Reviews

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The Reviews department includes reviews of publications, films, audio and video tapes, and exhibits relating to the history of computing. Full-length studies of technical, economic, business, and institutional aspects or other works of interest to *Annals* readers are briefly noted, with appropriate bibliographic information. Colleagues are encouraged to recommend works they wish to review and to suggest titles to the Reviews editor.

Agatha and Thomas Parke Hughes, eds., *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After*, MIT Press, Cambridge, Mass., 2000, $50.00, 513 pp., ISBN 0-262-13363-6.

This collection of essays is the result of a conference, held at the Dibner Institute on the Massachusetts Institute of Technology campus in May 1996, on "the spread of the systems approach." The conference reflected the interest of Thomas Hughes, an MIT professor, whose writings over the past 20 years have shaped much of the current framework of study in the history of technology. This book gives an excellent survey of the deep and broad roots of systems engineering, and serves as a guide to those who would apply it to such problems.

For Hughes, the spread of the "systems approach" was the defining paradigm of American technology in the 20th century, especially after the Second World War. His writings on American electrification, on the life and work of Elmer Sperry, and on several large-scale postwar engineering projects in America all point toward this thesis. This volume attempts to go further in answering the question of just what is "systems engineering."

By its very nature, systems engineering is hard to pin down, largely because it is so pervasive—nearly all modern engineering incorporates it. Aspects include technology based on scientific research, often conducted in universities or large corporate research labs, and the use of mathematical modeling and simulation to test a prototype in a virtual environment before actual hardware is developed.

Commercial product development relies on an information system that closely couples sales and market data with scientific and technical know-how and with rates of production. This technique, now called just-in-time production, has roots in the work of Henry Ford, Frederick W. Taylor, and others in the early 20th century. Naturally, the digital computer plays a role in all these activities, but "computerization" does not equal "systems engineering" unless the computer is used in specific ways to support these activities.

Computer modeling, science-based engineering, and a coupling of design, production, and use of a technology define the essential core of the systems approach. Those who study it, including Hughes in his other writings, further claim that this approach has been enormously successful in bringing about a material prosperity to the industrialized world after the Second World War (but there are major exceptions, as will be discussed).

The volume begins with essays by David Mindell and Erik Rau that trace the specific roots of postwar systems engineering in the US and British military during the Second World War. Stephen Johnson continues this theme by discussing how the US Air Force became a champion of systems engineering after the war and did much to encourage its development from a more narrowly focused activity known as "operations research."

These essays, and others, reveal that the systems engineering definition is incomplete without acknowledging that it bears the stamp of military funding and support. On the surface, that aspect does not do much to explain systems engineering in terms of the specific activities described above, but it is so important that it must be considered part of the definition. The essays by Johnson and Mindell, in particular, show the clear military roots of systems thinking, while those by David Hounshell, Davis Dyer, Roger Levien, and David Jardini show the military's indirect, though still important, influence through quasi-military agencies like Ramo-Woldridge (later known as TRW) and Rand.

The most fascinating parts of this book describe how systems engineering was broadened to include experts from the social and physical sciences as members of systems teams carrying out complex projects. Hounshell shows how Rand successfully incorporated the views of economists, whom many scientists in the hard sciences might otherwise disparage, in Rand's work on weapons analysis. However, Hounshell and others show that this was the exception; the application of a systems approach to social problems, such as those that engulfed the country in the 1960s, was much less successful.

With the end of the Cold War in 1990, questions concerning the relevance of the systems approach to social problems have risen to the fore. Systems engineering has established itself without question in engineering and military planning, places where quantification and modeling are straightforward. But as long as social problems persist, there will be attempts to apply systems engineering techniques to their solution.

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Raúl Rojas and Ulf Hashagen, eds., *The First Computers—History and Architectures,* MIT Press, Cambridge, Mass., 2000, $39.95, 457 pp., ISBN 0-262-1817-5.

