lack of responsibility, or rejection of limits, must be taken seriously if systems theory is to be elevated to the center of discussions about how to build a just and sustainable human future.

<u>Chapter 1: Histories of Cybernetics</u>

Systems Theory Scholarship in History of Science

Existing scholarship on the history of systems theories takes several forms, as I have discussed. One trend within scholarship on systems theory takes a history of science approach, that emphasizes how science is shaped by external political aims including militarism, social engineering, economic enterprise, and utopian values. There are many excellent examples of scholarship on systems theory that are situated in the field of history of science and technology. However, as I will argue, this branch of scholarship often fails to recognize and fully theorize the comprehensive effects of politics on science. I would characterize the work of Ronald Kline, Fred Turner, and Lily Kay within this category of scholarship.

One example of this strand of historical scholarship, *The Cybernetics Moment* by Ronald Kline (2015), is a book length exposition of the history of the information revolution. Kline argues that the now ascendant utopian information narrative associated with the computer revolution is actually a truncated and diminished offshoot of earlier, formative dialogues surrounding the information sciences. The result of this is that

> "The basic analogy of cybernetics—that all organisms use information-feedback paths to adapt to their environment—is reduced to the adjective cyber. The scientific concept of information is reduced to digitized data. In today's discourse, information is no longer a measure of uncertainty in communications, nor is it related to biological, psychological, and physical processes" (Kline, 2015, p. 7).

Thus, according to Kline, the meaning of information has been drastically simplified over time. Throughout the course of the book, Kline explains the original meaning of information within early cybernetics conversations, through a discussion of pivotal figures in the field such as Norbert Wiener and Claude Shannon. Kline shows that these figures made proclamations about how information could be used to reveal, describe, and design complex feedback pathways and communicational systems.

Importantly, it is the currently ascendant, contemporary "utopian" narrative of information that Kline characterizes as trite and unimaginative. The intellectual forays of the early cyberneticians are portrayed by Kline as far more interesting, innovative, and pivotal. In impressive detail, Kline explains the timeline of the intellectual and scientific evolution of Wiener, Shannon, and others. He also describes how these scientific findings were received by the broader society, and how prominent systems theorists navigated the substantial public attention received by their field. While Kline's research has provided an important springboard for many of the investigations within my dissertation, my analysis seeks to add a deeper dimension of political analysis to my historical discussion of these developments.

Another example of the historical genre of systems theory scholarship is Fred Turner's (2006) *From Counterculture to Cyberculture,* which has also provided valuable background on many of the developments that my dissertation considers. However, I would argue that Turner offers a similarly truncated analysis of the broader political forces surrounding the uptake of systems theories. Turner describes the seemingly drastic shifts within American culture that accompanied the rise of systems theory, computing, and information technologies. Turner also discusses the irony of how World

War Two systems theory research, originally funded for military purposes, was appropriated by utopian countercultural figures who, ostensibly, aimed to overcome militarism, domination, and hierarchical power structures. Similarly, the shift from the countercultural focus on spirituality, community, and ecology to the free market ascendance of the so-called neoliberal revolution is often portrayed as a seismic shift. Turner argues, through an often persuasive analysis of key texts and individuals, that these developments are in fact more continuous than they seem. In Turner's telling, the freedom-loving counterculture, right-wing free market proponents, and militarized science have always been part of the same cultural ferment, spurred by shared cultural influences.

Turner rejects the idea that a decisive shift occurred in 1960s American culture with the advent of the counterculture, or that the 1980s neoliberal revolution reflected fundamental changes away from the counterculture. Turner argues that historical narratives that emphasize such dramatic shifts often miss important continuities in the application of the systems theory concept. Instead, Turner (2006) argues, the counterculture's emphasis on a shift "away from agonistic politics and toward technology, consciousness, and entrepreneurship" was part of the same set of cultural forces that spurred the rise of free market ideologies (p. 8). Ideas moved freely between these contexts, according to Turner, because these contexts were different variations of the same basic cultural agglomeration. Similarly, the counterculture was less of a decisive shift from the postwar research projects and cultural ferment of the 1950s, but rather a direct outgrowth of them. What has happened during these shifts, Turner argues, is simply the emergence of new variations of relatively stable cultural values and imaginaries.

I find Turner's analysis helpful because it exemplifies how to discuss cultural change without false separating various political and cultural movements, or reducing them to stereotyped representation. I try to maintain this appreciation for complexity and the relationships between political movements in my analysis. However, Turner's discussion of politics is often restricted to narration of the actions of specific figures and the networks they participated in, while the broader political impact of their work on ideological formation in American politics is often under-theorized. Furthermore, Turner's emphasis on lines of continuity between political movements, while often helpful, can also risk erasure of the importance of major turns and shifts in American political thought.

The final scholar I will discuss who exemplifies the historical approach to documenting the rise of systems theories is Lily Kay. Kay's (1993) book *The Molecular Vision of Life*, documents the rise of molecular biology, and discusses the centrality of institutions such as the Rockefeller Foundation and Caltech to the development of this field of science. Her second book, *Who Wrote the Book of Life? A History of the Genetic Code* (Kay, 2000), is a more explicit discussion of the influence of systems theory and theories of information on the field of biology. Both texts have provided useful and important background knowledge for my investigation, but due to the historical framing of the narration, Kay's analysis does not include a sustained investigation of how political forces shaped these developments. This dissertation aims to build existing on historical work by Kline, Turner, and Kay, by adding the dimension of political analysis.

Systems Theory Scholarship in Political Theory

In addition to the scholarly literature that I would classify as located within the history of science, there is a body of scholarship has taken seriously the impact of systems theory on American political thought. Most of this scholarship is deeply critical of the influence of systems theory on politics, and often blames systems theory for the rise of neoliberalism. However, there are a few limited examples of scholarship which celebrates the impact of systems theory on political thought. Perhaps the most prominent example of this is *Gaian Systems: Lynn Margulis, Neocybernetics, and the End of the Anthropocene* by Bruce Clarke (2020). Clark's book discusses the rise of Gaia theory, which describes the planet itself as self-organizing, homeostatic, and organismic in behavior without being exactly an organism. Clark discusses major figures in the rise of Gaia theory, notably earth systems scientist James Lovelock and theorist of biological symbiosis Lynn Margulis. However, unlike the scholars who I have characterized as historians of science, Clarke discusses Margulis and Lovelock as political thinkers outright, whose concerns interfaced with politics intrinsically, rather than incidentally. Clarke discusses how the theory of Gaia was not simply a scientific hypothesis, although Margulis and Lovelock made sustained efforts to publish their work and establish a reputable status for their research. Rather, Gaian thought also became a comprehensive approach to thinking ecologically and acting politically. Further, as Clarke discusses, this approach was understood by its proponents as political.

Clarke's body of scholarship, which includes sustained a sustained investigation of the development of second-order systems theory in ecological and countercultural circles, does consistently emphasize the comprehensive political and cultural impact of systems theory (Clarke & Hansen, 2009; Clarke, 2014, 2020). According to Clarke, second-order systems theory, which highlights ecological relationships and processes of observation, was a departure from earlier attempts to use systems theory as a form of control. Clarke associates this variation of systems theory with egalitarian thinking, ecological sensibilities, and a general receptivity towards recognizing the imbrication of the human and the environment.

While examples of political theory scholarship that celebrate the egalitarian and ecological effects of systems theory are limited, the work of Ilya Prigogine and Isabelle Stengers (1984) is another important example. Prigogine was a theoretical chemist who won a Nobel Prize for his work on the spontaneous emergence of order in chemical reactions, specifically dissipative structures. Stengers, also trained as a chemist, later became well known as a philosopher. In their co-authored book, Stengers and Prigogine (1984) discuss the philosophical implications of the science of spontaneous reactions. They argue that the older Newtonian paradigm of reversible, mechanistic change had been replaced by a new scientific paradigm as scientists gained tools to better understand irreversible, nonlinear, and far-from-equilibrium reactions. Stengers and Prigogine claimed that the complexity sciences of the late twentieth century could lead to a politics of reenchantment, based on appreciation for nature's complexity, that would resist tendencies to take the earth's resources for granted. Stengers went on to write several books about how systems theory and various complexity sciences could add beneficial dimensions to the practice of politics. Stengers (2010, 2011a) coined the term cosmopolitics, a reference to the relevance of cosmological questions to the realm of politics. Rather than turning to science to find certainty, Stengers (2010) explains how "scientific practices...have never had any role other than that of creating possibles" (p. 12). The "possibles" introduced by the complexity sciences are not simply a discovery of a fixed truth, but rather are created by the contingent choices of scientists. These choices can shape the perception of the world, and thus have significant political effects.

One of the most important concrete applications of Stengers' theories is her discussion of Gaia theory, which posits the existence of a self-organizing planet. Stengers points out that the idea of Gaia's independence challenges the myth of human autonomy in ways that are sometimes unsettling. Stengers stresses humanity's deep dependence on Gaia's patience and stability. Stengers compares the idea of Gaia to Alfred North Whitehead's process philosophy, noting that it is the act of seeing processes as ontologically primary that leads to the rejection of the idea of a transcendent individual who can be separated from the environment. This view has implications both for ecological thought and for political thought more broadly. In her book *In Catastrophic Times: Resisting the Coming Barbarism*, Stengers (2015) argues that this should lead to a deep ethical humility, along with the recognition that

> "That on which we depend, and which has so often been defined as the 'given,' the globally stable context of our histories and our calculations, is the product of a history of co-evolution, the first artisans and real, continuing authors of which were the innumerable populations of microorganisms" (p. 44).

Stengers' imaginative discussion of how scientific findings about self-organization in nature could lead to greater humility and ecological awareness echoes comments made by Clarke. Both Stengers and Clarke are sensitive to the possibility that scientific findings about complex, self-organizing systems could lead to real changes in political values. Whereas the historians of science I have discussed, including Turner, Kline, and Kay, include anecdotes about how the systems sciences were applied to social issues, what Stengers and Clarke point towards is a more comprehensively political claim. Stengers and Clarke show that the conceptual frameworks of the systems sciences, when taken seriously, open a door towards a decisive shift in thinking, giving new political ideologies the potential to form. While other scholars such as Kay make important observations about how the informational metaphor gave rise to shifts in perception, Clarke and Stengers show how these shifts have been formative of new approaches to politics, aligned with ecological and egalitarian goals.

As I have discussed, however, the positive portrayal of the political impact of systems theory in the work of scholars such as Clarke and Stengers is a small minoritarian trend within political theory scholarship. By far, most recent scholarship on the political impact of systems theory has been deeply critical, and has often even blamed systems theory for the spread of neoliberal governance. While the arguments of these contemporary theorists about lines of influence between systems theory and politics contain elements of truth, my argument throughout this dissertation is that the political impact of systems theory should be understood as more ambiguous and shifting than is depicted in these dominant narratives about the ascendance of neoliberalism.

As an example of this strain of scholarship, Jairus Grove's 2019 book *Savage Ecology* discusses cybernetics alongside his theoretical account of the connection between ecological destruction and militarism. Grove argues that contrary to common portrayals of militarism and environmentalism as contrary, opposing forces, both are in fact modes of deeply interlinked governance. Grove claims that warnings about climate chaos and other impending natural disasters have failed to generate a resounding response from governments because the techniques of governance of modern societies have always been about instituting systems of control that adjudicate matters of life and death, rather than aiming to protect all forms of life. Grove (2019) argues that "Geopolitics, enacted through global war, is itself a form of life that pursues a savage ecology, radically antagonistic to survival as a collective rather than discriminatory goal." (p. 4).

Grove's characterization of geopolitics as a form of life emphasizes that the status quo of governance is rooted in a deep, persistent logic that undergirds more superficial individual policy choices. Grove positions cybernetics as one of the main techniques that exemplifies the homogenizing control systems of contemporary governance. Grove (2019) claims that cybernetics requires "the flattening out and regularization of unruly natures and spaces such that things can be frictionless and useful: everything in its right place, and everything with a name and function" (p. 35). Grove never differentiates between the origins of cybernetics in military research programs, and later applications of cybernetics to various strands of American cultural, political, and economic thought. Instead, Grove implies that cybernetics has never escaped its early military associations, and that it cannot have any effect other than to promote a homogenized ethos of militaristic control.

The association between systems theory and military origins, promoted by scholars such as Grove, is challenged by Bernard Geoghegan's (2023) *Code: From Information Theory to French Theory.* Geoghegan argues that the rise of cybernetics is best explained not by military associations, specifically the influx of World War Two era science funding, but rather by the reformist philanthropic aims of organizations such as the Rockefeller Foundation, which funded research in molecular biology, and the Macy Foundation, which supported the Macy Conferences. Geoghegan agrees with Grove that cybernetics was understood by its proponents as a technique of control, deployed to create conditions of homogeneity and conformity. Additionally, Geoghegan agrees with Grove that the drive to institute homogenization was connected to exclusionary political projects that sought to centralize political power in the hands of a few. However, in contrast to Grove's argument about the logic of global geopolitics, Geoghegan insists that the roots of these projects of control lie in early 20th century progressive reformism.

As has been documented in numerous historical accounts, the aims of the early 20th century Progressive Era were intertwined with biological racism and eugenics. Geoghegan shows convincingly that many of the racial attitudes of this era left problematic traces on cybernetics research. Geoghegan argues that the philanthropic organizations that funded cybernetics research and the related field of molecular biology believed that scientific developments in these fields would yield techniques to aid the control of populations. These projects of social control, according to Geoghegan, were not about instilling genuine equality, but rather about coercing supposedly aberrant citizens, including minorities and the poor, to better conform with mainstream society.

Further, the racial associations of cybernetics research were not always subtext. As Geoghegan discusses, anthropologists Margaret Mead and Gregory Bateson, influential figures in the intellectual history of cybernetics, developed theories about informatic codes that shape human culture through their anthropological studies in Bali. Geoghegan argues that Mead and Bateson presented Bali society as a simpler, proto-society, representing an earlier stage of development through which anthropological observers could ascertain informatic truths about the more complex and developed Western societies. Thus, systems theory often reproduced Eurocentric attitudes. Geoghegan also documents how cybernetics was disturbingly intertwined with the so-called science of eugenics. The prominent information theorist Claude Shannon agreed to study at an office of eugenics following the advice of his PhD advisor. Furthermore, many of the organizations that funded systems theory research had openly eugenicist aims of purifying and controlling populations.

In addition to Geoghegan's arguments about the existence of explicit racism within cybernetics research communities, political theorists have also argued that systems theory has been a vessel for insidious, implicit racist effects. Seb Franklin (2021) argues that systems-based, cybernetic approaches to governance have bolstered pre-existing exclusionary tendencies within racial capitalism. According to Franklin, the value function within capitalism can be compared to digitality because both involve the reification of abstractions. Franklin argues that this reification of abstractions, similar to what Grove terms homogenization, has had the effect of reinforcing capitalism's logic through digital networks and feedback loops. Franklin argues that new digital technologies and systems of cybernetic control have replicated and reinforced pre-existing inequalities by creating a globalized, mandatory system of value which is differentially accessible to various groups of people. Yarden Katz (2020) has made a similar argument about the implicit racist effects of digitality in the context of artificial intelligence, which Katz claims is a nebulous and shifting signifier that has had the effect of centering and upholding the ideology of whiteness.

Other scholarship on the political effects of systems theory emphasizes how systems approaches have reinforced neoliberal values. Philip Mirowski and Edward Nik-Khah (2017) discuss a shift to a focus on information that took place in the discipline of economics after the Second World War. They claim that the type of information that became popular in the discipline of economics was "an alienated information—something that takes on a life of its own, a hypostasized entity that has its own dimensions and metrics" (Mirowski & Nik-Khah, 2017, p. 13). The authors attribute such shifts in the conceptualization of information to mathematician and theorist of communication Claude Shannon, whose information theory helped to influence early developments in cybernetics.

Information, as described by Shannon, was separable from a specific context or deep layers of meaning, and could be easily transmitted through signals. Mirowski and Nik-Khah claim that it was this conceptualization of information that became dominant in the late 20th century discipline of economics. This reliance on abstract conceptualizations of information in economics was a departure from more situated understandings of knowledge. Instead, Mirowski and Nik-Khah argue that information became a way to reference a way of knowing that was not located in any particular mind, and that in fact could not be accessed by any one particular mind. According to Mirowski and Nik-Khah, it was this version of information that influenced economists such as Hayek to posit the metaphor of the economy as an information processor that, similarly to a computer, could process an enormous number of elements with complex relationships and produce useful results. While I will contest Mirowski and Nik-Khah's historical narrative about Hayek's intellectual influences, their basic argument exemplifies an important trend in political theory scholarship.

The tendency of political theory scholarship to criticize neoliberal applications of systems traditions is also found in Melinda Cooper's 2008 book *Life as Surplus.* Cooper argues that twentieth century biological research gave rise to speculative theories of spontaneous order that helped to propel neoliberal projects of decentralized governance. In Cooper's telling of the events, systems theory, and particularly informatic approaches to biology, was ripe for appropriation by neoliberal forces. As evidence, Cooper draws on comments about anti-entropy in the work of Prigogine and Stengers, and even argues that Margulis and Lovelock's Gaia hypothesis was compatible with neoliberal theories of growth. In particular, Cooper is concerned by the claim made by Margulis that is it possible to see "the history of microbial evolution...as a succession of catastrophic pollution events, many of them much greater than the contemporary threat posed by industrial waste" (Cooper, 2008, p. 36). Such an attitude, according to Cooper, can only lead to a naïve faith in the ability of nature to correct itself, with potentially disastrous consequences.

Cooper claims that theories of spontaneous order in nature either implicitly or explicitly celebrate the periodic crises that provide the creative impetus for reorganization, innovation, and creative adaptation. Cooper indicates that such views fall almost automatically into the hands of anti-environmentalist politicians and business interests. This argument is laid out in a co-authored article by Jeremy Walker and Melinda Cooper (2011), which shows congruences between C. S. Holling's theories of ecological resilience and Friedrich Hayek's neoliberal theories of spontaneous order.

Cooper and Walker argue that systems approaches to government have naturalized neoliberal goals such as financialization and deregulation of the economy. A similar critical argument about the convergence between ecological resilience thinking and Hayek's economic philosophy is made by Michael Watts (2014). In a study of approaches to development economics in the extremely poor Sahel region of Africa, Watts argues that a Hayekian emphasis on individual and community resilience has minimized the urgency of the situation, and falsely ascribed responsibility to extremely marginalized people.

While I am sympathetic to the critiques laid out by Cooper, Walker and Watts, these portrayals over-simplify and often conflate diverse political perspectives. The Gaian philosophy of Lynn Margulis is not, in fact, an argument that life is on a course of infinite growth and boundless resilience. The resilience philosophy of C.S. Holling is, likewise, not the same as the free market philosophy of Hayek. Furthermore, there are important differences between the claims found in Hayek's actual writings, and the neoliberal economic conditions that theorists such as Cooper, Walker, and Watts castigate. I take a more genealogical approach to analyzing the formation of these discursive regimes that seeks to better understand specific intellectual histories, and that does not take the ascendance of particular approaches, such as neoliberalism, as inevitable.

The term neoliberal, widely used in political theory scholarship, is often a frustratingly vague signifier, though in general it refers to decentralized governance, protection of markets, and an emphasis on individual personal responsibility. As Watts discusses poignantly, such ideological attitudes have real world effects, and implementation can be disastrous when extraordinarily vulnerable people are subjected to abstract governance approaches. However, as I will show throughout the dissertation, neoliberal outcomes are not the inevitable or only possible effect of systems theory. So-called neoliberal political outcomes are not even necessarily the inevitable outgrowth of philosophies of political decentralization. While understanding how systems metaphors shape economic philosophy, and thus real world outcomes, is a worthy endeavor, scholarly accounts that only show lines of appropriation and influence moving in one direction, or towards one set of outcomes, are too simplistic.

There are a few limited examples in the existing scholarship of work that attempts to show how systems theory can function as a modality of both freedom and control. *The Fragility of Things*, by William Connolly (2013), is one such example. Connolly shows that a systems approach provides a lens that can encourage greater appreciation of self-organizing processes within nature. Connolly pairs this discussion with a critique of neoliberal philosophies of economic self-organization, most notably the work of Hayek. Connolly argues that Hayek went wrong not because of his embrace of theories of spontaneous order, but because he failed to recognize the fragility of the self-organizing natural processes that interface with the self-organizing processes in the economy. If these natural processes were truly taken seriously, Connolly claims, an ecologically sustainable political vision could emerge, following the basic framework of decentralization. While Connolly's account is a rare attempt in the contemporary scholarship to acknowledge both potential salutary and nefarious applications of systems theory, Connolly limits his research to the study of the neoliberal revolution, and fails to engage with important homologous developments in America's counterculture.

Similarly, work by Michael Thompson (2022) presents a more nuanced view that acknowledges how systems theory can provide a language to identify both systems of control, and possibilities for creative autonomy. Thompson discusses how the rise of cybernetics fueled the conjoined development of technological and economic systems. In contrast to Franklin's emphasis on material inequalities, Thompson emphasizes how these systems have robbed individuals of cognitive autonomy. Thompson argues, drawing on psychoanalytic theory, that the deep structures of human consciousness have been hijacked by cybernetic systems of control that reinforce the capitalist values of efficiency and homogenization. Thus, human desires and cultural activities are preemptively formatted by the matrix of social control perpetuated by the cybernetic society.

Thompson's analysis, unlike most other scholarly discussions of cybernetics, offers a path towards challenging and overcoming these systems of control, within the terms of systems theory itself. Thompson argues that what needs to be resuscitated is the human capacity for true critique. This capacity for critique, Thompson argues, is an inherent quality of the naturally occurring self-organizing mental processes of the human mind. Due to the comprehensive immersion of human consciousness in the recursive social scripts perpetuated by media, discourse, and social interactions, Thompson argues that the formation of an authentic critical attitude has become more and more difficult. In a departure from other contemporary theoretical approaches, Thompson argues that the Western enlightenment offers resources for rebuilding an authentic culture of criticism and rational critique. Such critique, according to Thompson, should not be built on a false edifice of isolated individualism, but rather depends on a recognition of interrelatedness and dependence—a full recognition of the complex systems that undergird contemporary life. It is only through recognizing this dependence and reflecting on the conditions of society that true autonomy and authentic critique can be fostered. Thompson claims that without the recultivation of real autonomy, we are doomed to be trapped in the feedback loops of a technological society whose values have been engulfed by capitalist rationalities. Thus, real freedom depends on the ability to build alternative systems and cognitive habits that challenge the hegemonic social scripts.

Thompson's decision to describe the turn towards true freedom and critique as an expression of enlightenment values is potentially controversial. I would argue that any such attempt should be accompanied by a real effort to acknowledge how the enlightenment has contributed to the formation of racial, gendered, and economic exclusion, capitalist rationalities, and short-sighted myths of self-sufficiency. Nonetheless, I find Thompson's analysis of contemporary society through the cybernetic lens to be productive. What I find most significant about Thompson's analysis is the way that Thompson describes the interrelationships between two kinds of self-organizing systems. The main focus of the book centers on the self-perpetuating, cybernetic systems of global capitalism, which Thompson claims have been reinforced and strengthened through sophisticated technological forms of control. However, Thompson also shows that these cybernetic systems are deleterious not simply *because* they are cybernetic, but because they constitute a coercive master rationality that has overpowered more organic forms of individual autonomy and self-consciousness, which also have recursive, systemic characteristics. Thus, the project of challenging sophisticated forms of contemporary political control is not simply about rejecting the systems concept. Rather, the project of reconstituting true autonomy through the critical faculties of the individual can benefit from the tool of systems theory.

While I disagree with certain aspects of Thompson's analysis, I have found Thompson's more balanced approach to the politics of systems theory useful for my study. While the political theory scholarship I have examined includes strong, persuasive arguments about how systems theory has had either beneficial or harmful effects on politics, I am most persuaded by the view that the truth about systems theory lies somewhere in the middle. I argue that it is essential to understand how systems theory has often, through ideological and technological mechanisms alike, constituted sophisticated modalities of control that, too frequently, impose mandatory participation in abstract value systems and foreclose individual autonomy.

At the same time, the systems perspective has provided genuine inspiration for political projects centering greater individual freedom, community participation, and ecological awareness. Rather than dividing various manifestations of systems theory into sharply differentiated categories, I argue that applications of systems theory always straddle a complicated and shifting divide between both freedom and control. It would be too simple to seek authentic impulses towards freedom or nefarious power grabs in the case studies I will examine. Instead, in the chapters that follow, I will show the persistent tendency for freedom and control to coexist in various systems discourses, often in ways that the proponents of such discourses seem unaware of. In so doing, I will challenge dominant portrayals of various major systems theorists, avoiding the genres of hero or villain. Before concluding this first chapter, I will discuss the career of the first person to use the term cybernetics in its modern sense, Norbert Wiener, and show how Wiener's career illustrates these ambiguities.

Case Study: Examining the Career of Norbert Wiener

The formative and lasting influence of Norbert Wiener's work on information theory and cybernetics is highlighted throughout the systems theory scholarship. In fact, Wiener's influence looms so large that his findings and statements are often presented as representative of the consensus of the field, despite Wiener's well-documented professional and political disputes with other systems theorists. Most likely, the continued prominence of Wiener's ideas stems from the sheer popularity of Wiener's popular writings in the mid twentieth century. After establishing himself as a respected researcher of feedback systems and statistical mathematics, Wiener published two bestselling books, *Cybernetics: or Control and Communication in the Animal and the Machine* and *The Human Use of Human Beings: Cybernetics and Society,* that were surprisingly well read, far beyond any specialized audience. The books were originally published in the years 1948 and 1950. It was through these books that a broad popular audience was first introduced to concepts including automation, artificial intelligence, and the growing congruences between machines and biological life.

Wiener's motivation for writing the books is generally understood as rooted in a desire to distance himself personally, and the field of cybernetics more generally, from the military associations of his research. During World War Two, Wiener had received funding from the US government to develop statistical methods to improve the accuracy of weapons systems. Wiener found that accuracy was best improved by ascertaining probabilities. The probability of hitting a target was increased when feedback measurements were incorporated into the calculation. The feedback information was used to recalculate trajectories; thus, a systems based approach undergirded the calculations. This research shaped the development of the field of cybernetics, the study of the communication and control of information in complex systems. Fearing that the field would become associated with military applications and, more generally, the expansion of top-down forms of political control through systems governance, Wiener wrote his books to redefine the purposes and applications of the field.

In the context of the broader arguments of my dissertation, the life and work of Norbert Wiener is a perfect illustration of the ambiguous nature of systems theories. As I have discussed, systems theory has manifested in various historical forms which tend to blend characteristics of control and freedom. This ambiguity extends to both the intentions of systems theorists, and the documented effects and applications of their research programs. In the case of Wiener, the historical evidence indicates that he hoped to explain, especially in his communication directed towards a more popular audience, why systems theory could be a genuine modality of freedom. At the same time, it is clear that Wiener did not truly have the ability, notwithstanding his substantial public influence, to control the future applications of the field that he had helped to found. As I will discuss, many contemporary theorists frame Wiener's contributions as indelibly linked to the creation of new strategies, in discourse and governance, that sought to engineer human society in the form of a highly controlled, machinic meta-entity that would reinforce and reproduce the social scripts of hegemonic power.

In line with the overall approach of my dissertation, my critical discussion of Wiener's contributions will emphasize the dual nature of Wiener's life's work and overall influence. Through a close examination of Wiener's popular writings, I will show that Wiener thought seriously about social and political decentralization. Further, contrary to portrayals in recent scholarship, Wiener in fact did differentiate between unaccountable, totalitarian, and coercive power, and forms of control that were based on open communication and greater political equality. However, while recent scholarship has often unfairly characterized Wiener's intentions and substantive arguments, these interventions do point towards a real phenomenon: the way that systems theory was taken up and adapted to suit schemes and purposes that Wiener would not have supported. While Wiener cannot be held accountable for every unintended application of the field of cybernetics, he can be criticized for a certain political blindness, and a failure to foresee the ways that his work could be used to entrench social hierarchies, rather than challenge them.

