tell us how the story that he has just given us illustrates the generalizations that he made in the beginning. Perhaps he believes the story speaks for itself, but more of his own interpretation would be helpful.

Electricity was not the only subject of experimental physics in the 17th and 18th centuries; heat, optics, and chemistry were equally important. Historians have tended to treat them as separate disciplines, and this is surely a mistake. There are signs of change, however. Historians of chemistry in particular have begun to emphasize the importance of theories of heat in the chemical revolution. We need to know how the sciences of electricity, heat, optics, and chemistry all grew out of the single subject of experimental physics, if indeed that is what happened. Heilbron's excellent book is an important beginning for this promising new investigation.

THOMAS L. HANKINS
Department of History,
University of Washington,
Seattle 98195

Looking for Insights

A Retrospective Technology Assessment. Submarine Telegraphy: The Transatlantic Cable of 1866. VARY T. COATES and BERNARD FINN, with Thomas Jaras, Henry Hitchcock, and Robert Anthony. San Francisco Press, San Francisco, 1979. xvi, 264 pp., illus. Paper, $8.50.

The play-within-a-play or book-within-a-book, a literary device familiar to readers of *Hamlet* and *The World According to Garp*, has now been extended to social science. The history of the transatlantic cable has been embedded in a book whose main concern is helping to define a new discipline: retrospective technology assessment.

In the outer book, social scientist Vary Coates and historian Bernard Finn lead a multidisciplinary team seeking to link the past and the present by retrospectively carrying out a technology assessment (defined as "a systematic attempt to anticipate the potential impacts of technology on the economy, the environment, social institutions, and behavior"). In the inner book, businessman Cyrus Field leads a consortium of industrialists, engineers, and scientists seeking to link the Old World and the New by an undersea telegraph cable. Field's effort and its impacts make up the technology the outer book attempts to assess.

In the inner book, money is raised from businessmen and governments on two continents; naïve expectations are crushed as the initial straightforward attempts to lay the cable fail; an expert commission gets the project back on the right track; and, finally, with the aid of the world's mightiest steamship, the *Great Eastern*, and the world's most productive scientist-technologist, William Thomson (later Lord Kelvin), the cable team succeeds not only in connecting the continents but even in grappling from the depths and splicing a failed earlier cable.

In the outer book, money is raised from the National Science Foundation to pay for the study; naïve expectations persist; an expert commission meets at the George Washington University Library to eat a buffet supper and unconvincingly impersonate its 1861 predecessor; and rejecting two of the most productive tools in the historian's kit—archival research and imagination—the authors grapple in the depths for "productive insights and provocative hypotheses."

The conclusions that surface are unsurprising. Mankind ought to assess in advance those technologies that give entirely new capabilities—like instantaneous world communication, nuclear power, and genetic engineering. Networking technologies are especially worthy of assessment. The public is more interested in how technologies can be used than in how they work. Technology assessments can be biased by the assumptions and the interests of the assessors.

Unlike William Shakespeare and John Irving, the authors of this book fail to surround their inner plot with an outer story worthy of it. The play here is the only thing.

It features the impetuous Cyrus Field, whose energy made the cable project succeed at the same time as his impatience nearly doomed it. After the 1858 cable failed within a month of operation, businessmen learned to listen to their engineers' demands for quality standards. And those engineers, in turn, learned to listen to scientists' insistence that physical theory could be translated into guidance about power levels and detection methods. Governments learned to listen to technical experts: the 1861 Parliamentary Inquiry on Cables is a direct ancestor of the Kemeny Commission on Three Mile Island. The cable's direct impacts on the economics of shipping and futures markets, as well as its surprisingly damped and delayed impact on diplomacy, also make interesting reading.

But it is the outer book that carries the authors' real purpose. A retrospective technology assessment, we are told, is history not for its own sake but "in the hope of providing new insights into the relationship between technological change and social change."

The way the authors (particularly Coates and physicist Robert Anthony) seek this aim is through a positivist method of reaping a historical harvest already standing in the field, winnowing it according to mechanistic views of "impact," and grinding it in the mill of generalization. The tools of the technology assessor are employed: the Delphi method (here applied incorrectly); fully articulated impact trees; and the authors' own invention, the period profile approach.

The results totally lack the richness and the grace of recent books that rejected the armory of new methods and sought instead sympathetic yet critical involvement in the historical situation. Examples are Leslie Hannah's *Electricity before Nationalization*, an insightful administrative history of the impact of electricity in Britain; Anthony Wallace's *Rockdale*, an evocative account of the impact of the textile industry on 19th-century America; and even David McCullough's lively popular history of the Panama Canal, *The Path between the Seas*.

It would be unfortunate if the muse of history that inspired such works should find it necessary to disguise her virtues beneath the lab coat of positivist history for no better reason than to secure funding of studies in retrospective technology assessment from the hard-science-oriented funding officers of the National Science Foundation.

GEORGE WISE
Research and Development Center,
General Electric Company,
Schenectady, New York 12301

A Memoir of Computing

From Dits to Bits. A Personal History of the Electronic Computer. HERMAN LUKOFF. Robotics Press, Portland, Ore., 1979 (distributor, International Scholarly Book Services, Forest Grove, Ore.). xvi, 220 pp., illus. $12.95.

Herman Lukoff's warm and human *From Dits to Bits* fills a void in the rapidly growing literature of computing. In the double introduction by John W. Mauchly and J. Presper Eckert, Mauchly writes,

> Until now, [the] history of the computer field has not been told in human terms by any of those who helped to create that history.

The fun of accomplishment kept us all busy, too busy to write about what we were doing and the fun we were having doing it. . . .

Now, for the first time, we can read the very human story of a really active participant in computer development. Herman Lukoff was one of the handful of engineers who worked with Pres Eckert and me at the University of Pennsylvania, designing, building and testing the first electronic digital computer.

