Reviews

Raul Rojas, Editor
Free University of Berlin

Pamela J. Hinds and Sara Kiesler (eds.), Distributed Work, MIT Press, 2002, ISBN 0-262-08305-1, 495 pp., $52.00.

Patterns of work have changed radically in the past few decades. Within organizations, more collaboration across hierarchies exist, and the home has, once again, become a common site of regular paid work. Networks of collaboration have been spun within organizations that operate across cities and countries, and between organizations, partnerships have become pervasive. The spread of information technologies has been both a cause and an effect of these social changes. The bulk of this collection, edited by Pamela Hinds and Sara Kiesler, which surveys the phenomenon of geographically distributed work, concerns contemporary situations. However, they start their book by including two papers that will be of keen interest to the historian.

In "Managing Distance Over Time: The Evolution of Technologies of Dis/ambiguation," John Leslie King and Robert L. Frost argue that the successful management of distance "requires a careful balancing of disambiguation and ambiguation," by which they mean the processes that either do or do not act to "improve the precision and veracity of communication" (pp. 3–4). They take four case studies, two (texts and coins) of which are examples of disambiguating technologies. Texts let Phoenician traders record clear summaries. Money, at least in its modern form, is an unambiguous measure of value that permits global trade. The other two case studies are of ambiguating technologies. The success of the Roman Catholic Church in becoming a geographically dispersed enterprise was "very much the result of a carefully constructed and maintained doctrinal ambiguity" (p. 11). Likewise, King and Frost highlight the feature of the US Constitution that "it goes into great detail regarding the process by which decisions will be made, but it says virtually nothing about what those decisions should be" (p. 17).

Some of this history is broad-brush (the brutal disambiguities of Justinian, for example, and their contributions to the split of the Church are passed over without comment), but the conclusions are perhaps more interesting in consequence. Recent information technologies dedicated to assisting management over distance, argue King and Frost, are almost all dedicated to reducing ambiguity. But be too precise, and innovation can falter. As is well known, part of the reason why regional economies—Silicon Valley being the cliche—can spectacularly take off is because informal face-to-face communication between organizations has been encouraged. Sometimes vagueness can help grease the wheels of the economy.

In the second article, Michael O'Leary, Wanda Orlikowski, and JoAnne Yates examine issues of trust and control in the Hudson's Bay Company, from the late 17th to the early 19th centuries. The headquarters of the Hudson's Bay Company lay in London, yet its employees were distributed thousands of miles away in the icy American north. The Company deployed many different means of control (direct oversight, contract, communication by letters, and other information technologies) alongside relationships built on personal contact and trust (such as recruiting servants often from one group of islands off Scotland, Orkney, with which Company staff had contacts). Yates will be well known to *Annals* readers as the author of the excellent study of systematic management, *Control through Communication* (Johns Hopkins University Press, 1989). She, with her coauthors, continues that book's theme of looking at the techniques of information management within organizations. Their core argument is that trust and control should not be seen as opposites—with control being asserted where trust has broken down or otherwise removed—but instead as closely intertwined.

This thought-provoking paper reads like the first foray into a fascinating study, and many of the conclusions are suggestive rather than demonstrated. I hope their project is pursued further. If so, an important aspect they might explore would be the extent that the model of control over a geographically dispersed organization exhibited by the Hudson's Bay Company anticipates and departs from the classic Chandlerian organizational form.

What are the lessons for the historian of computing? These papers remind us that there is a rich history of information management that the history of computing is just part of (within the history of information, the history of computing becomes the task of accounting for a particular form of mechanization). This route provides the best means, in my opinion, of demonstrating the importance of our subject as a central component of general history.

Jon Agar
Cambridge University
ja310@cam.ac.uk

David Mindell, *Between Human and Machine: Feedback, Control, and Computing Before Cybernetics*, Johns Hopkins University Press, 2002, ISBN 0-801-86895-5, 432 pp., $46.00.

