# Looking at Mathematics

**The History of Modern Mathematics.** DAVID E. ROWE and JOHN MCCLEARY, Eds. Academic Press, San Diego, CA, 1989. In two volumes. Vol. 1, Ideas and Their Reception. xvi, 452 pp., illus. $39.50. Vol. 2, Institutions and Applications. xvi, 325 pp., illus. $37.50. From a symposium, Poughkeepsie, NY, June 1989.

Gleaned from an international gathering of historians of mathematics, the 24 papers in these volumes discuss topics in 19th- and 20th-century mathematics ranging from projective geometry to group theory and from von Neumann to Cauchy. In approach they range from highly technical to institutional to philosophical. In short, they provide a revealing and suggestive overview of the state of the field.

An intriguing perspective from which to survey them is found in John McCleary's "A theory of reception for the history of mathematics," which opens the first volume. McCleary suggests a new historiography of mathematics, based on ideas borrowed from literary reception theory. The key to the perspective he proposes lies in recognizing that the import of a work of mathematics is no more clear or fixed than is that of any other kind of written work; this in turn means that what McCleary calls the "horizon of expectations" of those who read and respond to a paper plays a crucial role in the mathematics that subsequently develops. According to McCleary, recognizing the role of readers' expectations could considerably broaden the scope of mathematical history—as he puts it, "the broader issues of social order and [intellectual] canon alike can coexist in a dynamic system that provides a broad brush with which to consider a particular work or idea."

Although McCleary's is the only paper that discusses reception theory, the concern with broadening the scope of the history of mathematics runs through many of the others in this volume devoted to "ideas and their reception." Thus, for example, all the authors dealing with the foundations of mathematics emphasize the importance of philosophy to understanding their mathematical subjects, and Gregory Nowak makes a similar point about Riemann's *Habilitationsvortrag*. Jeremy Gray prefaces his discussion of algebraic geometry at the end of the 19th century by rejecting "the standard mode" of historical writing about mathematics; a "mode . . . close to the style of mathematics papers themselves; impersonal and sparing in motivational details." Instead of this "bloodless" history Gray traces the twists and turns of thought that led from Abel's theorem to the geometrical algebra of Segrè, trying to illuminate the changing "interests" that shaped it. Other papers such as David Rowe's and Thomas Hawkin's biographical treatments of the early development of Klein's and Lie's group-theoretic ideas take on a new kind of interest when seen as describing processes in which the protagonist moves seamlessly from the role of author to that of reader of his own work.

These examples attest to the resonance of McCleary's reception-theoretic approach with the rest of the contributions. Nonetheless, their historical sweep does not seem as great as his reference to "broader issues . . . coexisting in a dynamic system" would imply. With the possible exception of Helena Pycior's treatment of the developing textbook tradition in 19th-century America, none of them ventures into what a historian or even a historian of science would consider a wide sweep of social, cultural, or historical influences. Their breadth is at best intellectual, and even in that regard they are focused on mathematics or on philosophy narrowly defined.

This is somewhat startling given the protestations of many of the contributors to the volume. A clue to the reason may be found by turning again to McCleary's reception theory, this time to his discussion of whether it is legitimate to transfer the approach from literature to mathematics. He concludes not only that it is, but that mathematics, because of its discrete, specialized, and eager readership, may be even more appropriate for reception-theoretic analysis than is

"Warren Weaver (1894–1978), left, and Richard Courant (1888–1972), with shovel in hand, at the Groundbreaking Ceremony for Warren Weaver Hall, Courant Institute for Mathematical Sciences, November 20, 1962." [From *The History of Modern Mathematics*, vol. 2; courtesy of Springer-Verlag Archives]

"The monument to Carl Frederick Gauss (1777–1855) and Wilhelm Weber (1804–1891) in Göttingen. Dedicated 17 June 1899." [From *The History of Modern Mathematics*, vol. 1.]

literature, that the reception process, which is somewhat diffuse in literature, is concentrated in mathematics. It is certainly true that a clearly delineated readership was an increasingly strong characteristic of European mathematics in the 19th century as the mathematical community was becoming professionalized. The persistence of the national stylistic differences described by Pycior and Karen Parshall notwithstanding, pure mathematics was being developed in an increasingly isolated, sharply focused, and intellectually homogeneous community; broadening the scope of its history beyond these confines may be at best unreflective of the situation and at worst impossible.

The single volume does not tell the whole story, however. In the second volume of the work, entitled "Institutions and Applications," the historical world of mathematics opens considerably; physics, education, philosophy, and mathematics intermesh so closely that the major problem is to distinguish among them. In his paper on the mathematical community in France after the Revolution, Grattan-Guiness sketches a wide variety of investigations to support his point that the designation of "applied" mathematics is too vague to be useful for describing the variety of activities it presumably encompasses. Larry Owens points to a similar variety of interpretations of mathematics and mathematical activity fought out behind the lines of the Second World War. The several papers on developments in 19th-century German education point to still other shades of meaning in the development of mathematics there. Here, at last, one finds the kind of human interaction and historical sweep often reached for but not attained in the first volume.

