

The first few chapters take a mathematically inclined reader smoothly from a fractal built solely of the letter H, through the ideas of number, past fractals built on the innumerable—nicely treated—to intricate coastlines, delightful dragon curves, realistic trees. Next comes the fundamental analysis of dimensionality. Chance enters with a flourish, to simulate the noisy natural world. The last chapter climbs to fractal peaks, Mounts Poincaré, Julia and Mandelbrot in color. The final action chapter lists about 50 programs for any who can use a compiled BASIC.

Michael McGuire has come along less steep portions of the route. He has made or found 100 and more quite beautiful black-and-white photographs from nature, mostly roots and waterfalls, to which he adds a brief, relevant account of computed fractals. "This book," he says, "is about a way to see." In a foreword Professor Mandelbrot himself concurs: fractals for him, too, are not merely a chapter of mathematics but a way to "see the same old world differently." An eye-opening few pages tell about the sense of "scaling self-similarity," evident in Leonardo's old drawings of water and widespread in classical Chinese and Japanese painting. This is a book that will help assuage the fear of mathematics.

The third book records a fine exhibition about fractals that was shown in the Palais de la Découverte in Paris. These are large, attractive, glossy photographs, first made available as a gift from the publishers to their friends. They have agreed to sell the book to the public at a bargain for packets of 10 copies. The text consists of brief captions, plus a page from Mandelbrot that welcomes the eye back to science. Some 50 computer and natural examples fill the colorful, thin brochure; the final one is the famous Lick mosaic map of the galaxies. These three books differ widely in their audiences: choice among them depends on the reader's background and inclination.

## Centuries of Science

**THE TIMETABLES OF SCIENCE: A CHRONOLOGY OF THE MOST IMPORTANT PEOPLE AND EVENTS IN THE HISTORY OF SCIENCE**, by Alexander Hellemans and Bryan Bunch. Simon and Schuster, 1991 (paperbound, \$19.95).

**D**rag a net with 100-year mesh through the 10,000 dated entries of this thick volume. Here is a sample of what you catch over the centuries: In 1892 a new

cholera vaccine saved thousands of lives in India, and water filtration controlled a cholera epidemic in Germany. In 1792 the inventor of coal gas first used it to illuminate his home. In 1692 the mathematician Gottfried Leibniz introduced the terms "coordinate" and "ordinate." In 1592 Korean astronomers observed the appearance and subsequent development of a nova in the constellation Cetus. In 1492 Leonardo da Vinci drew his conception of a flying machine. Roger Bacon, the English philosopher-scientist, died in 1292. And in 1092 the emperor Su Sung built a celebrated giant water clock and armillary sphere.

Listed events are categorized under up to 10 headings, from general interest through a gamut of the sciences, on to technology. A lengthy topic index offers some 5,000 headings; about half as many personal names are indexed as well. In early times the listings do not march by annually. The tempo of science is signaled by the gaps, first only decades, then centuries and millennia, and near the beginning bigger still. The grand parade opens with "science before there were scientists," when in 2,400,000 B.C. African hominids made stone tools. It closes in 1988, when one among many entries reports the claim that the missing proof of Fermat's last teasing theorem had after three centuries been found! (Those old stone tools work, but flaws were soon found in the new "proof.")

This book is open to any reader nimble enough to follow a terse text and an intricate tabular layout. There are no images at all, not one diagram or figure. (What an opportunity to work up your own maps, graphs and family trees of ideas out of all this ready lumber.) The two science writers from England and New York whose partnership produced the adroit book are well read in the modern scholarship of China, so that we are spared the dubious innovations of the Yellow Emperor, nor do we read that printing was a European invention. The integrated-circuit chip did not make the chronological listing, but the drama that led to what is arguably the most important technological invention of the 20th century is well described, complete with its players, Robert Noyce, Gordon Moore and Intel.

A hundred varied introductory essays and single-topic boxes deepen our understanding of all these staccato-timed events. Those pieces treat such matters as mathematical notation; Galileo's focus on instrumentation; the nonsensical but prevalent Victorian "scientific" view of women (not, alas, vanished along with its main postulate,

the long-ago exploded idea that brain weight meant intelligence); and the nature of the vacuum, addressed here both as the matter-of-fact vacuum of siphons and air pumps and also as the active "vacuums" of today's microcosmic physics. The big bargain work is not error free, a standard probably unreachable across so wide and varied a landscape, but it is a careful, usable resource for all, for school library and book-loving home.

## From Dog-Power to Turbines

**A HISTORY OF INDUSTRIAL POWER IN THE UNITED STATES, 1780-1930, Vol. 3: THE TRANSMISSION OF POWER**, by Louis C. Hunter and Lynwood Bryant. The MIT Press, 1991 (\$50).

**A**n engraving shows a "modern dog-power" of 1877, 30-watt Rover walking along the endless-chain track to drive the farmhouse butter churn (double dog-powers were recommended for corn shelling). New dog-powers were noticed repeatedly in *Scientific American* from 1848 on; they were certainly always marginal. The prolonged interest in such faintly risible contrivances is deeply diagnostic. Waterpower demanded a nearby stream or a whole river's worth of canalization. The smoky steam engines of urban industry worked cranes and forges well, but at a power of five or 10 kilowatts and up.

In 1860 almost half the value of all manufactured goods still came from small establishments employing fewer than 10 hands, power under one kilowatt. Almost all the mechanical power they used came from human muscles applied to the hand cranks, wheels and levers that drove clever mechanisms in wide variety, turning, grinding, pressing, cutting. No other handy source of fractional horsepower, up to a few hundred watts, was there to help "a couple of craftsmen" at the bench. "Standing out among all... machinery like a monadnock above the plain was the sewing machine," driven then by foot treadle. Over one million of this "first consumer appliance" were sold during the decade of the 1870s alone; their main prime mover was womanpower, well under 100 watts per machine.

Once again the *Scientific American* spoke. Long an advocate of workshop steam engines, it conceded in 1875 that there were on the market none cheap and practical enough for the family-size enterprise. There were "power buildings" in some cities, where you could rent both work space and belt-