Wiener's Theory of Cybernetic Systems

As I have discussed, Wiener's theory of cybernetics hinged on the claim that information was equivalent to the opposite of entropy, or disorder. A highly patterned system, infused with information, represented a local exception to the constant increase in the entropy of the universe as a whole. Wiener found that this theory was applicable to the study of biological organisms and machines alike. Both organisms and machines represented local zones of reduced entropy due to the ability of their internal homeostatic systems to respond to feedback inputs and changing conditions, while preserving the basic order and integrity of the organism or machine. New developments in science, Wiener explained, had shifted the basic paradigm of both biology and machine design away from the control of energy, and towards the control of information. Information, Wiener insisted, was neither matter nor energy, but rather a distinct phenomenon that could be ascertained in nature.

Wiener dismissed portrayals of biological life as a heat engine, claiming that such framings were a vestige of the past, and argued that in the future, representations of life as the exchange of messages would become dominant. In an example that was later criticized as sensationalist, Wiener argued that due to the informatic nature of all biological organisms, teleportation was entirely plausible and was out of reach only to the limits of current technology. Thus, in theory, Wiener claimed that the informatic code of an organism could be extracted, transmitted, and then later reconstituted to allow for spontaneous travel of the organism from one location to another. In addition to claiming that individual organisms were informatic, Wiener also framed the process of biological evolution through similar terms. According to Wiener (1961), “Darwinian evolution is thus a mechanism by which a more or less fortuitous variability is combined into a rather definite pattern” (p. 36). Thus, the development and progressive adaptation of biological species to their environment was driven by a fundamentally informatic process.

Wiener’s theory of cybernetics emphasized not simply the ability of a system to be automated, but the ability of a system to continually adjust itself and to steer towards specific purposes. The word cybernetics itself, as coined by Wiener, was a reference to *kubernetes*, the Greek word for steersman. Etymologically, *kubernetes* is also the word root of governor and gubernatorial. Wiener’s usage of the term emphasized the idea of control, specifically through steering. However, this steering occurred not through top-down mechanisms, but through the immanent and distributed functional characteristics of the system itself. Wiener argued that systems maintained relative stability in the face of external forces and local decay due to continual, repetitive, steering processes. These processes aimed towards some form of purpose. Without a purpose, an automated process could not be cybernetic. Thus, a simple mechanical watch, though automated, is not cybernetic in Wiener's sense.

The concept of purpose, as used in Wiener's research, was first laid out in a co-authored piece that Wiener wrote with his longtime collaborator Arturo Rosenblueth, as well as Julian Bigelow. The article criticizes behavioralist approaches to psychology, not because the quest to understand behavior was misguided, but because of the simplicity of dominant behavioralist approaches. The authors proposed an alternative "functional analysis," emphasizing the "intrinsic organization of the entity studied, its structure and its properties" (Rosenblueth, Wiener, & Bigelow, 1943, p. 18). Such functional analysis, drawing from a consideration of the holistic integrity of the individual, would reveal the existence of purposeful behavior. Purposefulness, the authors claimed, was under-theorized in behavioralist psychology.

True purposeful behavior was not simply the result of a simple repetitive process, even if such a process, as in the case of a watch, yielded a specific result. Rather, purposeful behavior, though it could involve repetitive qualities, was about the orientation of the organism towards a specific final goal. The authors further divided purposeful behavior into feedback and non-feedback systems, and divided feedback into positive and negative inputs. The specific type of system that best represented living processes was a negative feedback purposeful system, with regulating features in which "If a goal is to be attained, some signals from the goal are necessary at some time to direct the behavior" (Rosenblueth, Wiener, & Bigelow, 1943, p. 19). Despite the original framing of their intervention as a rejection of dominant approaches to psychology, the authors reveal that their primary purpose is not as simple as delineating an alternative psychological science. Rather, Rosenblueth, Wiener, and Bigelow emphasize that the intention of the article is to show, through functional analysis, that basic characteristics of the behavior of organisms can also be found in machines. Thus, understanding behavior as a systemic, cybernetic process would reveal that machines and organisms had ontological and functional similarities.

In his first book on cybernetics, Wiener emphasized that the distinction between organisms and machines was no longer significant. Thus, old philosophical debates, including debates about vitalism, a 19th century theory of semi-mystical, biologically based organismic forces, were now defunct. Wiener explains,

> "Thus the modern automaton exists in the same sort of Bergsonian time as the living organism; and hence there is no reason...why the essential mode of functioning of the living organism should not be the same as that of the automaton of this type. Vitalism has won to the extent that even mechanisms correspond to the time-structure of vitalism; but as we have said, this victory is a complete defeat, for from every point of view which has the slightest relation to morality or religion, the new mechanics is fully as mechanistic as the old."

Wiener believed that to try to distinguish the unique ontological attributes of life from human-built machines was a wasted intellectual effort. Rather than to holding onto the ontological attachments of past worldviews, it was more useful to seek to understand the dynamic processes underlying the universe, and to channel those findings towards desired purposes.

Wiener argued that a fundamental paradigm shift was underway in human consciousness with the discovery of information theory and complex systems analysis. He compared this shift to the transition from Ptolemaic to Copernican astronomy. Specifically, Wiener claimed that the massive conceptual change that was underway was a shift from the reversible universe of Newtonian time, illustrated, for example, by the motion of the planets, to the irreversible universe of constantly increasing entropy. The Newtonian universe was "a universe in which everything happened precisely according to law, a compact, tightly organized universe in which the whole future depends strictly upon the whole past" (Wiener, 1989, p. 7). In contrast, the biological organism, and now even many machines, unfolded in irreversible time. While the concept of irreversibility had been prefigured by the discovery of heat engines, it was only through information theory and advanced mathematical analysis that the true irreversible qualities of the universe could be perceived, according to Wiener.

Closely related to the concept of irreversibility was the concept of the arrow of time. As Wiener (1987) explained, "The whole conception of the apparently purposive organism, whether it is mechanical, biological, or social, is that of an arrow with a particular direction in the stream of time" (p. 48). An organism's life cycle cannot be reversed, but rather goes through definite stages of development. Machines and social systems with similar qualities would also show evidence of progressive, cumulative change. The emergence of novelty was a key component of such systems. This novelty and contingency could be perceived, according to Wiener, due to new scientific discoveries. Wiener claimed that physicist and mathematician Josiah Gibbs, through his studies of statistical probabilities, had inaugurated a shift in science even more significant than the development of quantum physics. Gibbs made visible the contingencies of the natural universe, and showed that

> "a physical system belonging to a class of physical systems, which continues to retain its identity as a class, eventually reproduces in almost all cases the distribution which it shows at any given time over the whole class of systems. In other words, under certain circumstances a system runs through all the distributions of position and momentum which are compatible with its energy, if it keeps running long enough" (Wiener, 1989, p. 9).

Thus, a complex system was best described through the language of statistical probability: what mattered what not any measurable state of the system in any particular moment, but rather the overall structural features of the system. Wiener argued that Gibb's appreciation for the dynamic processes of the universe and the elusive forms of order revealed by patterns of distribution provided a scientific foundation for the engineering applications of systems theory.

In his popular books, Wiener first introduces the concept of control in the scientific context. Control depended on systems that registered feedback and incorporated feedback into decision-making. Specifically, control was about stymying the force of disorder and disorganization, also known as entropy. Wiener even went so far as to claim that cybernetic control was about the control of entropy itself, through feedback processes. These processes could be observed in natural systems, and engineered in human-built mechanical ones. Wiener positioned order as a source of moral good, and disorder as a source of moral harm. He characterized disorder in moralistic terms, claiming that "For this random element, this organic incompleteness, is one which without too violent a figure of speech we may consider evil" (Wiener, 1989, p. 11). Thus, it follows, processes of spontaneous change that introduced and maintained zones of order were a moral good.

In order to promote order, it was necessary to understand information. In a scientific sense, this meant a shift away from the previous emphasis in the many of the sciences on the concept of energy. Wiener dismissed energy as a dated 19th century fixation, which could only describe very generalized metabolic and homeostatic processes, rather than their specificities. While Wiener acknowledged that energy was often necessary to facilitate the transmission of informatic signals, energy alone could not maintain the integrity of the organism, or the advanced machine. Furthermore, Wiener emphasized that the shift from energy to information would change conventional understandings of scarcity. Wiener argued that informatic processes required comparatively small amounts of energy. Neurons, which Wiener explained functioned similarly to vacuum tubes, were best understood as systems of informatic exchange, rather than exchange of energy, due to the very small amounts of energy they required. Thus, energy itself should no longer be understood as a scarce resource, in nature or any other context. Instead, the resource whose scarcity or plenitude mattered was information.

Both of Wiener's popular writings, *Cybernetics: or Control and Communication in the Animal and the Machine* and *The Human Use of Human Beings: Cybernetics and Society,* contain a striking shift, towards the end of each book, from a discussion of scientific theories of entropy and technical discussions of mathematics to an examination of social and political theory. Wiener develops a theory of human society that characterizes social organization as a system of messages. A healthy society, according to Wiener, is built upon the free and open flow of information. Correspondingly, corruption and abuse of power can be found where the flow of information is restricted. Wiener (1967) claims that "control of the means of communication" is the worst of the "anti-homeostatic factors in society" (p. 160). Wiener believed that small communities, free of corruption, more easily achieved homeostasis, due to the presence of accurate feedback signals. Correspondingly, sprawling hierarchical societies usually contained impediments to their communicational systems that interfered with the homeostatic processes, and thus the overall organized functioning, of that society.

In large societies, Wiener explains, forms of communication are not directly interpersonal, but rather are mediated by various institutions, including the press, technology, media, education, and social institutions. The corruption that occurs in large hierarchical societies, organized by capitalist commerce, reveals itself when communicational messages are warped. This warping is what Wiener (1967) terms the "secondary aspects of the means of communication," rather than its primary purposes (p. 161). If communicational systems, including the press, education, and the media, stay oriented towards producing signals that reflect real conditions with fidelity and accuracy, then the ideal homeostasis of the society can be maintained. When the means of communication fall into the hands of those who seek profit above all else, the information that is produced does not create the correct homeostatic feedback signal, and thus society falls into a state of chaos. Wiener (1989) worries that such capitalist attitudes are intrinsic to American society, and that "The fate of information in the typically American world is to become something which can be bought or sold" (p. 113). Thus, in Wiener's telling, capitalist forces are not the invisible hand that ensures processes of informatic commerce can reach a natural balance, but rather are the cause of imbalances in the flow of information, leading to political corruption.

According to Wiener, the best way to prevent corruption in any institution or human social system is to facilitate the proper flow of information. Specifically, information should flow in more than one direction. Wiener (1989) argues that anyone in a leadership position, "whether of a government or a university or a corporation, should take part in a two-way stream of communication, and not merely in one descending from the top." (p. 49). In any context, whether in business or the practice of science, Wiener argues that ineffective and corrupt leadership can be ascertained by a failure to respond to feedback signals from the level beneath. It follows that a more ideal, even utopian society would result from the unhindered exchange of information. Thus, the most just society was a decentralized one with multiple nodes of power, distributed decision-making, and robust flows of information.

The Cultural, Political, and Scholarly Reception of Wiener's Theories

While Wiener's political musings could be dismissed as a layperson's attempt to bolster the relevance and popularity of a series of primarily technical findings, his ideas were nonetheless surprisingly influential. His books were widely read, particularly on university campuses, despite the inscrutability of the extended sections containing mathematical proofs. Wiener's critiques of social hierarchies and rigid bureaucracies resonated with powerful cultural currents in America, particularly countercultural values of individuality and freedom. His books were heavily promoted by Stewart Brand in the *Whole Earth Catalog*, another widely read publication that landed on countless coffee tables in America. And to this day, Wiener's contributions to systems theory and cybernetics continue to be elevated to the center of scholarly representations of this period, despite the fact that countless other academics were involved in the research collaborations through which systems thinking took root.

Depictions of Wiener in the secondary scholarship vary quite significantly. In the more historically focused secondary scholarship, Wiener's desire to distance himself from military research, in order to use cybernetics for the force of good, is taken more seriously. In fact, as Ronald Kline (2015) discusses, Wiener was quite vocally opposed to the Cold War stance of other information theorists, putting him at odds with many of his colleagues. After the war, Wiener refused to accept further research funding from the military. He also hoped to strengthen research collaborations between Americans and the Soviets, rather than taking a competitive stance. In *The Human Use of Human Beings*, Wiener wrote that while he deplored the rigidity of the communist system, he respected the intention of communism to protect the rights of workers. These commitments distinguished Wiener sharply from his colleagues in the information sciences, including Warren McCulloch and Vannevar Bush, both of whom strongly affiliated themselves with the Cold War and anti-communism.

Additionally, many of Wiener's colleagues viewed his foray into writing for a popular audience as a sign of unseriousness, and were not impressed with his musings on the political and philosophical applications of cybernetics. Warren Weaver, one of his colleagues, found the book inscrutable and fantastical. Many others accused Wiener of sensationalism, perhaps an unsurprising assertion due to the inclusion of an argument favor of the plausibility of teleportation. However, as Kline discusses, Wiener was perceived more positively by social theorists, such as Lewis Mumford and Marshall McLuhan, who had similar interests in the social and political effects of technology. While not necessarily taken seriously in a scientific or technical sense, Wiener's popular writings, and his claims about social forces, were clearly taken seriously by influential figures in America's intellectual culture.

Nonetheless, despite Wiener's popularity in intellectual circles associated with the freedom loving counterculture, is clear that Wiener was interested in theorizing control. As Lily Kay (2000), explains,

> "many features of Wiener's cybernetics were not new. The potency of his project, however, stemmed from the ways in which these terms-*feedback, control, message,* and *information*-became resignified...Within that space, control was abstracted and diffused: it was not a thing but a manifestation; not a mode of decision making but a process pervading the whole system" (p. 85)

As Kay explains, Wiener did view the flow of information as a modality of control in the sense that the exchange of information could replace chaos with functionally appropriate patterns. Wiener did not believe that this interchange was inherently oppressive. Oppression and corruption resulted when the flow of information became restricted or unidirectional, or was monopolized by specific groups.

It is these distinguishing factors, however, that are often missed by contemporary scholars who perceive Wiener as the original engineer of insidious systems of control. Michael Thompson's (2022) philosophical work *Twilight of the Self* positions Wiener's contributions to cybernetics as the founding premise of a sophisticated, totalitarian system of social control that Thompson argues has come about through the establishment of neoliberalism. Thompson argues that due to the omnipresence of the values of efficiency and extraction in neoliberal thinking, human consciousness has been thoroughly suffused by the logics of the capitalist value system. Thus, the basic functions of cognitive autonomy and critical rationality are close to falling extinct in contemporary society. Thompson claims that Wiener's cybernetics helped to usher in a machinic culture in which neoliberal economic values were promulgated, replicated, and continuously reinforced, through the operation of autonomous systemic forces, both social and technological.

Bernard Geoghegan (2023) provides a slightly different argument, no less critical of Wiener but more substantively critical of Wiener's professional activities. Geoghegan notes that Wiener frequently commented on the need for cross-disciplinary collaboration, and the importance of avoiding excessive specialization in academic pursuits. The mature theory of cybernetics was, after, the result of collaborations involving human physiology, behavioral analysis, statistics, physics, and electrical engineering. Geoghegan connects Wiener's views with the overall ethos of the Rockefeller foundation, responsible for funding much of Wiener's research at MIT, as well as the Macy and Guggenheim foundations. According to Geoghegan (2023), these philanthropic outlets had unified goals, and thus,

> "Foundations' dreams of communication across borders complemented a technocratic tactic—ultimately an antipolitical hypothesis—according to which scientific collaboration would overcome boundaries of race, class, and nation. This conflation of communication and reason conceived of social conflict as mere misunderstanding, and scientific or technological improvements in

communication as the natural solution. The funding for Wiener and Rosenblueth, or for the small groups meeting under Macy auspices, was itself a laboratory for overcoming difference through communication" (p. 43)

Geoghegan's argument implies that such overt portrayals of science as a neutral, universal system of progress are connected to an underlying project of the uplift of certain groups, and the exclusion of others. In fact, Geoghegan claims that the desire to overcome variation and difference is, ultimately, inseparable from other reformist projects such as eugenics. Thus, in Geoghegan's telling, Wiener is at the very least an accomplice to a sophisticated scientific research regime whose goal was to bring nonconforming people into alignment with universalist ideals.

This theme can also be found in Seb Franklin's (2021) discussion of the connection between racial capitalism and cybernetics. Franklin emphasizes that Wiener's innovations, while formulated through a universalizing language, were far from universal. Franklin argues that Wiener's attempt to define the human being as a kind of informational pattern was bound up with specific political construction of humanity. By positioning a human as that which expresses "the maximal exchange of messages," Wiener reproduces "in explicitly information-theoretical terms the form of the possessive individual whose capacities are allocated through the informatics of value" (Franklin, 2021, p. 99). For Franklin, the desire to conform by becoming the possessive individual of the capitalist system involves an endorsement of systems of abstraction that characterize the world in terms of economic value.

For Franklin, capitalist value has always been informatic, even before the advent of information theory. In the context of capitalist exchange, value is often represented as the idealized, frictionless transmission of messages. Franklin argues that the abstractions of digitality and capitalism are fundamentally interlinked. He argues that racial capitalism has, for centuries, sought to hide the externalities of its operation, the concrete effects that accrue to bodies and environments. Further, the systemic regime that was generated and reproduced through twentieth century information technology had similar effects, and worked to reinforce existing economic inequalities. To participate in the technologically mediated capitalist value network by both selling one's labor and purchasing goods is to be connected to a complex flow of messages. Thus, social and political life is ever increasingly governed by abstractions, to which individuals have differential access.

Franklin argues that far from being an accidental participant in the invention of systems of cybernetic control, Wiener is more directly responsible for the eventual applications of his theories. Despite Wiener's stated alignment with the cause of workers, Franklin claims that the specific conditions of workers are too easily abstracted in Wiener's informational account. Franklin claims that this is why "Wiener can critique certain aspects of automation, white supremacy, and settler colonialism while at the same time elevating and calling for the intensification of those phenomena's logical and imaginative foundations—the dynamics that reproduce optimal personhood as abstract, communicational form" (p. 100). The ideal worker, racialized through constructs of whiteness, is the worker who is reliable and participates in informational networks in a way that is frictionless, freed from evidence of corporeality or limits. Wiener, Franklin claims, fails to understand that the idealized value network of capitalist was always supported by material substrates, specifically the labor and the continual wearing down of human bodies and natural ecologies. The ideal digital-liberal person, supposedly the imagined subject of Wiener's theories, is the one who can act as though their actions are not fully determined by material limits, and who can imagine that they are participating freely in the market system. Franklin claims that this is an intrinsically racialized subject.

As evidence, Franklin points to Wiener's frequent remarks about how the laborers of the information age would be eclipsed by the rise of automated machines. Franklin notes that Wiener chose to compare such machines to slaves, as a way of emphasizing the constrained and repetitive nature of the work that was carried out. Franklin argues that

> "Although Wiener briefly acknowledges slavery's 'human cruelty,' he overwhelmingly deploys the slave as a rhetorical figure in order to evoke sympathy for the future 'free' persons whose 'potential'—but really whose value and prospects of regular connection—will be constrained" (p. 114).

In contrast to the experience of the slave, the qualities of the free person are "universality, mobility, transparency, and wage-mediated self-reproduction" (p. 114). Franklin argues that the implications of this are that Wiener overestimates the ability of any worker to achieve liberation through the capitalist system. Wiener also, Franklin claims, invokes an early version of the trope of the neoliberal entrepreneur of the self. The ideal worker should be able to navigate conditions of precarity without evidence of attenuation or stress. The freedom that is available to a participant in such a system is highly orchestrated and constrained, a tension which Wiener never acknowledges.

Franklin connects Wiener's racialized language to the growing rise, among proponents of cyberculture, of language referring to a digital frontier, digital natives, and digital settlers. This language appeared in many twentieth century political manifestos, notably John Perry Barlow's "A Declaration of Independence of Cyberspace." Barlow (1996) addresses "Governments of the Industrial World" to state that "I come from Cyberspace, the new home of Mind... You have no sovereignty where we gather." The new space of cyberspace is positioned as a new virgin territory, demanding the establishment of new political arrangements. This would be "naturally independent of the tyrannies you seek to impose on us" and will take place "a world that is both everywhere and nowhere, but it is not where bodies live" (Barlow, 1996). Barlow echoes classical social-contract philosophers such as John Locke, who argued for property rights for European settlers who had discovered unclaimed territory in the new world (despite Locke's acknowledgment, in *The Two Treatises*, that native people were already living there). This time, however, the settlers are digital settlers, and their right to freedom of information was the central demand as they expanded into the new, formless digital space.

In the context of these writings about cyberspace, however, Franklin notes a curious ambiguity. While many of the commentators on the new information systems adopted a seemingly entitled settler's attitude towards defining and setting the rules of a new space, they frequently referred to themselves as "digital natives." While other figures such as Barlow promoted this term, Franklin traces the salience of the concept back to Wiener. In Wiener's choice to name cybernetics after a steersman, and in his creation of conceptual examples out of abstracted commercial systems, Franklin argues that Wiener expressed a clear sympathy towards the merchant capitalists of European capitalism. As Wiener began to develop his theory that economic processes could be improved by better alignment with the imperative to increase the transmission of information, Wiener failed to conceptually acknowledge or depict “the accumulation drive that animates circulation and the practices of colonial expansion” (Franklin, 2021, p. 106). Only the idealized circulation was represented, and frictionless circulation was positioned as ideal. The expansion of circulation was seen as a progressive ideal. The ideal person who participates in this network is racialized, according to Franklin, because of the prescription that such an individual should enter the market with a minimum of characteristics, cultural, economic, or otherwise, that would interrupt the frictionless flow of commerce.

Franklin then argues that a transformation occurs in this discourse, as worker shifts to settler, and then finally becomes the digital native. Franklin explains that even for the ideal worker,

> “The maintenance of the individual person as a ‘continuity of pattern’ requires a continuous feedback loop of production and reproduction that only steady and sufficiently waged work can maintain; but such work impedes the full expression of human capacities that is value-mediated personhood’s promise” (p. 110).

Full entrance to the feedback loops of capitalist production is a privilege that not all workers have ever had, given the complex histories of global capitalism over many centuries. However, even from this privileged space, an additional desire of the worker cannot be fulfilled: a desire for full and unimpeded expression of the self on the stage of a space that transcends material limits.

This is how Barlow’s language comes into the story. Franklin argues that “In Barlow’s ‘Declaration,’ ‘native’ is not opposed to ‘settler.’ Instead, it stands in its place, deployed in deracinated form to trope maximum connectivity and frictionless mobility...the deracinated forms of native and nomad are positioned after and in a state of greater freedom than the settler, who by definition settles into sedentary dwelling." (p. 111). Thus, the invocation of the settler frontier in discussions of cyberspace is an attempt to transcend racialized history, to declare the insignificance of its material effects. Franklin argues that Wiener falls into a similar trap with his construction of workers: Wiener's imagined worker is the ideal participant in the uninterrupted flow of communicational messages. Neither Wiener now Barlow understand, however, the true mediations of value: its constitutive exclusions and the externalities it creates. This leads them to make naïve pronouncements about the freedom and political power that would be constructed through the new digital spaces. Failing to recognize that the rules of these new spaces would easily reproduce capitalism's tendency to promote oppression and the wearing down of life, they never fully understood the significance of the cultural and political moment that they were living through.

Examining Wiener's Legacy

Theorists such as Thompson, Geoghegan, and Franklin provide a powerful argument that the development of cybernetic systems theory led to the intensification of sophisticated systems of social control that, through the combined forces of capitalism and technology, have reinforced political inequality and domination. I do not wish to contradict the basic contention of these theorists that sophisticated systems of social control exist, and that these systems reinforce deeply entrenched forms of political and economic marginalization. However, I do wish to contest the implied inevitability of the ascendence of cybernetics as a system of rigid and centralized control. Wiener can certainly be criticized for a lack of attention to political and social inequalities outside of the class system. Further, Wiener often seemed to have a naïve ignorance about the possible uses towards which his technologies could be applied. However, I would argue that Wiener's intentions do matter, and that his stated desire to build a more equal, less hierarchical world speaks to the adaptability of the concept of cybernetic control. Wiener understood that cybernetics could be used to entrench social hierarchies, but he saw another way forward, and he thought that discussing this alternative path was important enough to merit the writing of his various popular books.

Further, Wiener's popular writings indicate that his views about the scientific and social uses of cybernetics were not nearly as blindly utopian as critics such as Geoghegan attest. While it is true that Wiener supported interdisciplinary research that could bring together expertise in various fields, he was also skeptical about the ability of science to overcome all problems. Wiener (1967) writes that many of his colleagues had unrealistic expectations about the social applications of cybernetics, revealing "an excessive optimism, and a misunderstanding of the nature of all scientific achievement" (p. 162). Wiener implies that his own approach to discussing the social applications of systems theory was meant to offer more realistic possibilities, rather than false hopes.

These comments contradict Geoghegan's portrayal of Wiener as fully complicit with the reformist aspirations of the Rockefeller Foundation and the other groups that supported Wiener's research. As Geoghegan discusses, the functionaries of the Rockefeller Foundation emphasized how science was a part of a universalist project of social uplift. In contrast, Wiener's philosophical critique of progress narratives emphasizes that change must be oriented towards the right social values to cause beneficial results. Wiener (1989) explains that, contrary to the views of many

Americans, "It is possible to believe in progress as a fact without believing in progress as an ethical principle" (p. 42). Thus, the changes that can be wrought through the operation of spontaneous systems can give rise to results that are either good or bad. Certainly, it is difficult to read Wiener, as Franklin and Thompson did, as authorizing the spread of systems of totalitarian social indoctrination based on cybernetics. Wiener deplored centralized control and relentless commercialization. While he may have been naïve about the natural compatibility between capitalism and cybernetics, Wiener also laid out a path by which information theory could be used as a tool to enhance equality and social balance.

It is indisputable that Norbert Wiener was a central figure in the history of information theory, systems theory, and cybernetics. As I have argued, his career and writings exemplify the ambiguity that it at the core of the history of cybernetics more broadly. I have argued that Wiener's invocation of communication as a source of potential freedom and political equality cannot simply be dismissed as rhetoric meant to disguise a more insidious project of social control. Wiener was aware of his field's potential to consolidate entrenched social power, but he also saw a liberatory potential in the new science of informatic systems that he was determined to elucidate. His popular writings and activism can be seen as an attempt to engage the public's attention and to shape the future of the field to support the best interests of society. However, while Wiener's contributions represent an influential stream within the history of information theory in America, Wiener was also a participant in a broader social and political project, spearheaded by the Rockefeller Foundation. The history of the Rockefeller Foundation, and its impact on broader applications of systems theory, will be explored in chapter 2.

Chapter 2: Two Systems Trajectories in Twentieth Century Biology

Examining Biological Science as a Site of Ideological Formation

This chapter will outline how the Rockefeller Foundation shaped the formation of the field of molecular biology, and how developments within molecular biology gave way to a late twentieth century shift towards ecology in the biological sciences. I will argue that the field of biology underwent a transition, over the course of the twentieth century, from molecular biology's emphasis on the tiniest scale of living phenomena, to ecology's concern with large scale phenomena. However, this transition encompassed far more than simply the scale of the objects studied; the shift from molecular biological research to ecological research was also accompanied by shifting values and political goals. While the historical discussion in the chapter will not encompass the entirety of biological science in the twentieth century, I will show how shifting points of emphasis within research programs, and shifting claims by scientists themselves, reveal patterns and trends within the field that had significant political impacts.

While the divide that arose between molecular biology and ecology is an important part of this story, I will also draw attention to important continuities between these two trajectories in biological science. Most importantly for my investigation, both molecular biology and ecology drew significantly from, and were in dialogue with, developments in cybernetics and information theory. This engagement allowed biologists to understand living processes, both microscopic and macroscopic, through a new language, rooted in concepts from physics such as entropy. As discussed in earlier chapters, information theorists, such as Norbert Wiener and Claude Shannon, argued that information could be quantitatively described by the equation for entropy, or disorder. Many biologists were fascinated by this comparison and believed that biological processes were essentially informational patterns, resisting the entropic tendency of the universe. Thus life, as a pattern of organized information, was the opposite of entropy. The organized attributes of life, expressed on cellular and ecological levels alike, were theorized as informational manifestations of life's ability to resist the movement towards disorder in the universe.

