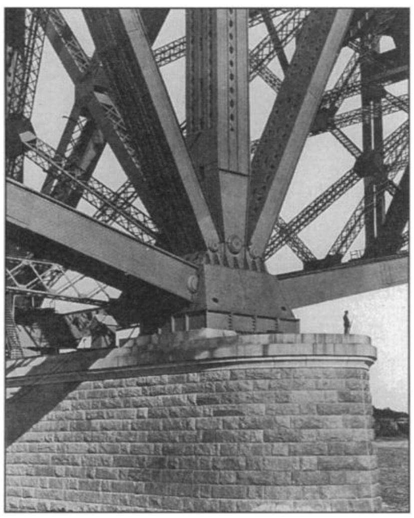
BOOK REVIEWS

Grand Constructors

Engineers of Dreams. Great Bridge Builders and the Spanning of America. HENRY PETROSKI. Knopf, New York, 1995. xii, 479 pp., illus. $30.

Several streams of inquiry find a confluence in the history of technology. To many the field as a serious discipline began with the publication beginning in 1954 of Singer *et al.*'s five-volume *History of Technology*. In some sense, this work was a history of inventions and to its proponents an integral part of the history of ideas. Its critics, on the other hand, decried its lack of context in terms of both social and economic history. This led to the establishment of the Society for the History of Technology and its journal *Technology and Culture*. This emphasis on contextual studies has led environmental historians to consider technology in a new, and often unfavorable, light.

The history of technology, however, has a much earlier proponent in Sir Samuel Smiles and his immensely popular biographies of eminent engineers and artisans. At mid-century, 1861–1862, Smiles published his panegyric *The Lives of Engineers*. It extolled the careers of engineers as the leading agents of an Age of Progress. By carefully selecting his heroes, Smiles validated the doctrine of self-help. In his *Engineers of Dreams*, Henry Petroski takes on the role of a latter-day American Smiles as he traces the careers of James Buchanan Eads, Theodore Cooper, Gustav Lindenthal, Othmar Ammann, and David B. Steinman. These men were cast in a heroic mold in the role they played in conceiving and designing and executing the greatest long-span bridges in the world.



"The scale of the Quebec Bridge shown by a guard posted during World War I." [From *Engineers of Dreams*]

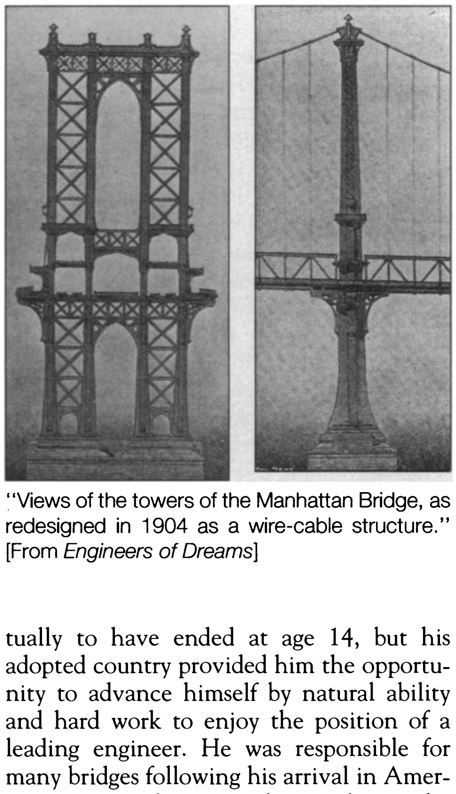
Conceiving the enterprise in terms of dreams, Petroski begins by asking his readers to imagine a world without bridges. This is an effective device for giving context to his biographical study, which he characterizes as being "about how the late 19th and early 20th century engineers did what they did to leave us a legacy of bridges that define our material environment, shape our cities, suburbs, and rural areas, and ordain our routes of communication over distance and time."

Since bridges can be considered "pure" structures in the sense that their sole requirement is to carry loads, one would have wished for more emphasis on the relation between material properties of bridge components and the resulting types of structure, such as suspension, arch, and cantilever bridges. The author supports the idea of the artifact as evidence in unraveling the history of long-span bridges. For industrial archaeologists who have long campaigned under this banner, he offers a powerful endorsement of the concept. Having endorsed it, however, he leaves it without development. A more important lack in his account is that he does not offer insights into the creative engineering process that gives rise to such monumental structures—into the journey, as Petroski would say, from "dreams to final execution."

