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Review: 'The Rise of the American Electrochemicals Industry, 1880-1910: Studies in the American Technological Environment'

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dle contrasts such ratiocinations, central to creativity in mechanical technology, with the verbal, mathematic, and analytic processes of science, at the same time connecting spatial thinking to the kind of training that creative inventors needed. As Hindle claims, every inventor, or even anyone who had to repair machinery or keep it going, "thought spatially, and therefore emulation came naturally to them, since it was the approach the ages had found for cultivating the spatial thinking required in technology" (p. 22).

There is a nice parallel between Hindle's emphasis on nonverbal thinking in technology and his conviction that historians of technology should learn to use nonverbal sources of documentation. Accordingly, two of the book's chapters are pictorial essays in which sketches and pictures of objects are employed to illustrate technology's mode of discourse.

The book is full of provocative ideas. "Men saw in emulation," Hindle claims, "a kind of elemental force that had an indelible relationship to technology" (p. 22). Or, when using biological evolution as a model for technical change, he remarks, "inventiveness is a constant accompaniment of machine technology, just as individual variation is a constant feature of all life" (p. 128). What inspires this sort of language is the strong sense that interpretations of technology that do not come from the "inside" miss important intellectual, aesthetic, and emotional dimensions of the subject. Hindle originally put that idea forward in the introductory essay he wrote for *Technology in Early America*, and it reappears here in more developed form as an answer to those who would see technological creativity simply as a function of economic forces or as a lesser form of science.

Most of us will have little problem with the claim that mechanical ingenuity calls for a certain turn of mind, as well as a particular sort of training. But it might be difficult for someone not already so persuaded to understand what Hindle really means by spatial thinking. The ability to see things whole presumably also characterizes those successful in business on a large scale, composers of symphonies, and great dramatists. In a similar fashion, the continuing power of emulation seems open to question. The engineering schools so widely established in America after 1850 were called into existence precisely because the agencies traditionally concerned to encourage mechanical creativity had not proved equal to the complexities of mid-nineteenth-century technology.

Emulation and Invention originated in the opportunity given a mature scholar to think out loud about his interests. The speculative nature of the book is therefore appropriate, and it reflects an effort to devise something like a history of ideas framework for the history of technology. Along with Eugene Ferguson and Edwin Layton, Hindle finds the core of technical creativity in design, the manipulation of mental images, the combining and recombining of known elements to produce novelty. His is an attractive, even romantic, view of the past—but one with the power to explain important elements of technological activity.

BRUCE SINCLAIR

Martha Moore Trescott. *The Rise of the American Electrochemicals Industry, 1880–1910: Studies in the American Technological Environment.* (Contributions in Economics and Economic History, 38.) xxxviii + 391 pp., illus., apps., bibl., index. Westport, Conn./London: Greenwood Press, 1981. $45.

Historians of science and technology have recently recognized that the spectacular advances made during the 1920s in the manufacture of synthetic chemicals can best be understood within the context of industrial and educational developments prior to World War I. In *The Rise of the American Electrochemicals Industry, 1880–1910*, Martha Moore Trescott contends that the electrochemical industry provided the essential bridge between mechanical and metallurgical knowledge of the nineteenth century and chemical technology of the twentieth century.

Since the term "electrochemicals" encompasses a broad group of intermediate industrial chemicals (e.g., aluminum, sodium, silicon carbide, graphite, chlorine, and caustic soda), one could view this industry as a fragmented group of individual product lines. However, Trescott considers the early stages of the electrochemical industry to be unified not only by the use of standard electrolytic and electrothermal apparatus, but also by the common goal of finding a profitable process for the manufacture of aluminum. The quest for cheap aluminum developed techniques and processes later applied to the manufacture of other materials. The author also contends that the establishment

of professional societies, technical publications, and university electrochemical departments facilitated a flow of information among key individuals and led to "nonrandom" industrial growth.

In Part I Trescott traces the establishment of the electrochemical manufacturing complex at Niagara Falls, where a symbiotic relationship developed between power and chemical companies. With a guaranteed base level of demand the electrical utilities realized economies of scale, and the industrial consumers were assured of having abundant quantities of cheap electricity. Lured not only by a sufficient supply of power, but also by the presence of a large pool of skilled labor and extensive transport facilities, electrochemical companies discovered the favorable economics of a geographically centralized complex of interdependent manufacturers, where one producer's output became another's input.

Although this modern industry was dominated by scientific, process-oriented principles, Trescott describes in Part II how nineteenth-century mechanical knowledge continued to be used to attain the traditional goals of high-volume production with cheap machinery. Further, she asserts that the characteristics of modern chemical manufacturing—the widespread employment of university-trained scientists, the emphasis placed upon process design, the application of chemical engineering knowledge, the importance of the industrial research laboratory, and the notion of unit operations—first emerged in the electrochemical industry.

The final section of the work examines industrial scientists, independent research laboratories, and university curricula in electrochemistry and electrochemical engineering. Trescott emphasizes the significance of physical chemistry and independent laboratory research for the process of industrial innovation and stresses the influence of electrochemistry on emerging university curricula in chemical engineering. In closing Trescott focuses on the technical and managerial achievements of Julia B. Hall in the discovery and development of a profitable process for the manufacture of aluminum.

The primary value of Trescott's study is her recognition of the transference of key elements of mechanical technology into the emerging modern chemical industry. In general, however, the work suffers from the author's failure to examine case studies in detail and from a lack of systematic and thorough explanations. For example, in an analysis of university curricula, the author did not investigate the conceptual differences and professional tensions that existed between chemists and engineers, the attitudes of university administrators towards new engineering programs, the content of important courses, and the careers of graduates.

In addition Trescott does not satisfactorily characterize either the practical advantages or the limitations of physical chemistry in an industrial environment. Confusion and contradiction are the result. Without providing adequate examples to substantiate her claim, Trescott asserts in three separate chapters that this discipline was extremely important to the solution of industrial electrochemical problems. In effect, the author therefore contradicts herself in Chapter 9 by emphasizing the primacy of practice rather than the importance of physical chemistry and electrochemical theory in applied electrochemistry.

Furthermore, because Trescott incorporates the ideas of numerous individuals but fails to present clearly an opinion of her own, this work lacks the coherence that a predominant viewpoint would provide. Despite these criticisms, the work remains a valuable contribution to the history of chemical technology. The author poses several important questions and provides the reader with a variety of interpretations of the development of chemical technology in the United States prior to World War I.

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■ Classical Antiquity

Aristotle; Michael of Ephesus. *On the Movement and Progression of Animals.* Translated with an introduction by **Anthony Preus**. (Studien und Materialien zur Geschichte der Philosophie, 22.) 209 pp., illus., bibl., indexes. Hildesheim, FRG/New York: Georg Olms Verlag, 1981. DM48.

The bulk of this work consists of translations of Aristotle's short treatises *De motu animalium* and *De incessu animalium* and of the commentaries on them by the Byzantine scholar Michael of Ephesus (to whom Preus plausibly assigns a *floruit* in the first half of the twelfth century, roughly a century later than the standard assignment