While this chapter will catalogue specific moments in which the uptake of informatic concepts took place, my goal is not simply to explain the developments in science, but to also show how these developments contributed to the formation of political and social beliefs. This belief formation took several forms. First, many biological scientists believed that they were discovering microscopic systems of control that could then be replicated on larger scales. Second, many biological scientists, inspired by informatic approaches, believed that they were discovering autonomous creativity and freedom in natural processes, either microscopic or ecosystem based, that could be mimicked and replicated in social systems. As I have discussed, political applications of systems theory frequently reveal this type of oppositionality; interpreters of the systems concept frequently disagree about whether control or freedom is the main implication of the systems perspective. Within this historical account of biological science, I will both discuss shifting rhetorical claims within biological research, and the lines of continuity that nonetheless persisted as the conversations shifted.

Molecular biology, a field originally formed in conjunction with intense guidance and intervention from philanthropic organizations, became associated with projects of rationalistic reform and social control. Over time, however, research networks in the field of biology proliferated that rejected the goal of such centralized control. Molecular biologists began publishing books on more speculative topics, commenting on the practical and philosophical implications of molecular biology. The result of these organic shifts within molecular biology was that goals of social control, prominent in the earlier years of the field, became less pronounced, and in fact began to recede in favor of more radical discussions of new scientific paradigms, reflections on human consciousness, and musings about how science could be a tool to align society with the pursuit of freedom. It was this latter sensibility that made its way from certain factions in molecular biology into the ecological sciences.

The course of development that I will trace within this chapter is not simply a history of the field of biology in the twentieth century. Rather, it is an examination of how an approach to biological research centered on social control and the elimination of social aberrancy gave way to an interpretation of biology linked with countercultural associations, invocations of freedom, and celebrations of the possibility of radically reinventing society. This transition toward more speculative values can be found in the writings of some molecular biologists beginning in the 1960s, and can also be found in scientific commentary emerging in the same period from early ecologists.

There are several implications of this historical analysis of trajectories in biological research. First, I will show that the attempt by centralized organizations such as the Rockefeller Foundation to instill science with specific social aims could not be permanently successful. One reason for this is that the scientists themselves had political agency, and were able to communicate their research and its implications directly with the public through books and other forms of engagement. Many such scientists were more aligned with the freedom loving counterculture than with carefully planned projects of social reform. The less obvious implication, however, is that the more countercultural, imaginative varieties of scientific commentary that emerged cannot be severed from their genealogical relationship to the early history of the field. The more speculative, freedom-centered late twentieth century developments in biological research were still continuous in important ways with earlier stages in research in the field. Furthermore, while systems ecologists and countercultural political theorists inspired by ecological findings claimed to be acting in pursuit of collective freedom, they never fully escaped the modalities of both political and scientific control that they claimed to be rejecting.

The version of systems theory that appeared in biological research in the later decades of the twentieth century was more likely to reflect second order thinking, unlike the more simplistic version that had circulated among molecular biologists. However, important lines of continuity nonetheless can be seen. Despite the proclamations, made by heterodox and counterculture-aligned biological scientists of the late twentieth century, that they had reinvented their respective scientific fields and discovered radical new purposes for science, their departure from existing traditions in both scientific and political thinking was often overstated. Thus, the story that I will narrate is not a simple transition from modalities of control in molecular biology to modalities of freedom in ecology. Rather, "control" and "freedom" can be seen as interlinked iterations of a rhetorical tactic of pairing science with hopes for transformative, utopian social change.

The Rockefeller Foundation and Projects of Social Control

Philanthropic associations closely shepherded the development of the field of molecular biology. The Rockefeller Foundation, and especially the head of its Natural Science division, Warren Weaver, was pivotal in supporting the uptake of information theory in molecular biology, following the publication of Norbert Wiener and Claude Shannon's seminal contributions to the field. Many historians of science have catalogued how early molecular biology was shepherded into being by the Rockefeller Foundation. In particular, Lily Kay's detailed historical account of the formation of the field of molecular biology, and the uptake of information theory within the field, emphasizes the impact of the highly organized research agenda that the Rockefeller Foundation promoted (Kay, 1993; Kay, 2000). Similarly, Bernard Geoghegan (2023) emphasizes the key role of the Rockefeller Foundation, in addition to other similar philanthropic organizations, in generating funding and enthusiasm for informatic research and its biological applications in the early to mid-twentieth century. The centrality of the Rockefeller Foundation to the eventual bridging of information theory and biology is a major theme within secondary scholarship.

Kay and Geoghegan argue that the Rockefeller Foundation was driven by a rationalistic utopianism, characteristic of the early twentieth century Progressive Era, that was rooted in the belief that human vice and imperfection could be progressively engineered away through the appropriate, scientifically informed techniques. Aberrancies in the population were a threat to the cohesion of the social body, and thus should be eliminated. The dark side of this pursuit, Kay and Geoghegan emphasize, was the association between early twentieth century progressivism and eugenics. Reformers of the era worried that cultural and individual variation in behavior would destabilize the coherence of society. Prejudiced beliefs circulated within such circles, associating immigrants, the poor, and people of color with characteristics such as alcoholism, work absenteeism, divorce, disease, and crime.

According to Kay (1993), by the time of the interwar period during which the Rockefeller Foundation decided to lay its stamp on the biological sciences, the most crude and open expression of such beliefs had become less socially acceptable, at least in so-called progressive circles. As Kay argues, the terminology of eugenics shifted away from social and behavioral intervention towards a vocabulary more rooted in the lexicon of medicine. By turning to the smallest components of biological cells, it was possible to discover microscopic systems of control and organization that provided not only an allegory for social control, but also potential tools through which rational, reformist intervention could be carried out. Molecular biology could provide a scientific, physiological explanation of aberrant human behavior, and thus could lay the groundwork for interventions to steer that behavior towards desirable goals.

These social and scientific objectives were shaped by a broader political context. As Kay discusses, the Progressive Era can be seen as a reaction to, and a rejection of, political ideologies of *laissez faire,* individualism, and unfettered free market capitalism. The inequality, excess, and subsequent discontent of the late 19th century Gilded Age was one factor in the development of new political movements emphasizing the need for social cohesion. Certainly, the Rockefeller Foundation's founding date in 1913 predated the development of modern social democracy or Keynesian governance. However, the early twentieth century period was a time in which the vestiges of the imperial, capitalist rule of the 19th century were directly challenged by political movements. The early decades of the twentieth century gave rise to the Russian Revolution in 1917, Communist and socialist political movements around the world, and National Socialism and fascism. While obviously quite distinct, the common thread of such movements was the prominence of populist political action as well as the goal of building a cohesive social body through which citizens, however fairly or unfairly they were defined, could uplift themselves.

The philanthropists of America's early twentieth century progressive movement were strongly opposed to any such populist energies, though they recognized the destabilizing influence of *laissez faire* governance and the need to promote a cohesive social body. Their social agenda can thus be seen as an attempt to find a middle way that avoided what they perceived as destabilizing extremes. The Rockefeller Foundation, along with other foundations such as the Guggenheim and Macy Foundations, sought to use the power of science to rationally solve problems caused by the excesses of capitalism. The supporters of such projects saw their efforts as scientific, neutral, and aligned with universalist values, rather than partisan interests. From a contemporary vantage point, the scope and ambition of the social interventions promoted by such philanthropic foundations contradicts any claim that these organizations were politically neutral actors. Nonetheless, these organizations sought to position themselves as neutral and aligned with universalist projects of uplift. As Kay and Geoghegan show, the purpose of reformist science that was promoted by philanthropists was less to uplift the welfare of individuals, but rather to eliminate variations in human behavior that threatened the coherence of social organization. Kay and Geoghegan view this effort as an attempt to reinvent eugenics through more a socially acceptable language and set of strategies, including tools from the field of medicine.

I have argued that the information sciences and systems theory provided a set of tools that were amenable to social control. However, the desire for such rationalistic control predates the emergence of information theory itself. One notable example from the field of sociology is *Means of Social Control* by Frederick Lumley. The text describes the organization of society in abstract, theoretical terms. Lumley (1925) explains that when a given order contains "arrangement and relationship" and "uniformity in nature," it is possible to make relevant predictions (p. 3). According to Lumley, it is desirable for society to be organized in such a way that it is predictable. Every social order is constituted by repeating patterns that instill dependability in social relationships, which is necessary for society to function. Thus, echoing attitudes that would later be expressed by information theorists such as Wiener, the pattern itself is a source of moral good.

Further, Lumley uses the concept of order to differentiate between functional and dysfunctional societies. Functional societies, which according to Lumley are usually societies with the longest history, are characterized by order and harmony, expressed through the behaviors of individual members of that society. Thus, Lumley (1925) explains,

> "The members of any given group *are* members by virtue of their harmonious and cooperative actions, feelings and thoughts...The older the society, the more harmonious, the more integrated, the more interlocked do these action-, feeling- and thought-patterns become." (p. 7).

It is important to note that for Lumley, the well-functioning society is determined in reference to a series of universal standards. The appearance of universality allows Lumley to present his framework as apolitical. Furthermore, Lumley does not simply measure overt displays of social behavior, but also analyzes the private thoughts and feelings of individuals. This private sphere must be governed, according to Lumley, in order to create a harmonious whole. The drive to maximize social conformity through the governance of private and interior experiences was a major theme of the efforts towards rationalistic reform characteristic of the period.

Lumley's account of governance and means of control also has important parallels with later developments in cybernetic theory. Social control, as Lumley describes it, occurs through either physical force or the "human symbol method" (Lumley, 1925, p. 14). The latter method is preferred because of its efficiency. It requires less energy and effort to control people through the abstract realm of symbols, compared to the realm of material forces. The abstract control that Lumley prefers involves various forms of psychological manipulation, that play on the biases and weaknesses of human nature. In a passage that is strikingly reminiscent of claims about communication that would later be made by information theorists such as Wiener and Shannon, Lumley (1925) argues that for the social planner, "The *best* possible situation conceivable, in the work of control, is where the controller clearly and unmistakably delivers his message, the recipient clearly and unmistakably grasps its meaning , and then the body responds readily and accurately" (p. 17). Thus, the ideal form of social control, according to Lumley, is communication. Lumley asserts that such manipulation of messages can only be unethical if it undermines the social order as whole; the manipulation of the motives of individuals was not itself an ethical violation.

While Lumley's account is only one example of the state of the early twentieth century field of sociology and the social sciences more broadly, his arguments reflect attitudes that circulated among in the broader culture at the time. Disorder was seen as inherently dangerous and as an urgent threat to society, but disorder was also unavoidable. The unregulated capitalism of the industrial era had placed workers in very challenging work conditions, and there was widespread anxiety about the chaotic and unpredictable populist movements that were arising worldwide in response to capitalist excess. Continuous immigration to America from Europe during this period instilled fears about a lack of social cohesion due to the importation of people with bad habits or poor work ethic. Uneducated workers were perceived as a threat to the progressive improvement of society in accordance with universalist principles.

In response to this perceived chaos, reformist approaches hoped to shape human behavior in radical ways. One notable example was the Prohibition Movement, which was built upon the belief that human behavior could be radically altered and improved through regulation of alcohol. However, in regard to the Rockefeller Foundation, it was eugenics that received the most attention. The Rockefeller family themselves were deeply involved in advocacy for eugenics, and their foundation provided funding for activists such as Margaret Sanger who supported both the right to birth control and, in certain circumstances, compulsory sterilization. The Rockefeller Foundation also funded several German eugenicists, even after Hitler's rise to power. These activities represent a deeply horrifying chapter of American history that deserves full investigation. However, in the context of this chapter, it is the Rockefeller's funding for molecular biology research, and the connection between this funding and political aims, that is most significant.

The Rockefeller Foundation had the deep pockets and the resolve to take on the project of mobilizing the sciences in pursuit of social order and the vanquishment of social chaos. Eugenicist aims were the subtext of many of these efforts. Science provided a seemingly neutral tool to carry out social interventions. However, in order to use science to effectively shape human behavior, the sciences themselves had to be reformed. The Rockefeller Foundation supported research in the new field of molecular biology in hopes that the chaos of previous generations of biological research could be reformed through methods and styles of inquiry inherited from physics, a field that was widely perceived as more rigorous and respectable. The social sciences were to be shaped to be more scientifically serious as well, drawing from developments in the biological sciences and medicine. However, it was molecular biology that received enormous attention, funding, and prominence from the 1930s onwards.

The Rockefeller Foundation launched their "Science of Man" initiative in the 1930s with the aim of bringing the same rigor to the biological sciences that had been developed in the physical sciences. The control of living matter was seen as a major frontier of science that had to be conquered to achieve social progress. Max Mason, the president of the Rockefeller Foundation at the time, himself a mathematician, chose fellow mathematician Warren Weaver to be in charge of the Natural Sciences division. Mason and Weaver had previously co-authored a textbook on the topic of electromagnetic forces. Weaver certainly brought a mathematician's sensibility to the new post. He was deeply suspicious of branches of science he considered insufficiently exact, most notably psychiatry and the social sciences. However, he believed that biology could be reformed, through his guidance, to adopt rigorous research methodologies and to pursue serious research questions.

Weaver coined the name Molecular Biology to describe the new field, and was committed to making biology more like physics. Just as physics had revealed the hidden order in the physical forces of the universe, biology should reveal the fundamental principles behind biological order. The purpose of such investigations was far from theoretical. Rather, Weaver explicitly insisted that the field of biology should pursue the discovery of rational explanations of human action. By understanding the function of microbiological processes at the most minute level, it would be possible to gradually develop a more complete theory of biological behavior at an observable scale. Even the human mind would eventually be decoded by the persistent study of the life's fundamental processes. These discoveries, it was hoped, would be the key to the development of efficient modes of social control. Biology would no longer be hampered by associations with "medical education, agricultural interests, evolutionary biology, the residues of natural history" and would instead be "wedded to engineering and the physical sciences" (Kay, 1993, p. 50).

In his role, Weaver had enormous power to allocate funding to specific projects and to shape the direction of postwar biological research. Weaver was a key figure providing financial support for Norbert Wiener's postwar research on cybernetics, and also supported other researchers who were working to translate the principles of information theory into biology. Nonetheless, while Weaver considered Wiener a type of genius, he also was critical of the imprecision and imaginative expression of many of Wiener's ideas, particularly those that made their way into the popular realm. Weaver was a closer collaborator with information theorist Claude Shannon, and together they published *The Mathematical Theory of Communication* in 1948, as a more sober and technically complex alternative to Wiener's *Cybernetics*.

The majority of *The Mathematical Theory of Communication* is a very technical discussion of mathematical equations, authored by Claude Shannon. However, the book also contains a separate essay on information theory written by Warren Weaver. In the essay, Weaver argues that information theory might ultimately give rise to a true theory of meaning. Weaver explains that

> "This idea that a communication system ought to try to deal with all possible messages, and that the intelligent way to try is to base design on the statistical character of the source, is surely not without significance for communication in general. Language must be designed (or developed) with a view to the totality of things that man may wish to say; but not being able to accomplish everything, it too should do as well as possible as often as possible. That is to say, it too should deal with its task statistically." (Shannon & Weaver, 1963, p. 116-117).

Thus, the study of communication of meanings cannot be about the communication of any specific message. Rather, it must be a study of the whole totality of the system of communication, and how frequently that communication is successful. Creating systems in which communication is effective should be the priority. Furthermore, Weaver hoped that the information concept would hold the secret to decoding the complexities of human behavior. He believed that information was the key to fundamental truths about complex phenomena that could be decoded only through statistical approaches. He agreed with those who celebrated the mathematical equivalence of information and entropy, and saw this equivalence as proof that information was the key to fundamental scientific truths. Weaver was also convinced that these insights from information theory, applied to the field of biology, would reveal the hidden order, code, and even meaning behind the perceived complexity of biological phenomena.

While these developments were taking place in molecular biology, the Josiah Macy Jr. Foundation supported a series of conferences from 1941-1960, during which cybernetic approaches to psychiatry and medicine were discussed intensively by the workshop participants. The influence of cybernetics on the conference participants can be seen in the very frequent references to feedback loop and feedback systems in human psychology and neurobiology. Norbert Wiener, neurophysiologist Warren McCulloch, and anthropologists Margaret Mead and Gregory Bateson were major figures in the conference proceedings, particularly in the years from 1949-1953. The conferences contained extensive discussion of the applications of cybernetic concepts including homeostatic regulation, communication of messages, and informatic control of both the behavioral and physiological aspects of human psychology.

During the 1949 conference, psychiatrist Lawrence Kubie's talk, "The Neurotic Potential and Human Adaptation," exemplifies how systems thinking was used as a tool to bridge science, information theory, and behavioral control. In the talk, Kubie discusses how the unconscious force of the human psyche could be rationally analyzed and controlled. Kubie establishes early in the talk that conscious forces are superior to unconscious ones. Conscious behavior is responsive to the powers of reason, and people are able to change their conscious behaviors to respond to feedback of various kinds. In contrast, unconscious behavior, according to Kubie generally

> "is rigid and inflexible. It never learns from experience. It cannot be altered by argument or reason or persuasion or exhortation or rewards or punishment, and not even by its own successes and failures. Since by its very nature it can never reach its unacknowledged and unrecognized goals, it is insatiable and endlessly repetitive, repeating its errors as often as and perhaps even more often than its successes, and marching ahead on blindly stereotyped paths" (Kubie, 2015, p. 71).

The goal of scientific intervention, according to Kubie, should be to reduce the prevalence of such irrational, unconscious behavior. Unconscious behavior was flawed because of a flaw in the feedback loops of the mind; behavioral improvements could be achieved by finding techniques to intervene in this iterative replication of mental processes.

Completely eliminating the unconscious aspects of the mind would also eliminate what Kubie admits are the basis for the depth of feeling that can sometimes lead to human greatness. Kubie argues, however, that human progress itself depends on the ability to "extend the area of conscious motivation and purpose and control in human life; and to shrink and circumscribe the territories of that darker empire which is ruled by unconscious forces" (Kubie, 2015, p. 72). Thus, the ordered and rational progress of the social whole depends on the ability of individuals to act rationally and to improve themselves. The irrational and dysfunctional feedback loops of the unconscious should be replaced by conscious rationality. The shaping of the individual was thus the key to comprehensive social control. For figures such as Kubie, insights from information theory strengthened the belief that informatic, homeostatic circuits of control were both the source of psychological problems, and the best mechanism for intervention. Kubie's analysis of the unconscious mirrors the enthusiasm for rational control and the elimination of aberrancy would later animate activities by the Rockefeller Foundation.

The Uptake of Information Theory in Molecular Biology

The goal of highlighting life's inherent order, for the purpose of reducing its disorder and unpredictability, guided Weaver's role as head of the Natural Sciences division at the Rockefeller Foundation, and the ongoing development of the field of molecular biology. At the time that the information sciences were starting to gain interest in the scientific community, biological research was still dominated by the protein paradigm, the view that genetic inheritance was attributable to proteins rather than DNA. Weaver strongly supported research into proteins, which he saw as the control mechanisms within cells. Understanding these control systems was the first step in the long term project of discovering techniques to manipulate the macroscopic scale of behavior. Weaver was also a supporter of the effort of translating information theory into biological research, even during the period during the 1940s and 1950s in which the protein paradigm was still ascendant. The genetic encoding function of DNA would achieve widespread acceptance just a few years later, and this paradigm shift would only reinforce the centrality of information discourse in biology.

While proponents of information theory as a tool in biology frequently described the association of information with entropy as an important breakthrough, the concept of entropy itself was not entirely new to the biological sciences. Erwin Schrödinger's (1944) text, *What is Life?*, argues that life feeds on negative entropy. Thus, rather than viewing the organism as a metabolizer of energy, Schrödinger argued, it was possible to view the organism as a metabolizer of order itself. The coherence of an organism over time was a result of its ability to maintain the set of patterns that directed cellular processes. While many historians have seen Schrödinger's claims as a prefiguration of the full uptake of information thinking in biology, Lily Kay (2000) claims that this portrayal is misleading. Schrödinger, Kay argues, was stuck in an earlier paradigm that emphasized multi-dimensional protein patterns rather than an abstractable code, the hallmark of information theory.

One of the earliest true attempts to translate information theory to biology was an essay by Hans Kalmus (1950), "The Cybernetical Aspects of Genetics." Kalmus claimed that it was obvious that Norbert Wiener's contributions to cybernetics would have implications for biology. Kalmus insisted that a gene is clearly a message, through which the instructions of life are transmitted by way of processes of inheritance. A neuron was also likely an informatic component of a cell, according to Kalmus, but other cells such as liver cells were not. The distinguishing feature of a true informatic component, according to Kalmus, was its gestalt and holistic qualities, and ability to convey meaning. This meaning was the force that opposed the entropic tendency of all matter; thus, Kalmus claimed, communication was the source of the maintenance of order within cells. The essay was written in alignment with the protein paradigm, still dominant at the time, that theorized that genetic inheritance was carried out by proteins. Despite the scientific inaccuracy of the article, Kalmus illustrates the enthusiasm with which biologists took up the new informatic lingo even before the discovery of DNA.

Another figure who made important contributions in the brief span of time between the development of information theory and the uptake of the DNA theory of the gene was Henry Quastler. Quastler was at the center of various scientific collaborations and conferences seeking to translate information theory in biology (Quastler, 1953; Yockey, 1958). In these discussions the concept of specificity was frequently used as a stand in for information. The study of biological specificity, especially specificity relating to the function of proteins, was seen as the key to discovering fundamental truths about the organism. Furthermore, the study of biological specificity was seen as the key to understanding macroscopic, emergent characteristics of organisms. This could be applied to the study of disease and death, which were described by some biologists as manifestations of the force of entropy, destroying the informational coherence of the cell. The implication, it seemed, was that information discourse, the key to unlocking the secrets of aging and illness, could finally tackle fundamental shortcomings of the human condition.

While the uptake of information theory within the protein paradigm of biological research was only a short lived development, the centrality of information theory to biological research was only enhanced with the discovery of DNA. The exact timeline of the discovery of the genetic function and structure of DNA is somewhat contested. While James Watson and Francis Crick are often credited with discovering DNA's double helix shape, as discussed in their paper published in 1953, Rosalind Franklin had already made a similar discovery. Erwin Chargaff had also made key discoveries in the 1940s about the DNA bases that indicated that DNA could have a hereditary function. The comprehensive shift in the field of molecular biology, away from proteins and towards DNA as the source of genetic inheritance, was not instantaneous but did become definitive by the 1960s. If biological research, rooted in information theory and the protein paradigm, had planted the seeds of scientific hopes that life could be brought under control, the direction of biological research with the entrance of the DNA paradigm only reinforced these many of these hopes.

Carl Woese (1967), a molecular biologist who made discoveries about RNA, the intermediate material between DNA and protein in the cellular translation process, described his findings to the public in his book, *The Genetic Code*. Throughout the book, Woese compares both RNA and DNA to the tape reading systems of the early computers that were in use at the time. The metaphor implied that it was *because* genetic material was informatic code that it was able to be a source of control within the cell, capable of managing and directing complex processes. Woese argues that what genetic code made possible was control of the delicate and precise regulatory processes in the cell. Without highly specific and refined systems of control, organized and higher forms of life would not be possible, or perhaps any form of life at all. Thus, Woese portrayed life as a continuous homeostatic mechanism that depended on control for its very existence. The discovery of DNA and RNA provided clues to the "underlying principles from the which the whole superstructure sprang" (Woese, 1967, p. 3). These underlying mechanisms of cellular order, which Woese compared to both computers and to human language, were the key to the secrets of the cell. Furthermore, just as in human communicational systems, the genetic code included punctuation, modulation, and translation.

While Woese emphasized the importance of the maintenance of cellular order, he made other comments that pointed towards future directions in genetic research. Woese noted that current scientific consensus had not been able to definitively assess whether the genetic code was fully mechanistic, or whether more random stochastic elements, best measured by probability, might be present. He acknowledged that the processes of evolution over millions of years of life had been enormously complex, and that this process could never be fully reconstructed from the vantage point of the present. Further, Woese noted that complex interaction between components of the cell were most likely the element selected for in evolution, rather than simply an abstract form of code. Thus, Woese insists, it was relationships between nucleic acids and amino acids that must have been selected for in evolution, rather than the abstract arrangement of nuclear acids themselves.

Other molecular biologists who worked on the science of DNA showed a similar recognition of how the genetic code was both a system of control, and an artifact that hinted at systems of enormous complexity that could never be brought under human control. Another book which made an impact on the public's understanding of the new science of DNA was *The Language of Life*, co-written by George Beadle and his wife Muriel Beadle. Beadle, along with his collaborator Edward Tatum, introduced the one gene, one enzyme theory of genetics. Beadle (1966) argues that the genetic code has "revealed our possession of a language much older than hieroglyphics, a language as old as life itself" (p. 207). This language, now in the "possession" of humankind, allows for fundamental discoveries about the linguistic programming behind life's processes. Beadle further compares developments in the field of molecular genetics to the 18th century discovery of the Rosetta stone. While Beadle does not engage directly with information theory itself, his consistent references to the metaphor of language can be seen as an exemplification of the impact of information theory on the conceptualization of biological problems. This linguistic conceptualization of biological processes affected how scientists understood the purposes of their research endeavors. According to Beadle, the discovery of DNA genetics should be seen as uniquely momentous, not simply because the new branch of science had created new tools and means of analysis, but also because it would give rise to new abilities for humans to manipulate their own future destiny.

Beadle believes that throughout human history, science has been the modality of thought through which humans first grasped the idea of social progress. Beadle argues that the concept of progress was not conceivable when humans were still captured by religious thinking. Because science has no final truth, only ongoing processes of experimentation, the practice of science revealed basic truths about the lack of finality and closure in the human condition. Thus, according to Beadle, the purpose of not only science, but also all human endeavors, became oriented around the concept of progressive improvement. Beadle argues that with the discovery of the language of life, the DNA genetic code, humankind was facing essentially new choices about how to engineer its own future. Specifically, Beadle explains, the keys to the code of life would give humans the tools to direct their own biological evolutionary processes, in order to engineer and create superior humans. Beadle was not unaware of the eugenic associations of such projects, but he attempts to separate overt racism from genetic engineering itself. He acknowledges that racial preferentialism, along with the manipulation of other arbitrary preferences such as height, would be problematic. However, Beadle argues that the primary reason genetic engineering would be wrong stems not from an intrinsic moral objection, but rather from the lack of skill and wisdom of humanity. That is, humans do not yet have enough accumulated knowledge or wisdom to direct the course of their own evolution.

Nonetheless, Beadle remarks that humans will not be able to avoid such projects forever. Echoing concerns aligned with the goals of eugenics, Beadle worries that modern life will exert undesirable selective pressures on human reproduction. Since modern life provides access to technology and a standard of living that allows people with rare diseases to survive and even reproduce, Beadle claims that deleterious mutations or simply less desirable DNA will be more likely to pass to the next generation. Before modern life, such individuals might not have survived long enough to reproduce. Beadle (1966) also remarks that

> "even as humane a society as ours will find that people with inherited diseases and disabilities constitute a social burden so great relative to our resources that we will be forced to limit what most of us consider one of our inalienable individual rights—the right to bear children" (p. 223).

Thus, Beadle's comments reveal both a sensitivity to the value of the concept of liberty, but also a tacit assumption that systems of control are needed, in conjunction with science, to engineer human destiny.

The differential reproduction that should be of the most concern, according to Beadle, is the differing reproduction rates between developed and developing countries. Beadle includes evidence showing that citizens of developing countries have children at higher rates. Beadle's assertions align with Kay's argument about the repackaging of eugenics in a more socially acceptable language through molecular biology. Beadle rejects outright racism, and disavows the belief that any race of people is genetically inferior or superior. Beadle even acknowledges that African American people in Western countries face challenging environmental factors that can contribute towards the difficulty these communities have faced in efforts to uplift their economic conditions. Nonetheless, racist undertones are present in Beadle's assertion that higher birthrates in developing countries have problematic implications for the genetic quality of the human population. Beadle's arguments about birthrates are cloistered in the final pages of the book, presented as an unfortunate but necessary conclusion following from the discovery of a linguistic order that undergirds the chaos of life processes. Beadle implies that the work of intentionally designing the course of human evolution will be difficult but necessary, even essential for the future survival of humankind.