Following a lengthy introduction concerned with the bridge in society, Petroski's case studies begin with James Buchanan Eads (1820–1887), a practical and untrained engineer who made the Mississippi River his lifelong study. His career provides the author an opportunity for a brief digression on engineering education in the early 19th century. The crowning glory of Eads's career was the elegant multispan steel and iron arch bridge across the Mississippi River at St. Louis (1874). Although in charge of the design and construction, Eads employed German-trained engineers for the analytical work to back up his intuitive and empirical approach to bridge building. A parallel case could be cited for Louis Strauss and his magnificent Golden Gate Bridge, where highly skilled engineers were also used for theoretical work to back up the design decisions.

The scene changes with the study of Theodore Cooper (1839–1919), who rose to eminence as a bridge engineer after graduating from Rensselaer Polytechnic Institute in 1858. Cooper may well be regarded as the dean of bridge engineers in the late 19th and early 20th century. His career was, however, badly tarnished when he served as a consulting engineer for the ill-fated Quebec cantilever bridge over the St. Lawrence River (1917).

The mantle of dean of American bridge engineers was passed to Gustav Lindenthal (1850–1935), a Moravian-born engineer who immigrated to the United States and promoted himself as a technically trained engineer. His formal education appears actually to have ended at age 14, but his adopted country provided him the opportunity to advance himself by natural ability and hard work to enjoy the position of a leading engineer. He was responsible for many bridges following his arrival in America in 1874, his most famous being the Smithfield lenticular truss bridge over the Monongahela River in Pittsburgh (1882) and the Hell-Gate steel arch bridge in New York City, completed in 1917.



"Views of the towers of the Manhattan Bridge, as redesigned in 1904 as a wire-cable structure." [From *Engineers of Dreams*]

As a leading bridge engineer, it would appear that Lindenthal was the person to build a single-span suspension over the Hudson River from New York City to the New Jersey shore. But despite his years of promoting his dream, the project was left to the Swiss engineer Othmar Hermann Ammann (1879–1965), formerly chief assistant to Lindenthal. The taciturn Swiss engineer altered the landscape of New York City with the Arthur Kill (1928), Bayonne (1931), Triborough (1936), and Bronx Whitestone (1939) bridges around Manhattan. His greatest achievement was the Verrazano Narrows Bridge in 1964, one year before his death.

Petroski ends the book with the career of the flamboyant David B. Steinman (1886–1960), who also served as an assistant to Lindenthal and, like Ammann, established his own consulting firm and devoted his career to long-span bridges. A precocious student, Steinman comes closest of all the subjects of Petroski's study to being a renaissance man. He wrote poetry as well as prose and is noted for his celebratory history of John A. Roebling and his son Washington, builders of the Brooklyn Bridge. Equally important, he had a solid reputation for his numerous technical papers on bridge building. He undoubtedly would have flourished as an academic, but the lure of fame associated with monumental bridges could not be resisted. In his career he claimed to have built 400 bridges. To his mind, his most notable achievement was the Mackinac Bridge (1954). Beginning as early as the 1920s, he conceived and later heavily promoted his Liberty Bridge across the Hudson River, and later in his career the Messina Strait Bridge linking southern Italy with Sicily. If completed, these mighty structures would have fulfilled his dream and earned him the sobriquet of the 20th-century Roebling, his lifelong idol.

From Eads to Steinman, the biographies are in fact interlinked, as the careers of these "heroes" overlapped in time. Many other leading bridge engineers also enter the drama. Thus the artifacts themselves become a backdrop to what is an intensely human activity on the part of the bridge engineers. Unlike science, where one expects unique solutions to stated problems, bridge engineering is a creative art form. The engineer is faced with providing the most suitable structure from among many possibilities. Thus, the work of these leading bridge engineers is very much akin to the sister profession of architecture. In fact, David B. Steinman could well be considered the Frank Lloyd Wright of long-span suspension bridges in American. This is an engaging study that should appeal to a much wider audience than civil engineers. Though Steinman's greatest dreams turned out to be wraiths, Petroski's book and his earlier work may well turn out to earn him the sobriquet of the American Smiles.

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Also Noteworthy

Physics of the Magnetopause. P. SONG, B. U. Ö. SONNERUP, and M. F. THOMSEN, Eds. American Geophysical Union, Washington, DC, 1995. xii, 447 pp., illus. $80; to AGU members, $56; to AGU student members, $52. Geophysical Monograph 90. Based on a conference, San Diego, CA, March 1994.

