the development of these highly successful satellite capabilities. (See "Corona: The First Reconnaissance Satellites," by Albert D. Wheelon; PHYSICS TODAY, February 1997, p. 24)

In 1955, Land noticed what hundreds of others must have also observed—that the redness of an apple in a bowl or a color projection is extraordinarily robust to variations in the spectral composition of the light. Demonstrating this fact ever more clearly and seeking a sound theory to explain it became Land's passion for the next 30 years, at Polaroid and then at the Rowland Institute, founded and endowed in Cambridge, Massachusetts, by Land and his wife.

Land's ability to achieve the (near) impossible and persuade the public to buy it failed with Polavision—instant film movies—in 1978. A three-minute cartridge, without sound, signaled the conquest of the impossible, but it bombed in a market that was soon to see video cameras and players. In 1982, Land was forced out of Polaroid, and by 1985 he and his family had sold all their stock in the company he had created. He died in 1991 after several years of infirmity.

McElheny has written a fascinating account of the work of Edwin Land, who, for all his showmanship, speeches, patents, and publications, was a private person whose personal papers were shredded during the months after his death. Although they were cordial to McElheny, Land and his family provided no material for the book; the author has thus emphasized the technical and not speculated to fill in the personal gaps. The book makes a major contribution to the reader's understanding of the chemistry and physics of polarizers and instant photography as well as to an appreciation of the accomplishments of one individual and the contagion of his competence and achievement. An accomplished journalist, McElheny covered science and technology over a 40-year span (including stints at *The New York Times* and *Science Magazine*) and was founder of The Knight Science Journalism Fellows program at MIT, which he led from 1982 to 1998. The book is factual and well written.

Ecological Numeracy: Quantitative Analysis of Environmental Issues

Robert A. Herendeen
Wiley, New York, 1998. 331 pp. $44.95 pb ISBN 0-471-18309-1

More than most fields of research, environmental science uses and benefits from estimation and approximation. Physics and chemistry can be precise and are generally approached in a precise way. Engineering can be precise as well, but the "engineering estimate" has a long history as a starting point. In environmental science, the parameters are often poorly understood, or there are unquantified but important variables, or a prediction depends partly on human behavior. As a result, there are often no correct answers, but an estimate or reasoned projection can be of great value. In his book *Ecological Numeracy*, physicist Robert Herendeen has produced a guide to the straightforward, often simple mathematics that has the potential to guide much ecological thinking.

The book is largely based on four equations: one that analyzes components of charge, a second that treats exponential growth, a third used for resource budgeting analysis and a fourth that examines the calculation of indirect environmental effects. A chapter is devoted to each, and three other chapters treat applications. Exercises are liberally provided, with the level of difficulty indicated. Along the way, students will face calculations designed to estimate the number of piano tuners in Chicago, the supply of coal in Illinois and the alteration of global carbon cycles.

Herendeen is at his best when the topic being treated is clearly defined and susceptible to straightforward mathematical treatment, as in the solid chapter on end-use analysis and the excellent one on dynamics, stocks and flows. The student working through these topics will get a good sense of the benefits to be gained by ecological numeracy in these areas.

I share fully Herendeen's notion of the value of simple mathematics in addressing environmental issues and in putting those issues into perspective. His book can be used as a teaching tool in several different ways and at several different levels, and the level of writing and extensive problem sets make it quite appropriate for advanced undergraduates with a modest mathematical background.

Herendeen is not an environmental scientist, and he tends fairly uncritically to climb aboard a few environmental bandwagons. One example is the "ecological footprint," proposed by Matthias Wackernagel and William Rees as a measure of the "load" imposed on nature by a given population. This is an interesting concept, but its quantification is contentious, and Herendeen does not explore its numeracy. Similar treatment is afforded the natural step conditions intended to provide basic principles for sustainability, in which Herendeen repeats the misdefinition of the geological term "lithosphere." An entire chapter is devoted to ecological economics, an area not yet either well defined or numerated, and Herendeen adds nothing of particular value. The chapter on limits is short and contains little of value, notwithstanding the importance of the subject. Particularly unfortunate is the confusion of stressors and impacts in the classic IPAT (impact = population × affluence × technology) identity, an extremely useful conceptual idea, but one that incorporates a logical error now almost three decades old.

Herendeen's style is breezy, often as if he were in casual conversation with friends. This approach offsets the sometimes intricate discussions, and overall the book is quite accessible. I discovered only two errors in printing—a misspelling and an editor's provisional page heading that managed to survive the proofreading process.

A book on this topic immediately brings to mind John Harte's *Consider a Spherical Cow* (University Science Books, 1988), which Herendeen characterizes as "deeper and narrower" than his own book. I think this is a reasonably accurate description, and I would use Harte's book with students actively engaged in research. For a more general introduction to the use of estimation and semiquantitation in environmental studies, however, Herendeen's book has much to offer and deserves serious consideration as a component of modern science and engineering curriculums.

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Explorations in Quantum Computing

Colin P. Williams
and Scott H. Clearwater
TELOS (Springer-Verlag), New York, 1998. 307 pp. $59.95 hc ISBN 0-387-94768-X. Includes CD-ROM

Colin P. Williams and Scott H. Clearwater aptly describe their book *Explorations in Quantum Computing* as "the first book on quantum computing" and a "whirlwind tour." It undertakes, with mixed results, the ambitious task of explaining this new field in a self-contained manner, presuming no prior knowledge of quantum physics or theoretical computer science. The book does cover most of the important parts of the field in a readable fashion, but it lacks the accuracy, thoroughness and consistency of exposition one expects of a good textbook.

Explorations in Quantum Computing is likely to be most rewarding to