It is the fate of all serious interdisciplinary efforts to get hung on the horns of the communication dilemma: you either explain too much and bore some people or you move too fast and snow them. The more disciplines covered, the more likely you are to accomplish both unfortunate ends at the same time with different groups of readers. Money and Ehrhardt have worked hard to find an appropriate middle ground. This has been accomplished in part by the presence of a glossary which contains almost all the technical words and phrases found in the text, from "Addison's disease" through "iatrogenic" and "pseudocyesis" to "zoophilia"; the Jacksonian law of release is one exception to complete coverage. Also, a bit of what one must assume is conscious humor creeps in from time to time to lighten the load, as for example when sexual intercourse more than three times daily is said to be "usually an imposition on one of the partners, just as a handwashing compulsion is an imposition on the hands" (p. 194). On the other hand, the light touch sometimes extends to making large-scale generalizations without appropriate documentation, an instance of which has already been cited. But it is evident that the book was carefully prepared, and it is both informative and provocative. It presents the most coherent treatment of the psychobiology of gender and its vicissitudes currently available in a single volume. It can be commended to all who will read thoughtfully.

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On the History of Computing

The Computer from Pascal to von Neumann. HERMAN H. GOLDSTINE. Princeton University Press, Princeton, N.J., 1972. xii, 378 pp. + plates. $12.50.

Few developments in man's scientific history have stirred the imagination like the advent of computers, as well as affected him so strongly in his daily life. That is partly why many persons compare the "Computer Revolution" with the Industrial Revolution. Herman H. Goldstine puts the case thus:

> [Charles Babbage], together with his predecessors, started a new trend—the Computer Revolution. It got off to a slow start, and it has only been in the last quarter century that this revolution has become of importance to society; and, in a relative sense, it is still in its earliest infancy, even though it has moved at a prodigious rate in the years since the end of World War II.

In Goldstine's opinion,

> The world-view of mankind has been irreversibly altered; man's way of life is changed and will continue to change in response to the challenges and problems raised by the computer in society.

The book is divided into three parts: Part 1, The Historical Background up to World War II; part 2, Wartime Developments: ENIAC and EDVAC; and part 3, Post-World War II: The von Neumann Machine and the Institute for Advanced Study. There is also an appendix on World-Wide Developments. Throughout the book Goldstine interweaves technical descriptions of the developments taking place. These descriptions may enhance the book for some readers, but many may wish to skip over them.

Goldstine was himself deeply involved in the events described in parts 2 and 3. He was associated with John von Neumann, more or less closely, from the time he introduced himself to von Neumann in a train station in Aberdeen, Maryland, "sometime in the summer of 1944" until von Neumann's death in 1957. His esteem for this internationally famed mathematician is very high. He relates that it used to be said about von Neumann in Princeton that while he was indeed a demigod he had made a detailed study of humans and could imitate them perfectly. He provides little intimate glimpses into von Neumann's life that make very interesting reading.

As a representative of the Ballistic Research Laboratory, who had the technical responsibility for the Army's ENIAC contract with the Moore School of Electrical Engineering at the University of Pennsylvania, Captain Goldstine, as he was then, had a responsible position and one that gave him access to, and eventual ownership of, the Army's files of information on the project. He is therefore in a unique position to write a history of this important period in the development of electronic computers.

His viewpoint on this history is sometimes at variance with that of other key participants. Naturally, every participant is entitled to his own viewpoint, but it is unfortunate when this viewpoint is simply presented as fact. Not all readers may be aware of the differences of opinion and deep cleavages that took place as early as 1945, and that continue to the present day, among various persons connected with this early period of computer history. Several lawsuits have brought out widely differing testimony from participants, as well as engendered much bitter feeling. For example, in his testimony during one of these trials in 1971 (*Honeywell vs. Sperry Rand*, U.S. District Court, District of Minneapolis, Fourth Division) John Mauchly in no way agrees with the statement in this book that his discussion with John V. Atanasoff in 1941 "greatly influenced Mauchly and through him the entire history of electronic computers."

