

How your FETs, LEDs, bubble memories, and so forth, work

Electronic Devices and

Components, J. Seymour, 504 pp.,
Wiley, New York, 1981. \$29.95

Principles of Electronic

Instrumentation, A. de Sa, 280 pp.,
Wiley, New York, 1981. \$29.95

Reviewed by William Vetterling

Electronic Devices and Components by J. Seymour treats the physical principles underlying electronic components. Although the book is designed for students of engineering and applied physics, students of physics may also find it enjoyable because its presentation departs frequently from direct applications to focus upon curious properties exhibited by these components. The "applied" nature of the book is actually exposed only by the straightforward numerical problems at the end of each chapter.

More than half of the book concerns semiconductors. Seymour begins with short descriptions of the quantum theory of atomic levels and of bonding, then discusses the special attributes of electrons in crystals, particularly those due to the development of band structure. (While this discussion draws modestly upon quantum mechanical ideas, the mathematical analysis throughout the remainder of the book is semiclassical.) The text then turns to the effects of doping, and for several chapters, to the investigation of a broad variety of semiconducting devices. These include not only diodes, bipolar transistors, and FETs, but also thyristors, optoelectronic components (including LEDs, liquid crystals, solid-state lasers and fiber optics), and integrated circuits. Seymour gives a clear picture both of the operation of these devices and of the steps and compromises involved in their manufacture. He illustrates integrated circuits by an explicit demonstration of the steps that would be used to create, on the surface of a semiconductor wafer, a simple circuit of an npn transistor with a resistor tied to its base. The generalization to much more complex structures is clear from this simple example. He covers many other interesting topics, such as the nature of connections between metals and semi-

conductors and the dependence of characteristic curves on the type and concentration of dopants.

The remainder of the book covers vacuum and gas-filled devices to the extent that these (for example, photomultipliers, electron microscopes, cathode-ray tubes), microwave devices (klystrons, magnetrons, TWTs and microwave semiconductor devices), dielectric devices (capacitors and quartz crystals), and magnetic devices (ferrites, cores, and bubble memories). Four brief appendices treat various background or supplementary topics which are not central to the discussion, such as the relativistic mass increase of electrons and the basic ideas of wave mechanics.

This entertaining introduction to device physics, though not as detailed as some others, is filled with insightful physical descriptions and well-chosen supplementary references. Seymour avoids labored mathematical derivations and anticipates our questions. His clear expositions and wide-ranging choice of devices make this book espe-

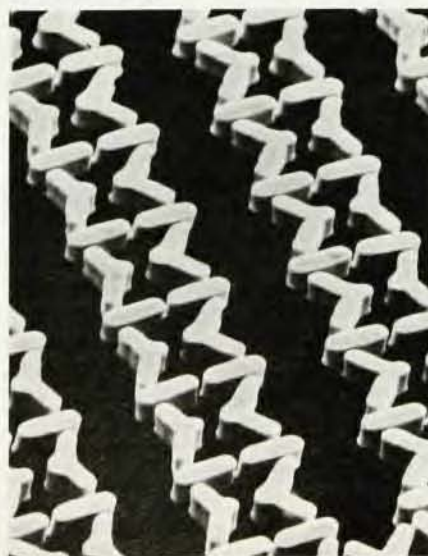
cially successful.

A. de Sa's *Principles of Electronic Instrumentation* also discusses some aspects of modern device physics, but only as a prelude to its presentation of the physical and electronic principles underlying modern instrumentation. de Sa adopts an "electronic building blocks" approach, avoiding the description of specific circuits and concentrating on circuit "blocks," or segments, in terms of which the instrument can be understood. The book begins with some details on the operation and construction of semiconductor junctions and includes discussions of analog and digital circuitry, data conversion, feedback, and transducers. It concludes with an introduction to frequency domain analysis and the application of such analysis to the recovery of signals from noise. This is a broad palette, stretching from quite detailed to very general aspects of electronics. The coverage of each area is, consequently, sketchy. Unfortunately, the references and reading lists are often poor and do not adequately supplement the material. For example, the book devotes only one page to microprocessors and suggests three references—two of which are to articles in trade magazines. One must also be critical of many other aspects of this book:

- ▶ the large number of undefined jargon words and of undefined quantities in the equations, charts, and graphs
- ▶ mathematical derivations that drift off along unusual lines with confusing typographical errors
- ▶ application examples that are incorrectly solved
- ▶ frequent definitions of concepts not used in the book (most of the theorems in the chapter on frequency analysis, for example, seem never to serve any purpose).