Alternative Approaches Within Molecular Biology

While Beadle implies that scientific developments in genetics create a kind of burden for humankind to take up, in order to control human destiny, other molecular biologists who studied the genetic code had more certainty that science would provide tools to push back on such social control, to instead support human freedom. One such book was *The Logic of Life* by Francois Jacob (1973). Jacob won the Nobel Prize in 1965, along with Andre Lwoff and Jacques Monod, for research into how the regulation of genetic transcription controls enzymes in the cell. However, in contrast to Beadle's claim that the discovery of the genetic code was a singular, Rosetta stone moment in history, creating a unique imperative for humanity to engineer its own destiny, Jacob portrays the genetic science of DNA as simply one paradigm among a long succession of paradigm shifts throughout history. While Jacob does not directly cite the seminal work on paradigm shifts in science by Thomas Kuhn, or even use the word paradigm itself, he uses very similar terminology to discuss how successive regimes of scientific practice give rise to historically specific ways of viewing the world. Jacob emphasizes the importance of scientific questions themselves, and how these questions continually undermine the cognitive attitude of certainty in practitioners of science. In fact, Jacob (1973) claims, “what is important in science is as much its spirit as its product: it is as much the openmindedness, the primacy of criticism, the submission to the unforeseen” (p. xxi). Jacob argues that nothing is more destructive to human civilization than the attitude of certainty; thus, uncertainty is the antidote. Jacob argues that uses of science for racist or bigoted purposes are simply an injection of false certainty and distorting prejudice into the scientific process. If the progress of science is allowed to unfold, it will eventually counteract these forms of false certainty, just as scientific progress counteracted the false certainty of religious viewpoints in the past.

While Jacob agrees with Beadle that there are linguistic aspects to the genetic code, Jacob’s claims do not align with Beadle’s assertions about the amenability of the genetic code to projects of social control. Instead of emphasizing the amenability of the code to control, Jacob emphasizes how the code eludes centralized control. In fact, Jacob claims, the organism is the perfect example of emergent order. Thus, “The living being does indeed represent the execution of a plan, but not one conceived in any mind. It strives towards a goal, but not one chosen by any will” (Jacob, 1973, p. 2). The actions of the organism must then be understood through a different terminology, less determined by anthropocentric metaphors of centralized direction. Furthermore, according to Jacob, the genetic sciences reveal the continual, recursive flow of information within organisms, undermining dominant conceptualizations of organisms as objects. Instead, the organism should be seen as "a transition, a stage between what was and what will be" (Jacob, 1973, p. 2). Jacob explains that this understanding of the processual nature of life directly challenges cosmological views, directly or indirectly influenced by religious viewpoints, that emphasize how life is "administered externally by a supreme power" (Jacob, 1973, p. 3). Instead, the picture of life that emerges, through developments in science, is that of life as an anti-entropic force of order that defies the tendency of nonliving matter to deteriorate. This anti-entropic force is not directed by any centralized form of control. Further, Jacob discusses the shortcomings of reductionist approaches to biology that attempt to separate the organism from the environment in which it is constituted. Reductionist scientists, Jacobs explains, will miss the insights picked up by more integrationist methodologies that take the entire context of life into account, even the vast context of the evolutionary history of life.

Jacob argues that rather than searching for final truths, science should be about peeling back progressive layers of knowledge. He compares scientific paradigm shifts to the shift between levels of a Russian doll, explaining that "the demonstration of these consecutive levels are not the result of a mere accumulation of observations and experiments. More often they express a deeper change, a new way of considering objects, a transformation in the very nature of knowledge" (Jacob, 1973, p. 17). Thus, molecular biology, as one such new paradigm of knowledge, isn't simply a set of facts about the transmission of genetic material, but rather a new way of thinking about biological artifacts. Through the genetic paradigm, it is possible to see the functional complexity of genetic code. The organism, rather than being an artifact of natural history, is revealed to be an organized system whose structure is oriented towards functions and purposes. These purposes defy any top-down understanding of design; rather, systems within cells emerge spontaneously, both within the lifespan of the individual and over the course of evolutionary history. Thus, Jacob explains,

> "Every object that biology studies is a system of systems. Being part of a higher-order system itself, it sometimes obeys rules that cannot be deduced simply by analysing it. This means that each level of organization must be considered with reference to the adjacent levels." (Jacob, 1973, p. 307).

Jacob's recognition that biology was becoming a science of systems has continuities with the cybernetic influences that had shaped the field of molecular biology since the 1950s. Additionally, Jacob's recognition of multiple levels of analysis aligns with an important development in cybernetic theory that shaped the application of cybernetics to ecology: second-order systems theory, which will be discussed later in the chapter. While the ecological appropriations of cybernetics, in the context of second-order systems theory, would lead to strong claims about the relationship between humans and the environment, Jacob's commentary recognizes that the human condition cannot be separated from the biological grounding of human life. Just as biological organisms are complex systems, governed without centralized direction through functional rules, Jacob argues that human social systems are also dynamic, decentralized, and governed at their core through information. Furthermore, just as an organism's evolution depends on the ability of life to permanently store new information, social evolution depends on the transference of contingent information into collective memory. The practice of science could yield insights into these processes, not for the purpose of social control, but in order to enter consciously into the dynamic processes of history.

The connection between biology and cybernetics was made even more explicitly by Jacques Monod, one of Jacob's research collaborators. In his book *Chance and Necessity*, Monod (1971) describes biological organisms as cybernetic systems. Monod explains that the cybernetic character of the organism is demonstrated by its functional coordination and systems of control. Furthermore, the nature of the organism as a "self-constructing machine" that "shapes itself autonomously by dint of constructive internal interactions" reveals its cybernetic nature (Monod, 1971, p. 46). According to Monod, the significance of this discovery, and growing developments in the field of molecular biology, is not simply greater descriptive or predictive capabilities. Rather, the systems concept is a new way of thinking about the emergence of purposes and forms of order within living organisms. While Jacob discussed how systems thinking would alter humanity's understanding of its own evolutionary cultural processes, Monod states even more explicitly that biology has the tools that can, more than perhaps any science, "clarify man's relationship to the universe" (p. xi). Once humans realize their own status as cybernetic organisms, they will be able to understand their own lives as expression of vastly complex processes.

In addition to using language from the field of cybernetics to support his argument about the development of human self-consciousness through science, Monod also turns, perhaps surprisingly, to dialectical materialism. While the Cold War context of the mid twentieth century might seem relevant to this inclusion, Monod does not directly mention the Soviet Union at any point in the book. He does, however, frequently mention Marx, along with Friedrich Engels, in relation to a philosophical discussion of dialectical materialism. Dialectical materialism, outlined by Marx and Engels, is a materialist reworking of Hegel's dialectical theory of history. While Hegel argued that history was a dynamic, dialectical expression of consciousness or spirit, Marx and Engels argued that the mutually interactive, dialectical forces of history were material. While intellectual ideas should be seen as part of these interactive, dialectical processes, intellectual ideas should also be understood as products of historical moments, and specifically as products of the material conditions of each historical moment.

Monod argues that the evolutionary processes of living and even nonliving matter can only be truly perceived through the proper form of awareness, enhanced by the perspective of dialectical materialism. Thus, knowledge about the universe "is obtained only in the interaction, itself evolutive and a cause of evolution, between man and matter (or, more exactly, the 'rest' of matter). All true knowledge is therefore 'practical'" (Monod, 1971, p. 34). In order to truly grasp the processes of the material universe, even within the practice of science, it was thus essential for humans to be aware not only of their role as observers, but of their role as participants in the universe. Human conscious awareness is always shaped by the dynamic processes of the universe, and all forms of knowledge are shaped by this encounter.

The specific kinds of processes that, according to Monod, can be perceived through this form of awareness include the complex cybernetic systems within cells. Only a true understanding of dynamic interactions between functional cellular components would reveal the self-organizing and emergent qualities of the cell. While Monod acknowledges that the cell's coherence depends on systems of control, this type of control is emergent, rather than top-down. Bolstered by this new understanding of living systems, Monod argues that humanity's scientific pursuits in the future should center around two aims: the discovery of the evolutionary origins of life, and the understanding of the human nervous system. Specifically, Monod hoped that science would help humanity to cast off limiting value systems, to achieve true "authenticity" based on an awareness that humanity

> "is alone in the universe's unfeeling immensity, out of which he emerged only by chance. His destiny is nowhere spelled out, nor is his duty. The kingdom above or the darkness below: it is for him to choose" (Monod, 1971, p. 180).

Thus, only by understanding the biological, evolutionary nature of the human condition can humanity truly be free enough to invent its own purposes and its own future destiny.

For Monod, dialectical materialism and cybernetics contribute to the development of a point of view from which it is possible to see the contingency of the human condition. Only by acknowledging this contingency can real human autonomy be possible. Thus, Monod articulates how biological science can become more than a tool of social control, or a means towards engineering away the defects of human biology. Instead, rather than seeking control, Monod argues that humans should seek authenticity. This authenticity is the key, for "Authentic discourse in its turn lays the foundation of science, and returns to the hands of man the immense powers that enrich and imperil him today" (Monod, 1971, p. 177). The turn towards true ethics made possible by this point of view should be driven not by a desire to transcend or escape the imperfections of human existence, but rather should be rooted in an acknowledgement of them. Thus, the proper approach towards knowledge should be based on "a clear-sighted appreciation of the urges and passions, the requirements and limitations of the biological being" that is able to "confront the animal in man" (Monod, 1971, p. 178). Understanding the human condition, and the universe itself, through the dynamic language of both cybernetics and dialectical materialism is thus positioned by Monod as the core task of science and ethics alike.

The Origins of Modern Ecology

While scientists hailing from the field of molecular biology were speculating about how the biological sciences might enact paradigm shifts in human consciousness, similar developments were taking place in the field of ecology. Though the origins of modern ecology and environmentalism are often traced to the early 1960s, ecological thinking predates this late twentieth century period. The word ecology, coined by a German zoologist, was in usage since the 19th century. Ecology also became a major science within the British empire, as Peder Anker (2001) has extensively documented. However, during the late twentieth century, ecological perspectives became significantly more prominent in American culture. The publication of Rachel Carson's *Silent Spring* in 1962, an account of the harmful effects of DDT on human and nonhuman life, is often mentioned as a major instigator of America's environmental movement. The book reached a wide public audience and expressed a growing anxiety within American culture that technological modernity had reached a state of development that could truly threaten living beings. It was also during this period that biological scientists began to take on the task of defining ecology as a branch of science.

A special issue of the journal *Bioscience*, published in 1964, illustrates the growing belief among biological scientists that the field of ecology was in need of definition (Platt & Wolfe, 1964). The special issue contained a variety of essays devoted to defining the new field and its purposes, with one notable essay by Paul Sears (1964) which argued that the field of ecology was of unique political and social importance. Sears states that the field of ecology would directly challenge Cartesian dualisms between observer and observed, and that understanding ecology would depend on seeing the human as part of the complex systems constituting the natural world. As such, Sears claims that the knowledge produced by ecology would be inseparable from "a continuing critique of man's operations within the system" (p. 12). In particular, Sears is critical of approaches to ecology and the biological sciences which assume that growth is equally salutary for societies, ecosystems, and organisms. Sears argues against the "ever-expanding, ever-rising spiral" of the growth-based approach to human economies, which he implies stems from a misappropriation of biological concepts (p. 12). Sears also expresses hope that ecological science speak to the diversity of specific places and ecosystems on the planet. For Sears, describing the material conditions of the Earth's ecological systems requires attention to novelty and difference, and caution about abstract principles.

The challenge of balancing material specificity and theoretical abstraction would become a persistent fixation for the field. Several articles published during this period capture this debate about which methodological approaches could best describe the real conditions of ecological systems while satisfying the principles of sound science. A scientific article, written by Frank Pitelka (1974), expresses the worry that ecology had become a field that tolerates only a narrow range of methodological possibilities. Pitelka claims that the field of ecology had been captured by mathematical approaches, to the exclusion of more holistic approaches that, for example, include "the study of real organisms" by way of "gathering facts" which are "more than data points" (Pitelka, 1974, p. 925). Pitelka argues that qualitative information observed by scientists during encounters with nature, which cannot always be translated into mathematical models, has an indispensable place in the field of ecology. Additionally, Pitelka complains that mathematical models which describe a very limited number of components in an ecological system are too often used by ecologists to make broad generalizations that are not justified by their existing knowledge. This preference for mathematical elegance is explained by Pitelka as a tendency to "sacrifice facts for the sake of beauty," apparently meaning the beauty of the mathematical explanation (p. 925). Pitelka indicates that ecological facts must be more than either reductionist or abstract formations; Pitelka's preferred facts retain a qualitative character based on methodological and observational sensitivity for the phenomena being studied, even in the context of the practice of science.

Another article which outlines some of the persistent controversies in the field was written by Timothy Allen (1981). Allen argues that ecology shouldn't settle on any single interpretive approach, including either reductionist or holist varieties, but that ecologists should "lift our heads...from the mechanics of data collection, analysis, or whatever" in order to "look at the big picture" (Allen, 1981, p. 871). Allen implies that scientists should be curious about the purposes of their discipline, and tailor specific research projects and methodological choices to the specificity of the object being studied.

Allen's article was written in response to a piece by the prominent scientists and frequent co-authors, ecologist Richard Levins and biologist Richard Lewontin (1980). Levins and Lewontin's co-authored paper, "Dialectics and reductionism in ecology," took aim at what they saw as both overly reductive approaches to ecological science, and overly idealist ones. While acknowledging that reductionist approaches, which seek to isolate parts from wholes, can be analytically useful due to their greater simplicity, Levins and Lewontin questioned whether the sacrifice of the more qualitative environmental context was always appropriate. The authors also rejected what they call the idealist approach, which attempts to account for isolated ecological processes through scientific abstractions such as mathematical formulas. The authors argue that both reductionism and idealism are only capable of describing part of the picture, and that a more "proper materialism...accepts neither of these doctrinaire positions but looks for the actual material relationship among entities at all levels" (Levins & Lewontin, 1980, p. 51). As an alternative to the "mechanistic reductionism championing materialism, and idealism representing holistic and sometimes dialectical concerns," they offered an alternative syncretic approach, dialectical materialism (Levins & Lewontin, 1980, p. 47). Thus, as I will discuss, Levins and Lewontin's approach echoes that of Monod in important ways.

Levins and Lewontin acknowledge that the reference to dialectical materialism, a phrase also used by Karl Marx, is not entirely accidental. While the authors express sympathy with critiques of capitalism, the invocation of Marx has a more philosophical than directly political significance. They seek to accommodate both the rigorous collection of empirical facts and serious theoretical and mathematical accounts of the processes found in nature. The article is not explicitly positioned as intervention in information theory. In fact, the word information is not mentioned at all. Nonetheless, Levins and Lewontin land upon central insights from the information sciences about the methodological challenge of describing and quantifying complex distributions of data. Levins and Lewontin don't want to reject mathematics, but they worry that mathematics tends to have the effect of over-simplifying complex processes. Furthermore, Levins and Lewontin arrive upon the insight that some molecular biologists, such as Jacob and Monod, had apparently perceived: that ecological systems are essentially systems within systems. Levins and Lewontin favor the dialectical materialist approach because of its ability to describe the ecological community as "a contingent whole in reciprocal interaction with the lower and higher-level wholes" (p. 55). Further, these investigations, according to the authors, should have a qualitative aspect. According to Levins and Lewontin, ecological terms including "diversity, equability, biomass, primary production, invasibility, and the patterning of food webs" are identified as important because they "appear as striking" and are qualitatively coherent (p. 55).

For Levins and Lewontin, describing the material reality of an ecosystem depends on finding a way to integrate abstract theory with the complex material context of an environment. While acknowledging the importance of pure theory for some investigations, Levins and Lewontin argue that "Abstraction becomes destructive when the abstract becomes reified and when the historical process of abstraction has been forgotten so that the abstract descriptions are taken for descriptions of the actual objects" (Levin and Lewontin, 1980, p. 67). Thus, ecological science, following the philosophy of dialectical materialism, should embrace complexity, and even in some cases contradictions. One of the most important truths about the material world that Levins and Lewontin want to capture through their dialectical materialist philosophy is the overlapping and even contradictory interrelationships of various components within ecosystems. They argue that recognizing, rather than running from, the complexity is essential for positioning ecology to be effective, including in the political realm. A true understanding of how ecological processes impact and are affected by human social life can only be built through an acknowledgment of life's complexity and ecological relationality. Clearly, Levins and Lewontin seek goals that are vastly different from the social engineering plans of the architects of molecular biology. While not all ecologists were politically radical, or willing to describe the practice of science as political, many more did so eagerly.

The Influence of Information Theory on Ecology

It was in fact within a community of biologists and ecologists influenced by systems theory that some of the most ambitious approaches to the political applications of biology emerged. For Warren Weaver and the functionaries of the Rockefeller Foundation, systems and information theory had been a way to shape the field biology in alignment with goals of social control, well-defined research methodologies, and technocratic progress. However, a version of systems and information theory, known as second-order systems theory, had the opposite effect on biological and ecological research in the later decades of the twentieth century. Second-order systems theory was the inspiration for various radical claims about the purposes and politics of biological research. It provided a conceptual terminology that became the unifying ethos of a broad community of counterculture-aligned systems enthusiasts. In particular, I will discuss how second-order thinking inspired the systems biology of Francisco Varela and Humberto Maturana, and the earth systems Gaia theory of Lynn Margulis and James Lovelock. I will discuss how these scientists participated in politically oriented organizations, most notably the Lindisfarne Association, led by William Irwin Thompson. I will discuss Thompson's colorful and ambitious claims about how the field of biology could inspire new forms of political thinking, heralding a society based on integration rather than dualistic, alienated human consciousness. I will also discuss how systems theory and ecology appeared in Stewart Brand's *Whole Earth Catalog* publication, and how systems thinking was presented as the key to a new form of consciousness built on integration and, importantly, freedom.

Second-order systems theory rejected the tendency of earlier variations of cybernetics to separate the system being studied from the broader context. Thus, it was no longer the isolated system that mattered, but rather the imbrication of the system within many other systems, overlapping on multiple levels of scale and complexity. Second-order systems theory also emphasized the central importance of the process of observation. Observation was theorized as not simply cognition, but as a more generic process by which the human mind, or even a nonconscious organized system, interacted with the complex systemic forces of nature. Second-order systems theorists often minimized the distinction between conscious and nonconscious forms of information processing, and conscious and unconscious forms of observation. They often referred to information processing in nature, whether taking place in a human mind or in a fully nonconscious context, as "cognition" or a process of "observation." Thus, living processes can be seen as cognitive in the sense that they reflect the processing of informational patterns. However, according to second-order systems theorists, the informational units that are mediated by repetitive, systemic living processes are not pre-constituted. Any unit of information, according to these theorists, is a result of a contingent choice that separates an object from its original context.

The scientist and mathematician Heinz von Foerster is often credited with creating second-order systems theory, also known as second-order cybernetics. In response to conversations with biologist Humberto Maturana, who criticized the notion that preconstituted information exists in nature prior to processes of observation, von Foerster reconceptualized systems theory to better account for the complexity of natural phenomena. Eventually, von Foerster decided that there is in fact no information in the environment; there are only processes of observation. Von Foerster believed that this understanding was not simply theoretical; rather, it was the best way to get closer to the real, material characteristics of phenomena. In an essay from 1979, von Foerster rejects traditional scientific notions of objectivity, which he describes as a "cognitive blind spot" that cannot see the participation of the observer in the active construction of scientific information (p. 285). The task of science should be to uncover this blindspot, not simply for the purposes of the self-reflection of the scientist, but in order to practice better science.

However, second-order systems theorists were interested in far more than reflexivity in science. For the second-order systems theorist, the context of observation could either be a conscious process of human observation, or a nonconscious organizational principle stemming from the autonomous systemic properties of nature itself. Observation, in this sense, was about recognition of boundaries and the mediation of difference, rather than necessarily the conscious viewing of an object in nature. The two Chilean biologists who were most closely associated with this point of view are Humberto Maturana and Francisco Varela. Maturana and Varela used second-order systems theory to describe forms of organization and autonomous regulation that occur in living processes. They explain that

> "The basic cognitive operation that we perform as observers is the operation of distinction. By means of this operation we specify a unity as an entity distinct from a background, characterize both unity and background with the properties with which this operation endows them, and specify their separability" (Maturana and Varela, 1980, p. xix).

The formation of objects of observation was not, in their account, only a conscious process, but could also be a form of impersonal cognition carried out by living processes. As such, according to Maturana and Varela, "A cognitive system is a system whose organization defines a domain of interactions in which it can act with relevance to the maintenance of itself...Living systems are cognitive systems" (p. 13). Thus, Maturana and Varela converged on an informatic definition of life, but their definition was informatic in a non-reductive way. Maturana and Varela hoped that an awareness of these intricate processes would help to overcome simplistic notions of objectivity in science. Their aspirations, however, reached beyond intervention in methodological debates. They also hoped that a more complex understanding of ecological processes would radically transform human awareness and systems of knowledge, a claim they explored in their book *The Tree of Knowledge: the Biological Roots of Human Understanding*, published in 1987.

Francisco Varela developed this idea further in an essay which claims that the field of systems biology had the potential to fundamentally change how information is conceptualized. Varela (1987) explained that biology could exemplify the arbitrary nature of the informational units that were perceived in nature. Varela insists that such informational units never truly have an independent existence; they are constituted by the environmental context and the context of observation. Rather than seeking arbitrary and isolated units in the chaos of nature, it would be better to seek processes of interaction. Varela hoped that biology would show how “unities can endow a world with a sense through their structure and history of interaction” (p. 53). Varela contrasts this holistic approach to biological science with reductionist approaches that aim to ignore the relations between parts. For instance, Varela criticizes dominant approaches to evolutionary research, claiming that “The search for trait optimization has, in fact, failed to produce basic mechanisms capable of explaining major evolutionary phenomena, either at the genetic level or in morphological change” (p. 50). Rather than seeking isolated traits, Varela implies, scientists must become more curious about the complex interrelations between components of an organism.

Varela further argues that the assumption that biology aims to maximize traits is an application of human-created metaphors that do not accurately describe the internal purposiveness of nature. In order to truly understand natural processes, Varela suggests careful choices of theoretical lenses and a recognition of the importance of context. In another essay in the same volume, Maturana (1987) makes a similar comment that “whenever one has an explanatory principle, one invents a mechanism to conceal what one wants to explain” (p. 65). That is, any simplistic explanation of complex phenomena will always ignore certain aspects of that phenomena. Scientists must actively interrogate their methods of inquiry in order to find these blindspots within scientific explanation.

While Maturana and Varela's discussion of the application of second-order systems theory to biology emphasized the role of cognitive assumptions in shaping the perception of the units and processes within the organism, other applications of second-order systems theory focused on ecological interactions at the macro-scale. One prominent example of this is Gaia theory, created by earth systems scientist James Lovelock and theorist of biological symbiosis Lynn Margulis. Lovelock originally applied cybernetics to the study of earth's processes in pursuit of a theory that could identify the presence of life. Lovelock discovered that life's presence left an imprint on the planetary atmosphere; the levels of oxygen and other gases in the atmosphere could not be maintained in a nonliving environment. Only the active processes of life could reduce the natural entropic tendency of the gaseous atmosphere; thus, life could be seen as a force of anti-entropy. Lovelock was thus interested in how the conjoined effects of vast numbers living organisms could have a regulatory effect that was revealed on the planetary scale.

When Lynn Margulis began collaborating with Lovelock, she brought a keen understanding of processes of cooperation between biological organisms, having been the first to show, against the prevailing scientific assumptions of the time, that symbiosis, specifically the "swallowing" of one organism by another, could explain events in evolutionary history such as the origin of complex organelles within the cell. Together, Lovelock and Margulis developed the theory of Gaia, arguing that the planet itself was a type of organismic entity characterized by processes of regulation that operate on the planetary scale. All life on the planet participated in these processes, and it was only through the metabolic processes of life that living organisms continuously maintained the conditions that made it possible for other living organisms to survive. Thus, life on the planet expresses a deep intelligence, revealed through the operation of autonomously functioning complex systems. This intelligence, Margulis and Lovelock argued, did not need to be conscious to be significant and worthy of protection. Margulis and Lovelock hoped that Gaia theory would create a sense of urgency around the protection of the living processes on the planet. They also sought to publish their results in major journals and to establish their theory as a respectable position within the field, an endeavor which was only partially successful.

While Gaia theory was formulated as a serious attempt at scientific theorizing, Lovelock and Margulis did make comments indicating that they were aware of the potential political applications of their theory. They consistently rejected political hierarchies and aligned themselves with more decentralized approaches to politics. Lovelock used the metaphor of unionization to argue that humans should no longer see themselves as the managers or property owners of the planet. Rather, Lovelock claimed that "we are just shop stewards, workers chosen, because of our intelligence, as representatives of the others, the rest of life of our planet. Our union represents the bacteria, the fungi, and the slime moulds as well as the nouveau riche fish, birds, and animals and the landed establishment of noble trees and their lesser plants" (Lovelock, as cited in Clarke, 2020, p. 74). Margulis, on the other hand, was attuned to her career's mission of identifying the forms of symbiosis that occur among forms of life, with the implication that life can be seen through the lens of what historian of systems theory

Bruce Clarke terms "mutual-aid colonies" or the "internationalist symbiotic communism of the microbes" (Clarke, 2020, p. 74). Both Margulis and Lovelock were clearly aware of potential political applications of systems approaches to ecological theory. However, these political implications were laid out most clearly by two pivotal figures who sought to show the intersection between ecology, systems theory, and radical politics: William Irwin Thompson and Stewart Brand.

Political Applications of Systems Ecology

William Irwin Thompson (1987a) was the editor of *Gaia: A Way of Knowing: Political Implications of the New Biology*, the volume in which Maturana and Varela's essays appear, as well as essays by Lovelock and Margulis. Thompson was also the founder of the Lindisfarne community, a blend between an intellectual center and a commune which hosted both full time residents and periodic academic conferences. It was during the conversations that occurred at Lindisfarne events that the political implications of shifts in consciousness associated with new approaches to science were described (Thompson, 2013). Thompson argues that ways of knowing can generate new social systems, since all social structures have historically been brought into being as a result of specific perceptual patterns. Thompson explains that humanity has been led astray by the "preferential perception of objects over processes, of fragments over constitutive relationships, of technology and control over epistemology and understanding" (Thompson, 1987a, p. 26). In place of ideologies, humans need more creative forms of consciousness, built upon more holistic perceptions of reality. Information that was produced by these processes of perception would better reflect reality because it would be inseparable from the specificities of context. Thompson argues that existing approaches, such as E.O. Wilson's sociobiology, failure to develop a truly radical approach that could challenge the concept of informational units, long dominant in biology. Instead, Thompson uplifts Maturana, Varela, and other systems scientists as examples of the true potential of the biological sciences.

In an essay focused on political applications of biology, Thompson (1987b) explains his theory about the significance of biology for politics. Thompson argues that citizens of modern societies are fundamentally disconnected from the full series of forces that constitute their lives. Citizens tend to focus on what Thompson describes as the more surface level, rationalizing forces such as economics and political debates. What most citizens stay blind towards are the complex material and biological forces that provide support for social structures. The blindness of many modern people towards the relevance of material forces leads to a disavowal of the biological nature of humanity, and the complex nonhuman ecological relationships that provide support for the conditions of human existence. Thompson argues that these ecological forces can be seen as the repressed unconscious of modern society. Society, in Thompson's portrayal, is a type of collective mind, divided between conscious, rationalistic and unconscious forms of information processing. Thus, in the public's imagination, "the abstraction is taken for concrete reality and the sensuous experience dismissed to the margins of society" (Thompson, 1987b, p. 168). Ecological problems that become serious enough to burst through to the public consciousness can be compared to repressed psychological experiences, that eventually resurface. Thompson also explains that the social unconscious is not simply a collective condition; it is also reflected in the experience of individuals whose minds are conditioned by mainstream society.

