BOOK REVIEWS

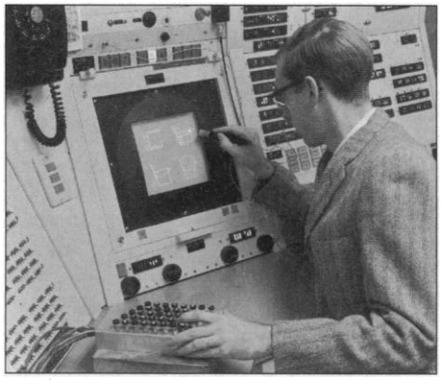
Credits for the Information Highway

Transforming Computer Technology. Information Processing for the Pentagon, 1962–1986. ARTHUR NORBERG and JUDY E. O'NEILL, with Kerry J. Freedman. Johns Hopkins University Press, Baltimore, 1996. xvi, 361 pp., illus. $49.95. ISBN 0-8018-5152-1. Johns Hopkins Studies in the History of Technology.

Where Wizards Stay Up Late. The Origins of the Internet. KATIE HAFNER and MATTHEW LYON. Simon and Schuster, New York, 1996. 304 pp., illus., + plates. $24 or C$32.50. ISBN 0-884-81201-0.

Judging from the popular literature, one would think that the development of computer technology has been driven by a few giants of the industry, such as Bill Gates, Steve Jobs, and IBM, supported by legions of adolescent hackers who make computer systems by day and break into them by night. The truth, of course, is very different. Many of the developments we take for granted today were brought about with the support and often the leadership of the government, including one little-heralded institution, the Defense Advanced Research Projects Agency (DARPA).

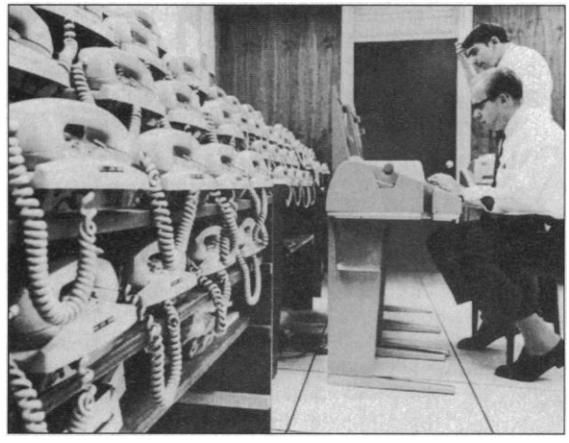
Two fine new books, Arthur Norberg and Judy O'Neill's *Transforming Computer Technology* and Katie Hafner and Matthew Lyon's *Where Wizards Stay Up Late*, give DARPA the credit it is due, albeit in very different ways. The first is a scholarly monograph on the activities of DARPA's Information Processing Techniques Office (IPTO), which for almost 25 years, from 1962 to 1986, was responsible for the information technology programs within the agency. (In the latter year IPTO was superseded by a new office, the Information Science and Technology Office, at which point the authors end their account.) IPTO did not itself perform research, but it acted like a venture capital firm, investing in technologies important to the military and the civilian industrial base. With a small, highly trained professional staff—nearly all the directors and program managers have held doctorates—and, by government standards, minuscule budgets, IPTO had a remarkable impact on the field of computing. It has sponsored some of the most fundamental advances in the field, including time-sharing, computer graphics, networking, advanced microprocessor design, parallel processing, and artificial intelligence.



"Sketchpad represented the state of the art in computer graphics until IPTO invested heavily in developing graphics capabilities in the late 1960s. Ivan Sutherland, second IPTO director, developed the Sketchpad program as a graduate student at MIT." [From *Transforming Computer Technology*; MIT Lincoln Laboratory]

IPTO did more than simply hand out R&D funding, however. It followed a deliberate investment strategy in pursuit of what is sometimes called the "Licklider vision," after the first director of the office, J. C. R. Licklider. This vision sought increased interaction between humans and computers—"man-machine symbiosis," Licklider called it—by making computers more powerful, intelligent, and user-friendly. For example, during the 1960s the dominant environment for computing was batch-processing, which required users to submit their programs one at a time and then wait, sometimes hours and even days, to get back the results. Debugging a program under these circumstances was a difficult and tedious process. The development of time-sharing allowed users to interact with the computer, writing and debugging programs on-line. It also allowed multiple users to work on the computer simultaneously and to share data and program files with each other.

Norberg and O'Neill, until recently of the Charles Babbage Institute at the University of Minnesota, have ably chronicled and documented these efforts and emphasized their impact on computing. Their book is arranged topically, with an overview of IPTO and then chapters focusing on its activities in the technology areas of time-sharing, graphics, networking, and intelligent systems. The book examines IPTO's management techniques and both the problems and the opportunities presented by



Bolt, Beranek and Newman's time-sharing set-up. Early time-sharing systems relied on ordinary phone lines to link terminals with computers in offices, schools, and research facilities." [From *Where Wizards Stay Up Late*; BBN]

DARPA's position as an agency of the Department of Defense. The study was sponsored and supported by DARPA, so the authors had adequate (if not full) access to the agency's records. Norberg and O'Neill bolster their account with interviews with a number of former DARPA officials and contractors. The book is slow going for the casual reader, but it is solid and informative and an important contribution to the history of computing.