Although the diagrams in this book sometimes look like realizable circuits, they are strictly schematic and only meant to portray idealized electronic or Boolean concepts. The author does not make their notation clear. Quite often they contain examples of poor design for actual circuitry (for example, TTL gates with floating inputs, operational amplifier inputs with no dc path to

A bubble memory pattern formed by x-ray lithography. The books reviewed here include discussions of bubble memories as well as many other recently developed electronic devices. The patterns here are 1 micron wide. (Courtesy IBM.)





An Introduction to Error Analysis is the book behind this *tour-de-force* cover illustration. Author John S. Taylor introduces college students in introductory experimental-physics courses to uncertainties in measurement and to methods to estimate and reduce them. The first half of the book discusses why error analysis is interesting and important and how its tools (error propagation, elementary statistics, normal distributions) are used. The second half includes topics as advanced as an undergraduate is likely to encounter (least-squares fitting, correlation coefficients, the chi-squared test). In this carefully prepared text Taylor illustrates discussions with examples drawn from standard introductory experiments; he provides problems—and answers to many.

ground). Perhaps the book's most unsettling feature, however, is its failure to define its audience. While introductory in content, it contains notational and graphical conventions that would be meaningful only to intermediate students. It is therefore difficult to imagine readers to whom this book would be useful.

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The Turning Point: Science, Society and the Rising Culture

F. Capra

Simon & Schuster, New York, 1982. \$17.50

In his widely read first book, *The Tao of Physics*, Fritjof Capra popularized an approach to the interpretation of modern physics, especially the quantum theory, that can be summarized as follows:

► The difficulties in modern physics are due in large measure to the rigid, mechanistic, Cartesian world-view that

is so deeply rooted in Western science

► A more "holistic" approach, emphasizing the unity of nature and abandoning the rigid boundary between observer and phenomenon (the "subject-object distinction"), would be more fruitful

► In this enterprise, the more "contemplative" schools of oriental philosophy, such as Taoism and Zen Buddhism, can help point the way.

In *The Turning Point*, Capra extends this analysis to all the ills that beset humanity, from the nuclear-arms race and economic stagnation to environmental damage and the *anomie* that haunts the Western mind.

In his view, these are but "facets of a single crisis." The key to resolving this crisis is to be found in the position stated above. The same mind-set that has failed intellectually in science has failed morally in society. This message is aimed at professionals in science, technology, health care, economics and government.

Capra brings to this overreaching effort some of the mental discipline of his training in theoretical physics. He has read widely, and with a critical eye. The problems are not simple, and the solutions will not be simplistic. In this respect, Capra's book contrasts favor-

ably with Jeremy Rifkin's *Entropy*, which has attracted considerable attention in the circles Capra hopes to reach. As his title suggests, Rifkin traces all of our woes to the second law of thermodynamics and seeks their remedy in the socioeconomic equivalent of "reversible processes."

Readers may or may not endorse Capra's goals, which are largely those of the social movements of the 1960s, but few would share his rosy optimism. "All" that is needed is a radical transformation of the human consciousness, and he is convinced that this process is well under way: The public is way ahead of its leaders; the "turning point" of his title has already been passed; the resurgence of the New Right is dismissed as a mere "noise pulse." However intractable our problems may seem, men and women armed with a new consciousness will solve them.

Many physicists who read this book will take exception to Capra's views on contemporary physics. As an unreconstructed bootstrap theorist, a disciple of Geoffrey Chew, he is not terribly impressed by the recent triumphs of quantum field theory and the quark model. The bootstrap credo—there are no fundamental entities—fits too neatly into his philosophy to abandon. The hierarchies of subatomic physics are no more than convenient working hypotheses, and to take them too seriously is to fall back into the darkness of Cartesian mechanism.

But are quantum field theories really all that "mechanistic"? The entities they describe can scarcely be said to have independent existences. A fundamental "particle" has *no* properties other than its couplings to fields. These cannot, even in principle, be studied in isolation, but only through their *interaction*—even mass and spin are regarded as dynamic in origin. Quantum statistics tells us that it is erroneous to assign the "particles" individual identities, and they exhibit the correlations of the Bell inequality, for which no truly mechanistic interpretation is possible. Finally, two of their more important manifestations, quarks and gluons, probably exist only in combination.

What could be more "holistic" than grand unified field theories? At the heart of their reality lies a deep harmony, masked by a hierarchy of symmetry-breaking mass scales. Proton-antiproton colliders have already carried us into a world in which the photon looks like the Z^0 . Experiments on proton decay promise a glimpse closer to the core, where quark and lepton, particle and antiparticle, lose their distinctness. A few orders of magnitude beyond lies gravity, which was the first problem of modern physics and