Thompson argues that in order for society to reorient itself and to achieve sustainability, it is necessary to achieve unity of the conscious and unconscious forces in society. Thompson argues that it is not productive to describe greed or environmental destruction as evil, nor is it helpful to celebrate rationality as the tool that will lead society to salvation. What is necessary instead is to achieve integration of the conscious and unconscious aspects of society. Since, according to Thompson, ecological problems are caused by an economic system governed by abstract rationalism, a turn towards more reason will not fix the fundamental processes that cause ongoing damage to environmental systems. What is necessary instead, to truly achieve the goals of ecology, is to acknowledge that "the Truth cannot be 'known' by the process of intellectual analysis, critique, or communicative rationality; nor can it be socially administered by a philosophical or religious elite" (Thompson, 1987b, p. 209). Strikingly, Thompson's solution points in the opposite direction of insights from early molecular biology and cybernetic biology, as discussed earlier in the chapter. While molecular biology emphasized social control, breaking down complex processes into constitutive parts, and the ability to predict behavior, Thompson emphasizes that the root causes of environmental degradation can only be solved through a turn to a more holistic form of consciousness. While cybernetic approaches to neurophysiology, such as that of Kubie, emphasized the need to limit the influence of unconscious processes, Thompson argues that the way forward can only be found through integrating the unconscious. Further, Thompson argues that developments in the science of biology will only continue to support the relevance of holistic and non-reductive ways of thinking.

Another major figure who was involved in the popularization of cybernetics, systems theory, ecology, and cybernetic approaches to biology was Stewart Brand. Brand was the creator of the *Whole Earth Catalog* publication, which achieved a very wide popular audience in the late 1960s and the 1970s. The catalogs were an often whimsical, but also often intellectually serious attempt to explain developments in technology, science, and design to the public. In these catalogs, Brand consistently emphasized the importance of systems theory. He included a "Whole Systems" section at the beginning of nearly every issue, that allowed him to introduce concepts such as cybernetics and information theory to his audience. In addition to specific tools and survivalist artifacts that were available for purchase, Brand wrote book reviews to recommend a broad variety of texts related to the philosophy of technology, ancient history, physiology, ecological science, religion, and more. Brand promoted Norbert Wiener's information theory, and was also a strong proponent of Buckminster Fuller's design theory and speculative writings on history of technology. The unifying feature of Brand's approach was an emphasis on the importance of the power of the individual. Most editions of the *Whole Earth Catalog* began with the following statement:

> "We are as gods and might as well get good at it. So far remotely done power and glory——as via government, big business, formal education, church--has succeeded to point where gross defects obscure actual gains. In response to this dilemma and to these gains a realm of intimate, personal power is developing--power of the individual to conduct his own education, find his own inspiration, shape his own environment, and share his adventure with whoever is interested.

Tools that aid this process are sought and promoted by the WHOLE EARTH CATALOG." (Brand, 1970).

In other words, the purpose of the *Whole Earth Catalog* was to teach individuals the tools for self-reliance. Recently published books on systems theory, cybernetics, biology, and cybernetics were presented by Brand not simply as opportunities for intellectual enrichment, but as direct tools for individuals to increase their own personal power through manipulation of the environment. While Brand presented this type of undertaking as a kind of personal freedom, it was also clearly about learning techniques of control in order to manage the natural world. The philosophical and historical books that Brand promoted were front and center at the beginning of every *Whole Earth Publication*, later followed by more practical tools including survivalist manuals, instructions on spiritual practices such as meditation, instructions on how to have a more environmentally sustainable household, discussions of new technologies for home design, primers on emerging communications technologies, and instructions on how to perform more traditional crafts such as weaving and glassblowing.

Both Brand and Thompson illustrate how systems approaches to biology and ecology helped to support the development of political approaches that emphasize personal power and freedom. On the surface, the goals of these political projects seem almost entirely opposed to the goals of the Rockefeller Foundation. While the Rockefeller Foundation had pursued informatic biology as a tool of social control, Brand and Thompson believed that cybernetic and biological research was leading the way to a radically new civilizational path of human freedom. Brand and Thompson discussed how technology could be engineered for the human scale, and how the pursuit of self-reliance would give the individual the freedom to uplift themselves while living harmoniously with the natural world and other human beings. In Brand and Thompson's vision, scientific findings about the systemic complexity of biological processes would become both the source of humanity's newfound ecological concern, as well as a resource to support the improved self-understanding of humanity. The individual, in Brand and Thompson's formulation, would no longer be longer the target of projects of social engineering, but rather the inventor of his or her own destiny.

However, despite these shifts in rhetoric, Brand, Thompson, and the scientists I have discussed never fully escaped the paradigms and the forms of control that they criticized. After perusing the assortment of extravagant tools that were marketed in *The Whole Earth Catalog,* it can be inferred that Brand's libertarian vision, while marketed as universal, was in truth targeted to an educated and privileged audience with the means to implement his radical experiments. William Irwin Thompson, on the other hand, admits in his memoir that women were never fully treated as equals in his utopian community (Thompson, 2016). On a more philosophical level, however, I would like to point to how both Thompson and Brand never fully left behind the pursuit of control. They sought to radically reshape society in line with a vision that was countercultural, but also homogenizing in its own way. The forms of social transformation they sought contain a kind of coercion: both Thompson and Brand thought that the mindset of most of humanity needed to radically change, and that scientific and technological perspectives should replace existing cultural values. They believed that their own utopian insights should be used to guide humanity's development. Both Brand and Thompson used the tools and language of science and technology to present their aims as universalist and anti-political, but these efforts to promote their own neutrality and open-mindedness never fully succeed. In fact, one could argue that the positioning of science and technology as anti-political is itself a political intervention that uplifts the privileged subjectivities of those who have access to these forms of knowledge.

Ultimately, both Brand and Thompson uplift the ideal of the autonomous individual, thus reinforcing cultural tropes that have long been associated with the status quo of American political life. These critiques do not entirely outweigh the value of what they proposed. However, Brand and Thompson illustrate the risks of naively assuming that a turn towards nature's complexity is politically radical in itself, or aligned with the cause of political freedom. In the next chapter, I will discuss the opposite phenomenon: how a political philosophy that presented itself as protective of the status quo and tradition turned out to be more radical than was perhaps intended.

Chapter Three: Hayek and Biological Order

Engaging with Hayek

In existing political theory scholarship, Hayek is generally discussed as one of the primary theorists behind the neoliberal revolution. Thus, Hayek is associated with a political movement that is perceived as the source of income inequalities and the dominance of business interests in the politics of the West. Hayek is generally portrayed as a purveyor of free-market capitalism with little concern for social or ecological responsibility. While this chapter does not seek to defend Hayek's documented political activities on behalf of his vision of free market capitalism, the chapter does argue that Hayek's intellectual contributions are more complex than the existing scholarship has captured. While Hayek's theory of spontaneous market order is often presented as a proposal to subordinate all of society to the control of the market, Hayek's arguments about processes of social organization are not fully encompassed by this portrayal.

Furthermore, Hayek is frequently accused by political theorists of supporting the domination and destruction of nature, but the truth is more complicated. In this chapter, I will show that Hayek's theory of free market economics, while not inherently ecological, has surprising theoretical compatibilities with systems approaches to ecology. In fact, the convergences between Hayek's theories, and the writings of twentieth century systems ecologists, are surprisingly prominent. This is because of the strong influence of the ontology of systems theory throughout Hayek's work. While Hayek's theories of political decentralization are often assumed to be fully and inevitably aligned with the market-based order and its possessive individualism, I will show that Hayek's theorization of both the individual and the market draws from a systems ontology, complicating this traditional view.

Before proceeding any further, it is necessary to acknowledge that a serious body of scholarly literature exists which has rejected the idea that Hayek's theories might carry this kind of ambiguity. Such scholarship raises important objections about whether Hayek's decentralized market order is truly spontaneous and free in any meaningful way. Instead, such arguments outline how Hayek's writings emphasize submission to power, and reject the idea of popular sovereignty. In this next section, I will discuss and reproduce as closely as possible the objections that have been laid against attempts to complicate the dominant portrayals of Hayek. I will then explain why, despite the real insights that these objections raise, many of these critiques of Hayek do not accurately capture the framework that Hayek develops in his theories, and thus never fully engage Hayek on his own terms. Such accounts tend to miss the central ontological arguments, and positions on the status of the subject, that are laid out in Hayek's writings.

One recent critique of Hayek's theories, written by Annabel Herzog (2020), criticizes the idea that theorists of decentralization such as Hayek can contribute to contemporary political debates. In the essay, Herzog explores convergences in the writings of Hayek and the French theorist Michel Foucault. As Herzog discusses, the thinking of both Foucault and Hayek was shaped by the rise of new systems of government in the twentieth century, including totalitarian political forms affiliated with fascist or Marxist philosophy. Herzog portrays both Hayek and Foucault as reactionary figures suspicious of concentrated power, although Foucault was notably far more reticent about the normative political implications of his theorizing. Both Hayek and

Foucault promoted the idea that political power was not best understood as top-down in nature. Hayek, however, connected this understanding of power to a strong critique of the concept of sovereignty. Hayek emphasized that the government should act to limit its own sovereign power, rather than acting on behalf of other goals such as the fulfillment of the popular will.

According to Herzog, Hayek came to believe, perhaps ironically, that the exercise of government power could only be justified by the need to counterbalance or limit some other source of political power. However, Hayek's suspicion was not simply directed at modern techniques of governance; he also was suspicious of social contract theory himself, rejecting not only Hobbes but also Locke and Rousseau. His suspicion was not simply rooted in a fear that justifications for sovereign power would be abused by charismatic leaders and demagogues, or the sheer power of an unaccountable state. Hayek was also suspicious of the concept of rationality itself: the idea that humans could rationally decide to leave the state of nature to willingly contract themselves into a government. Hayek argued that the important institutions and systems of modern society, most notably but the market system, emerged through spontaneous collective action that was not centrally directed or centrally planned. Thus, he saw social contract theory, and modern theories of sovereignty, as myths that created a false narrative about the course of events that led to modern governments and their established legitimacy.

Herzog portrays Hayek's intervention not as a principled rejection of theories of rationality, but rather as an expression of his strong aversion to popular politics itself. Collective, popular political participation is, according to Herzog, exactly the kind of potential energy that Hayek sought to prevent from being crystallized as sovereign power. Specifically, Herzog criticizes Hayek's proposed system of government, discussed in his work *Law, Legislation, and Liberty*. In the text, Hayek (1979) lays out a potential legislative system that seems designed to shield lawmakers from accountability to popular pressure. Hayek's proposed plan is quite specific; legislators were to be elected at the age of 45 and to serve for 15 year terms. Herzog argues that Hayek's proposed legislative body seems designed to become a new form of unchecked power, an unchallengeable sovereign. Thus, according to Herzog, not only is Hayek's rejection of sovereignty anti-political and in opposition to the public will, it is also hypocritical.

My purpose in this chapter is not to rescue or exonerate Hayek from such accusations. There is clear evidence that Hayek was suspicious of the destabilizing impact of the popular will. In fact, it seems unlikely that Hayek himself would deny that particular allegation; he just would disagree with Herzog about the desirability of the political consequences of his preferred approach. What I will argue is that dominant critiques of Hayek, such as that laid out by Herzog, fail to fully contend with the ontological specificity of Hayek's description of the world. Hayek was not simply a theorist of decentralization; he was also clearly influenced by the systems sciences and cybernetics, and developed a detailed account of how arguments from the natural sciences could inform economics. Furthermore, in the analysis that follows, I will show that Hayek understood subjectivity itself as an emergent and illusive property, rather than a given. Thus, his refusal to accept that pre-constituted subjects could rationally enter a government to authorize sovereign power is consistent with his broader ontological viewpoint, not simply his political positions.

A similar argument can be found in an essay by Jessica Whyte (2017) that acknowledges potential convergences between Hayek and some critical theorists, but attempts to discredit Hayek as a figure who can contribute meaningfully to democratic theorizing. While Herzog's account emphasizes Hayek's rejection of sovereignty, Whyte instead emphasizes Hayek's support for the concept of submission. Specifically, Whyte argues that Hayek's work can best be seen as an attempt to provide a secular justification for what was originally a religious argument in favor of submission. Whyte highlights how Scottish Enlightenment theorist Adam Ferguson influenced Hayek; according to Whyte, Hayek drew his famous critique of rationality from Ferguson. Ferguson's suspicion of reason was rooted in arguments about the necessity of human submission to divine providence. By appropriating Ferguson's theory, Whyte argues, Hayek's philosophy took on not simply a critique of rationality but also an implicit acceptance of the need of human submission to larger processes. Such submission, Whyte claims, aligns with Hayek's defense of the market. In place of submission of divine providence, Hayek encouraged a deference towards market forces. Thus, in Whyte's telling of the story, an originally religious attitude was smuggled into economic arguments and repackaged as a universal, secular observation about the need for submission to larger forces. Whyte portrays this as a dangerous rejection of politics and popular participation. For Whyte, rational action and intervention is necessary for individuals to act collectively, challenge their material conditions, and advocate for political change.

Thus, for Whyte, Hayek's theories, specifically his rejection of rationality, are opposed to democratic politics. Whyte criticizes theorists such as William Connolly who have sought to rescue certain elements of Hayek's views that could be compatible with spontaneous action, creativity, and individual freedom. What I would like to draw attention to is that Whyte never engages with the influence of systems science perspectives on Hayek's thinking. As I will discuss in this chapter, there is extensive evidence to show that Hayek's views about market order formed in conjunction with his views about other complex processes, from psychology to biology. Hayek's market order is misunderstood if portrayed, as in Whyte's discussion, as an ontologically fixed abstraction to which pre-constituted, atomistic individuals must submit. Instead, Hayek's market order is an emergent and dynamic entity, comprised of the subjective impressions and partial knowledge of its participants. Thus, from Hayek's perspective, individuals are not asked to submit to the market; rather, the market order and human subjectivity are co-constituted complex processes. Furthermore, as will be discussed, it is far from clear that Hayek viewed the individuals who participate in the market order as atomistic pursuers of economic goals; Hayek emphasizes that human intentions and actions are emergent qualities that rise out of the complexity of context.

Some of Hayek's critics have more clearly acknowledged the influence of the systems science and information theory on Hayek's work, but this acknowledgment is often incomplete. In a book by Philip Mirowski and Edward Nik-Khah (2017), Hayek's theory of market order is presented as the culmination of the uptake of information theory in the field of economics. Just as information theory provided a language to model the world through a series of imposed abstractions, economics followed a similar trend. Mirowski and Nik-Khah claim that a trend emerged in the second half of the twentieth century in which economists became obsessed with information, which they define as knowledge abstracted from particular circumstances. The culmination of this process, the authors claim, is Hayek's theory of the market as spontaneous information processor. Curiously, however, Mirowski and Nik-Khah fail to mention Warren Weaver or Norbert Wiener, both of whom are cited by Hayek. Instead, their account centers around the work of Claude Shannon, a theorist who Hayek is not known to have engaged deeply with. As such, their critique fails to engage with the specific uptake of information theory in economics that led to Hayek's influential theories. It is true that the connection between Hayek and the broader cybernetics movement is acknowledged in Mirowski's other writings (Mirowski, 2007). However, ultimately, even a critic such as Mirowski, who seems to have understood better than most the influence of the systems sciences on Hayek's thinking, casts doubt on whether the influence of systems science and systems ontologies was a decisive factor in the elaboration of Hayek's theories. Mirowski (2007) views Hayek as a committed anti-socialist who sought increasingly elaborate scientific justifications in support of his more basic and fundamental aversion to populist power.

Beyond Mirowski, there is a strain of critique of Hayek that does acknowledge the influence of systems theory on Hayek's work, specifically in regard to the concept of resilience. Melinda Cooper's (2008) *Life as Surplus* argues that rhetoric supporting the legitimacy of neoliberal financial capitalism has often drawn on metaphors that compare markets to self-organizing forms of life. Further, Cooper argues that the popularity and uptake of the resilience concept in economics can be explained, in large part, due to Hayek's heavy promotion of the tools of systems theory in economics. Cooper, who develops her argument further in a co-authored essay with Jeremy Walker, argues that neoliberal theorists such as Hayek relied on an idea that both life itself, and economic markets, were fundamentally resilient and had the spontaneously organizing capacity to respond to outside shocks (Cooper and Walker, 2011). The concept of resilience, Cooper and Walker argue, authorizes a political status quo that normalizes the impoverishment of marginalized groups, and encourages those groups to simply be resilient rather than challenging their material conditions. Michael Watts (2014) develops a similar line of critique against neoliberalism, and blames economic attitudes promoted by figures like Hayek for faulty approaches to international development in vulnerable regions such as the Sahel in Africa. These critiques do acknowledge the influence of systems theory on Hayek's work. However, these critiques tend to align with the potentially flawed assumptions found in the argument put forward by Herzog and Whyte, namely that Hayek was trying to encourage pre-constituted, atomistic individuals to submit to an external, abstract market. As I have discussed, an examination of Hayek's ontological claims and intellectual influences will complicate this portrayal.

The purpose of this chapter is not to definitively resolve these questions. As I have discussed, however, many of Hayek's critics have failed to take Hayek's theory on its own terms or to take seriously the ontology of Hayek's argument. Such critics have also often failed to acknowledge Hayek's processual, phenomenological understanding of the subject. These issues will be more fully discussed in later sections. At this point, however, I wish to connect the argument in this chapter to the broader framing of the dissertation. This dissertation argues that political appropriations of systems theory frequently fall into a nebulous space, straddling freedom and control in a way that is not easily resolved. I would argue that Hayek is exactly such a figure. Critiques of Hayek's suspicion of politics are not entirely wrong: it is reasonable to worry that efforts to repress popular power can lead to coercive governance. However, this chapter will also endeavor to present Hayek's theories on their own terms, and in doing so, I will show that the elements of coercive control in Hayek's thinking are more elusive than they might seem. Specifically, I will discuss the centrality of influences from the natural sciences and information theory within Hayek's overall body of work. The goal is not to rescue Hayek from his critics, but to show how on the level of theory, his ontological claims and understanding of subjectivity turn out to be surprisingly compatible with views promoted by the systems ecologists that were discussed in chapter two. This compatibility raises questions about whether Hayek's thinking might be more compatible with environmentalism than is traditionally believed, especially decentralized visions for ecology.

Situating Hayek's Environmental Views

Friedrich Hayek's description of the spontaneous order that unfolds in complex systems has received sustained scholarly attention. This chapter will consider a topic about which limited scholarship has been done: Hayek's views on the environment. This topic has not received attention in recent scholarship, as Hayek is typically remembered for his participation in organizations such as the Mont Pèlerin Society, and for his advocacy on behalf of free market economics. The topic of the environment was not a central preoccupation of his scholarly writings or public advocacy, and Hayek was skeptical of many environmentalist claims. He was sharply critical of the influential *Limits to Growth* report during his Nobel Prize speech in 1974, arguing that the pronouncements about resource limits in the report were based on hubristic and unjustified scientific measurements. In his other writings, Hayek emphasized that the material characteristics of economic goods are not what is ultimately computed by the market. Rather, the perceptual apparatus of the human mind responds to changing material, social, and economic conditions to form contingent knowledge that allows for successful economic decision-making. The market does not directly mediate material resources; rather, it computes this changing, local, and contingent knowledge that arises in the course of ongoing economic processes.

According to Hayek, government planners who try to implement policy based on generalized ecological goals are interfering with a complex process based on a false rationalism that misunderstands what reason can achieve. While Hayek's stated political preferences, and his intellectual project, are clearly not aligned with mainstream environmental politics or strategy, this chapter will explore how Hayek's theory converged with more esoteric developments in ecology in ways that have not been acknowledged by existing scholarship. Hayek's emphasis on the mind, knowledge, and cognition, especially as developed in his works *The Sensory Order* and *The Fatal Conceit*, has convergences with similar developments in systems ecology.

Hayek believed that the market generated spontaneous order by facilitating the cooperation of numerous individuals with distinct purposes and aims. Many of the intellectual theories that drove Hayek's account of spontaneous order, notably cybernetics, systems theory, autopoiesis, and complexity theory, also animated discussions in the fields of ecology and biology. Humberto Maturana and Francisco Varela's writings on theoretical biology utilized the word cognition to describe the non-conscious, not centrally directed force that provided organization to recursive biological systems. Earth systems scientist James Lovelock, who with biologist Lynn Margulis developed the concept of a self-regulating planet known as Gaia, drew on cybernetics to provide legitimacy for Gaian theory. These invocations of spontaneous order and self-regulating biological systems are similar to many of Hayek's statements about the organizing principles of the market order.

Many scholars have dismissed Hayek's environmental commitments due to his political advocacy for unregulated markets and his history of remarks dismissive of warnings about environmental problems. However, Hayek's relation to environmentalism is more ambiguous than the traditional portrayal reveals. It is significant that Hayek consistently chose metaphors from the natural world to develop his ideas. These metaphors include a discussion of self-organizing chemical reactions in *Law, Legislation, and Liberty*, biological evolution in *The Fatal Conceit,* and a reference to cultivating the market as a gardener tends plants in Hayek's Nobel Prize speech. It is possible to read Hayek's consistent use of natural metaphors as evidence that he saw value in nature and that he understood that nature contained certain forms of order which, like the market, may fall beyond human understanding. In the case of the market, Hayek's description of the complexity, intricacy, and autonomous emergence of market processes provided the reason that the interventions of government planners would be actively destructive. Hayek then used metaphors invoking forms of life to emphasize the fragility of the market, and the urgency of protecting it.

It is in this context that Hayek's documented antipathy to environmentalist political projects appears striking. If the market, something that is like life, should be protected, why not life itself in the form of an ecosystem? Available evidence shows that Hayek's distaste for the discipline of ecological economics and associated approaches to government planning was related to the specific top-down nature of the interventions that were promoted. Hayek's critique of scientific rationality put him at odds with mainstream environmental science in the 20th century. Scientific knowledge that described, and aimed to intervene in, large, distributed processes depended on techniques of abstraction and the removal of context, which Hayek consistently decried.

However, Hayek may not have found his views so clearly in conflict with the more esoteric approaches to ecology developed by Maturana, Varela, Lovelock, and Margulis. It is not clear to what extent that Hayek was aware of these other intellectual conversations. However, from our contemporary vantage point, it is worth considering whether convergences between Hayek's project and the claims of systems ecologists should cause us to reevaluate Hayek's theories and commitments. Hayek's antipathy towards environmental politics is not necessarily proof that the protection of nature could not be compatible with Hayek's theories.

This chapter will discuss how Friedrich Hayek and a group of systems ecologists, writing in the 20th century, independently developed theories of mind that were not simply about consciousness, but that were also a theory about the organization of reality. Both Hayek and the systems ecologists I will examine postulated that minds were information processing entities. Hayek agreed with the ecologists that this information processing was not necessarily attached to consciousness, though it could be. Information processing, as Hayek understood it, involved "selection, evaluation and interpretation...at every step in the creation of the sensory order" (Caldwell, 2004, p. 247). The mind, according to Hayek, does more than simply represent an objective reality; the mind actively constructs and interprets that reality. Furthermore, once these characteristics of the individual mind are properly understood, the theorist can grasp how society and other systems are like minds, expressing the collective creative energies of countless individual actions. Through his later career, Hayek theorized that human society, and especially the market, could be seen as a complex system which facilitated the processing of information in a mindlike way. These claims are similar to claims made by systems ecologists about how natural processes can be theorized as a form of cognition that involves informatic selection, mediation, and the creation of order within the processes of nature.

Both Hayek and the systems ecologists believed that traditional rationality, which celebrated the power of the mind to simplify and capture the truth of the material world, was not sufficient for understanding complex processes. This critique of rationality led to Hayek's criticisms of the version of environmental science that used abstract characterizations of broad processes for the purpose of large-scale social planning. However, the systems ecologists that I discuss argued for ecological approaches that incorporated information gathering and interpretation using principles that, it can be argued, are philosophically compatible with Hayek's theories. Such methodological approaches in ecology that insisted on the need for local, contextual use of abstractions never became the dominant paradigm of ecological research, but these approaches did achieve occasional recognition in mainstream scientific journals (Levins & Lewontin, 1980; Pitelka, 1974). Bringing together these two schools of thought, Hayek's economic thinking and systems ecology, this chapter shows that Hayek's ideas have philosophical similarities to the systems ecology approach.

Hayek's Theories of Mind and Information Processing

Friedrich Hayek's theories of mind have received attention in scholarship on the history of economics, though these aspects of his economic philosophy are less widely acknowledged (Caldwell, 2004; Dold & Lewis, 2022). Hayek's understanding of how minds process and interpret sensory information had important implications for his account of the informational processes within markets and society. Within Hayek's published work, the document that most directly addresses psychological theory is *The Sensory Order*, published in 1952. In this work, Hayek (1952) explains that he will address the problem of "what part of our knowledge can properly be described as knowledge of mental events as distinguished from our knowledge of physical events" (p. 1). The task of separating subjective and objective occurrences has long been central to psychology. However, Hayek insists that the relevance of subjective events to scientific explanation has not been sufficiently appreciated. That is because, according to Hayek, there is no access available within the human mind to the pure events themselves. Even sensory experiences are always facilitated by processes of interpretation.

Importantly, however, Hayek avoids the possibility that his theories could be aligned with an idealist, non-material ontology; he insists that the functions of the mind always take place in the context of some form of environment. Hayek (1952) asserts:

> "*What we call 'mind' is thus a particular order of a set of events taking place in some organism and in some manner related to but not identical with, the physical order of events in the environment*. The problem which the existence of mental phenomena raises is therefore how in a part of the physical order (namely an organism) a sub-system can be formed which in some sense (yet to be more fully defined) may be said to reflect some features of the physical order as a whole; and which thereby enables

> the organism which contains such a partial reproduction of the environmental order to behave appropriately towards its surroundings." (p. 16).

Thus, Hayek's characterization of the mind as an emergent, functional order is quite similar to observations by figures such as Norbert Wiener in the early field of cybernetics.

In his comments, Hayek emphasizes that while pure access to physical reality is not possible, the mind is always interfacing with an environment. The successful adaptation of any organism, including its mental adaptations, depends on the ability to respond to conditions that the organism will confront. Thus, the mind, as Hayek understands it, can be understood as a mechanism of learning, processing, and mediation that incorporates subjective and interpretive elements, while not being reduced to them. The subjective facets of the mind interact with external, environmental feedback inputs to facilitate the organism's behavior and adaptive responses.

According to Hayek, it is not clear that the goal of science or knowledge should be to gain access to something called the real. In fact, Hayek (1952) asserts, "It is indeed doubtful whether on the plane on which we must examine these problems the term 'real' still has any clear meaning" (p. 4). Hayek argues that the quest to discover the true or pre-cognitive nature of a thing is ultimately not possible or a useful exercise. What is more important is the search for patterns of order, such that one may ascertain "how a particular object or event differs from other objects or events belonging to the same order or universe of discourse." (Hayek, 1952, p. 4). What the mind gathers from reality is always already sorted into categories and groupings; this process is implicit in all processes of cognition. Understanding the abilities and limits of the mind is an essential undertaking for Hayek because it also defines what academic fields such as economics can and cannot aspire to understand and predict.

For Hayek, the interpretive work of the mind is not necessarily conscious. The recognition of the importance of non-conscious cognition was important for Hayek's theory in several ways. First, Hayek's psychological views led him to believe that human society was primarily shaped into a coherent order by the frequently unconscious, learned, rule-following behavior of individuals. The work of an economist was then to observe human behavior and make visible these unconscious operations. Hayek came to believe that this decentralized rule-following was both more productive and more consequential than any form of planning. Thus, understanding how the mind works was essential for understanding how economies and societies function.

The second implication of Hayek's discussion of cognition, which this chapter will discuss, is that Hayek discovered forms of information processing in social systems such as markets, which he posited operated through similar principles of complex coherence as were contained in the functions of a human mind. An important similarity between the writings of Hayek and the assertions of systems ecologists is the insistence that self-organizing systems and patterns can be found in the external world. Hayek identified self-organizing patterns that he argued were found throughout markets and human society more generally. Hayek (1942, 1948) believed that knowledge is the primary entity that complex systems such as markets mediate, rather than the goods themselves. While this emphasis on the subjectivity of reality would put Hayek into conflict with many ecological economists of his day, I will show that Hayek's understanding of knowledge is not necessarily incompatible, on a theoretical level, with certain methodological approaches in ecology. In fact, Hayek's views about the information processing that occurs in markets were similar to the claims of many systems ecologists about information processing in nature.