The title of David Mindell's *Between Human and Machine* can be read in two ways. In one sense, this book examines the development of feedback and computing devices that

enabled the integration of people and machines into larger control and communication systems from the 1910s to the 1940s. In the other sense, this book fills the yawning gap between the machine-centered technical histories of control and communication devices and the human-centered organizational histories of institutions that brought such devices to life. In an exceptionally insightful and lucid account, Mindell shows how engineering cultures emerging in specific institutional contexts profoundly shaped the design of human–machine systems and defined the human operator as part of a larger technological system.

This remarkable book shatters a whole cluster of stereotypes perpetuated in history of computing, control, and communications literature for decades. Did the digital computer emerge as a replacement for the obsolete analog technology? Did computer applications start with calculation and only later expand into simulation, control, information processing, and communication? Was World War II a major break from prewar engineering practice? Did the cybernetic ideas originate in the minds of great mathematicians and logicians? Was the invention of the feedback amplifier purely serendipitous? Mindell critically reexamines all these claims and brings a wealth of historical data to validate a new, convincing interpretation of the history of control, communications, and analog computing in the prewar and wartime periods.

Mindell brings to a new level of sophistication the analytical apparatus of a historian of technology. He draws on the seminal approaches developed by Lewis Mumford, Thomas Hughes, and Donald MacKenzie. He links together Mumford's idea of machines producing symbolic representations of the world, Hughes's notion of large-scale technological systems that include human actors, and MacKenzie's emphasis on the role of local cultures in engineering.

In the first several chapters, Mindell examines four distinct engineering cultures that emerged in different institutional contexts in the prewar period. The US Navy Bureau of Ordnance and its contractors developed fire-control systems that displaced human operators with automated measuring devices and transformed human-control tasks into simple manipulations with machine controls. Engineers at the Sperry Gyroscope Company designed control devices that added feedback loops to the actuating mechanisms of ships and airplanes, and they conceptualized human operators as "human servomechanisms." Bell Telephone Laboratories' communications engineers developed negative-feedback amplifiers that transformed the telephone network from a passive medium into an active machine, and they began thinking of telephony in general terms as the transmission of abstract signals that could carry any type of information. Working on the problem of stability of power networks, Massachusetts Institute of Technology engineers developed a general theory of feedback control and articulated a new method of representing the world in analog calculating machines, such as the differential analyzer. Mindell argues persuasively that, in the culture of electric power systems, analog computing was viewed as a successful innovation compared to the numerical methods of punch-card business machines.

Mindell offers a sophisticated model of dynamic interactions among these four cultures, by analyzing both the active exchanges of people, information, and hardware through porous borders, and the obstacles to such interactions in the form of military secrecy and proprietary interests. These interactions took a new form with the onset of World War II. By closely examining the previously classified archival records of the National Defense Research Committee (NDRC), especially Section D-2 (fire control) and its successor, Division 7, Mindell elucidates the ways in which influential science managers, such as Vannevar Bush and Warren Weaver, directly shaped university and corporate research on control and communication to produce efficient antiaircraft weapons.

In subsequent chapters, Mindell examines several of the most significant projects funded by D-2 and Division 7. The development of control and computing devices that linked antiaircraft guns and radar equipment at MIT's Servomechanisms Lab, Bell Labs, and MIT's Radiation Lab led to the understanding of control systems as processors of signals; the interpretation of tracking errors as noise; and the eventual integration of radar, analog computer, and controller in a unified feedback-controlled signal-processing system.

The conceptual synthesis of control and communication and the fundamental analogy between people and machines laid the foundation of cybernetics. Rather than accepting Norbert Wiener's purely intellectual version of the genealogy of these ideas, Mindell demonstrates how the wartime understanding of the human–machine combination as a feedback system emerged first in engineering practice, and he traces it to the prewar analogies between human operators and servomechanisms.

