to explain the genesis and prosperity of the American electrochemicals industry. Other factors also played a role, in particular the mechanical and metallurgical experience of American engineers and inventors. Metals are the final product of many electrochemical processes, and the processes themselves take place in cells and furnaces, the design of which requires skill in mechanical engineering. The entrepreneurs and inventors who migrated to Niagara Falls in the 1890's were experienced both in the extraction of metals and in machine design. Many began their careers in an effort to discover ways of producing aluminum inexpensively. The experience and knowledge they gained in this search for cheap aluminum—the silver in clay—could be and was applied to the making of many products. Their electrolytic cells and electrical furnaces could yield alkalies, Carborundum, calcium carbide, graphite, sodium, and ferroalloys. And some of these products in turn were used in the manufacture of others. Calcium carbide, for instance, is a starting point in the production of acetylene, from which a multitude of organic chemicals may be derived. Like the organic chemists employed by German dye firms, the inventors and entrepreneurs at Niagara Falls could turn their knowledge to many purposes.

Unlike the organic chemists of Germany, however, the first American electrochemists typically lacked formal and prolonged indoctrination in scientific theory or research techniques. Charles Martin Hall and Edward Acheson are cases in point. Both exhibited shrewdness in the design and arrangement of equipment, but neither possessed impressive scientific credentials. Trescott is quick to point out, however, that this does not mean that science had no bearing on the rise of the American electrochemicals industry. Although these pioneers were unprepared to contribute to the edifice of electrochemical theory, they often did benefit from their exposure, however meager, to physics and chemistry in school. And soon after plants began to open at Niagara Falls a new generation of electrochemists appeared who, while no less interested in profits than their predecessors, were convinced that formal training, especially in physical chemistry, would prove useful in designing and improving electrochemical processes. Out of the efforts of industrial scientists like F. M. Becket, research laboratories emerged where reaction processes were studied under controlled conditions and interpreted with the help of chemical thermodynamics. Nor did benefits flow only in one direction, from science to technology. Trescott argues, for example, that the growing electrochemicals industry was an important stimulus toward the development of programs in chemical engineering in universities and technical schools.

Trescott is hardly the first historian to credit Americans with a proclivity (some would call it genius) for mass production. Nor is she the first to call attention to the importance of machine design and the extractive industries in the history of American technology. Nevertheless, her use of these themes is novel and intriguing. By stressing the importance of "the American technological environment," she at one stroke suggests how the growth of the electrochemicals enterprise was of a piece with contemporary developments in other sectors of American industry, such as automobile production, and contributes toward explaining why both the chemical industries and the profession of chemical engineering evolved along different paths in America and Germany. There was a powerful and pervasive logic underlying the development of American technology and industry.

Trescott's imaginative and suggestive book, however, is not without serious shortcomings. Economic historians will be disappointed by her perfunctory treatment of factors such as pricing policies, labor costs, tariffs, and production statistics. Business historians will find that she has all but ignored the internal organization, capitalization, and management of the firms involved in electrochemical manufactures. Historians of science will be alarmed by some of her cavalier assertions about the history of physical chemistry and electrochemistry, and historians of technology will be dismayed by her vague accounts of machines, processes, and products. Moreover, Trescott's book is poorly organized and written. Needlessly repetitive passages and distracting cross-references mar every chapter, and Trescott's prose is littered with jargon and other infelicities. What meaning can a reader derive from phrases such as "a nonrandom information amalgam" (p. 245), "people systems" (p. 314), or "an interpersonal person" (p. 321)? These inadequacies of content and style detract seriously from the persuasiveness of Trescott's arguments. This is a misfortune, for her thesis merits notice.

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Science Publishing Indicators

Scientific Journals in the United States. Their Production, Use, and Economics. DONALD W. KING, DENNIS D. MCDONALD, and NANCY K. RODERER, with contributions by Patricia M. Dowd, Charles G. Schueller, Barbara L. Wood, and Mary K. Yates. Hutchinson Ross, Stroudsburg, Pa., 1981 (distributor, Academic Press, New York). xvi, 320 pp., illus. $34. Publications in the Information Sciences.

In 1976 and 1977 Donald W. King and associates published a wealth of statistics on scientific and technical communication (*1*). The present work updates their earlier research and analyzes the flow of information through the journal system, showing the interdependence of authors, publishers, libraries, and readers.

The book addresses two continuing concerns, the state of scholarly communication generally and the development of indicators of social change.

Humanists, social scientists, and librarians—troubled several years ago by rising costs, cutbacks in library budgets, and the adjustment to rapidly changing technology—wrestled with the first problem in the report of the National Enquiry into Scholarly Communication (*2*). At that time the scientific community seemed better off, but that may no longer be true, judging from Philip Abelson's recent editorial on the plight of scientific communication in Britain (*Science*, 23 October).

Interest in social indicators burgeoned in the 1960's and led to the publication by the federal government of *Science Indicators 1972* and *Social Indicators 1973* (and their successor volumes). King's research, financed by a grant from the National Science Foundation, can be viewed as an extension of that line of inquiry.

The statistics presented in *Scientific Journals* range from direct counts (the number of scientific and technical journals in various disciplines, for example) to global estimates (such as the total annual cost of scientific information in the United States, including reading time and the imputed wages of academic editors who donate their services). Data from several surveys are also presented, including a sample survey of journal users.