The title of the book is worth an explanation. Lukoff's hobby as a youngster was radio, and he used the Morse code for communication. The book tells of his evolution from the "dits" (and "dahs") of the Morse code to the "bits" of information used in the computer.

The "dits" portion of the book has to do primarily with Lukoff's early years, during which he managed, in a nontechnical family and with a minuscule allowance, to acquire an excellent knowledge of electronics and radio circuitry by reading and experimenting. Apparently history, with infinite variations, does repeat itself, because this reviewer acquired his early electronics background in the same manner.

Chapters 3 and 4 of the book cover Lukoff's college years at the University of Pennsylvania's Moore School and his association with the ENIAC (Electronic Numerical Integrator and Computer), then being developed there under the direction of Eckert and Mauchly. Lukoff devotes a chapter to his "time out for the Navy." Then in 1946 he is back at the university working on the EDVAC (Electronic Discrete Variable Automatic Computer). When Eckert and Mauchly left the university, after a dispute over patent rights, and formed their own company, Lukoff accepted a position with the new company. We relive his experiences in the industrial and commercial sphere as the initial company, Electronic Control Company, evolves into a corporation, Eckert-Mauchly Corporation, is purchased by Remington Rand, and becomes, as a division of Sperry Rand, Remington Rand Univac and then Sperry Univac. These chapters encompass Lukoff's days (and many nights) with the BINAC (Binary Automatic Computer), the UNIVAC I (Universal Automatic Computer), and the "ahead of its time" computer, the LARC (Livermore Automated Research Computer). The concluding chapter presents some highlights subsequent to the completion of the LARC.

The book blends accounts of technological progress and frustration with Lukoff's own viewpoints and accounts of his personal triumphs and disappointments. I can vouch for its historical accuracy, having been involved from the U.S. government's side, as a customer, in many of the events described. I spent a year and a half at the Eckert-Mauchly plant in close contact with Lukoff, and for many more years continued to have business contacts with him.

The book is enhanced by an excellent glossary to guide the reader through the sometimes specialized computer terms used in the text and a bibliography for those interested in delving deeper.

GORDON D. GOLDSTEIN
Information Systems Program,
Office of Naval Research,
Arlington, Virginia 22217

Alpine Plants

Ecology and Phytogeography of High Altitude Plants of the Northwest Himalaya. Introduction to High Altitude Botany. M. S. MANI. Chapman and Hall, London, 1979 (U.S. distributor, Halsted [Wiley], New York). xii, 206 pp., illus., + plates. $40.

M. S. Mani has had a long and distinguished career as the premier high-mountain biologist in India. His books on the ecology and biogeography of alpine insects are invaluable to an understanding of their adaptations and ecosystemic roles in these cold, severe environments. In the present book, he shifts his attention to adaptations and geographical relationships of the plants in his favorite milieu: the high, relatively dry, and continental northwestern Himalaya. This region has a set of high-mountain environments rather different from those of the Nepal Himalaya and the East Himalaya. Mani makes the shift in subject matter with rather mixed results.

The real value of the book is in chapters 4 and 5, which list some typical high-mountain plant families, genera, and species in the Northwest Himalaya and their vertical distribution in relation to alpine environments. Among these is *Christolea himalayensis*, in the mustard family, collected at an elevation of 6300 meters by G. Singh. This is the highest recorded flowering plant on earth. It slightly exceeds the previous record of 6222 meters for *Arenaria musciformis*, in the pink family, collected in the Nepal Himalaya by A. F. R. Wollaston on the first British Everest Expedition in 1921. The latter collection is apparently unknown to Mani. While Mani's list of plants is not complete and is written in a rather casual way, with mostly qualitative data, it is useful because of the scarcity of easily accessible information on the flora of this part of the Himalaya. These mountains are much drier than the better-known Nepal Himalaya; the flora reflects this.

Chapter 3, on the ecology of high-altitude plants, is a disappointment. Throughout the chapter, teleology prevails. The author is not conversant with the modern physiological ecology of high-mountain plants. He makes numerous assumptions based upon few, if any, data. There are a number of factual errors in this chapter in regard to plant adaptations to severe alpine environments. It is stated that "nearly all plants that belong to the ecosystems present more or less the same general and uniform habits." This is true only to a very limited extent. The differences far outweigh the similarities for root systems as well as aboveground characteristics. I doubt that root systems of alpine plants in the Northwest Himalaya are "nearly all . . . characteristically succulent" and that "superficial fibrous roots are the general character of high altitude plants," for in other high mountains diversity in root system types is the rule rather than the exception.

The last chapter (on phytogeography) has a section on affinities. While rather wordy and qualitative, it seems to me the best and most fascinating part of the book. Some, but not all, floristic plant geographers have included the entire Himalaya in the Sino-Japanese floristic region. Mani, largely depending upon the works of several Russian botanists and the Dane Paulsen, correctly demonstrates the very strong affinities of the Northwest Himalayan alpine flora with those of the Pamir and the central Tien Shan in the Western and Central Asiatic floristic region. Troll, Meusel, and Gupta have remarked on the floristic relationships between these high mountains and those of the Mediterranean region.

The production of the book leaves something to be desired. Typographical errors are common. The reproduction of a number of the black-and-white photographs is fuzzy. The plates are not comparable to the sharp color photographs in Hara's volumes on the eastern Himalayan alpine flora.

In spite of its deficiencies, the book has value in providing some information concerning the vegetation and phytogeographical relationships of a relatively unknown high-mountain region. It definitely is not the last word on the plant ecology of this part of the Himalaya. But it is a start.

W. D. BILLINGS
Department of Botany,
Duke University,
Durham, North Carolina 27706