its development. Louise Trottier of the National Museum of Science and Technology and Deryck Holdsworth now with the Geography Department of Penn State, wrote the Canadian entries. Looking over the geographical representation, it could be argued that Quebec received too many entries and southern Ontario too few.

The articles for industrial materials and processes are perhaps the least satisfying because they are so general. Many of them contain only a brief amount of technical data with little historical or geographical context. For instance "Foundry," a key industry in the industrial revolution, is limited to a half-page description, and the same is true for "Iron."

The bibliography of "works...of major significance to the study of industrial archaeology" occupies fifty-eight two-column pages. It contains sources on railways, canals, companies and industries as well as national and local histories. A significant number of these texts are from languages other than English. This bibliography is a formidable resource on its own. There are three indexes; a subject classification, an alphabetical index plus an index supplement. The subject index is arranged into nineteen categories with numerous subdivisions covering everything from transportation and public utilities to IA theory. Each subdivision lists the relevant articles in the encyclopedia. The alphabetical index lists countries, geographical regions, cities, industrial materials and processes, and biographies. The index supplement provides additional entries for canals, museums and railways only. Unfortunately there has been no indexing of individual or company names occurring within articles, making it difficult to find specific information. A search for details on historic European engineering firms was slow and probably incomplete. Only a few establishments had their own entries such as Le Creusot in France. Most of the data came from the descriptions of cities where the engineering works were located which requires a certain amount of existing knowledge.

The index confusion comes from putting together a number of quite different types of knowledge into one alphabetical sequence. The editors included information on IA and its methodology, geographic based descriptions and industrial techniques. If these types of information had been put into separate sections, then a proper name index might have been possible.

The Blackwell Encyclopedia of Industrial Archaeology is a monumental work. It contains vast amounts of information on the physical aspects of the industrial revolution and its aftermath. However it has limited geographical coverage and has a limited proper names index. In spite of these restrictions, it is a most useful reference work for all those interested in the field of industrial archaeology.

Robert Bud and Susan E. Cozzens (eds.), *Invisible Connections: Instruments, Institutions and Science*

RANDALL C. BROOKS

Bud, Robert and Cozzens, Susan E. (eds.). *Invisible Connections: Instruments, Insititutions and Science.* SPIE Institutes for Advanced Optical Technologies, v. IS 9. Bellingham, Washington: SPIE Optical Engineering Press, 1992. xiv & 306 pp., 35 illustrations. Hardcover U.S. $62.00 ISBN 0-8194-0767-4, paper U.S. $56.00 ISBN 0-8194-0768-2.

Books based on the proceedings of conferences are rarely really successful; *Invisible Connections* adds evidence to this assertion. The basis of this volume was a meeting held at the Science Museum (London) in 1991. It was attended by people from an unusually broad spectrum of backgrounds. The conference was organized around three broad topics and the present work includes the papers discussed. Unfortunately, the material available to the editors was quite variable in quality, level and faithfulness to the theme and sub-themes of the book. I suspect the best papers in such books might have greater circulation and impact if they had been published in journals. Only thanks to modern technology, on-line searches and on-line abstracts, are the contents of such tomes likely to be rescued from oblivion.

A problem encountered with conference proceedings is that strict editorial control is often bypassed. Lack of peer-review means papers that would have been weeded out or highly modified as a result of referees' comments may slip in with little change. In this book we encounter the gamut of verbal diarrhea,

sections suited only to the footnotes of specialist journals, and philosophical meanderings. I am rarely very impressed by the latter type of paper, but Chandra Mukerji's paper entitled "Scientific Techniques and Learning" presents some interesting insights and a paper I would recommend as reading for every historian of scientific instruments and especially students preparing for the discipline.

Despite the above generalizations, there are other positive aspects about *Invisible Connections*. In particular, it is refreshing to finally read a book on the history of scientific instruments which largely deals with instruments of the twentieth century. Is this because, other than Robert Bud, the participants and authors of papers are not active members of the IUHPS's Scientific Instrument Commission or the Scientific Instrument Society? These two established groups should be spearheading such studies but, like many history of science societies, their members are bogged down in the study of seventeenth- to nineteenth-century topics and most often of intruments which were probably never even used in scientific research or education.

Three divisions are found in *Invisible Connections*. They are titled "Industrial Connection," "Modern Science" and "National Concerns." Of these, the first and third are weak — partly because there is limited reference material. In "National Concerns" we would like to have a broad perspective but only find four case histories (two from the U.S. and one each from France and Britain). The origins of cooperative experimental science (i.e. sharing of instruments) was much earlier than one would deduce from reading this book — i.e. 1920s or '30s rather than the 1970s. As the complexity, size and cost of primary research instruments of "Big Science" has increased, the pressure to follow stated or perceived priorities has evolved hand-in-hand with rising levels of government funding. Pressures to buy expensive equipment within one's own country have also distorted scientific process and such realities have affected scientific institutions in many countries. The consequences of this aspect of twentieth-century science is barely touched on but deserves greater analysis, including the social impact of policy decisions and the changing directions and priorities of scientific investigations under the new regime.