The magnetopause is the boundary between the Earth's magnetic field and interplanetary space. Much of the geomagnetic activity that impacts human endeavors on the Earth's surface or in orbit is driven by the solar wind flowing past its magnetic field. Our understanding of geomagnetic activity is dependent, therefore, on our understanding of how mass, momentum, and energy are transferred across the magnetopause. This volume is a compilation of reviews that cover every aspect of the magnetopause—from historical accounts of theoretical ideas about the Sun's influence on the Earth's geomagnetic activity, descriptions of the early exploration of the space environment, and overviews of global structures to detailed discussions of microphysical processes. It provides an excellent tutorial for graduate students beginning a career in space physics and a useful summary of our current understanding for the expert. This comprehensive review of the physics of the magnetopause is well timed. It pulls together knowledge based on the ISEE and AMPTE space missions, on ground-based measurements of the particles and fields at the base of the field lines where the magnetopause maps to the Earth's polar regions, and on recent computer simulations of plasma processes that these observations suggest must occur at the magnetopause. Such a review provides a valuable context for the major new era of space exploration of the magnetopause that has begun with the launching of the first of a flotilla of spacecraft in the International Solar-Terrestrial Physics program.

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Conservation Genetics. Case Histories from Nature. JOHN C. AVISE and JAMES L. HAMRICK, Eds. Chapman and Hall, New York, 1996. xx, 512 pp., illus. $69.95 or £39.

A presidential symposium at the 1994 meeting of the Society for the Study of Evolution gave rise to this volume intended to show "how various genetic perspectives can sometimes mesh with those of other biological disciplines in the service of conservation concerns." The book opens with a brief introduction in which Avise discusses some relevant recent developments—most notably, the wider application of molecular methods—in genetic analysis, calls for "an eclectic view" drawing on a variety of genetic and other approaches, and discusses how genetic findings might be translated into conservation strategies. The collection of papers that follows takes an "illustrative rather than comprehensive" approach. The first of the book's two main sections is devoted to case histories focused on particular taxonomic groups: whales and dolphins (Baker and Palumbi), felids (O'Brien *et al.*), canids (Wayne), primates (Pope), birds (Haig and Avise), marine turtles (Bowen and Avise), and salmonid fishes (Allendorf and Waples). The accounts in the second section are oriented toward geographic regions or ecosystems or toward patterns and processes. Here the topics discussed are endemic plant species in the southeastern United States (Hamrick and Godt), several island plants (Rieseberg and Swenson), pelagic marine and North American desert fishes (Graves; Vrijenhoek), African bovids (Templeton and Georgiadis), and faunas of the southeastern United States (Avise), with Michael Lynch expounding the relevance of quantitative genetics to conservation. The volume ends with an epilogue in which the editors outline the "provisional if not definitive answers" that have now been obtained to questions regarding within-population genetic variability, parentage and kinship, population structure, phylogeny, species boundaries, hybridization, and macroevolution. An index is also included.

Katherine Livingston

Books Received

All About Albumin. Biochemistry, Genetics, and Medical Applications. Theodore Peters, Jr. Academic Press, San Diego, 1995. xx, 432 pp., illus. + plates. $85.

Bioenergetics at a Glance. David A. Harris. Blackwell Science, Cambridge, MA, 1995. 116 pp., illus. Paper, $24.95.

Carbon Dioxide and Terrestrial Ecosystems. George W. Koch and Harold A. Mooney, Eds. Academic Press, San Diego, 1995. xviii, 443 pp., illus. $79.95. Physiological Ecology.

Dominion. Niles Eldredge. Holt, New York, 1995. xviii, 190 pp. $25 or C$35.

The Elements on Earth. Inorganic Chemistry in the Environment. P. A. Cox. Oxford University Press, New York, 1995. x, 287 pp., illus. $88; paper, $34.95.

The Story of Mathematics. Lloyd Motz and Jefferson Hane Weaver. Avon, New York, 1995. x, 356 pp., illus. Paper, $14 or $C19. Reprint, 1993 ed.

Structural Electron Crystallography. Douglas L. Dorset. Plenum, New York, 1995. xiv, 452 pp., illus. $69.50.

Structure and Bonding in Condensed Matter. Carol S. Nichols. Cambridge University Press, New York, 1995. xvi, 307 pp., illus. $64.95; paper, $24.95.