

eral times, however, Drlica lapses into detailed scientific histories (for example, of Max Delbrück) that may seem confusing and tangential to his "consumer" audience.

No single guidebook is sufficient to lead us through the uncharted territory of genetics; indeed, there are no three guidebooks that will accomplish that. But the territory is vast and we are approaching it more rapidly than we know, so such books are valuable as we as a society decide where we will go and how we will deal with what we find when we get there.

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## Industrial Geophysics

**Science on the Run.** Information Management and Industrial Geophysics at Schlumberger, 1920–1940. GEOFFREY C. BOWKER. MIT Press, Cambridge, MA, 1994. viii, 191 pp., illus. \$27.50 or £23.50. ISBN 0-262-02367-9. Inside Technology.

At a time of growing interest in the development of so-called industrial science, this book examines the strategies by which one firm—specializing in the assessment of potential oil fields—developed proprietary techniques that were vital to its industry and rose to international prominence.

The Schlumberger firm was founded after World War I, at a time when theories of petroleum formation were not effectively predictive. Prospectors employed a range of surface and drilling techniques to discover and map oil fields, but scientific understanding lagged greatly behind technological exploitation and, embarrassingly, wildcat discoveries. Schlumberger used electrical logging to map oil fields by measuring subsurface resistivity. But, as Bowker notes, there is no simple measurement. Each oil field had its own peculiarities. Practicing what Bowker calls "science on the run," the firm, by imposing laboratory conditions in the field and maintaining close contact between field engineers and the calculators at its Paris headquarters, managed to weave generalizable knowledge from local data. Bowker focuses on the tightly controlled interpretation, manipulation, and dissemination of the information generated as key reasons for Schlumberger's success.

Schlumberger began with the major advantages of being a family-owned business with special access to the geophysically challenging Alsatian oil field of Pechel-



"Wherever the drill goes, Schlumberger goes." [From *Science on the Run*; Proselec]

bronn. This rear base enabled brothers Conrad and Marcel Schlumberger to experiment with their techniques, train staff in relative secrecy, and watch competitors. Unstated but implied is that revenue from Pechelbronn supplied the deep pockets that kept the firm alive after some initial failures in the United States, the world's largest oil market, in the 1920s.

Contingency—or luck—played a major role in Schlumberger's fortunes. Its unsuccessful North American ventures were in salt domes, where at the time seismic measurements were more predictive than electrical logging. Oil fields in the Caucasus and Venezuela, however, had the geophysical conditions necessary for electrical logging to succeed. A friendly Soviet government and the isolation of Venezuelan drilling sites further contributed to a more receptive business environment. While Schlumberger developed its logging techniques and expanded in those regions in the 1920s and '30s, potential competitors were removed as similar exploring firms were swallowed by vertically integrating oil firms in the United States.

When the company returned to the United States in the mid-1930s, it arrived with an international reputation, an array of well-developed techniques, and a tight organization for managing information. Not only was electrical logging now effective in a wide range of geological formations, it soon proved invaluable in the legal regulation of oil production in California and Texas. Following some adroit maneuvering in two crucial patent battles, Schlumberger established the leading international position it has maintained for over half a century.

Bowker looks at the firm's business strategy between 1920 and 1940; shows how it represented its work to different audiences to justify its activities, appear "scientific," and

defeat competitors; and explores the internal infrastructure by which it established and maintained its position as an independent creator and broker of knowledge. The firm kept the specifics of its techniques secret while its engineers worked to generalize and adapt locally acquired information. For their money its clients received logs of electrical resistivity of their wells whose usefulness required interpretation by the Schlumberger engineers.

Key to Bowker's analysis is the assumption that Schlumberger's success depended on changing the way oil companies perceived the ground they drilled and how they drilled it. Local knowledge and control of the wells were insufficient; Schlumberger also had to negotiate and alter its corporate and political environments. Anyone working in biotechnology today will appreciate this situation and the skills it required.

Bowker's conclusion that innovations in work and organization—"locally controlling social and natural time and space"—preceded theory and the development of an industrial science fits well into the larger portrait being drawn by other studies in the field. His study demonstrates the importance of measurement and information management in the history of technology. Schlumberger succeeded in large part because of its ability to coopt both the natural and the social environments in which it operated.

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## 17th-Century Issues

**The Scientific Revolution.** STEVEN SHAPIN. University of Chicago Press, Chicago, 1996. xiv, 218 pp., illus. \$19.95 or £15.95. ISBN 0-226-75020-5.

General accounts of the scientific revolution of the 17th century have been few and far between. Until the appearance of this

book by Shapin, the two most recent attempts were Richard S. Westfall's *The Construction of Modern Science* (1971) and A. Rupert Hall's *The Revolution in Science* (1983). Unlike these and other predecessors, Shapin's book offers no survey of the major scientific developments in fields such as astronomy, cosmology, mechanics, optics, anatomy and physiology, and natural history. Rather, it contains but three chapters, each consisting of a provocative, relatively self-contained essay on the nature of scientific activity in 17th-century Europe.

Shapin's chapter titles nicely declare what this book is about: (i) "What was known?" (ii) "How was it known?" and (iii) "What was the knowledge for?" The first chapter, limited as it is to 64 pages (further reduced by illustrations), is of necessity a very selective account of 17th-century scientific achievements. Shapin concentrates on the overthrow of ancient cosmology and natural philosophy by Copernicus, Galileo, and their fellow heliocentrists; the creation of the mechanical philosophy by Descartes, Boyle, and others; and the mathematization of nature by Kepler and Newton. Selective and limited though it may be, Shapin's account is informed, nuanced, and articulated with clarity.