Then there is the question of who was responsible for the important "stored-program concept," which grew out of discussions on how to build the computer that was to follow the ENIAC at the Moore School. This computer-to-be came to be known as the EDVAC, and in 1945 von Neumann wrote a report called "First Draft of a Report on the EDVAC" (Report on Contract No. W-670-ORD-4926, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, 30 June 1945). This report gave no credit to anyone else, and was widely distributed, howbeit at the time without von Neumann's knowledge. Largely as a result of this report von Neumann has, by and large, been given the sole credit for the authorship of this important concept. Clearly, Goldstine thinks this credit is deserved. In referring to the design worked out for the EDVAC he writes,

> It is obvious that von Neumann, by writing his report, crystallized thinking in the field of computers as no other person ever did. He was, among all members of the group at the Moore School, *the* indispensable one. Everyone there was indispensable as regards some part of the project—Eckert, for example, was unique in his invention of the delay line as a memory device—but only von Neumann was essential to the entire task.

N. Metropolis, who with Stanley P. Frankel had "the honor of running the first problem on the ENIAC," presents this development differently in his recent paper, "A Trilogy on Errors in the History of Computing" (coauthored with J. Worlton, *First USA-Japan Computer Conference Proceedings*, cosponsored by the American Federation of Information Processing Societies and the Information Processing Society of Japan, Tokyo, 1972). In fact, "the stored-program concept and early implementations" of it is the subject of one of the trilogy referred to in this paper. Metropolis and Worlton quote a report written by Eckert and Mauchly in September 1945 ("Automatic High Speed Computing: A Progress Report on the EDVAC," J. P. Eckert, Jr., and J. W. Mauchly, Moore School of Electrical Engineering, University of Pennsylvania, September 1945) as follows:

> . . . in January, 1944, a "magnetic calculating machine" was disclosed. . . . An important feature of this device was that operating instructions and function tables would be stored in exactly the same sort of memory device as that used for numbers. . . . The invention of the acoustic delay line memory device by Eckert and Mauchly early in 1944 provided a way of obtaining large high-speed storage capacity with comparatively little equipment. . . . Therefore, by July, 1944, it was agreed that when work on the ENIAC permitted, the development and construction of such a machine should be undertaken. This machine has come to be known as the EDVAC (Electronic Discrete Variable Computer). . . . During the latter part of 1944, and continuing to the present time, Dr. John von Neumann, consultant to the Ballistic Research Laboratory, has fortunately been available for consultation. He has contributed to many discussions on the logical controls of the EDVAC, has prepared certain instruction codes, and has tested these proposed systems by writing out the coded instructions for specific problems. Dr. von Neumann has also written a preliminary report in which most of the results of earlier discussions are summarized.

Metropolis and Worlton conclude:

> From this it is clear that the stored-program concept predates von Neumann's participation in the EDVAC design. That von Neumann is often given credit for this fundamental concept is likely due to the fact that he wrote a preliminary report which summarized the earlier work on the EDVAC design, including the stored-program concept. Von Neumann contributed significantly to the *development* of this concept, but to credit him with its invention is an historical error.

Goldstine quotes this same report by Eckert and Mauchly, but he uses it to show the high esteem Eckert and Mauchly had for von Neumann's part in the project, starting his quotation at, "During the latter part of 1944, and continuing to the present time, Dr. John von Neumann, consultant to the Ballistic Research Laboratory, has fortunately been available. . . ."

It is this reviewer's opinion that no one is indispensable to a development when the time is right. For example, in the spring of 1946 this reviewer, along with others, was working out logical designs for a stored-program computer. We understood logical AND and OR circuits since these had been used in the ENIAC, and with Eckert's mercury delay-line storage we knew that data and instructions could be stored together. This reviewer can remember reading von Neumann's report and thinking that there was little help in the material presented there. I feel certain that several of us on the Moore School team could have written a sample stored program if we had felt it necessary. This in no way detracts from von Neumann's ability to recognize the importance of an idea, and to develop such concepts at rates that the rest of us could only admire as spectators at a race. Also, von Neumann's documentation of the ideas was of tremendous value in disseminating the concepts. Neither do I think anyone else on the project, such as Eckert, was indispensable; others might have thought of using delay lines, and if not I am sure that cathode-ray tube storage would have come to mind. After all, moving-target radar involved the storage of complete pictures on the face of such tubes. Therefore, in my opinion, the development of stored-program computers was a natural consequence of computational needs and the technological environment at the time that the ENIAC was being completed.