The First Computers contains all 24 papers that were originally presented at the First International Conference on the History of Computing, in Paderborn, Germany, August 1998 (see Michael Williams' report in *IEEE Annals of the History of Computing*, vol. 21, no. 1, 1999, pp. 72-73). The conference organizers stated, in the preface, that "we have witnessed a renewed interest in exploring the roots of modern computer technology in recent years." The organizers could make such a statement because machines like Zuse's Z1 and Z3, Atanasoff's ABC, the Colossus at Bletchley Park, and the University of Manchester's Mark I have been or are in the process of being reconstructed. They can be reconstructed because enough material has accumulated over the past decades to enable a historical comparison of the world's first computer architectures. The papers selected by the program committee dealt with the architecture and reconstruction of the oldest computers and the contribution of reconstructions to the scholarly historiography of computing technology.

Thus the book focuses not on chronology (what came first and who deserves credit for it) but on the actual architectures of the first machines that made electronic computing a practical reality. The book covers computers built in the United States, Germany, England, and Japan. It seeks to demonstrate that similar concepts were often pursued simultaneously and that the early researchers explored many architectures beyond the von Neumann architecture that eventually became canonical. The contributors include historians as well as engineers and computer pioneers.

This mixture of historians, engineers, and pioneers writing books about computing's history, typical in recent years for the historiography of the computer, has both merits and weaknesses. While it is certainly insightful to obtain information from those who actually built the first computers, the different types of contributors have different interests, with varying results for the reader. In his essay, Robert Seidel states that

> [the] current interest in the simulation, reconstruction, and reactivating of early computers reflects an enthusiasm on the part of the practitioners. The historian's interest in artifacts is different from the practitioner's. The difference between their perspectives creates tension between the historian's use of artifacts and the practitioner's reconstruction of them that should be reconciled if both are to profit from such reconstructions. (p. 33)

Since this tension is also a characteristic of this book, how can the historian of technology profit from it? Almost all pioneers and computer scientists among the authors describe architectural and engineering characteristics of "their" machines in painstaking detail. Their essays might be helpful to understand the inner mechanism and the engineering problems in the construction of the first digital computers but provide little help in answering the "big questions" in the history of technology that George Daniels asked in 1970. Raúl Rojas, for example, states that the internal structure of the Z3, which we would call microcode today, also permitted conditional branching and could therefore "emulate any modern computer" (p. 237). However, Zuse's conception of the Z3 was that of a calculator controlled by a fixed sequence of instructions. Thus Rojas focuses on a possibility—conditional branching—that is of little importance in evaluating the importance of Zuse's machine in its historical context.

Nevertheless, a number of essays present stimulating new ideas about a unique historiography of computing. The essays by Michael Mahoney, Paul Ceruzzi, and William Aspray especially construct an insightful framework for the intellectual and the engineering side of computing history. Mahoney shows the interrelationship of computer development with mathematics and philosophy that resulted in the emergence of theoretical computer science

Briefly Noted

Dieter von Jezierski, *Slide Rules: A Journey Through Three Centuries*, translated by Rodger Shepherd, Astragal Press, Mendham, N.J., 2000, $23.50, 136 pp., (paperback), ISBN 1-879335-94-8.

Dieter von Jezierski, a long-time employee of Faber-Castell, first published this book in German in 1997. It has been translated into English by the American physician and slide rule afficionado Rodger Shepherd. Particularly noteworthy are the discussion of the materials and methods of producing 20th-century rules and the listing of some 22 relatively recent makers and vendors. The focus is on linear slide rules, with some discussion of cylindrical models. Collectors will find that this book nicely supplements Cajori's *History of the Logarithmic Slide Rule* and the book by Hopp mentioned next.

Peter M. Hopp, *Slide Rules: Their History, Models and Makers*, Astragal Press, Mendham, N.J., 1999, $35.00, v + 310 pp., (paperback), ISBN 1-879-33586-7.

In this ambitious volume, Peter M. Hopp has accumulated a wealth of information about slide rules. Collectors will especially appreciate his detailed listing of instrument makers who produced slide rules from 1620 to 1900 and of manufacturers' and vendors' products from 1901 to 1998. Hopp considers not only linear slide rules but various circular and cylindrical models. The book's international scope is particularly noteworthy, as Hopp lists makers from Great Britain, continental Europe, and the United States as well as from Australia, Japan, and China. There is an extensive bibliography.