Chapter 2 offers a non-traditional account of 17th-century methodological developments. Of course, Shapin joins everybody else who has ever written on the topic in considering the central question of how inference from particular observations can lead to knowledge of universal causes and the attendant question of the level of certitude thus achievable. But readers familiar with Shapin's previous publications will not be surprised to find that he goes much farther, problematizing many of the certainties of traditional historiography. For example, he discusses meanings of the term "experience," tracing a crucial 17th-century shift in usage—from representing a statement of universally accepted fact (the product of many observations) to representing the particular experience of a particular natural philosopher. He discusses the practices by which private experiential knowledge could be converted into public property. As an example of the "making of scientific facts," Shapin analyzes Robert Boyle's use of the air pump. And he casts doubt on the value of 17th-century methodological theory for revealing anything about the actual scientific practice of the time, suggesting that the former should perhaps "be understood as a set of rhetorical tools for positioning practices in the culture and for specifying how those practices were to be valued" (p. 94).

Finally, in his third chapter Shapin turns to the social and political uses of 17th-century science. He believes that science is

"the contingent, diverse, and at times deeply problematic product of interested, morally concerned, historically situated people" (p. 165). It follows that the traditional view of science as an objective account of external reality, totally uncontaminated by human interests or passions, is untenable. However, Shapin insists, this is not to attack or devalue science but to reveal its richness as the human endeavor that it most surely is. Indeed, Shapin repeatedly affirms (both by word and by historiographic deed) his respect for the scientific enterprise—17th-century as well as modern—accepting its historically situated character but acknowledging also that it is "the most reliable body of natural knowledge we have got" (p. 165).

Viewed as a whole, Shapin's book is an impressive achievement. Informed readers will not agree with all of its interpretations and emphases: for example, I do not believe Shapin's portrayal of the background against which 17th-century developments are to be viewed does justice to non-Aristotelian alternatives. On the other hand, certain sections of the book are extraordinary for their insight and clarity: my future students will be required to read the discussions of the mechanical philosophy (pp. 30–54) and of the relationship between science and religion (pp. 142–55), which are superior to any other brief, introductory accounts available. Despite such virtues, I doubt that this book will attract a large readership among undergraduates; for, notwithstanding the sections praised just above, much of the book is packed with difficult ideas that will present a stiff challenge to all but the brightest and most dedicated. Nor do I believe that it will be seen as an adequate substitute for the traditional survey of major 17th-century scientific developments. I am hopeful, nevertheless, that Shapin's book will contribute to pedagogy in the history of science—if not as a required textbook, then as a teacher of the teachers, showing them how to communicate to their students a vision of science as a historically contingent, human activity.

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## Browsings

**Australian Astronomers.** Achievements at the Frontiers of Astronomy. Ragbir Bhathal. National Library of Australia, Canberra, 1996. viii, 236 pp., illus. Paper, \$A24.95. ISBN 0-642-10666-5.

Excerpts from oral history interviews with 18 astronomers, from Bart Bok to Jeremy Mould, along with biographical and

scientific background information.

**Biological Psychology.** Mark R. Rosenzweig, Arnold L. Leiman, and S. Marc Breedlove. Sinauer, Sunderland, MA, 1996. xxiv, 835 pp., illus. \$64.95. ISBN 0-87893-775-7.

A textbook that "explores the bodily bases of our experience and behavior," aimed at students with a variety of interests and backgrounds; CD-ROM, study guide, and other ancillary material also available.

**The Collected Works of P. A. M. Dirac.** 1924–1948. R. H. Dalitz, Ed. Cambridge University Press, New York, 1995. xxiv, 1310 pp., illus. \$250 or £175. ISBN 0-521-36231-8.

The first of two volumes bringing together the quantum theorist's scientific papers, arranged chronologically and accompanied by English translations when in other languages.

**Concert and Opera Halls.** How They Sound. Leo Beranek. Published for the Acoustical Society of America through the American Institute of Physics, Woodbury, NY, 1996. viii, 643 pp., illus. \$49.95. ISBN 1-56396-530-5.

An extensively illustrated account of 76 concert halls around the world accompanied by discussion of acoustical concepts, principles, and methods, and relevant architectural factors.

**Conversations on the Uses of Science and Technology.** Norman Hackerman and Kenneth Ashworth. University of North Texas Press, Denton, TX, 1996 (distributor, Texas A&M University Press, College Station). xiv, 109 pp. Paper, \$14.95. ISBN 1-57441-015-6.

A former chairman of the National Science Board is interviewed by the state of Texas's commissioner of higher education.

**Cultural and Language Diversity and the Deaf Experience.** Ila Parsanis, Ed. Cambridge University Press, New York, 1996. xiv, 306 pp. \$49.95 or £35. ISBN 0-521-45477-8.

A collection of 18 papers, including six "personal reflections," considering "the notion that deaf people are members of a bilingual-bicultural minority group" in the United States.

**Encounters in Magnetic Resonances.** Selected Papers of Nicolaas Bloembergen (with commentary). Nicolaas Bloembergen, Ed. World Scientific, River Edge, NJ, 1996. x, 550 pp., illus. \$86, ISBN 981-02-2505-9; paper, \$36, ISBN 981-02-2590-3. World Scientific Series in 20th Century Physics, vol. 15.

Thirty-three reprinted papers by the Nobel Prize winner with an autobiographical introduction and prefatory comments on individual papers or groups thereof.

## Correction

In the heading of the review of *Comparative Vertebrate Neuroanatomy* (25 Oct. 1996, p. 521) the surname of the second author of the book, William Hodos, was misspelled and the ISBN number of the book, 0-471-88889-3, was given incorrectly.