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Ronald R. Kline. *The Cybernetics Moment: Or Why We Call Our Age the Information Age.* Baltimore: Johns Hopkins University Press, 2015. xi + 336 pp. $54.95 (cloth), ISBN 978-1-4214-1671-7.

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It is cliché to say that the current era is an information age. The objects, processes, and consequences of digital computing are omnipresent, built into everything from toys to weapons to domestic appliances. While the prefix "cyber" stands in for this vision of modernity, the actual science of cybernetics has become a marginalized failure. Ronald R. Kline traces the intellectual and social trajectories of cybernetics and information from their linked origins in 1948 to the present. Two geniuses of applied mathematics, Norbert Weiner and Claude Shannon, formalized an insight that information could be mathematically described in a form similar to the entropy equation, a standard measure of disorder in a system and its capacity for work. Moreover, human beings and machines could be described as interacting components of a larger system with emergent characteristics not capturable merely in the performance of machines or the decisions of men, and that a new science could define the contours of post-World War II life. From this insight, Weiner, Shannon, and a number of luminaries in the biological, psychological, and social sciences hoped that a new interdisciplinary language would arise uniting multiple fields of study and grounding them with the mathematical rigor of physics. But cybernetics never rose above the status of analogy for a range of scientific phenomena and faded as a field. Through a detailed reading of interdisciplinary conferences, the personal letters of involved scholars, and the popular press, Kline provides an invaluable account of how scientists and humanists came to understand the potential and pitfalls of increasing interconnectedness between humans and machines and the polymorphic meaning of the word "information."

Arguments over the true father of information are a feature of histories celebrating both Weiner and Shannon. The first chapter works around the priority dispute of 1948 by describing the near simultaneous origins of Weiner's and Shannon's ideas arising from their World War II work and contacts among a common circle of collaborators. Weiner developed an automated anti-aircraft sight at the MIT Radiation Laboratory that could calculate lead and direct the gun to ensure a hit as a human operator tracked a target. A series of these measurements over time would progressively make the gun more accurate. For Weiner, information was represented by a time-series of measurements, and as those messages became more randomless information was transmitted. Imagine an oscillating dial settling on a value, and one captures the essence of Weiner's thinking on information and entropy. Weiner's 1948 book, *Cybernetics,* was an extension of the insight that men and machines could be described in terms of information and feedback loops. Shannon's work, also published in 1948 in a two-part article, "A Mathematical Theory of Information," described information as positive entropy: as the receiver becomes more certain of what to expect next from a transmitted signal, the less information they actually receive. Though Weiner has been largely written out of the official history of information theory, Kline notes that Shannon visited Weiner several times at MIT in 1941 and 1942 and, according to Weiner's collaborator Julian Bigelow, they discussed the statistical basis of information. Combined with Shannon's acknowledgment to Weiner in his article, this suggests a greater degree of similar thinking between the two men than the later divergence between cybernetics and information theory supposes.

The second chapter follows ten interdisciplinary conferences funded by the Josiah Macy Jr. Foundation from 1946 to 1953 and the development of the basic worldview of cybernetics that "the nervous system was deemed to work like a feedback-control mechanism, the brain like a digital computer, and society like a communication system" (p. 45). Behind these analogies was the idea of negative feedback, a system which maintains a set level by correcting deviations from its outputs. Thermostats are a familiar use of negative feedback, a device which turns on a furnance when a room is cold, and turns off the furnance when the room reaches a comfortable temperature. While the Macy conference attendees hoped that complex behavior such as biological and social phenomena could be treated scientifically by cybernetic models, the conferences failed to develop these analogies into a research program due to the unmathematical messiness of data from the social sciences and personal conflicts between Weiner and conference chair Warren McCulloch over laboratory support at MIT.

While the scientific side of cybernetics floundered, the ideas presented caught fire in broader society. The third chapter explores an explosion of cultural interests in cybernetics in the early Cold War. Weiner's book *Cybernetics* became a campus favorite and attracted glowing reviews from the press. Weiner's 1950 book, *The Human Uses of Human Beings*, a non-mathematic treatment of his theories, attracted further popular attention to the potential of "thinking" machines. The course of cybernetics quickly ran away from Weiner, as his books were advertised alongside science-fiction novels like Isaac Asimov's *I, Robot* (1950) and Kurt Vonnegut's *Player Piano* (1952), and his name was even used without permission by L. Ron Hubbard to promote the pseudo-scientific cult Dianetics that would develop into Scientology. Scientific research in the field came to be monopolized by military projects in guided missiles and radar systems rather than the interdisciplinary vision of the Macy conferences. Weiner was leery of military domination of science, even though he was taking military funding for his work on a glove that translated sound into vibration for the deaf, and publicly distanced himself from military work in a letter to the *Bulletin of Atomic Sciences*. While cybernetics became strongly associated with thinking computers and automated factories in the public eye, for academics it remained a diffuse program of mathematical models in the social and biological sciences which had difficulty communicating across disciplinary boundaries or producing novel results.