Where Wizards Stay Up Late is essentially a case study of what many consider to be DARPA's most noteworthy success, the development of packet-switched computer networking. Packet switching is a technique in which a digital message is broken up into smaller "packets" that can be routed separately through a network to their destination. (By contrast, a circuit-switching system such as the telephone dedicates a complete line to a transmission during its course.) Hafner and Lyon follow the story from the conception of the idea of packet switching in the early 1960s, through the establishment of the first four nodes of the ARPANET in 1969, to the creation and

Vignettes: The Human Heritage

The desire to dictate the behavior of others is such a timeless and universal attribute of our species that it must rank with the sex drive, maternal instinct, and the will to survive in terms of the likelihood of its being part of our biological heritage.

—*Frans de Waal*, in *Good Natured: The Origins of Right and Wrong in Humans and Other Animals* (Harvard University Press)

Even a casual analysis of the number of ways the concept of fear can be expressed in the English language reveals its importance in our lives: alarm, scare, worry, concern, misgiving, qualm, disquiet, uneasiness, wariness, nervousness, edginess, jitteriness, apprehension, anxiety, trepidation, fright, dread, anguish, panic, terror, horror, consternation, distress, unnerved, distraught, threatened, defensive. The so-called ascent of man occurred in spite of the continued existence of fear rather than at its expense.

—*Joseph LeDoux*, in *The Emotional Brain* (Simon and Schuster)

development of the Internet, the vast network of networks that is now a fundamental element of the country's information infrastructure.

Like most popular narratives, this one focuses on people: the team at BBN that devised and installed the Interface Message Processors (IMPs) that served as ARPANET nodes; the researchers at the network sites (many of them graduate students) who made the system work and developed many of its specifications; the network users who unexpectedly made e-mail the most popular network application; and the officials at DARPA who conceived and funded the ARPANET and the later work on TCP/IP, the protocols that made the Internet possible. The authors convincingly demonstrate that the work on the ARPANET and Internet, as in the rest of the field of computing, was a team effort, with contributions from many individuals and organizations. They also show the importance of having people of vision in charge of such efforts, especially, as in the case of the ARPANET, when there is resistance from many who say the technology will not work.

Where Wizards Stay Up Late is a highly readable book. Indeed, it compares favorably with Tracy Kidder's *The Soul of a New Machine*, the Pulitzer Prize–winning account of the development of a commercial computer. Like Kidder, Hafner and Lyon show great skill in teasing an interesting story out of a complex tale and in maintaining the narrative while explaining highly technical concepts. To help bring life to the subject, they throw in plenty of amusing anecdotes, such as tale of the first-time network user at an early demonstration of the ARPANET. The man typed an instruction at a terminal and, receiving the response "HOST DEAD," cried out in terror, "Oh, my God. I've killed it!" (p. 181). The book is well researched. The authors rely heavily on original documents and oral histories, including many of the interviews conducted by Norberg and O'Neill for the IPTO history, which are currently on file at the Babbage Institute.

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A Mixed Career

The World Made New. Frederick Soddy, Science, Politics, and Environment. LINDA MERRICKS. Oxford University Press, New York, 1996. siv, 223 pp. $105 or £60. ISBN 0-19-855934-8.

Most biographies of scientists are stories of success. The case of Frederick Soddy is somewhat different. He achieved much in the years before the Great War as a pioneering radiochemist and won a Nobel Prize in 1921. In 1914 he got his first chair, in the Scottish university of Aberdeen. In 1919 he took up, at the age of 43, one of the two chemistry chairs at Oxford. He went to Oxford with the aim of building a new research school. In this he failed miserably: his temperament, jealous colleagues, the structure of teaching and research, all conspired to marginalize him. He managed to build a new laboratory in 1928 but got scant thanks for it. His own research in this period was practically non-existent, and after retirement he was almost forgotten. But in the late 1940s Soddy emerged again. The atomic bombs of 1945 gave Soddy, the last surviving important British atomic pioneer, a new lease on life. His fame rested in part on his work with Rutherford at McGill in Canada, in the very early years of the century, but Rutherford had died in 1937. Soddy published a history of atomic energy in 1949, and a biography of him by a crackpot nuclear enthusiast was published in 1953. Soddy had been immortalized in literature in 1914: H. G. Wells acknowledged him as the source for much of his atomic warfare novel *The World Set Free*, itself reissued in 1945.

Already before 1914 Soddy was a well-known popularizer and commentator on science: he argued that atomic energy if released on a large enough scale would transform the world ($E=mc^2$ became associated with atomic energy only in 1945); he was a great believer in progressive causes and in the power of science in the right hands. In the very early 1920s Soddy was briefly associated with the left, but thereafter he became linked with small groups of indeterminate political affiliation seeking to transform the world by various means. Soddy's particular interest was monetary reform; he hated conventional money and the banking system, as he saw it the cause of most modern miseries. He put energy and environment at the center of his alternative economics, publishing a great deal on the topic in the 1920s and early 1930s but continuing to write on it into the 1940s. Merricks acknowledges that his writings are allusive and obscure and difficult to summarize.

Merricks stresses Soddy's "prescience": about atomic energy, the social relations of science, the danger of war, European federalism, and environmental economics. But although she contextualizes Soddy by looking in some detail at marginal political and intellectual groupings of the interwar years, she does not recognize the extent to which his general ideas were fairly common, even among scientists. She is also somewhat too ready to accept Soddy's self-evaluation as a genius ahead of his time struggling against ignorance; that too has not been unusual in scientists. That said, Soddy is a worthy subject of a biography, even though his papers are not extensive enough for an especially rich portrait of the man.

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