Another similarity between Hayek and the systems ecologists is the issue of emergent properties. Gaia theorists saw the systemic regulation of the planet earth as an emergent property of countless distributed actions by individual organisms. As a result of the individual metabolic processes of countless living beings, the emergent property of the oxygenated atmosphere is continuously created. Similarly, Hayek believed that the market was an emergent property of individual actions. What scholarship on Hayek acknowledges less frequently is that for Hayek, the mind is also an emergent property of the individual neurons. Hayek considered his early work on psychology, *The Sensory Order*, to be the conceptual precursor to his more well-known work on economics. As discussed, in *The Sensory Order*, the mind is composed of a series of processes that interface with the real world. The mind, as portrayed by Hayek, was a relational system that could not be reduced to its physiological components. This is why Hayek rejected the idea that economic planners could predict human behavior, or engineer a top-down, centrally administered economic system based on over-simplified portrayals of the complexity of human actions.

What is less remarked upon about Hayek's theory of emergent properties, however, is what it reveals about Hayek's understanding of the individual. In an article about the concept of emergence in Hayek's work, Paul Lewis (2016) argues that Hayek's reliance on emergence supports the claim that Hayek considered individuals to be socially constituted, rather than atomistic, ontologically stable, pre-social beings. Lewis bases his argument partially on a recognition of Hayek's theory of the mind, which heavily implies that the mind is an emergent process constituted by interlocking systems, rather than a unified expression of a self. Lewis also discusses the strong influences of gestalt psychology on Hayek's portrayal of the mind as an entity that cannot be reduced to mechanistic parts. However, most importantly for this chapter, Lewis emphasizes the strong influence of a particular strand of systems biology on Hayek's thinking. Specifically, Lewis provides evidence that Hayek was strongly influenced by the biologists Joseph Woodger and Ludwig von Bertalanffy.

Both Woodger and Bertalanffy wrote about the significance of biology in relation to a series of debates, prominent in the early 20th century, between mechanistic and vitalistic portrayals of life. Woodger and Bertalanffy wished to distinguish themselves from mechanistic methodologies in the life sciences, which sought to isolate parts of phenomena rather than understanding them in an integrated way. At the time, however, the only alternative to a mechanistic portrayal of life seemed to be vitalism, which explained the organizational properties of life through reference to a mysterious life force. Woodger and Bertalanffy proposed that, instead, the concept of organization could be used in these debates to provide a scientific explanation of emergent properties, without needing to turn towards either mechanistic or vitalistic explanations. Viewing life through the lens of organization meant recognizing its relational qualities: rather than tracing the functions of separable parts of the cell, scientists should seek to better understand the parts of the cell relationally. These relations contributed to the stabilization of organizational processes of life, with complex emergent effects. Hayek explicitly cited Woodger and Bertalanffy in his writings to support the concept of emergent entities and principles of organization within social systems.

For the purposes of the discussion in this chapter, Bertalanffy's theories are especially relevant because they explicitly incorporated systems theory and cybernetics. Thus, Bertalanffy's work provides one of the clearest windows into understanding how Hayek himself was influenced by systems theory. Bertalanffy, it should be acknowledged, is a more problematic figure than the other cyberneticians I have considered thus far. As a German, Bertalanffy was not a prominent figure in the American systems theory debates. Rather, Bertalanffy contributed to the German field of systems theory, which included well-known systems scholars such as Niklas Luhmann. Bertalanffy was also not only a member of the Nazi party, but possibly a believer in Nazi ideology. Like many German scientists who conducted research during the Third Reich, there is some debate about whether Bertalanffy's participation in the regime was enthusiastic or transactional (Pouvreau, 2009).

Perhaps Hayek's choice to draw on Bertalanffy's work can be explained by the simple fact that, as an Austrian, Hayek may have preferred reading scientific works written in German. There is also evidence that Hayek and Bertalanffy were acquainted, and that Bertalanffy provided comments on *The Sensory Order* prior to publication. Whatever political or ideological reasoning may or may not have been involved in the collaboration between the two is unclear. Nonetheless, when Hayek published his psychological work *The Sensory Order* in 1952, it was Bertalanffy who was cited the most to represent the field of systems theory. While Bertalanffy had been working on the concept of emergence since the 1920s, by the 1950s he was starting to lay out what he called a “general system theory.” In an essay published in 1950, cited by Hayek, Bertalanffy lays out the contours of the field. General system theory, Bertalanffy (1950) argues, should elucidate the “*general system laws* which apply to any systems of a certain type, irrespective of the particular properties of the system or the elements involved” (p. 138). The goal of discovering these hidden laws about the functioning of systems was to overcome surface level distinctions between different kinds of phenomena, in search of deeper unifying truths about complex systems. General system theory was to be applicable to all fields of science, and to aid in discovering similarities and homologies between different fields of study.

Bertalanffy’s essay, however, was not restricted to discussing the implications of general system theory for scientific fields. He acknowledged the applications of his theory for the social sciences, perhaps explaining Hayek’s apparent appreciation for his work. Bertalanffy discussed how civilizations could be described as kinds of superorganisms (Bertalanffy, 1950, p. 135). The unifying feature of the study of systems, Bertalanffy explained, was the development of means of perceiving emergent wholeness out of the complexity of various processes.

Bertalanffy (1950) also explained that new systems approaches to science were increasingly showing that humans were not atomistic individuals, but rather part of broader wholes. This argument was made more explicitly in another of Bertalanffy’s book length works, *The Problems of Life: An Evaluation of Modern Biological Thought,* published in 1952. Bertalanffy (1952) decisively rejected the concept of a pre-constituted living individual, stating

> "Strictly speaking, there is no biological individuality, but only a progressive individualization, both phylogenetic and ontogenetic, which is based upon progressive centralization, certain parts gaining a leading role and thus determining the behaviour of the whole. Individuality is a limit which is approached but not reached, either in development or in evolution" (p. 49).

Later, Bertalanffy (1952) declared that "A living organism is a hierarchical order of open systems which maintains itself in the exchange of components by virtue of its system conditions" (p. 129). The work of scientists, then, should be to discover the basic principles of organization that maintain the complex processes. Explaining the behavior of organisms in a linear, functional manner that ignored the interplay of levels of organization would fail to capture the phenomena being studied. Bertalanffy's portrayal of the individual as a process would later be reflected in Hayek's description of the economic individual as an opaque mystery that could never be fully decoded by the economist. Hayek argued that rather than try to capture, reduce, or explain the complexity of the motivations of any individual, economics should seek to understand how markets become so effective at agglomerating and processing the shifting, subjective knowledge of individual participants. The answer that Hayek provided was that markets became successful due to the emergent properties of the complex system.

In addition to the evidence that Bertalanffy and the German school of systems theory had a strong influence on Hayek's thinking, Hayek did incorporate references to American cyberneticists in his work. One particular influence was Warren Weaver, who apparently left a comment in a review of one Hayek's papers, encouraging Hayek to read Warren's own essay, "Science and Complexity." In the essay, Weaver distinguishes between problems of simplicity, disorganized complexity, and organized complexity. Problems of organized complexity were problems of life:

> "What makes an evening primrose open when it does? Why does salt water fail to satisfy thirst? Why can one particular genetic strain of microorganism synthesize within its minute body certain organic compounds that another strain of the same organism cannot manufacture? Why is one chemical substance a poison when another, whose molecules have just the same atoms but assembled into a mirror-image pattern, is completely harmless?" (Weaver, 1946, p. 539).

What distinguished such problems of organized complexity from disorganized complexity, Weaver argued, was the insufficiency of simplistic statistical methods. Instead, it was necessary to understand the elusive principles of autonomous organization that maintained the system. Weaver briefly mentions that this insight applies to economics, as market forces can be seen as similar self-organizing processes.

References to Weaver's essay, as well as the work of other cyberneticists, can be found throughout Hayek's work, especially in his mid-career. Weaver's essay was cited in Hayek's 1964 essay, "The Theory of Complexity Phenomena." It was also cited in "Degrees of Explanation," published in 1955, in which Hayek presents a critique of positivism and discusses the proper methods for the study of complex phenomena. In addition to Weaver's essay, Hayek also makes a reference to the collaborative work between Norbert Wiener and Arturo Rosenblueth, in a discussion of building models of systems. The thesis of Hayek's discussion in the essay is that "the more we move into the realm of the very complex, the more our knowledge is likely to be of the principle only, of the significant outline rather than of the detail" (Hayek, 1955, p. 211). Hayek also references Norbert Wiener's cybernetics writings in his 1968 essay "Competition as a Discovery Procedure." In the essay, Hayek compares Wiener's theories to the theory of spontaneous order in Adam Smith's *The Wealth of Nations.* In fact, Hayek was known to have believed that Smith's theories were a precursor to the theory of cybernetics (Hayek, 1979).

Other convergences between cybernetics and Hayek's thinking are made clear by comments later in Hayek's career. In *Law Legislation, and Liberty,* Hayek explains that in instances in which he was referring to knowledge, he really meant information. In an extended comment explaining his own terminology, Hayek (1979) states, "instead of 'order', in conformity with today's predominant usage, I occasionally now use 'system'. Also 'information' is clearly often preferable to where 1 usually spoke of 'knowledge'" (p. xii). Hayek also explicitly links this terminology to the influence of information theory and systems theory.

While it was later in his career that Hayek sought to frame his contributions through the linguistic terminology of systems theory, the turn towards information appeared conceptually much earlier. In an essay titled "The Use of Knowledge in Society," Hayek (1948) emphasizes the centrality of knowledge to decentralized economic decision-making. Hayek develops the argument, essential to the political applications of his work, that centralized planning is ineffective because it is epistemologically invalid. This is because the distributed knowledge that undergirds the autonomous operations of the market economy has never been collected, processed, and made available to one single decision-making mind. To do so would involve unacceptable generalizations and simplifications of the complex market phenomena that stabilize society. To interfere in these phenomena based on generalizations or incomplete information could cause unpredictable damage to the function of markets and interrupt their autonomous information processing functions.

It is because of these assertions that the economic relevance of Hayek's psychological assertions in *The Sensory Order* becomes clearer. If it is true that subjective, psychological interpretations of reality are the fundamental basis of all cognition as well as human knowledge and action, it becomes essential for the field of economics to incorporate psychological theory. Specifically, Hayek insists that markets work as well as they do because humans are always attaching subjective, cultural, and situational meanings to the economic processes that they encounter in the world around them. Because of this, the central problem of the discipline of economics becomes "how to secure the best use of resources known to any of the members of society, for ends whose relative importance only these individuals know" (Hayek, 1948, p. 78). As Hayek explains, it is because of the interpretive work of the mind that people learn to categorize the information in their experience into useful patterns and aggregates.

Through these operations, people learn to participate in economic processes in ways that are of benefit to them. Hayek insists that this participation is not the opposite of planning, but that rather it is a form of planning that occurs on a more local and decentralized level. Furthermore, the processes of competition provide feedback that shapes the efforts of individuals to maximize their own profits and the efficiency of the economy. The type of knowledge that is most conducive to successful market outcomes is "special knowledge of circumstances of the fleeting moment not known to others"

(Hayek, 1948, p. 80). The locality and specificity of the individual's participation in the market economy is precisely the reason that it works so well, according to Hayek.

In Hayek's 1988 work *The Fatal Conceit*, which lays out his theory of social evolution, Hayek explains that the main achievements of human civilization have occurred not due to the genius of great leaders or the power of governments, but rather due to the agglomerated effect of countless small individual decisions. Through adherence to the rules of the market, and simply by following their own self-interest, individuals participate unwittingly in collective processes of invention, discovery, innovation, and adaptation that eventually have large-scale effects on social and civilizational progress.

Hayek acknowledges that the evolutionary processes of selection, competition, and adaptation that take place in the market are not the same thing as biological evolution. Nonetheless, a comparison between market forces and evolutionary forces is developed extensively in *The Fatal Conceit*. While Hayek never outright claims that the market is like a form of life, the comparison is implicit. Just as nature processes vast quantities of information, markets perform similar complex and autonomous functions. Elsewhere, Hayek invokes research into chemical reactions to make his point about the spontaneous processes that occur in the market. Hayek (1979) explains that "We understand now that all enduring structures above the level of the simplest atoms, and up to the brain and society, are the results of, and can be explained only in terms of, processes of selective evolution, and that the more complex ones maintain themselves by constant adaptation of their internal states to changes in the environment" (p. 158). At the end of this passage, Hayek cites the work of theoretical chemist Ilya Prigogine, who studied spontaneous reactions in chemistry.

Hayek repeatedly uses metaphorical language to suggest a comparison between social systems such as markets and natural processes. The political effects and significance of these frequent metaphors have been discussed in existing critical scholarship (Cooper, 2008; Walker & Cooper, 2011; Watts, 2014). These scholars have criticized the frequent inclusion of natural metaphors in Hayek's theories as hypocritical, and have criticized Hayek for his antipathy towards environmental economics. However, this existing scholarship has often over-simplified Hayek's views. When Hayek's theory of mind, his theory of society, and his theory of nature are considered concurrently, it can be argued that the ecological implications of Hayek's theories are more complex than recent scholarship has acknowledged. Furthermore, striking similarities can be seen between Hayek's theories and various views delineated by systems ecologists.

Ecological Theories of Mind and Information Processing

A related set of writings in the field of systems ecology, published around the time of Hayek's late career, included strikingly similar claims about how to understand minds and cognition. In particular, as discussed in chapter two, Humberto Maturana and Francisco Varela developed a theory of mind and cognition that was centered around the mediation of information. Using more explicitly normative language than occurs in Hayek's writing, Maturana and Varela connect the development of a new epistemological perspective not only with a better ability to understand the formation of knowledge, but with an ethical attitude generating responsibility towards nature. Francisco Varela (1987) argues that "the chance of surviving with dignity on this planet hinges on the acquisition of a new mind" (p. 49). Despite this divergence in language, however, Hayek's theories align with those of the systems biologists in surprising ways.

Similarly to Hayek, these biologists aim to explain how the mind processes information through interpretive maneuvers. In one essay, Varela encourages his readers to be aware of how the interpretative work of the mind shapes understandings of reality. Specifically, Varela argues that the objects that constitute reality are not simply apprehended and perceived by the mind. Rather, the mind actively interprets reality by classifying and ordering the raw material of perception. Information always occurs after the fact of perception. The units of information do not answer to principles outside of the context of observation and cognitive processing. Varela relates these insights to the question of how observers make sense of the complexity of nature, insisting that "instead of being mainly concerned with heteronomous units which relate to their world by the logic of correspondence, the new biology is concerned with the autonomous units which operate by the logic of coherence" (Varela, 1987, p. 50). Here, Varela is applying a principle of psychological perception to his observations about nature: just as all objects in the external world are constructed by perception, entities that we observe in nature are always contingent, constructed objects drawn from a background of inherent unity.

For Maturana and Varela, cognition does not necessarily take place in a brain or a mind. They define cognition as a modality that generates order through the coherence of systemic processes. The systemic processes work by continuously defining and maintaining the boundaries of that system. In their co-authored text, Maturana and Varela (1980) define cognition as a systemic process, explaining that

> “The basic cognitive operation that we perform as observers is the operation of distinction. By means of this operation we specify a unity as an entity distinct from a background, characterize both unity and background with the properties with which this operation endows them, and specify their separability” (p. 16).

This portrayal echoes some of Hayek’s comments about how cognitive processes mediate and interface with the context of the external world.

For Maturana and Varela, environmental context is certainly an intrinsic part of cognition. Information is not pre-constituted or acontextual; it is through the coherence of complex processes and the context of observation that ordered patterns and boundaries emerge. Using even more stringent language than that of Hayek, these biologists insist that predetermined objects do not simply exist in nature, waiting for the mind to recognize them. Rather, the mind actively participates in the construction of the objects that it perceives. According to these biologists, this is true both in the context of the mind of an organism, and in the context of “cognitive” natural processes that occur outside of a brain. Maturana and Varela argue for greater generalizability for the concept of cognition, claiming:

> “A cognitive system is a system whose organization defines a domain of interactions in which it can act with relevance to the maintenance of itself, and the process of cognition is the actual (inductive) acting or behaving in this domain. Living systems are cognitive systems, and living as a process is a process of cognition. This statement is valid for all organisms, with and without a nervous system.” (Maturana & Varela, 1980, p. 40).

As discussed in chapter two, Maturana and Varela's claims about cognition as a constructive and interpretive process are more legible when accounting for the influence of systems theory and cybernetics on their work. In particular, it was through the field of cybernetics that a language was developed to account for the processes by which order emerged within complex systems. Norbert Wiener argued that the processing of information was the central function of complex systems, social and natural alike. As discussed in Chapter One, Wiener frequently compared organisms to machines, claiming that both were governed by the transfer of communicational messages. Wiener defined information as anti-entropy, implying it was a force of order which defied the tendency of nature to decay. According to Wiener (1989),

> "The machine, like the living organism, is, as I have said, a device which locally and temporarily seems to resist the general tendency for the increase of entropy. By its ability to make decisions it can produce around it a local zone of organization in a world whose general tendency is to run down" (p. 34).

Ultimately, Wiener insisted that machines and organisms, while differing in levels of complexity, were governed by the same functional principles. Wiener's approach has important similarities with biological applications of systems theory.

In addition to Maturana and Varela's theories, which posit cognition as a force which creates order through the mediation of information, a notable trend in ecology that was influenced by cybernetics is Gaia theory, as discussed in Chapter Two. Controversial and often misunderstood, yet gaining influence as decades have passed, Gaia theory posits that the earth is a self-regulating system through which life creates the conditions for its own flourishing. Gaia theory was created and promulgated through a collaboration between earth systems scientist James Lovelock and the biologist Lynn Margulis, who famously discovered that in evolutionary history, primitive microorganisms were symbiotically incorporated as organelles into more complex organisms.

Of the two Gaia theorists, Lovelock was especially clear that cybernetic theories of autonomous regulation played a role in earth's processes. Lovelock's interest in Gaia theory began with a series of experiments in which he sought to understand the origins of life on earth. He discovered that the presence of life could be proved by the "chemical composition of the Earth's atmosphere, when coupled with such readily accessible information as the degree of solar radiation and the presence of oceans as well as land masses on the Earth's surface" (Lovelock, 1979, p. 6). The chemical composition of the atmosphere was the key element. There is no known mechanism by which such a high degree of oxygen in the atmosphere could have occurred through non-living processes. There is also no known mechanism by which such a chemical composition could be maintained if life ceased to occur. Through these observations, Lovelock, together with Margulis, posited that the creation of oxygen by organisms such as cyanobacteria had generated an atmosphere that could support life. Life, through repetitive feedback mechanisms, created the conditions for its own continued flourishing and evolution.

Ultimately, these observations led Margulis and Lovelock to theorize that meaningful homeostatic behavior and adaptation could be observed, even on a planetary level. These observations extend the concept of cognition or information mediation far beyond Maturana and Varela's concerns with specific living processes. Rather, Margulis and Lovelock were concerned with the much larger system of the Earth. Lovelock

(1979) specifically references the impact of Wiener's cybernetics on his theories, especially Wiener's description of "self-regulating systems of communication and control in living organisms and machines" (p. 44). Lovelock (1979) further explains that "One of the most characteristic properties of all living organisms, from the smallest to the largest, is their capacity to develop, operate, and maintain systems which set a goal and then strive to achieve it through the cybernetic process of trial and error" (p. 45). Information is the key to any system that generates order; it is through the ability to "to store, recall, and compare information at any time" that a system can be steered in a specific direction (Lovelock, 1979, p. 57). Living and non-living systems, according to Lovelock, operate by the same principles of information processing, but on different scales.

Margulis (1998) describes this regulation through more figurative language, explaining that the Earth's regulative processes can be understood as a form of proprioception. Margulis (1998) explains that "Proprioception, the sensing of self, probably is as old as self itself" (p. 142). In these comments, Margulis returns to the theme of the self-referentiality of a system, a claim that appears frequently within ecological appropriations of cybernetics. In these approaches, the reference point of a self, understood as a context of observation, drives the functions of a regulative system. Margulis describes the Gaian system as a pre-technological, global, communicational network by which life, in countless forms and circumstances, created the conditions for its own thriving. Margulis resists metaphors that present the Gaian earth as an organism, preferring an informational account instead. Margulis (1998) claims that "The sum of planetary life, Gaia, displays a physiology that we recognize as environmental regulation. Gaia itself is not an organism directly selected among many. It is an emergent property of interaction among organisms" (p. 149). Further, echoing language that was used by Hayek with reference to markets, Margulis remarks upon the non-centrally directed planning that occurs as the result of countless individual interactions. Similar to the planning that occurs in a market system, this planning occurs whether humans or in fact any conscious beings know they are contributing to a greater goal or not.

Hayek's Criticisms of Environmental Governance

As this chapter has discussed, convergences abound between Hayek's theories of mind, information, and order, and theories put forward by systems ecologists. While these convergences are intriguing, it is important to acknowledge that Hayek never expressed views sympathetic to environmental politics through his public platforms. Notably, Hayek took the opportunity during his 1974 Nobel Prize Speech to criticize the influential *Limits to Growth* report, which made various pronouncements about the future resource limits that might stymie modern society if steps were not taken to reach environmental sustainability. Hayek's criticism of the report is that it was based on epistemologically invalid methods. Knowledge about broad conditions such as resource limits would depend on exactly the kinds of fallible generalization and simplification that Hayek criticized in the actions of government planners. Hayek's rejection of ecological warnings was justified for similar epistemological reasons.

Hayek's criticisms of ecological economics began earlier in his career. As John O'Neill (2004) discusses, Hayek's interventions in the *in natura* debates were formative for his critiques of government planning and ecological economics. These debates positioned Hayek in opposition to prominent Vienna Circle logical positivists such as Otto Neurath. Neurath argued for *in natura* decision-making or "in kind economic choices as against calculations in monetary valuations" (O'Neill, 2004, p. 432). Neurath promoted an economic system that was essentially socialist, and that would involve a process for making economic decisions based on the physical attributes of entities, rather than their subjective economic value.

Hayek was opposed to this central planning approach for epistemological and political reasons. The debate became relevant not simply to issues of central planning to achieve socialist objectives, but also to the field of ecological economics. Hayek opposed various proposals to incorporate material features such as energy units into economics. He was also fiercely opposed to the idea that an optimum state of resource management could ever be attained. Hayek insisted that the market system, including its autonomous pricing mechanisms, was the best available tool for the management of collective resources. The market was epistemologically and functionally superior, Hayek claimed, because of its ability to mediate the subjective meanings attached to things, rather than the things in their raw form. This ability would result in superior decision-making than could occur through centralized planning.

Hayek continued this line of argument in his three essays on the subject of scientism (Hayek 1942, 1943, 1944). In these essays, Hayek develops a lengthy critique of what he terms "scientism," or science that is based on false and unjustified scientific claims. Emphasizing that his critique is directed towards unjustified uses of science, rather than science itself, Hayek aims to delineate the difference between scientism and true science. Interestingly, rather than insisting that true science should be the form most free of subjective values, Hayek makes a different claim. Hayek explains that while the trajectory of early scientific discoveries in past centuries was towards a relinquishment of mysticism, subjectivism, and anthropomorphism, the present-day practice of science had erred by taking a course correction towards excessive objectivity that didn't take psychological interpretation into account at all. Thus, Hayek explains that

> "Sciences had in their beginning to fight their way in a world where most concepts had been formed from our relations to other men and in interpreting their actions. It is only natural that the momentum gained in that struggle should carry Science beyond the mark and create a situation where the danger is now the opposite one of the predominance of scientism impeding the progress of the understanding of society" (Hayek, 1942, p. 270).

Specifically, the scientism that Hayek decries is scientific approaches that seek to completely purge the subjective element of perception and interpretation. Hayek argues that these subjective elements are in fact critical to achieving good science. It was for this reason that Hayek rejected many approaches to ecological economics; he doubted the validity of scientific claims about broad and abstract processes that did not incorporate sufficient theorization of those processes in ways that could account for the role of subjective impressions.

These comments about the importance of subjective interpretation led to other assertions that Hayek makes in the essay which diminish the importance of the material characteristics of economic entities. Echoing his other comments, Hayek (1942) explains that "Neither a 'commodity' or an 'economic good', nor 'food' or 'money' can be defined in physical terms but only in terms of views people hold about things. Economic theory has nothing to say about the little round disks of metal as which an objective or materialist view might try to define money. It has nothing to say about iron or steel, timber or oil, or wheat or eggs as such." (Hayek, 1942, 282). Scholars such as O'Neill take such comments as indication of Hayek's general antipathy to environmental economics. Certainly, it is possible to argue that forms of economic theory that diminish or outright reject the relevance of the material characteristics of things will be incompatible with environmental perspectives. Environmental resource limits and environmental damage, after all, do not take place in an abstract realm, but in the material world. However, this chapter will now consider whether Hayek's presumed antipathy to environmentalism has been overstated, and whether Hayek's views might be compatible with certain ecological perspectives.

Interpreting Hayek's Systems Ontology

Views abound in recent scholarship that position Hayek's theories as incompatible with environmentalism. William Connolly (2013) argues that Hayek goes wrong not because of his claim that society is formed by spontaneous order, but because he fails to acknowledge the true fragility and interrelatedness of the complex orders that support human and nonhuman flourishing. The market system appears in Hayek's theories, Connolly asserts, as an abstract and separable system that does not incorporate feedback from the environment. Hayek's analysis thus fails to account for how the self-organizing system of market prices intersects with other self-organizing systems such as ecologies, which operate by different rules and are vulnerable to specific kinds of fragility. Notably, Connolly does not argue that Hayek's claims about market self-organization are intrinsically anti-environmentalist. Rather, claims about spontaneous order become opposed to environmental objectives when it is asserted that economic decision-making must remain within a truncated and abstract realm of subjective economic impressions, while steering clear from engagement with material entities.

Similarly, Stephanie Erev (2019) argues that not all aspects of Hayek's theories necessarily lead to the rejection of nature. Rather, Erev emphasizes that Hayek actually does incorporate an appreciation of nature into his work. The use of evolutionary theory and the references that compare society to a form of life within Hayek's writings can be seen as more than simply passing metaphors. According to Erev (2019), such references are evidence of what Hayek "heard but failed to affirm: nature's active voice" (p. 1). Erev thus positions Hayek ambiguously in relation to ecology. Hayek, Erev points out, did in fact acknowledge that there were important parallels between the organizing processes in nature and the organizing processes in society. He also acknowledged, implicitly, that the forms of organization occurring within nature were productive and complex, and that nature was far more than a mute and passive resource. However, echoing Connolly, Erev argues that Hayek overestimated the stability and solidity of the market order, and its separability from the other orders of material and social existence.

The critiques put forward by Connolly and Erev raise important questions about the applicability of Hayek's impactful school of economic thought in the context of urgent contemporary questions about the management of environmental problems. While acknowledging the importance of Connolly and Erev's criticisms, I wish to ask a different question: could Hayek's views have been compatible with a less top-down version of environmental intervention that more closely mirrored Hayek's positions on empiricism, epistemology, and rationality? By putting Hayek's views into conversation with Maturana, Varela, Lovelock, and Margulis, I would argue that the answer is yes.

As has been discussed in this essay, both Hayek and the systems ecologists I have examined developed a theory of cognition that was linked more closely to information processing than to consciousness. They argued that a nuanced view of human knowledge construction, taking the processes of cognition into account, could inform better empirical practices, as well as a more accurate understanding of macro-level phenomena that operate by principles of self-organization. Both Hayek and the systems ecologists agreed that complex systems operated in the world, whether in nature or in society, that reflect a type of information processing and non-personal cognition. Certainly, Hayek's views were less strident than the systems ecologists in acknowledging the importance of environmental context. However, I would argue that there is nothing to suggest that Hayek could not have further developed his ideas to develop ecological applications of his theory of spontaneous order.

Hayek clearly acknowledged, in *The Sensory Order* and elsewhere, that the context of observation matters, and that minds interact with environments. He did not develop a purely idealist theory of phenomena, despite his tendency at times to downplay the importance of material entities. Rather, there is a more complex point that is developed in Hayek's theories about the way that people construct knowledge about the world. By emphasizing that the empirical examination of entities should always occur as a co-production between observation and theorization, Hayek was, in many ways, methodologically aligned with an important though minoritarian tradition within ecology. While expressing different political views from those of Hayek, biologists Richard Levins and Richard Lewontin (1980), Varela (1987) Maturana (1987), and others made similar claims about how good science is built upon intentional selection of abstractions, taking context of observation into account. While Hayek's understanding of forms of spontaneous order, carried out through autonomous processes of cognition, does not inevitably lead to environmental consciousness, the methodologies made available by systems thinking are compatible with certain kinds of environmental thinking. While these possibilities are not explicitly developed in Hayek's work, it is not possible to conclude with finality that Hayek's views are intrinsically opposed to an appreciation of ecological processes, or that Hayek was promoting the unrestrained control and domination of nature.