Stephen Hoffman, "The Navajo Code Talkers: A Cryptologic and Linguistic Perspective," *Cryptologia*, Oct. 2000, vol. 24, pp. 289-320.

When discussing cryptography in World War II, historians of computing generally focus on the development of machines for encrypting and decrypting messages. Undoubtedly these efforts had an important role in the history of the electronic computer. At the same time, the advent of telephone and radio communication encouraged other means of disguising messages. This article describes the code developed by a group of Navajo Indians and used widely by them in battlefield communications of the US Marine Corps while fighting in the Pacific.

as an independent basic theory. In doing so, he shows how far the development of scientific instruments shapes scientific theories—an often-ignored aspect in the history of science.

Paul Ceruzzi succeeds in portraying the history of computer architecture as far from being a static field with "Nothing New Since von Neumann." He shows that many actors and organizations have contributed ideas that have refined von Neumann's original design over the past 55 years.

William Aspray revisits the Institute of Advanced Study (IAS) and Princeton University, where the most influential of the first computers—the IAS machine—had been designed and built, and analyzes how these facilities benefitted from this head start. Using concepts that were originally developed by business historians, Aspray shows how and why IAS and Princeton University—like the Moore School in Philadelphia and Harvard University—failed to establish lasting and significant computer research activities.

Only a few of the essays in this book address the issue of reconstructing historical computers, which was meant to be the conference's original focus. Besides essays emerging from major reconstruction projects (Manchester Mark I, Atanasoff-Berry Computer, Colossus, and ENIAC), only the contributions of Robert W. Seidel and Martin Campbell-Kelly explore the value of reconstructing historical artifacts. Using the examples of the Antikythera mechanism and the Babbage engine, Seidel shows that the most significant historical results come from the contextual interpretation of reconstructed artifacts that "illustrate the development and application of material culture interpretation in a historical context" (p. 45).

Campbell-Kelly in his essay about the software simulator of the EDSAC computer argues that a physical reconstruction of historical computers is not always necessary to form an impression of what programming a first-generation computer was like. He shows that software simulation is a good way to get hands-on experience of early programming techniques and to validate historical software artifacts. In so doing, Campbell-Kelly presents an approach to the historiography of software that is worth exploring further.

The editors state that this volume is of more than simply historical interest, as architectures designed to solve specific problems in the past may suggest new approaches to similar problems in today's machines. It is, however, a bit too simplistic to expect that historical case studies will be the blueprints for solving today's problems. Moreover, for a modern historiography of computing technology, only part of this book is of value because most of the contributions conform to a dated, artifact-oriented approach.

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Wurzeln des Personal Computers [The Computer as Tool and Medium: The Technical and Intellectual Roots of Personal Computing], published by Verlag für Geschichte der Naturwissenschaften und der Technik, 1999.

Peter Menzel and Faith D'Alusio, *Robo Sapiens: Evolution of a New Species,* MIT Press, Cambridge, Mass., 2000, $29.95, 240 pp., ISBN 0-262-13382-2.

No field of science or technology is as diverse as robotics. The robotics enterprise includes yellow GM-Fanuc robot arms repeating the same welds on a thousand cars a day, the demolition derby robots of BattleBots, amusement park audio-animitronics, kids playing with AIBO robot dogs, and arms and legs and disembodied heads hanging in university and corporate research labs. *Robo Sapiens*, a book of spectacular photographs, uneven interviews, and a minimal amount of interpretation, captures the full range of the field in a way that no previous book on robotics has.

While *Robo Sapiens* lacks detailed analysis, historical depth, scholarly distance, and never makes a case for its silly hype about "robots as a new species," the photographs of robots in labs and at work more than make up for those failings. Buy this book for the photographs, which bring the robots and their inventors to exuberant life, and for the way that the authors capture and convey the field's diversity, and for the enthusiasm and creativity of the field's engineers. *Robo Sapiens* is a snapshot of an enormously exciting field of endeavor taken by a truly gifted photographer.

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