personal anthologies of good and bad instances of visual presentation. His second book, *Envisioning Information* (1990), includes such arresting images as an exploded diagram of an IBM copier-duplicator, in which 300 parts are kept in their relative positions but separated and labeled.

Motion in time, both physical and abstract, is the focus of the present volume. Process, change, causation—the challenge here is the compression of four-dimensional data into two-dimensional images. Hence the striking cover image of a developing thunderstorm. On a clear but subdued time-space grid, the viewer sees both the enormous cloud depicted at a particular moment and six smaller depictions of its past and future states.

"Certain methods for displaying and analyzing data are better than others," writes Tufte. "The difference between an excellent analysis and a faulty one can sometimes have momentous consequences." Thus he compares the ways in which crucial information was presented in "two life-and-death decisions": the attempt to curb a cholera epidemic in London in 1854, and the decision to launch the space shuttle *Challenger* in January 1986. In 1854, the Victorian physician John Snow drew lucid data maps that linked the epidemic with a single contaminated water pump. In 1986, the *Challenger* engineers used number charts that were incomplete and confusing, and seven astronauts died. The same *Challenger* data—the recorded effects of hot and cold temperatures on the rubber O-rings holding the rocket together—show up much more clearly in the two formats devised by Tufte: a number chart that includes all the relevant information, and an old-fashioned scatter plot.

In Tufte's book, as in life, simpler is not always better. Most of his other examples demand unusual analytic and aesthetic skill—and often time. These are not always available. A second limit of Tufte's method is his penchant for purely visual analysis, abstracted from the history of representation. For instance, he describes the title page of Thomas Hobbes's *Leviathan* (1651) as having been organized as a "confection" along the same lines as an illustration from Jean de Brunnhoff's *Babar's Dream* (1933). Such ahistoricism can delight but it can also mystify. Tufte also deplores Isotype glyphs (e.g., one stylized coffin equals so many deaths) without explaining why they were once so popular. Nor does he say what is so very bad about Isotype. It may not be elegant, but is it misleading? Occasionally, aesthetics can even dehumanize. Tufte's own composite illustration of a psychotic patient's agonizing medical history is a masterpiece, but is there any evidence that it helped that particular patient or any other? Ultimately, what *Visual Explanations* illustrates best is the reason why good graphic designs are so uncommon: they are uncommonly hard to do.

—Edward Tenner

THE MATHEMATICAL UNIVERSE: An Alphabetical Journey through the Great Proofs, Problems, and Personalities.

By William Dunham. John Wiley & Sons. 320 pp. $24.95

The mathematician Felix Klein once responded to the hackneyed comparison of mathematics to music by saying, "But I don't understand; mathematics is beautiful!" Every mathematician knows what Klein meant. So will readers of this fine popularization. As he did in his previous book, a guided tour of the 12 great theorems called *Journey through Genius* (1990), Dunham describes the human and the historical dimensions of mathematical discovery. But while most popularizers settle for gee-whiz accounts of incomprehensible discoveries that merely reinforce our prejudice that math is baffling, Dunham, a professor of mathematics at Muhlenberg College, does the opposite. He walks us through the actual proofs, and we learn that with math, unlike sausage or legislation, we do want to see how it's made. His book is organized into 26 alphabetical entries, from A (Arithmetic) to Z (the symbol for the complex-number system). An awkward arrangement, perhaps, but in Dunham's hands it still permits some historical depth. The entry "Hypoteneuse," for example, presents three proofs of the Pythagorean theorem: an ancient Chinese diagram, an elegant 17th-century calculation, and a clever proof devised by President James Garfield when he was in Congress. About the latter, Garfield remarked drily that it was "something on which the members of both houses can

unite without distinction of party." This book, which requires no more preparation than high school algebra and geometry (and a willingness not to panic at the sight of formulas), harks back to a day when even politicians understood that, in math, beauty is proof and proof beauty.

—*David Luban*

BUFFON:
A Life in Natural History.
By Jacques Roger. Sarah Lucille Bonnefoi, trans. L. Pearce Williams, ed. Cornell University Press. 512 pp. $49.95

In our time it is nearly impossible for a scholar, however driven, to achieve true eminence both as a scientist and as a philosopher of science. It is even harder to achieve both these goals *and* write a best seller. Not so in the 18th century, when the great questions of scientific method—what is the proper role of hypothesis . . . of received religious truth . . . of observation?—were still urgent and of interest to the reading public. George Louis LeClerc (1707–88), born of upwardly mobile laborers in the small town of Montbard, Burgundy, seized the opportunity for fame offered by these questions. Educated by the Jesuits and later in the law, LeClerc chose a life in science instead. He became the Comte de Buffon and wrote his century's most celebrated work of natural history, in which he came down on the side of empiricism and materialism, yet managed to avoid the blacklist.

This admirable biography, the lifework of the late French historian of science Jacques Roger, is not driven (or defaced) by any particular sociopolitical-epistemological theory, although Roger was alert to the theoretical implications of his subject. The book provides a rich, expertly documented assessment of Buffon's science and philosophy, but it does not discount or overlook those scars and blemishes that were the marks of Buffon's humanity—and of his time.

Buffon was a sycophant and seeker after preferments, who assiduously cultivated his king (Louis XV) and the courtly circle, doled out favors to family and supporters, and heaped scorn on critics and those with less influence. He was also an effective manager of people, of his estate, and of the Jardin du Roi in Paris, which he turned into one of the leading scientific institutions of Europe. He produced an awe-inspiring body of work based not only upon the research of others but upon his own large-scale observations and experiments.

Buffon was the antagonist of the Swedish taxonomist Carol von Linne (Linnaeus, 1707–78) and of all "arbitrary," hierarchical "systems" of classification. Yet his own system for the investigation of nature was as comprehensive as Aristotle's. A good deal of it was murky or wrong, even in its day. But some of it was right. Buffon took issue, for example, with the prevailing explanation of embryological development. He argued that the notion of a miniature, preformed being—a "homunculus" or "animalcule" "instantaneously" present in the mixture of male and female sexual fluids—was absurd, a case of infinite regress. Living things are not dolls-within-dolls, he asserted. Against this preformationist view and its powerful clerical support, Buffon proposed his own, empirically based theory that, if not a complete account of epigenesis (the assembly of the embryo from substances in the fertilized egg), was nevertheless a rational and courageous step toward it.

Buffon was a predecessor of Charles Darwin, at least to the extent of his insistence upon natural explanations for natural phenomena—from the formation of the embryo to the origin of the planets. While outwitting the Doctors of the Sorbonne, the censors, and his enemies, and while preserving his reputation and fortune, he helped to set the life sciences on the independent, secular path they have followed ever since.

—*Paul R. Gross*