This chapter has argued that Hayek's theorization of market processes, often portrayed as a rejection of responsibility for social or ecological costs, is more complicated than traditional portrayals reveal. I have also discussed how the insights of Gaia theorists and systems biologists show that nature's complexity is never fully captured, or manipulable, by any blunt political tool. The comparison between Hayek and the systems ecologists is revealing because it calls into question whether Hayek's theory is truly about control. Certainly, the fact that Hayek recognizes society as a system is not enough to rescue him from the accusation that his theories are authoritarian. However, Hayek does more than that: he recognizes the elusiveness of human subjectivity and motivation, while also recognizing the creativity and complexity of the autonomous processes of nature. While Hayek's assertion that the market order should guide society can be interpreted as a kind of control, that control is not as totalizing as it might at first seem.

In keeping with the primary argument of this dissertation, I wish to close by acknowledging that the freedoms and liberties that Hayek's theory promises can never be separated from the specter of control. Hayek himself was skeptical of populist impulses, and preferred the creativity of the individual to be channeled primarily through economic processes. He certainly wished the market to be upheld at the center of the organization of society. However, a closer look at the ontology of Hayek's theories suggests a more complicated conclusion: the market that Hayek wished individuals to submit their efforts to was an emergent, shifting, dynamic entity, rather than a fixed abstraction. Furthermore, Hayek acknowledged that individuals are constituted by complex processes themselves, and that human motivation is quite opaque. Hayek positions the market as the best means of organizing human activity because he believes that it best organizes imperfect human knowledge and action, not because he celebrates the genius of the transcendent entrepreneur, inventor, or genius. Thus, I would argue that scholarly narratives that blame Hayek for neoliberal's worst excesses may be aimed towards the wrong target. In the final chapter, I will argue that the turn towards extreme individualism, rejection of material reality, and speculative economic theory in the late twentieth and early twenty-first centuries should instead by associated with the contributions of two pivotal figures: Kevin Kelly and George Gilder.

Chapter Four: Speculative Theories of Technological Life

Throughout this dissertation, I have discussed how conceptual tools, notably systems thinking and cybernetics, inaugurated scientific approaches to the study of technological and natural systems alike. In the context of nature, systems ecologists described the spontaneous emergence of order as ecosystems adapted to changing conditions. In the context of economics, Friedrich Hayek drew on systems theory to argue that economic markets had self-organizing and emergent qualities. This chapter will continue the discussion of theories of systemic emergence in economics, but will also add the lens of technology. Specifically, the chapter will discuss how Kevin Kelly, the first editor of *Wired Magazine*, exemplifies the blending of information theory and systems theory into a political ideology centering around technological utopia. This political ideology, as I will discuss in the conclusion, has clear continuities with contemporary political debates. The chapter will also discuss other figures, most notably George Gilder, who argued that the synthesis of technology, economics, and the information sciences would drive civilization to new heights of progress and prosperity. I will show how these hopes often depended on speculative arguments that diminished the significance of material or ecological limits. Further, as I will discuss, while both Kelly and Gilder claimed to be aligning society with the forces of freedom and liberty, the political aims they sought can also be seen as sophisticated systems of control.

Kevin Kelly's Theory of Technological Control

Kevin Kelly is one of the clearest examples of this style of speculative thinking. Kelly argued that the force of technology that had been unleashed in the information age would generate systemic adaptation, growth, and creativity, just like a form of life. This chapter shows that Kelly, in addition to other twentieth century technology enthusiasts, appropriated metaphors and concepts from ecology to bolster the legitimacy of utopian claims about the information age and its impact on economic growth. I show that ecological metaphors strengthened utopian assertions about technologically designed economic development that were often, in fact, a call to submission to a future of unimpeded capitalist growth. Thus, ecological concepts were used by prominent technologists such as Kelly to undermine environmental goals, while also undermining genuine human freedom.

The first part of the chapter discusses the contributions of Kelly, a former editor of *The Whole Earth Catalog*, the first editor of *Wired Magazine*, and the author of several books. In these roles, Kelly was a major figure who shaped the reception of information science and information technologies in the consciousness of the American public. However, his influence was not exerted only through his editorial roles, but also through his own writing. A series of books written by Kelly in the 1990s exhibit his perspective on the purposes, uses, and future applications of information technology. Specifically, Kelly compared informatic machines such as computers to a form of life, due to their apparent creative and intelligent powers. Accordingly, economic systems that incorporated information technologies would exhibit lifelike qualities. These qualities included autonomous organization, growth, creativity, and adaptive change. According to Kelly, the new world that was being built through information technology would be governed by the intangible yet lifelike principles of information, rather than by the concrete distribution of material resources.

Kelly described information technology as the source of an almost miraculous, anti-entropic organizing power that could allow its users to transcend the limits of the material world. Importantly, this anti-entropic power was described by Kelly not simply as lifelike, but as a form of life. Life, as defined by Kelly, was simply a specific kind of computation that allowed organization to triumph over chaos. Kelly framed this life force as dominant and inevitable. The supposed life force expressed in technological capitalism became, in Kelly's theory, more ontologically stable and real than genuinely biological life. Thus, for Kelly, protecting the abstract concept of informatic life was more important than the protection of actual biological life or real ecosystems.

In practice, protecting the informatic concept of life meant protecting the economic markets through which the intelligent powers of information would be most effectively expressed. Kelly's extended metaphorical discussion of biological life worked not only to legitimize neoliberal goals such as the deregulation of economic markets, but also to delegitimize environmental politics, which was rooted in the realm of materiality rather than information. I will argue that Kelly's writings are not simply isolated, eccentric musings, but rather are expressive of a broader ethos that has characterized the digital age: the prioritization of mind over matter, indifference towards resource limits, and a belief that information technology can overcome all shortcomings of the human condition.

In *Out of Control: the New Biology of Machines, Social Systems, and the Economic World*, published in 1995, Kelly articulates, through a long series of musings, anecdotes, and vignettes, an argument that the information age would be dominated by biological concepts. Initially, this might seem like a surprising comparison. After all, biological life is part of the realm of the natural; machines emerge from the realm of the human made. However, Kelly argues, the world in the mid 1990s had finally entered a phase in which machines were becoming complex enough to impinge on the realm of life. No longer were machines governed by the mechanical principles of a linear universe, as in more simple technologies such as the clock. Instead, according to Kelly, machines were becoming increasingly lifelike. They exhibited principles of intelligence, organization, computation, and evolvability that mimicked forms of life. Kelly argued that in the new information age that humanity was entering, nature would no longer be simply a raw material to support the designs of engineers and builders. Rather, nature would increasingly become a metaphorical reservoir: a source of concepts, structures, and processes that could inspire humans to build better machines. As Kelly (1995) explains, "Nature has all along yielded her flesh to humans...Now bios is yielding us her mind—we are taking her logic" (p. 7).

The logic of nature that could supposedly be extracted and repurposed, in concert with the advent of information technology, had a dual function for the human imagination, according to Kelly. First, there were specific computational processes from nature that machines had been able to mimic: "self-replication, self-governance, limited self-repair, mild evolution, and partial learning" (Kelly, 1995, p. 7). Accordingly, as the mysteries of the complex processes of nature were further decoded, inspiration would be found for increasingly more sophisticated machines. More broadly, however, Kelly indicated that nature could be the source of new ways to imagine civilization itself. In one particularly evocative passage, Kelly (1995) states,

> "Nature is also a 'meme bank,' an idea factory. Vital, postindustrial paradigms are hidden in every jungly ant hill. The billion-footed beast of living bugs and weeds, and the aboriginal human cultures which have extracted meaning from this life, are worth protecting, if for no other reason than for the postmodern metaphors they still have not revealed." (p. 8).

The brief mention of indigenous people in the passage is worth mentioning because of its clear implication: the knowledge of indigenous people, like the knowledge of nature, is worth protecting because of what it can offer to the modern people building the industrialized, informational societies of the future. It is also worth mentioning that for Kelly, the purpose of protecting nature is to fulfill utilitarian aims, rather than to fulfill an intrinsic, biocentric appreciation of nature's majesty. Thus, the tragedy of the destruction of a prairie "destroys not only a reservoir of genes but also a treasure of future metaphors, insight, and models for a neo-biological civilization" (Kelly, 1995, p. 8). Kelly's utilitarian portrayal of the preservation of nature is an attitude that shapes his perspective on environmental politics, as will be discussed later in the chapter.

However, Kelly's purpose in the book is not to defend environmental politics, but rather to explain how human society can extract the metaphorical and conceptual resources from nature that will help build a new civilization. Nature's wildness was valued for its utilitarian applications, not simply because of the way wild nature could inspire the human imagination, but because wildness was an example of self-defining purposes, "the mingling of cause and effect in circular logic," and a form of momentum that moved "only to enlarge itself, and that pushes its disequilibrium into all matter, erupting in creatures and machines alike" (Kelly, 1995, p. 98). Thus, wildness introduced both unpredictability and the expansion of its own logic into natural and human-built systems. Additionally, the tendency of wild life to affect a shift from equilibrium to disequilibrium was important to how Kelly, and other systems theorists, understood living processes.

While it might seem that life is characterized by equilibrium and homeostasis, many systems theorists thought otherwise. One of the most well-known depictions of life as a form of disequilibrium is Gaia theory, which Kelly mentions several times in the book. As discussed in previous chapters, Gaia theory originated through the investigations of James Lovelock. Lovelock argued that planets that had life on them could be distinguished from non-living planets by examining the level of disequilibrium in the atmosphere. A non-living planet would have equilibrium in the gaseous compounds because living organisms were not constantly modifying it. By contrast, in a living planet like earth, microorganisms and multi-celled organisms alike contributed to the formation of the oxygenated atmosphere, a state of disequilibrium that could not exist without life. When life processes institute disequilibrium in the atmosphere, for instance through oxygenation, it then follows that entropy (the tendency of the universe to move towards disorder) decreases. This is why some scientists, and Kelly himself, began to describe life as a force of anti-entropy—a force by which the inherent disorder of the universe was transformed into computational patterns.

Lovelock drew on a systems analysis of the informatic patterns of life to help formulate Gaia theory. Kelly (1995) uses a similar informatic definition of life, writing that "life is a nonspiritual, almost mathematical property that can emerge from network-like arrangements of matter. it is sort of like the laws of probability; if you get enough components together, the system will behave like this, because the law of averages dictates so" (p. 97). The mathematical properties of life were not simply an after the fact abstraction added on by human observers. Rather, for Kelly, the processes of life were self-constituting, autonomous systems that generated order and complexity, through a kind of immanent computation. Human society, Kelly argued, should mimic these spontaneous organizing features of nature, embracing the existence of disequilibrium and change.

These complex processes could be found in the interior of living organisms, but they also appeared in the forms of social organization that were characteristic of various nonhuman societies. For instance, Kelly was quite fond of the metaphor of the swarm, or the hive mind. The intelligent choices of an insect hive, such as the decision to move locations or seek a food source, could not be attributed to the limited intelligence of any individual insect. The intelligence of the hive overall was an emergent property. Similarly, Kelly explains, information technology was allowing humans build machines that could harness the principle of emergent properties, as found in a hive or a swarm. Information technology allowed humans to connect and aggregate their knowledge, and the result could be something as grandiose as an emergent planetary human intelligence. Thus, according to Kelly, the future prosperity of humanity depended on being able to build machines that could mimic the intelligent properties of life.

According to Kelly, once the principle of biological complexity was harnessed and engineered into machines, it would start to exhibit properties of inevitability. In one particularly stark statement, Kelly (1995) notes that

> "Biology is an inevitability—almost a mathematical certainty—that all complexity will drift towards. it is an omega point. In the slow mingling of the made and born, the organic is a dominant trait, while the mechanic is recessive. In the end, bio-logic always wins" (p. 160).

The existence of this bio-logic, or the patterns and processes that humans could extract from nature, had several implications. First, Kelly believed that information technologies, by facilitating connections and the sharing of information between humans, would orient society towards more intricately interwoven, self-organizing market patterns and systems of governance. Distributed, ground up decision-making would be favored, in both the economic and political realms. To orient society towards a more decentralized structure was not to leave it stuck in a state of disorganized stasis. Rather, it was through the decentralized structure that greater coordination could occur, allowing society to transition towards a more advanced state of being. Kelly (1995) saw the self-organizing processes of human society as continuous with the self-organizing processes of nature:

> "Spontaneous order helps create more order. Life begets more life, wealth creates more wealth, information breeds more information, all bursting the original cradle. And with no bounds in sight" (p. 22).

Thus, attending to the self-organizing principles in nature could inspire forms of political governance based on the idea of spontaneous emergence.

In Kelly's formulation, life, wealth, and information were patterns that could continually increase. Kelly was not worried that physical resource limits, including the limited supply of raw materials that could be extracted from the earth, would slow down the new information based economy. At one point, in a comment about the increasing prevalence of services in the economy, Kelly (1995) wrote that "Flows become more important than resources" as the decentralized network form takes over decisions about economic processes (p. 26). For similar reasons, Kelly was skeptical about the famous 1972 *Limits to Growth* report, issued by the Club of Rome. Kelly argued that the idea of resource limits failed to account for the major paradigm shifts that were taking place as society shifted into an information economy. The Industrial Revolution had been radically different from what had preceded it, and the new Information Revolution of the 1990s was likely to be no different.

Kelly was similarly skeptical of the idea that living ecosystems or organisms were truly vulnerable to the incursions of human civilization. Kelly discussed various evidence that he argued could show that life was too creative and resilient a force to ever be destroyed, once created. He also imagined that (natural) life would continuously expand, both on earth and on the other planets of the galaxy. He argued that "if left alone, the Earth will be solid green someday...the galaxy may be green someday too" (Kelly, 1995, p. 95). Kelly emphasized that life is capable of adaptation to harsh circumstances. Thus, the dire warnings of some environmentalists about the fragility of endangered species were simply a distraction from a simple truth: that life was a dominant, resilient force that could not be extinguished. Kelly argued that this point of view represented progress from earlier forms of environmentalism. He singled out Aldo Leopold's fear of wildfires as an example of the failures of the earlier conservation paradigm. Instead, the creative destruction of the wildfire should be seen as necessary for the creation of ecosystems such as prairies. Similarly, it was implied, environmentalists should not worry so much about specific episodes of death or destruction of natural life; rather, they should celebrate the ways in which life could adapt to be more resilient.

Rather than preservation of any particular status quo, either natural or political, humans should realize that the best they can do is to steer the complex systems of nature, information, technology, and political life that had become the backdrop of human society. Perfect prediction would always be impossible; the systems that were involved were too complex. Instead, it was necessary to learn to thrive within complex, decentralized systems, animated by the vital impulses of information technology. The creative processes at work in the society of the information age exhibited creativity and intelligence that could be steered and directed, but never fully understood. In fact, Kelly (1995) created a series of laws that were to govern the human response to the new age, including “Distribute being,” “Control from the bottom up,” “have multiple goals,” and “Seek persistent disequilibrium,” (p. 392). By following these principles it was possible to enter a future in which

> “The river of life—at least its liquid logic—flows through it all. We should not be surprised that life, having subjugated the bulk of inert matter on Earth, would go on to subjugate technology, and bring it also under its reign of constant evolution, perpetual novelty, and an agenda out of our control. Even without the control we must surrender, a neo-biological technology is far more rewarding than a world of clocks, gears, and predictable simplicity. As complex as things are today, everything will be more complex tomorrow. The scientists and projects reported here have been concerned with harnessing the laws of design so that order can emerge from chaos, so that organized complexity can be kept from

unraveling into unorganized complications, and so that something can be made from nothing." (Kelly, 1995, p. 395).

There are a few important points to unpack from this quote. First, it is implied that natural life is not vulnerable to the incursions of the economic systems of the information age. Rather, the information age, by capturing the principle of life and transmitting that principle into technology, is positioned by Kelly as another evolution of life itself. Life would no longer be restricted to the biological or the natural, but could now be found in machines. Furthermore, by following these principles, it was possible to generate substance and meaning from the chaos of the universe. The limiting factor was information itself, rather than any sort of physical resource. It was through the computational principle of life, after all, that the engines of society and nature alike kept turning.

Kelly's representation of society as a form of computation has important resonances with the theories of Hayek. Hayek also utilized metaphors of computation, and argued that economic markets computed important features of the economic systems, most notably pricing. Another important convergence between the theories of Kelly and Hayek is the shared emphasis on the concept of emergence. As discussed previously, Hayek viewed both the human mind and the economic market as emergent entities that illustrated the ability of numerous individual actions to add up to a coherent whole. The human mind was an emergent property of the actions of neurons, and the market was an emergent property of the actions of individual humans participating in the economy.

Bot Kelly and Hayek believed that the complex systems of the economic and social worlds were able to cohere together into emergent entities as a result of rule following processes. For Hayek, these rules were the implicit, learned values of the market order, as well as other traditional values. For Kelly, the rules that are followed are less a social construction built upon tradition than an algorithmic, autonomous response shaped by biological logic. Kelly (1995) argues that there is an important homology between "a swarm of bees, or a cloud of modems, or a network of brain neurons, or a food web of animals, or a collective of agents" (p. 21). All of these are complex systems in which some kind of individual agent contributes, such that each acts "according to internal rules and the state of its local environment" (Kelly, 1995, p. 21). Thus, for Kelly, the rules that are followed are not necessarily conscious or learned, but rather spring from the logic of the life processes themselves (or the technological systems that mimic the logic of life). Ultimately, the implications of this discovery lead to a similar result for Hayek and Kelly: centralized planning is revealed to be inefficient, wasteful, and misguided; only the emergent qualities of complex systems are sophisticated enough to guide and steer society effectively.

Despite these similarities, however, there are several key differences that reveal Kelly's theory to be far more speculative than that of Hayek. The first key difference can be found in the usages of biological metaphors in the work of the two theorists. For Hayek, the processes of human history are comparable to, but not the same as, biological evolution. In his work *The Fatal Conceit*, Hayek (1988) writes that it is the "complex structures" and the 'complex self-maintaining orders" that are subject to evolutionary forces of selection. However, he acknowledges that this evolution is different from biological evolution, which occurs more slowly. For Hayek, the evolutionary metaphor is meant to capture that processes of selection are at work in shaping the emergent systemic orders that constitute modern society. However, Hayek never treads all the way towards an ontological equivalence between natural and social orders. This is not the case in the writings of Kelly. Kelly believed that the invention of information technology had captured, encoded, and replicated the basic logic of biological systems, and embedded this logic in economic and social processes.

Further, in contrast to Hayek's emphasis on the fallibility of knowledge and prediction, and the centrality of subjective and imperfect human judgment, Kelly portrays the bio-logic that governs economic and technological systems as inevitable, almost infallible, and as a testament to the greatness of the powers of human invention. In another book, *New Rules for the New Economy,* written by Kelly in 1998, Kelly (1998) argues that rather than fallible human agency, it is technology itself, encoded with biological principles, that becomes "the dynamo" and the "Prime Mover" of the new information-based economy (p. 154). The technological revolution, according to Kelly, would unleash a force that was a variation of biological evolution. Aligning with this force would mean not simply allowing for society to develop through ongoing adaptation, but also channeling a force of inevitable progress. Drawing on the research of neo-Darwinian Stephen Jay Gould, Kelly (1998) argues that life not only resists the entropy of the universe, but that it gives rise to "the Great Asymmetry... the remarkable ability of evolution to create a bit more, on average, than it destroys...life ratchets up irreversible gains" (p. 141). According to Kelly, technology would only become more and more biological over time, as it became increasingly complex. As the biological nature of machines became more enhanced, the operation of evolutionary principles through technology would accelerate. This would be exemplified not simply in the invention of new technologies, but in their implementation. The ability of information technology to bring together separate human endeavors, enabling communication between individuals and businesses, would accelerate processes of change, competitive selection, and dynamic experimentation, taking humanity on a path towards a higher destiny. These statements about the emergent order of the technological civilization are significantly more grandiose than anything suggested by Hayek.

Crucial to Kelly's path of progressive evolutionary social development was the rejection of the idea of equilibrium. Equilibrium is a concept that has a long history in both ecology and economics; theorists of complex systems have long sought to understand the conditions in which highly variable systems are able to establish a steady or predictable state. Ecologists have found such steady states in nature in the form of prairies, grasslands, woodlands, and so forth. Economists, notably Adam Smith, argued that an invisible hand moved through the economy to establish a steady order. One of the major signposts of late twentieth century systems analysis, however, was a turn away from the equilibrium concept, in both ecology and economics. In ecology, C.S. Holling (1973) argued that what was most interesting about ecosystems was not how they would behave under conditions of equilibrium, but how they would act under conditions of disequilibrium. It was under conditions of disequilibrium that autonomous, creative reorganization would occur, as the system itself readjusted to a new set of conditions and parameters. Hayek (1974) rejected the pursuit of knowledge about equilibrium conditions in economics for epistemological reasons. There are limits to the knowledge that any economist can have about the components of an economic system, and thus attempting to explain the behavior of such a system through the abstract principle of equilibrium will have limited use. While Holling and Hayek rejected the concept of equilibrium as a response to particular debates in their academic disciplines, for Kelly this rejection went deeper.

For Kelly, life could be described as an enduring disequilibrium. Thus, the technological economy he believed was being birthed, based on lifelike machines, would also be characterized by persistent disequilibrium. The role of human intervention was to intentionally seek after this disequilibrium. This did not mean pursuing total disorder, but rather aligning with the right amount of change and flux to allow creativity and innovation to flourish. Enhancing the processes of autonomous organization and reorganization in social systems would enhance the development of self-reinforcing informatic patterns. The role of the human was then to steer the complex systems of society. This gives rise to a very different result than that imagined by Hayek. Hayek had argued that the computational abilities of economic markets were an emergent quality of the actions of individuals, acting based on their own limited subjective knowledge. Hayek believed that this should give rise to epistemological humility. The interventions of any individual human would always be simply one component of a larger process which could never be fully understood. For Kelly, however, bottom-up steering of the complex system of society was in fact possible. By inventing, building, and using technology, humans were in fact exerting a Promethean power. The technology was the tool that would allow humanity to ride the waves of disequilibrium in order to follow the course of human progress.

In his book published in 1998, *New Rules for the New Economy*, Kelly is clearer about what this means. Kelly (1998) explains that in the new economy,

> "the principles governing the world of the soft—the world of intangibles, of media, of software, and of services—will soon command the world of the hard—the world of reality, of atoms, of objects, of steel and oil, and the hard work done by the sweat of brows" (p. 2).

Specifically, Kelly predicted that information technologies would become the force that would govern the new economy. The implication of this is that information would govern over matter itself. Kelly argued that the transition towards information technology marked a period far more significant than the industrial revolution. This is because the new technologies centered around communication, which isn't a physical resource but rather is the symbolic basis of all human endeavors. Thus, all of human social life would soon be dramatically reorganized. Kelly predicted that massive profits would be available for those who understood the rules of the new economic order.

The new economic order, according to Kelly, was characterized by ubiquitous connectivity, cheapness of products, universal implementation, and continual dynamism. The new economy would grow rapidly as new innovations were discovered, but also could rapidly disintegrate as old technologies or products were quickly abandoned. The key to survival in the new economy was to align with the force of innovation. Departing from Hayek's emphasis on the centrality of the pricing system to economic markets, Kelly argued that it was innovation that drove economic processes. Since innovation was theoretically limitless, business profits and overall economic growth could be astronomical. Advantages in the market, especially technological advances, would compound rapidly, leading to the ascendance of the most astute competitors. Equally quickly, a successful company could be overshadowed and rapidly fall. Many of these insights, from the contemporary perspective, might seem like an ordinary and banal observation about the rapid changes that have since come through an information based economy. At the time, however, many of these insights were novel—the modern landscape of Silicon Valley had not yet reached its present-day recognizable form.

What I wish to draw attention to, however, is that the shift from Hayek's pricing system to Kelly's emphasis on networked connection and innovation was accompanied by a strong turn towards speculative observations. As has been discussed, Hayek was not an open champion of the environment, and was skeptical that material resource limits could ever be calculated or fully known. What Kelly introduced, however, was the idea that resources could become almost infinitely cheap. As Kelly (1998) argues, "Plentitude, not scarcity, governs the network economy. Duplication, replication, and copies run in excess. Whatever can be made, can be made in abundance" (p. 39). Kelly readily acknowledges that this point of view contradicts established approaches to economics, in which the value of a good is determined by its relative scarcity. While traditionally, successful consumer products led to scarcity and thus declining profits, the information economic had no such limits, and thus profits would be far more astounding. In the networked economy, success simply led to more success, as advantages compounded through what Kelly characterizes as exponential processes. Products would continually become cheaper, to the point that, as Kelly argues, chips would become so cheap and miniaturized that they could be added to any consumer product, almost limitlessly. Information, the all-important good of the network economy, would approach the point at which it was completely free. Thus, there was no reason to expect that economic processes would ever slow down. There was also no reason to believe that the dictates of material reality would slow down economic expansion.

Cyberspace as the Land of Infinite Potential

The themes that Kelly develops, which may seem quite speculative, are not simply the isolated musings of a singular individual. A similar view about the ability of technology to transcend material limits is well illustrated in two striking political manifestos, produced by advocates of cyberspace in the 1990s: the "Declaration of Independence of Cyberspace" (Barlow, 1996) and "Cyberspace and the American Dream: A Magna Carta for the Knowledge Age" (Dyson et al., 1994). The "Declaration of Independence of Cyberspace" a short document written in 1996 by John Perry Barlow during a trip to Davos, Switzerland, argues that the world created by cyberspace will become a new "civilization of the Mind" over which traditional governments will not have sovereignty. Barlow (1996) argues that the world of cyberspace will be ubiquitous, universal, and distributed, and that "Ours is a world that is both everywhere and nowhere, but it is not where bodies live." The prosthetic enhancement of thought enabled by the interface between the human mind, the personal computer, and the internet would allow a new world to be built not out of physical materials but out of mental formations, sharing of information, and interconnections between various minds and machines. Barlow emphasizes that despite the mechanical aspects of tools such as computer processing technologies, what computers would enable was not simply an increase in efficiency or information processing power. Instead, the machine of the computer would allow humans to transcend a fixed and mechanical universe and to see themselves as inhabitants of a new kind of space that transcended physical limits.

The “Magna Carta” document, written in 1994 by a group of libertarians and technologists including George Gilder and Esther Dyson, continued this pattern. The opening sentence of the document declared emphatically that “The central event of the 20th century is the overthrow of matter” (Dyson et al., 1994). The main resource of this new economy would be knowledge itself. Traditional reliance on physical resources such as land, labor, and materials would only hinder civilizations seeking to adapt themselves to the new world of the information age. Arguing that this emerging knowledge system was “More ecosystem than machine,” the authors emphasized the importance of process, relationship, and functional cooperation for the computational systems that were the building blocks of cyberspace (Dyson et al., 1994). The authors imply that those who worry that material resource limits would slow down growth of this informational civilization were stuck in naivete and could not understand the transformations that were coming. What mattered was not ecosystems themselves, but the abstract concept of the ecosystem, as expressed through a newfound union of information technology and economic markets.

George Gilder’s Persistent Disequilibriums

The views of these thinkers converge with George Gilder’s prominent writings on the benefits of capitalism. George Gilder was a technology enthusiast and economist whose fervent defense of supply side economics was frequently mentioned by U.S. President Ronald Reagan (Reagan Foundation, 2010). In his 1981 text, *Wealth and Poverty*, Gilder claims that capitalism had a nearly mystical status as the form of human social organization that would enable mysterious creative and mental forces to transform ways of life, technologies, and resource management strategies through drastic leaps and bounds of miraculous invention. In the prologue to the re-publication of the text, Gilder (2012) goes so far as to refer to capitalism as the "the supreme expression of human creativity and freedom, an economy of mind overcoming the constraints of material power" (p. xiv). In keeping with this grandiose style of language, Gilder refers specifically to the word miracles in the book, noting that Newton's mechanistic universe failed to capture the true complexity of reality because it had no place for miracles or unexpected novelty. Gilder strongly criticized any formulation of economic planning that depended on the top-down predictive capacities of the economist. While his disavowal of the possibilities of prediction in the economic realm mirrored the claims of Hayek, Gilder's position was motivated less by epistemology than by a critique of the ontology of the traditional mechanistic universe.