In spite of the marked contrast between the volumes, they are not describing two socially separable mathematical worlds; many of the same people, like Klein, appear as powerful figures in both. A persistent theme in the second volume is what the editors call the "despairingly simple question—what is applied mathematics?" McCleary's paper provides an interesting perspective from which to approach this question also. Even as he points to the focus of the mathematical readership as supporting a reception-theoretic approach, he recognizes the constant possibility of applications as a perturbing force that undercuts it. This leads to the question of the nature and legitimacy of the split in mathematics that leaves whatever goes by the name of "applied" to the mercy of the world and preserves the "pure" in a separate and sacrosanct universe. This seems to me to be the crucial question raised by these volumes overall. There is no better way to examine it than through its history, and no better group of people to do it than those who have contributed to this impressive collection.

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## Flying Machines

**Bird Flight Performance**. A Practical Calculation Manual. C. J. PENNYCUICK. Oxford University Press, New York, 1989. xii, 153 pp., illus., + diskette in pocket. $49.95.

At first glance, this slim volume *is* a practical guide to estimating the power requirements of birds in flapping, gliding, and soaring flight. If you wish to know how far your pigeon can travel on the energy in a handful of seeds, and how fast it should fly in order to maximize this distance, then you should consult *Bird Flight Performance.* Slip the IBM-compatible, 5¼-inch diskette into your personal computer, enter the mass (0.31 kg) and wingspan (0.6 m), and within a few seconds the program will tell you that at a maximum-range speed of 15.1 m/sec your bird has a power output of about 34 watts and consumes the energy equivalent of 0.058 g of fat per kilometer (or about 34,000 miles per gallon of gasoline!). But although this book was written to provide researchers with a simple means of estimating the energy used by birds while foraging or migrating and of assaying the consequences of wing design or payload weight on flight energetics, *Bird Flight Performance* has value far beyond this narrow purpose. Colin Pennycuick, who pioneered the application of aeronautical principles to the study of bird flight and who is also a skilled pilot of many types of aircraft, has written a lucid, witty account of the engineering perspective in biology, worth reading by anyone interested in the design of organisms.

Step by step, Pennycuick leads the reader from basic physical principles through the development of equations describing the power required to overcome drag and the acceleration of gravity. These are not empirical equations that generalize measurements of energy consumption by flying birds. Indeed, the difficulty of obtaining such data on birds under natural conditions made necessary the development of equations for flight performance from first principles. To be sure, these equations have constants that must be evaluated by measurements in wind tunnels or under other experimental conditions, and some of these are quite tentative. But the greater value of the engineering approach is that it relates flight performance directly to the design of the organism. This allows one to isolate critical design components of birds and to evaluate the impact of changes in design (primarily wing area and span) and size scaling on flight performance and power requirement. Pennycuick also relates, in detail, physiological and mechanical determinants of the power available from muscles in order to link aerodynamical considerations to other components of the flight system. For example, one learns that with increasing body size the power requirements of flight increase faster than the ability of muscle to provide power. Thus, larger birds must make greater use of soaring and gliding than smaller ones; such design constraints ultimately limit the maximum size of flying organisms.

Throughout, Pennycuick imbues *Bird Flight Performance* with a strong personal philosophy of science, in which engineering principles dictate the critical measurements of biological systems. He constantly reminds the reader of the fundamental importance of dimensional analysis and expression of variables in consistent units. One also learns that some measurements of the span and area of a bird's wing are aeronautically informative while others, including most of the traditional ones employed by ornithologists with other purposes in mind, are not. Even if one has no intention of measuring a bird or has no practical need for calculating flight performance, this book will bring considerable insight and enjoyment. Perhaps, however, the book's cover should carry a warning: after reading *Bird Flight Performance* one is likely to regard the grace and poetry of bird flight in terms of wing aspect ratios, parasite and induced power, glide polars, and thermal soaring.

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## Ciliates and Universals

**Pattern Formation. Ciliate Studies and Models**. JOSEPH FRANKEL. Oxford University Press, New York, 1989. xviii, 314 pp., illus. $65.

Joseph Frankel is well known among ciliatologists for three decades of work on the development of *Tetrahymena.* In chapters 2 through 9 of this 11-chapter work, he presents an account of some significant aspects of the development of *Tetrahymena*, *Paramecium*, *Euplotes*, *Stentor*, and other ciliates, which is as impressively organized as are the cell surfaces of these remarkable organisms. His ordering of the material is designed to