Goldstine and Metropolis also flatly differ as to who deserves the credit for originating the concept of "stored-program control" for the ENIAC. Metropolis states it was R. F. Clippinger and "not von Neumann as stated . . ." who "suggested that the function tables might be used to store sequences of decimal digit pairs, each pair corresponding to one of a possible hundred instructions, and that the control might be implemented (once-and-for-all) to interpret and execute such pairs" (a conclusion Metropolis and Worlton say is documented in a Smithsonian AFIPS History Project interview). Goldstine says that von Neumann "proposed using one or two of the ENIAC function tables as the place to store the orders describing a problem and to wire up the ENIAC once and for all to understand these orders."

There are also other instances in the book when what Goldstine states as fact differs from the way other participants of the time view the event. Unfortunately, as Metropolis notes in his paper, "Unlike computing itself, the history of computing has no automatic error-checking and correcting devices."

Another serious defect of the book as history, particularly in the post-ENIAC era, is its incompleteness. The author states that the "so-called Electronic Computer Project of the Institute for Advanced Study was undoubtedly the most influential single undertaking in the history of the computer during this period." There is only a skimming over of the other developments of this time.

For example, Goldstine spends less than a page describing the computer activities of the National Bureau of Standards. Yet the Bureau, starting after the Institute for Advanced Study, completed two computers two years prior to the completion of the Institute computer. It was early in 1948 that the Mathematics Division of the Bureau decided that they should build a computer in order to have one more quickly available than they would have had otherwise. The Electronics Division in May 1950 dedicated the SEAC (Standards Eastern Automatic Computer); the Mathematics Division dedicated the SWAC (Standards Western Automatic Computer) in August 1950. The SWAC, like the Institute machine, used cathode-ray tube (Williams's tube) storage in parallel mode; memory access cycle was 16 microseconds and 36×36 bit multiplication was done in 384 microseconds.

In a similar manner the work being carried on at the Massachusetts Institute of Technology at this time is discussed only briefly. RAYDAC, an early computer built by Raytheon Corporation, is not even mentioned. Certainly there were other very active centers of computer development. Even though the author notes that he is going to "focus principally on developments at the Institute" the account is too one-sided for a book of this type.

Rather surprisingly, the book contains no bibliography. It does contain many footnotes listing a wide variety of references, but the lack of an organized bibliographical list is a serious deficit for a historical work.

Indeed, this reviewer thinks that it is not as a historical authority that parts 2 and 3 of this book should be read, but rather as an often personalized account of *some* of the exciting electronic computer events of the 1940's and 1950's. Thus, perhaps the most serious criticism of the book is for its misleading title. Whereas the title promises a general treatment of computers "from Pascal to von Neumann," in fact the last two-thirds of the book is primarily a description of Goldstine's activities in computer development. Parallel developments receive little or no attention. The book does fill a need for more information on the computer achievements of the '40's and '50's, and with minor omissions it does give a rather complete earlier computer history.

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Pictorial Chronicle

A Computer Perspective. By the office of Charles and Ray Eames. Harvard University Press, Cambridge, Mass., 1973. 174 pp., illus. $15.