Two questions come quickly to mind: How good are the data and what do they mean?

The answer to the first question can only be guessed at. King and associates tell very little about the assumptions and methods underlying their data-gathering and presentation. Yet we know from the work of others, particularly from the four-volume study by Machlup and associates, that getting good data about publishing and libraries is extraordinarily difficult (*3*). The presentation by King and associates is disconcerting in its certitude; it would inspire greater confidence if the limitations of what is presented as well as the rationale for numerous grand estimations presented were explained.

Interpreting the data, which presents no problem in some instances, is difficult in others. What can be measured is generally a proxy for what we want to know, and not infrequently fairly contradictory inferences can be drawn. If total expenditures for information are rising faster than the gross national product, are we to consider the trend a sign of extravagance and inefficiency or a healthy sign for a society in which information is becoming increasingly important, or neither? If the number of articles published rises more rapidly than the number of scientists at work, are we to conclude that the productivity of researchers is increasing or that a perverse reward system gives scientists an incentive to maximize the number of articles emerging from a research project? Such ambiguities only touch on problems of interpretation that will take a great deal of further research and the clustering of groups of indicators to clarify. Uncertainty about such matters, however, reflects the state of the art more than shortcomings in the work by King and associates, which is intended as a pioneering effort, not as the last word. Still, I think it fair to say that the book lacks the quality of analysis that is reflected in *Toward a Metric of Science* (*4*), the volume emerging from a conference called to evaluate the first issue of *Science Indicators*. Similarly, in the area of economic estimates, it does not match the rigor of Machlup's work (which fell short of its own goals for quite different reasons).

Nonetheless, King and associates have a good deal to say that is interesting and suggestive. The authors are clearly on the right track in taking a broad view of the scientific and technical information system. Their survey results add another dimension to the study, and their outline of future developments will be useful to readers who are not familiar with the possibilities offered by technological developments.

The results of the user survey should interest scientists who wonder about the habits and predilections of their peers. Some examples:

Scientists decide what to read primarily by browsing, which leads them to 40 percent of the articles read. Citations in printed indexes are next in importance, accounting for the selection of 24 percent, and computer searches rank last, accounting for only two-tenths of one percent (but that was in 1977).

Readers depend on their own subscription copies for 69 percent of the articles they read, on library copies for 14 percent, and on photocopies for 12 percent.

Although the primary reason given for reading articles is self-education, 45 percent of the respondents said they read for methodology and 44 percent for research findings related to their current research.

A striking aspect of the responses to a number of questions is the range of differences among disciplines. Mathematicians, for example, say they spend 19 hours a month reading articles, computer scientists 3.4 hours.

A final question is implicit in this work: Where do we go from here? A book is suitable for reporting the results of a research project, but it is not a good tool for presenting up-to-date information, as this book makes painfully clear. The latest data are for 1977 (with extrapolations to 1980), and the concluding chapter discusses a National Periodical Center at length, as if its establishment were a foregone conclusion, when in fact the proposal was killed by Congress two years ago. If the state of scientific communication is worth monitoring, it ought to be monitored on a continuing basis and the results ought to be reported in a timely fashion.

Science Indicators 1978, the latest edition published, includes several measures of scientific communication that were apparently developed independently of the work by King. The estimates include the number of articles published annually by field and by the level of research (basic vs. applied), an estimate of cooperation among scientists (articles jointly written by authors in different institutions and countries), and frequency of citation. These indicators have been based on a sample of 2100 journals tracked by the Institute for Scientific Information. Such a fixed sample, though useful for some purposes, is not suitable for others. Conceivably, the work by King and associates may provide leads for the inclusion of additional items in *Science Indicators* or it may stimulate selective monitoring efforts by private agencies as a spinoff of the services they provide.

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Thermophysiology

Thermoreception and Temperature Regulation. H. HENSEL. Academic Press, New York, 1981. x, 324 pp., illus. $48.50. Monographs of the Physiological Society No. 38.

At present many aspects of the classical orderly model of temperature regulation are being questioned and new concepts are being advocated. But a new, widely accepted model has not yet been established. Therefore it is difficult to introduce briefly and clearly current ideas about temperature regulatory mechanisms. Hensel deals skillfully with this problem. He begins each chapter with a description of general aspects of the subject and then evaluates current theories and research. The descriptions are terse but well considered, so that the points at issue are clear.

The book emphasizes work on humans but refers to data on animals when they have "possible predictive value for human thermophysiology." The book covers temperature sensation, the neurophysiology of thermal reception, thermal comfort and behavior, and autonomic temperature regulation, especially as it is understood from neurophysiological and neuroanatomical findings. In addition, displacements of set point, including fever, circadian variation, and sleep, long-term thermal adaptation, and ontogenesis of temperature regulation are discussed. These are subjects in which there is particular interest nowadays.

Special emphasis is given to the introduction and evaluation of current theories of thermal perception. "Thermal perception" is a relatively recent term used to describe a process in which different levels of heat energy (temperature) are detected by living things. Hensel states that biological thermal sensors not only are involved in conscious temperature sensations but also play an important role in the autonomic and behavioral responses of organisms to thermal environments.