Historians of computing will find in this thoroughly researched book many illuminating examples of the early use of the term *computer*

by control engineers referring to data integration units and analog gun directors. Mindell also shows why continuous representations of the world in analog computers fit in MIT's prewar engineering culture better than digital methods, and he explains the reasons why the NDRC decided not to fund the ENIAC project but enthusiastically supported George Stibitz's work at Bell Labs on digital relay computers.

Between Human and Machine is essential reading for any student of 20th century computing, control, and communications. It sets an agenda for further research into the role of computer modeling and simulation, the interdependence of design and manufacturing, the development of user interfaces and functions of the human operator, and the evolution of computer representations of the world. Combining sharp analysis with a readable and engaging account, this book will interest a range of readers, from undergraduates to accomplished scholars.

Slava Gerovitch
Dibner Institute for the History of Science and Technology
slava@mit.edu

Jeffrey Zygmont, *Microchip: An Idea, Its Genesis, and the Revolution It Created*, Peresus Publishing, 2003, ISBN 0738205613, $25.

Journalists are capable of writing good history. G. Pascal Zachary's biography of Vannevar Bush and Sylvia Nasar's biography of John Nash are two of many such examples. Unfortunately, Jeffrey Zygmont clearly demonstrates with his book *Microchip* that journalists are capable of writing bad history. As readers of this journal are aware, the history of computing and semiconductors has matured to the point where it is no longer possible for a journalist to parachute in, spend a few months talking to people, and expect to produce a credible work. This appears to have been Zygmont's methodology, and not surprisingly, his account is about heroic individuals, showing no understanding of various factors that shape the development of large technological systems. Zygmont's work is covered with a (mercifully thin) layer of free-market triumphalism summed up in his assertion that the only rules that governed the integrated circuit's development was "that the best ideas would win" (p. xxi). If only it were that simple.

The author devotes the first five chapters to the work of Kilby and Noyce. This ground is much more ably covered by Michael Riordan and Lillian Hoddeson's *Crystal Fire* and T.R. Reid's *The Chip*. What is new about *Microchip* compared to previous works in the field is that Zygmont spends almost half the book on the development of integrated circuit applications, in case studies of microwave ovens, word processors, cell phones, and automotive electronics. This approach offered Zygmont the chance to make a real contribution to the integrated circuit's history by exploring the role that interactions between producers and consumers played in shaping the technology. But Zygmont's work is too superficial to take advantage of this opportunity. He says little about the development of the PC; I suspect because so much has been written about it.

In addition, *Microchip* is thinly researched. It betrays no knowledge of the standard works in the history of computing, such as *Computer* by Martin Campbell-Kelly and William Aspray; *A History of Modern Computing* by Paul Ceruzzi; or the standard work in the history of semiconductor technology, *Crystal Fire* by Michael Riordan and Lillian Hoddeson. Despite the dust jacket's claim that the work was based on countless interviews, I counted 25 interviews by the author cited in the notes. (In fairness to Zygmont, he did exploit the rich collection of interviews available at the Stanford University Library.)

To give an example of the evidentiary base that *Microchip* uses, the references cited in the notes to the first chapter on Jack Kilby's work on the integrated circuit are an interview with Kilby, interviews with two of his colleagues, the Texas Instruments' Web site, another Web site, the Encarta encyclopedia (for the history of computers), and T.R. Reid's *The Chip*. Many chapters are based on two or three interviews, and Zygmont accepts the accounts of his informants uncritically. Although Gordon Teal is typically accorded a leading role in the development of the silicon transistor at Texas Instruments, Zygmont never mentions his name, and instead accords primacy to Willis Adcock, whom Zygmont interviewed. A chapter on the development of word processing technology at Wang is based largely on an interview with one engineer—the chapter's centerpiece. Not surprisingly, Zygmont locates Wang's problems in the 1990s with this engineer's departure.

The net effect of this book is like being at a cocktail party where, over the course of the evening, you talk to a number of engineers about their accomplishments—you might hear some good stories, but you wouldn't want to base too much on them. I can only hope that this book's readers will be sufficiently stimulat-