As presented in the fourth chapter, the contrast between cybernetics and information theory in the years after 1955 became even more stark. Kline's analysis of the papers and conferences organized under the aegis of the Institute of Radio Engineers Professional Group on Information Theory (PGIT) shows that this group cited Shannon's work over Weiner's. Although the first PGIT conferences were highly interdisciplinary, featuring papers on automata and the social sciences along with communication engineering, by 1959 their focus had narrowed to the emerging technology of digital computers and the technical details of analog signal processing as applied to radar and telephones. By the 1960s,scholars cited either Weiner or Shannon, but rarely both. The academic community split between cyberneticists pronouncing sweeping theories, and information theorists working on discrete technical problems. Participants in the information theory conferences eventually separated their work entirely from the everyday semantic definition of "information" as conveyed meaning to focus on analog signal processing and the storage and manipulation of digital data.

The fifth chapter and sixth chapters return to cybernetics as science, by examining the influence of cybernetics in the origins of artificial intelligence and the work of six behavioral scientists from 1954 to 1959: Herbert Simon, George Miller, Karl Deutsch, Roman Jakobson, Talcott Parsons, and Gregory Bateson. These researchers used concepts from cybernetics and information theory to mathematically model human behavior and social interactions. Information theory had applications in psychology and linguistics, measuring the thresholds of humans to distinguish phonemes, the basic unit of speech, in a noisy environment. Miller's adage that human working memory consists of seven items, plus or minus two (now a commonplace observation linked to the length of telephone numbers) has its origins in this research. Although cybernetic thinking influenced research agendas and the formation of new interdisciplinary centers, its outcomes were distinct from the visions of a universal science that had surrounded the movement in the early 1950s.

A discussion of cybernetics is not complete without its avatar, the cyborg. Kline analyzes the 1960 articles of Manfred Clynes and Nathan S. Kline, a pair of doctors working in aerospace medicine, who coined the term "cyborg" to describe an ideal astronaut, a symbiont of human intelligence and machine durability capable of operating in the vacuum of outer space. The original cyborg, a cybernetic organism that could consciously adapt to its environment, has since come to mean any implantation of mechanical or electrical components in an organism.

For Clynes and Kline, the cyborg went beyond a solution to the immediate problem of space exploration to represent a spiritual leap in mankind's self-directed evolution. For reasons most likely relating to practicality, the Air Force rejected the cyborg in favor of life support capsules, but the idea lives on. Through science-fiction fantasies and Donna Haraway's ironic criticism of the military-industrial complex, the cyborg has become an evocative symbol, standing for both inhuman perfectibility and the indivisible tangle of social and technological systems in ordinary life.

The seventh chapter follows cybernetics through its decline in the 1960s and 1970s. The biologists and social scientists who had given the initial series of Macy conferences on cybernetics their deeply interdisciplinary character returned to their original fields, and cybernetics was abandoned to researchers in computers and electronics with heterodox inclinations. Cybernetics found a home in the Soviet Union, where feedback-control mechanisms had a natural alliance with the communist command economy. Out of concerns of a "cybernetics gap," the Central Intelligence Agency sponsored the founding of the American Society for Cybernetics in 1964, the year of Nobert Weiner's death. The organizers of the ASC and a separate Institute of Electrical and Electronics Engineers Group for Systems Science and Cybernetics attempted to recast cybernetics as a modern science capable of solving social problems but had little success in the tumultuous late 60s. The dreamers and visionaries of the counterculture actively co-opted the terminology of cybernetics, embarking on a legitimacy exchange that gave a gloss of respectability to their vision of a liberated technological utopia, while leaving the scientific project of cybernetics disordered and discredited.

Chapter 8 returns to the meanings of information beyond the technical, nonsemantic definition arrived at by the information theorists, the relationship between information in and of itself, information technology, and the information age. The term "information technology" originated in the management jargon of the 1960s and shifted from referring to statistical techniques for managing business processes such as operations research to all new devices for storing, communicating, and analyzing raw data into useful knowledge. Information technology gained credence as an ever-expanding budget item, another necessary expense for managers looking to root out inefficiency and coordinate global businesses. But the term "information age" has an alternative genealogy, one rooted in futurism and critiques published in the late 1960s and early 1970s by Daniel Bell and Marshall McLuhan. This rhetoric of radical transformation was picked up by government economists in Japan, the United States, the United Kingdom, and other advanced countries, but in the absence of agreed-upon definition of information in a social sense, the idea of an information age become an empty label to denote recent decades, without truly capturing the magnitude or consequences of the immense investment in information technology.

The Cybernetics Moment closes by reading Stewart Brand's journalism on cybernetics and computers as how an influential believer in the liberatory potential of Weiner's cybernetics became an information guru. Brand interviewed Margeret Mead and Gregory Bateson in 1976 about their time at the Macy conferences on cybernetics and also wrote about the birth of the ARPANET in *Rolling Stone* as "Spacewar: Fanatic Life and Symbolic Death among the Computer Bums" (1972). Brand was one of the last people to attempt to organize a social movement based around cybernetic principles. But Bateson's death and the rise of the commercial possibilities associated with the personal computer led Brand to instead evangelize the liberating power of information. Yet despite the failure of cybernetics to provide answers or even progress, the questions raised then remain provocative even today: that something about ourselves can be seen in devices that adjust to their surroundings; that information is a fundamental part of the universe on par with energy and matter; and that there might be a spiritual component to computers.

The Cybernetics Moment is an in-depth study of the field of cybernetics. It is also a useful case study of how researchers clarify the questions and boundaries of a field, offering an explanation for the success of information theory and the relative lack of success for cybernetics. Finally, for scholars studying the social implications of computing, algorithms, and automation, this book offers a look at some of the first formulations of those questions and how they were dealt with at the dawn of the information age.

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