As mentioned in the previous paragraph, Gilder believed that mind can overcome materiality. Gilder defines mind in a way that clearly exceeds the context of an individual brain. Instead, the mind that Gilder refers to seems to reference an autonomous creative power that operates independently from known mechanisms of control. Developing the implications of this theory, Gilder implies that it is possible to live a universe in which the laws of mind override the laws of matter. Gilder makes this point explicit in his comment that "Because economies are governed by thoughts, they reflect not the laws of matter but the laws of mind" (Gilder, 1981, p. 261). Gilder believes that the mental acts of individual geniuses, immersed in processes of innovation and implementation of new ideas, can transform society, leading to previously unimaginable breakthroughs. For the entrepreneur that applies the power of knowledge, "it is the leap, not the look, that generates the crucial information; the leap through time and space beyond the swam of observable fact, that opens up the vista of discovery" (Gilder, 1981, pp. 261-262). The leap, or the creative power of the mind, provides the framework through which new business strategies or forms of social organization can be glimpsed. To start with the facts, and the world as it can be known through physical attributes, would be to reside in a world of creative stasis that would lead only to society's decline. Gilder sees creative leaps not simply as a luxury to propel the economy forward, but as a necessary course corrective that holds back the forces of entropy and deterioration that threaten all human societies.

Gilder's version of social reality is that of a complex system that is constantly on the verge of breakdown and chaos. Only through the providence of unexpected invention are new techniques developed that can transcend resource limits or other material conditions that would otherwise spell doom for society. If overconfident economic planners attempt to organize society based on such material conditions, they will hamper the forms of creative invention that will break through from the realm of the mind. Gilder was very enthusiastic about the ability of cyber technology to facilitate these transformations, and he described the forms of knowledge that would thrive under these conditions as possessing an almost vitalist power, in excess of the rules of the mechanistic universe. Further, information itself starts to take on its own creative powers in Gilder's theory, especially when it is wielded by the entrepreneur.

Creative thought, Gilder explains, has a higher, religious source, and it is through alignment with this source, through the mediation of information, that society can flourish and prosper. A prosperous capitalist society, according to Gilder, is defined by its creativity and variety, leading to "an unpredictable flow of diversity and differentiation" that reveals capitalism's ability to mobilize the non-deterministic "laws of the mind" (Gilder, 1981, p. 265). Similarly to Hayek and even some ecologists, Gilder indicates that information can be associated with non-conscious, non-phenomenological entities. The universe, according to this perspective, unfolds through these extensions of mental and informational principles. Nonetheless, Gilder's speculative capitalist ideology furthers neoliberal tendencies to minimize the importance of acting on environmental crises. Gilder (1981) writes that even environmental crises can be framed as a "new frontier" which then "are themselves the mandate for individual and corporate competition and creativity; are themselves the reason why we cannot afford the consolations of planning and stasis" (p. 268). According to this vein of political thought, crises, including impending material resource limits, can be celebrated due to their potential to motivate creative, heroic responses that preserve the dynamism and necessary unpredictability of the human society.

The Radicalism of Kelly and Gilder's Vision

Both Kelly and Gilder drew their political musings from earlier developments in information theory. Kelly mentions Norbert Wiener as an influence on his understanding of non-material patterns. As Kelly explains, drawing on Wiener, the pattern that maintains complex systems does not arise from the substance itself, but something more intangible. This is illustrated by the way that a whirlpool perpetuates its own shape as a continuous stream of water flows. Gilder, on the other hand, frequently references Claude Shannon, especially in his 2013 book *Knowledge and Power*. In the book, Gilder explains that the economy is an information system. Information, for Gilder, is defined as surprise: the novel pattern within the transmission of a signal that exceeds the preexisting noise. This surprise must be contained: too much signal simply leads to chaos. The right amount of signal, information, or surprise then becomes the force that drives the economic system. The political implications of Gilder's view are twofold. First, the goal of public policy should be to protect the predictability the carrier channel, or the background conditions of the economy. In practice, this meant the promotion of standard conservative policies including a stable legal system, stable families, general social stability, and limited taxation and regulation. Secondly, Gilder believed that the turn to information theory would highlight the powerful role of the entrepreneur, the human individual who introduces the element of surprise into the system.

Gilder believed that Hayek had missed the central importance of entrepreneurship. Entrepreneurship, for Gilder, is valuable because it introduces true unpredictability and surprise. Hayek, on the other hand, valued the emergent social order itself, rather than the actions of any specific individual. In fact, Hayek emphasizes that people act unwittingly, muddling through their own ignorance and limited knowledge. Gilder's view of the market order is strikingly different. For Gilder, it is in fact the foresight, genius, and invention of the individual that drives the economy forward. Kelly is also much more celebratory of human agency than Hayek. Kelly argues that while the emergent order of social, technological, and economic life is a complex and mysterious beast, the human still has power to help steer it. Steering the complex systems of society is best accomplished, in Kelly's view, through the creation and implementation of technology, which depends upon the heroism of human invention. What Kelly and Gilder's account have in common, and what distinguishes them from Hayek, is their celebration of human agency. The heroic entrepreneur, and the inventor of technology, exemplify how human agency, ingenuity, and invention can fundamentally shape and change the course of human history, driving changes in even the most entrenched of social systems. Thus, for Kelly and Gilder, the realization of the centrality of autonomous, informatic systems, driving economic and political life, gives rise to a very different conclusion that that reached by Hayek.

For Hayek, understanding the complexity of the informatic patterns and systems behind society's façade should lead to humility about the powers, scope, and ability of human intervention. For Kelly and Gilder, this realization led to the opposite impulse: the drive to celebrate breakthrough inventiveness, brave entrepreneurial pursuits, and the greatness of the human individual. In Kelly and Gilder's world, a select few of the chosen elite have the unique skill, abilities, and foresight to shape the complex systems of contemporary society. The entrepreneurs and the technologists, after all, are the ones who understand the opportunities that are available for society to progress to a new stage of evolution. Rather than letting the autonomous patterns give rise to an emergent order beyond human control, Kelly and Gilder emphasize that the emergent order being built through an increasingly technologized society is very much within human control. However, Kelly and Gilder both imply that this control should stay in the hands of a few brave risktakers and daring geniuses. Kelly does acknowledge some limited role for bottom up control or grassroots steering processes, but he emphasizes that society's major revolutions will be carried out by those with the technical expertise to extract nature's wisdom and replicate life's autonomous systems through information technology. In Gilder's account, the public is also left subordinated, facing little choice other than to submit to the miraculous breakthroughs of successful entrepreneurs and the changes they implement in the economic system. Ultimately, for both Gilder and Kelly, the public of the power is eroded, and an elite few are left to carry out a project that is essentially about control.

However, for both Kelly and Gilder, it is through the logic and rhetoric of freedom that their project of control is legitimized and carried out. Kelly's account might initially seem to devalue human freedom: as the title of his first book *Out of Control* indicates, humans will not have transcendent, centralized power to change their collective destiny. Due to the networked nature of contemporary life, Kelly emphasizes the impossibility of truly directing economic and political systems. Instead, in various ways, the experience of human life will be increasingly dictated by the informatic systems that govern human society. However, Kelly's account of technological prosperity opens the path towards another kind of freedom: the freedom of limitlessness. In the universe that Kelly describes, humans will no longer be subservient to physical resource limits. Information will lead to more information, growth will lead to more growth, and society will continue indefinitely on an upward path. Thus, while the use of technology entraps humans, it is also the source of a particular kind of freedom.

Gilder promotes a similar argument. For Gilder, the ultimate pinnacle of human freedom is expressed in the freedom of choice of the entrepreneur. In fact, Gilder's extended discussion of the metaphorical power of Claude Shannon's information theory emphasizes that entropy is equivalent to freedom of choice. Gilder (2013) explains that

> "The economics of entropy describe the process by which the entrepreneur translates the idea in his imagination into a practical form. In those visionary realms, entropy is essentially infinite and unconstrained... the entrepreneur must

make specific choices among existing resources and strategic possibilities. Entropy here signifies his freedom of choice." (p. 25).

Thus, for Gilder, the greatest expression of freedom can be found in entrepreneurial activity. It is only the businessperson who has sufficient vision to bring real novelty into economic and social life. It is also, apparently, only through business activity that the supposed limitlessness of the future of civilization can be accessed. It is true that other figures such as Hayek would agree with Gilder that the economy is the source of the incentives that drive people to make contributions to society. However, Gilder emphasizes much more staunchly than Hayek that these contributions are an expression of transcendent vision, insight, and choice in the mind of the individual. Nonetheless, this freedom is qualified and limited: it seems designed to be accessed only by a specific few with the talent, vision, or resources to bring forth the miracle of innovation.

Throughout this dissertation, I have argued that control and freedom are often interlinked discourses. Complete freedom is an asymptote that is always unreachable for any human individual, no matter their power or status. Nonetheless, the desire for freedom seems to persist in many of the discourses that I have examined. Kelly and Gilder exemplify this tendency well. Both figures emphasize that freely flowing information, ubiquitous technology, and free markets will carry humanity to a desirable destiny. Further, Kelly and Gilder claim that those with the expertise to help facilitate this transformation express the greatness and freedom of the human condition. Nonetheless, neither author offers a real attempt to convince their audience that this freedom is for everyone. In fact, they imply that it is not. Kelly is willing to give the public a role as a ground up participant in grassroots processes, though these processes are clearly subordinated to the far more important path of evolutionary, upward movement of human progress towards technological greatness. Gilder, on the other hand, neglects to mention the public at all, except the role that the public can play as a potential impediment to the entrepreneur, by supporting politicians who seek to regulate and control business. Instead of centralized control or regulation, both Kelly and Gilder seek a decentralized, interconnected society energized by the forces of continual learning, communication, innovation, and change. While this vision might look like freedom on the surface, underneath the exterior lies clear undercurrents of control. In Kelly and Gilder's account, the will of the public, as well as the interests of nature itself, are continuously subordinated to the imperative of human progress.

Conclusion

Speculative Techno-Optimist Futures and the Rejection of Matter

The choice to end the narrative arc of this dissertation with a discussion of George Gilder and Kevin Kelly is not accidental. Both figures, I would argue, illustrate the formation of a political ideology that has since become a major force in American political life. Specifically, I am referring to the political ideology known as techno-optimism. With adherents spanning from Stewart Brand to Elon Musk, the term techno-optimism represents a widely held belief that technology is the solution for nearly all ills. Instead of making difficult choices about limiting human consumption, techno-optimists proclaim that the human destiny can be secured by radical schemes including space travel, nuclear fusion energy, or geoengineering.

This point of view is well illustrated in the recently published "The Techno-Optimist Manifesto" by Marc Andreessen (2023). The document argues that humanity should not be afraid of the power of technology; to do so would be to reject the trajectory of human destiny towards greater and greater progress. Andreessen dismisses critics of technology as those who would "denounce our birthright – our intelligence, our control over nature, our ability to build a better world." Andreesen argues that technology is in fact the basic building block of civilization itself. Technology should be celebrated not only because of the functional improvements it brings to human life, but also because technology is one of the clearest manifestations of human greatness and achievement. Further, improvements to technology are the only way that humans and their economic markets can remain on a trend of perpetual growth and expansion. Under normal conditions, resource limits would slow down the markets. With technological innovation, however, resource limits continually recede, and economic growth continues unimpeded.

While many of these statements might not seem particularly surprising, coming from a major Silicon Valley figure, Andreessen's manifesto is a useful exemplification and distillation of the ethos surrounding technology in contemporary American culture. At one point, Andreessen notes that "We believe this is why our descendents [sic] will live in the stars. We believe that there is no material problem – whether created by nature or by technology – that cannot be solved with more technology." Thus, Andreessen imagines that technology is more than a tool: it is a means of entry into a way of life in which traditional material limits no longer exist. Clearly, Andreessen is immersed in a similar cultural and ideological milieu as that inhabited by Kelly and Gilder.

Continuing this line of logic, Andreessen insists that there is in fact no conflict between protection of the environment and economic and technological growth. Andreessen argues that environmental problems are simply the result of stagnant political systems such as communism. Instead of accepting stagnancy and limited resource availability, Andreessen insists that societies should align themselves with capitalist dynamism and abundance. Further, according to Andreessen, abundance is self-reinforcing:

> "We believe energy should be in an upward spiral. Energy is the foundational engine of our civilization. The more energy we have, the more people we can have, and the better everyone's lives can be. We should raise everyone to the energy consumption level we have, then increase our energy 1,000x, then raise everyone else's energy 1,000x as well."

Andreessen provides few details about how this drastic increase in the availability of energy will be accomplished. However, he does provide a few vague comments that provide insight into his overall vision. For instance, Andreessen proclaims that

> "We believe we should place intelligence and energy in a positive feedback loop, and drive them both to infinity. We believe we should use the feedback loop of intelligence and energy to make everything we want and need abundant."

The answer, for Andreessen, seems to lie in simply having faith in the abundance of the forces of the universe. If one accepts that energy and intelligence are infinite, it seems, any scarcity can be overcome. By aligning with intelligence, and presumably information, materiality can be overcome. Andreessen writes that "ephemeralization" or "dematerialization" are the effects of advanced technologies. Quoting Buckminster Fuller, Andreessen proclaims that technology is not simply a tool for making processes of production faster or more efficient—at its highest stage of development, technology should allow humanity to create substance out of void. Further, Andreessen argues that humans should not seek harmony with nature, but rather seek to embrace our domination of it, as the "apex predator" of the natural world. The enemies of the techno-optimist perspective, unsurprisingly, are any social philosophies that emphasize restraint or limits. Some of the enemies that Andreessen names include "existential risk," "sustainability," "Sustainable Development Goals," "social responsibility," "stakeholder capitalism," "Precautionary Principle," "trust and safety," "tech ethics," "risk management," "de-growth," and "the limits of growth."

Andreessen's caustic rejection of any form of advocacy of social or ecological justice is quite striking. While he presents techno-optimism as an ideology offering freedom and abundance to all, his comments in the above paragraph reveal that techno-optimism is actually quite coercive. The techno-optimist vision depends on aggressively restricting political values or points of view that do not align with its dictates. Additionally, the techno-optimist vision demands that the public accept an accelerationist path, no matter the material or political consequences of the disruptions that might result.

While the techno-optimist point of view, as expressed by Andreessen, may seem almost too ridiculous to consider seriously, I would point out that Andreessen's claims bear important similarities to points of view found in earlier writings about cybernetics and information theory. Just as systems theorists such as Norbert Wiener argued that the spread of information was itself a moral good, Andreessen argues that the combination of human and technological intelligence will save humanity from all pitfalls that it faces. Further, Wiener's rejection of the importance of material substance, exhibited by his speculations about teleportation, can be seen as a prefiguration of Andreessen's turn against materiality. However, I do not believe that the possible applications of systems theory are encompassed by perspectives such as Andreessen's; in the next section, I will attempt to articulate potential alternative applications.

Reimagining Systems Theory as Mode of Immanent Critique

The trace of cybernetic thinking in Andreesen's outrageous arguments should not be taken as a mark against the political potential of the cybernetic concept itself. Alternative imaginaries have existed and will continue to exist that draw upon the resources of systems theory in service of more grounded political projects. Earlier in the dissertation, I discussed how countercultural communities incorporated systems concepts such as decentralization into political governance. While not perfect, these communities sought to create an alternative to the dominant values of modern society. While I have discussed the shortcomings of the political vision articulated by figures such as William Irwin Thompson and Stewart Brand, it is worth taking seriously the potential merits and promise of their vision.

William Irwin Thompson wrote eloquently about the disconnections facing modern societies. For instance, he emphasized the need to integrate the material and ecological backdrop of modern society into everyday consciousness, to create more continuous and integrated awareness of ecological issues. Thompson imagined the ideal human future as a decentralized collection of human settlements, each of which would be organized to enable local projects of technological, intellectual, and creative freedom. Such experiments would be a scaled up version of the communal living experiments he had pioneered through the Lindisfarne Association. For Thompson, cybernetics was a key component of the somewhat paradoxical postindustrial villages that he imagined as a potential future for humanity, that would be both futuristic and archaic in nature. This new human society would embrace cybernetic principles, which Thompson defined as the pursuit of educational and research purposes, and would be oriented towards the local scale. While recognizing that technology might be taking humanity on a path of doom, Thompson articulated another possibility. In his influential book *At the Edge of History*, Thompson (1971) wrote that the choice was not yet made: “But what we are is not what we are about to become: the aborigines of another fall or the adepts of a new civilization beyond matter. At the edge of history the future is blowing wildly in our faces, sometimes brightening the air and sometimes blinding us” (p. x). While the salvation of humanity was not guaranteed, Thompson argued, a different path towards a better human future might yet be available.

Similarly, despite his eventual affiliation with the cultural currents of the computer revolution and the techno-optimist movement, Stewart Brand's earlier work in the *Whole Earth Catalog* introduced a program for self-reliance through the use of tools that I would argue cannot be reduced to these later consumerist applications. It is true that Steve Jobs once famously described the *Whole Earth Catalog* as the Bible of his generation—with the implication that the creative vision of Apple computer had emerged directly out of the ethos promoted by Brand. However, I would argue that Brand's contributions cannot be fully captured by such an association. Throughout the dissertation, I have shown that lines of appropriation of ideas and ideologies are not inevitable, and that other pathways can often be found by excavating the history of important cultural moments. Similarly, I would argue that the problematic appropriations of Brand's ideas are not a reason to reject his cultural project wholesale. Brand introduced many basic tools of self-reliance and individual action to the consciousness of the American public. This included computing, but it also included protocols for recycling, composting, gardening, building energy efficient structures, and other strategies for living a more ecological life. Brand also encouraged Americans to inform themselves about the history, the philosophy, and the religious systems of various world cultures. Systems theory was the perfect conceptual scaffolding for these experiments not because the systems concept inevitably gave rise to atomistic individualism, but because the systems concept was a means by which individuals could learn to grasp their imbrication in broader forces that were social, ecological, and even historical.

In the conclusion to the second chapter of this dissertation, I argued that Thompson and Brand's contributions failed to fully challenge the entrenched social hierarchies, and philosophical underpinning, of the dominant American culture. Their experiments never expanded beyond a relatively elite cross-section of America's highly educated, primarily white middle class. Nonetheless, I do wish to emphasize that the spirit of these experiments in consciousness, community, and knowledge formation cannot be completely reduced to their failures. Rather, I would argue that elements of America's 1970s counterculture have persisted in today's society, due to the lasting appeal of the counterculture's perhaps naïve but also compelling insistence on the ability of humanity to change, and to choose another course. In today's world, such communities are less likely to describe themselves using the word counterculture, and are more likely to reference descriptive terms such as ecological justice, feminist ecology, degrowth perspectives, or even ecological decentralization and eco-anarchism (Bell et al. 2020, Demaria et al. 2019). While these communities are not located at the center of national politics, such off the grid experiments continue to exist, and to challenge the ascendance of our collective acceleration towards a techno-optimist future. One prominent, international example of the sustained implementation of the principles of decentralized ecology is the Kurdish community of Rojava, whose founder was inspired by American countercultural theorist Murray Bookchin.

Around the world, smaller experiments following the principles of decentralization and ecology abound. Communities in America and elsewhere continue to pursue experiments in intentional living, including small-scale farming, community gardens, off-grid communities, communal living, and other grassroots cultural movements bringing people together around a vast number of modalities, including music, art, movement, and learning. Countercultural systems theory discourse has continued relevance for the strategies of these movements. Systems theory can provide a map to imagine the ground-up creation of new kinds of social order and forms of consciousness supporting human well-being.

Aside from the relevance of systems theory to new forms of social organization, I would like to draw attention to the relevance of systems theory for psychology. In the first chapter, I discussed the dominant portrayal of systems theory in the contemporary scholarly literature, which emphasizes how systemic governance gives rise to homogenization, centralized control, and loss of individual freedom. However, as I argued, systems theory has a second possible meaning: it can be seen as a tool to uncover and facilitate individual freedom, authentic autonomy, and creative expression. I would argue that systems theory can be seen as an interpretive tool through which it is possible to better understand the often invisible, recursive patterns of value that govern contemporary society. These patterns are often invisible to the participants of a society, due to the persistent enculturation in dominant, homogenized narratives that too often occurs. As Michael Thompson (2022) argues, the dominant narratives of contemporary society are characterized by a "uniform deep logic of efficiency and profit maximization, as well as the attendant logics of control and organizational management that secure it" (p. 6). If these logics do in fact exist, and are continuously reinforced through technologically enhanced systemic mechanisms, the first step in challenging them likely rests in being able to see the systemic mechanisms at work. Thus, systems theory can be seen as an interpretive strategy to reveal previously invisible systems that govern social and psychological scripts alike.

In the context of psychological experience, systems theory offers many important tools to citizens of modern societies. It can be argued that the human mind is, in its natural state, a kind of spontaneously organizing system, able to creatively arrive upon novel thoughts and phenomenological experiences. For the sake of both individual and social well-being, this spontaneity and creativity is worth protecting. However, I agree with Michael Thompson's assessment that our contemporary cybernetic society has too often robbed humanity of basic cognitive autonomy. As Thompson argues, the ability of humans to think freely is abridged due to our constant immersion of various forms of technological media that expose us to a relatively homogenized series of narrative scripts. While the original promise of the internet was that information technology would empower a greater diversity of voices and experiences, I agree with those who assert that the opposite has in fact happened.

As Thompson argues, it is difficult for citizens of modern societies to establish effective forms of critique because they cannot see the foreclosed horizon within their own consciousness. The shaping of human consciousness by information technology is preemptive; thus, "This post-neoliberal phase of society that has taken root in Western democracies operates by absorbing the individual into its own matrix, not by coercively annihilating the individual but by recircuiting its needs, desires, interests, the perimeter of its knowledge, and the depths of its imagination toward its own imperatives, logic, and goals" (Thompson, 2022, p. 1). The constant immersion of modern humans in highly addictive internet media perfectly exemplifies this implicit shaping of human desires, goals, and thoughts. Highly specific economic logics, many of which only developed in recent decades, are transmitted and reinforced through such means. These include ideologies reinforcing dreams of infinite economic growth, alongside the rejection of the existence of material limits.

If Thompson is right, and I believe he is, then systems theory may be a useful interpretive tool to help reveal unconscious limitations, repetitions, and forms of structuring of the human mind in contemporary society. Importantly, using systems theory in this way, as a diagnostic or interpretive tool, does not depend on any assertion of the ultimate ontological reality of the systems concept. Systems theory can be used for pragmatic purposes, to provide a language to discuss the systems of control that undergird modern life. Systems theory provides a language to understand that human society, and thus human consciousness, is shaped by repetitive feedback loops. This awareness, it can be hoped, might help interrupt their inevitable repletion. Further, systems theory can be used to emphasize the importance of the original spontaneous organizing process underlying human experience: the mind. Systems theory can provide a language to discuss the importance of protecting cognitive autonomy, and the basic human ability to formulate authentic critiques that depart from established narratives.

Learning to Live with our Technological Creations

Beyond applications to psychology and experiments in intentional living, I would argue that systems theory might be useful as a way to conceptualize better interactions between humans and technology. Systems theory, by attending to flows of information and their transmission, is readily able to capture many aspects of the encounter between humanity and our technological creations. Earlier in the conclusion, I discussed William

Irwin Thompson and Stewart Brand's emphasis on the relevance of technology for individual creative projects. However, I would argue that systems theory can also provide insights into the improvement of human/technological interactions on larger scales. Specifically, the concept of ecomodernism provides a point of entry into these conversations.

While ecomodernism is often treated as a synonym for techno-optimism, the two terms have different connotations. Techno-optimism, at least the version presented by Andreessen, indicates that technology should never be seen as anything other than salutary and beneficial to the human condition. Ecomodernism, on the other hand, is a term that refers to modernist approaches to technology that recognize the need to respect environmental limits. Many critical political theorists have rejected the concept of ecomodernism as a dangerous compromise with powerful capitalist forces that will never be truly aligned with the quest to build a sustainable world. However, arguments in favor of ecomodernism cannot so easily be dismissed.

In a 2015 document entitled *An Ecomodern Manifesto*, a long list of prominent social commentators defend ecomodernism (Asafu-Adjaye et al., 2015). The authors write that there are good reasons to believe that high density city life may be the best way for humans to reduce their use of the planet's resources, and particularly their use of land. Pulling back new human settlements from wild areas can contribute to the rewilding of habitats for vast numbers of nonhuman beings, which the authors argue would be a desirable outcome. However, concentrating the population of humanity in cities likely requires intensive use of large-scale technology. Basic human needs such as food, water, and power cannot always be provided through decentralized or non-technological means.

Further, local production of goods and commodities may distribute and thus increase the environmental impact of some industries. Thus, from the ecomodern perspective, what is needed is not a rejection of technology itself, but rather a more intentional plan through which humans will learn to use technology to live in ways that are harmonious with natural systems. I would argue that systems theory provides an apt conceptual terminology that could be used to imagine and plan an intentional ecomodern future. Systems theory draws attention to exactly the kinds of flows, both material and informatic, that an ecomodern society would need to govern.

There are numerous other areas in which humanity appears to be in dire need of a more intentional relationship with technology. As discussed, the modern internet is a highly commoditized, repetitive space of informatic exchange that has failed to live up to its promise as a site of human freedom. Systems theory can draw attention to the problem by showing the distortions in the informatic systems of the internet itself. Too much of the internet is controlled by a tiny number of corporations, reducing the incentive for individuals, organizations, and small businesses to create genuinely new styles of informatic exchange.

Beyond the internet, systems theory might potentially be useful to help address the growing social panic over new technologies such as artificial intelligence and various human-technology hybrids that may soon become viable possibilities. Technology may soon be used to enhance human intelligence, create altered states of perception, or engineer different kinds of humans. Such pursuits, alongside newly triumphant developments in artificial intelligence, point to the increasing difficulty of instituting firm ontological boundaries between life and the machines. In the end, in a certain sense, Kevin Kelly was right. Unlike Kelly, I would argue that these new technologies do pose a genuine threat to human autonomy and well-being. However, I also do not believe that it is possible to avoid negotiating the meanings of these new technologies. If the entrance of artificial intelligence into every field, from computing to business to education, is inevitable, it is clearly urgent to better understand this transition, and to attempt to direct it according to human values. While powerful actors will attempt to shape the artificial intelligence revolution to their own ends, systems theory can provide a series of tools to describe and track the coming transformations. Understanding the interaction of technological, economic, cultural, and political systems will be a crucial component, and necessary first step, of the struggle to shape the coming transformations according to human values.

Throughout this dissertation, my approach has been to point out pitfalls: I have discussed how major figures and political communities, spanning countercultural and neoliberal affiliations, have sought to implement freedom through the systems concept, but have often fallen short. In practice, existing systems of social and political power are difficult to dislodge. Further, information technologies were implemented so rapidly and intensively that the human freedom to truly interrogate and critique the uses and functions of these technologies has been greatly limited.

In today's political context, the need for real freedom and autonomy is dire. Human beings are often at the mercy of complex, unaccountable global resource flows that extract mercilessly from the earth while exploiting human labor along the way. Information technology continuously modifies our minds, shapes political trends, and too often determines the limits of the possible futures that humans can imagine for themselves. If Kelly and Gilder are right that the new economic order being birthed by the information revolution will colonize and take over every aspect of human life, then there are real concerns about what human freedom will be left. The cheap freedom mentioned by Andreessen and others, the freedom to exploit or to profit, is not a satisfying solution. Perhaps by heeding the lessons of systems theory's pitfalls, it is possible to imagine how the systems concept could liberate new forms of real human freedom. The systems theory perspective can facilitate a greater understanding of complex processes, and thus also facilitate critique. The intrinsic human ability to critique stultified systems, both in our own lives and in society at large, has not yet been fully extinguished by information technologies. This form of true critique, and the accompanying power of mindful creativity and creation, is a form of human agency worth preserving and celebrating.

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