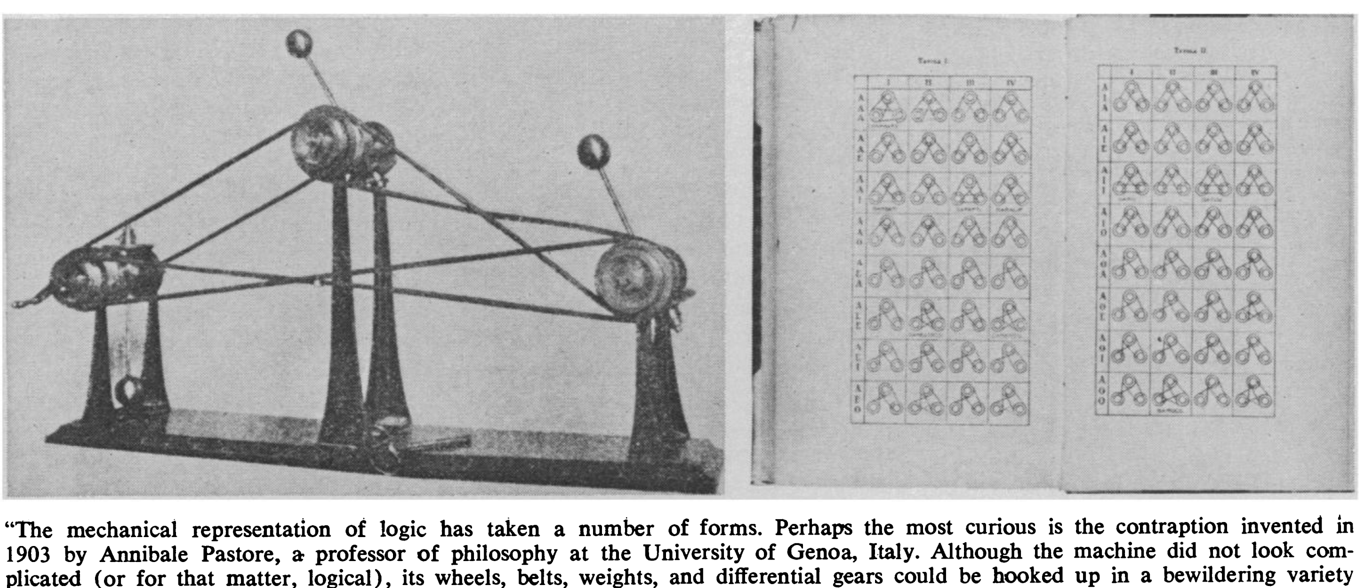
This volume is a pictorial essay on the ideas, events, individuals, and artifacts related to the 20th-century development of the information machine. It is based on an exhibit known as the "history wall" which opened on the ground floor of the IBM building at Madison Avenue and 57th Street in New York City in February 1971 (see *Computing Reviews*, May 1971, p. 203).

In many ways, the book is easier and more luxurious to read than the wall is to view. One can savor it without sore feet and without having to stretch for objects nearly eight feet above or having to attempt to study an artifact or document partially hidden by another object or picture.

The book, like the exhibit, covers six decades of events, beginning in 1890. The development of the modern-day computer is traced from its beginnings in terms of three distinct evolutions: "logical automata," "statistical machines," and "calculations." However, the book is not a history in the conventional sense of developing a clear chronology of its major themes or developing the relationships between their various facets. From a historical viewpoint, it is flawed by arbitrary forcing of events to their decades of occurrence, regardless of the flow of ideas. Thus the burden of evaluation and connection is placed on the reader. For example, the work of Vannevar Bush and Harold Hazen on control problems in the 1930's is pictured on pp. 106–07 and 115–17, while one of the major outcomes of this work, Project Whirlwind (1950's), does not appear until pp. 150–51.

While the disadvantages of this format are obvious, the advantages, of course, are also clear: The intellectual and technical developments are vividly placed to enhance the reader's awareness of the environment within which they occurred. This gives the reader the freedom to make his own way through the complexity of the evolution of ideas and their eventual foci in the contemporary scene. In this sense, the pages may give a much more accurate display of the history of computer development than any conventional approach. For example, one becomes clearly aware in this carefully constructed illustrated essay of the important roles played by von Neumann in a variety of areas: the stored program concept, operations research, automata theory, the EDVAC, the Institute for Advanced Study machine, and weather research. It is naive to assume, however, as one might as a result of the way this volume presents the material, that these milestones did not have complex conceptual and implementational evolutions in which a variety of individuals played critical roles.

The volume is attractively done, as one would expect from the Eameses, and will be of interest to the general reader as well as to the specialist. It admirably accomplishes, within the



"The mechanical representation of logic has taken a number of forms. Perhaps the most curious is the contraption invented in 1903 by Annibale Pastore, a professor of philosophy at the University of Genoa, Italy. Although the machine did not look complicated (or for that matter, logical), its wheels, belts, weights, and differential gears could be hooked up in a bewildering variety of configurations to represent any of 256 syllogistic structures." Pastore presented the 256 configurations in his book *Logica Formale: dedotta della considerazione di modelli meccanici*, "which includes the following example of the syllogisms his machine could handle: *Whatever is simple does not dissolve; The soul does not dissolve; Therefore, the soul is simple.* After making belt connections corresponding to each premise and the conclusion, the operator would crank wheel A. Since the syllogism is invalid, the wheels would not budge." [From *A Computer Perspective*]