Scientific progress is defined not only by the evolution of theories but is frequently held back by the limitations and errors of the instrumentation. As in most histories of scientific instruments, the authors here rarely discuss errors of observation — a fundamental flaw. From the mid-eighteenth century one occasionally discovers scientists' concern for errors, and from the 1830s, theories of errors and error handling had been developed. No scientific paper dealing with observational results that is of consequence has been published in this century without such a discussion. So why do historians ignore this fundamental aspect of the history of science?

Should *Invisible Connections* be listed in the bibliography of a history of science course? Perhaps this is where *Invisible Connections* may, despite its flaws and limitations, prove useful. An analysis of the introduction and foreword for each section by Bud and Cozzens would provide a starting point — one might take issue with some of their conclusions to stimulate discussion but, overall, their conclusions and observations are quite sound and cover many relevant points. The variety of historical approaches taken by the authors represented in *Invisible Connections* also provides material to stimulate discussion. One finds positive styles and some to avoid, from irrelevancies (e.g. C. N. M. Jansz, C. le Pair on the development of the electron microscope include a map [p. 77] of the Netherlands showing areas recalimed from the sea), to overly detailed and technical descriptions (e.g. David Edge on developing the CCD camera for astronomical use makes frequent reference to technical discussions found in correspondance between scientists; I personally found this interesting but only because of my involvement in the design of a similar system in the early 1980s).

Among the best papers (Simon Schaffer on "Late Victorian Metrology: A Manufactory of Ohms"), one learns of the importance of standards in the early electrical industry but even here it would have been useful to see how this compared with contemporary industries, e.g. machinists grappling with standardization of screw threads. The usefulness of such studies for economic historians unfortunately still remains little recognized. Likewise the papers of James Feeney and Peter Morris, despite occasional lapses into excessive technical detail, plot the development and application of nuclear magnetic resonance (NMR) techniques developed by physicists and now widely used in chemistry, medicine and industry — a phenomenally significant technology but little recognized or understood by the public at large.

The organizers of the London workshop had hoped to shed light on innovations in

industries supplying the scientific discipline. The authors' views here, as elsewhere recently, have only looked at the large firms and have ignored the small innovative companies, their critical role and frequent ignominious fates. The appearance of small firms headed by scientists or engineers with special skills and knowledge to market very specialized technologies to other scientists, is an untouched topic that scientists or engineers with a humanistic bent must record. Interactions between scientist, engineer, technologist and industry in the late-twentieth century are complex and occasionally obscured by state-imposed secrecy. A case in point is the appearance in the late-'70s of the CCD camera described by Edge. The computer-controlled, light-sensitive chips had been developed and supplied to the military for several years before being declassified. How does one record such stories? Even those with access to secret technology, with a few exceptions, have insufficient knowedge to record the historical evolution of classified technologies.

My first impression of *Invisible Connections* was negative, but on closer inspection, I found a few gems among the papers, though they account for only a small percentage of the text, while the commentaries by Bud and Cozzens hold the contributions together. But when it comes down to a final assessment, I am again left with the question "For whom are we trying to write the history of science?" Today the majority of historians of science and of scientific instruments are historians talking and writing to other historians, few of whom have detailed knowledge or understanding of twentieth-century science. Yet histories written by working or retired scientists are frequently too detailed and too technical to be easily understood by non-specialists. But with their personal involvement, special knowledge and unique insights, the history recorded by scientists can be more revealing and in fifty or one hundred years will be the papers sought by historians. We are in a position to leave a legacy to future historians which we do not enjoy because of the youth of the discipline. However, by focussing attention on topics of modern science history, Bud and Cozzens may have provided a sorely needed stimulus to studies of twentieth-century science and its technology.

Peter Freund and George Martin, *The Ecology of the Automobile*

CHRISTOPHER ANDREAE

Freund, Peter and Martin, George. *The Ecology of the Automobile*, Montreal: Black Rose Books, 1993. 213 pp. Cloth $38.95, ISBN 1-895431-83-2, paper $19.95, ISBN 1-895431-82-4.

This reviewer enjoyed Freund and Martin's *The Ecology of the Automobile*, even though much of what was written is familiar information. The novelty of their arguments stems from the different perspective on issues related to motor vehicle transport. Both authors are sociologists; Freund with an interest in health and Martin with a focus on social policies and urban issues.

The assumption that the automobile is creating havoc on the environment is dominant throughout the book. A sentence from the back cover makes the authors' position clear. "For today we are possessed by a mindless monster which threatens the planet itself." The text is not nearly as strident as that quote but nevertheless paints a picture that our environment, not to mention society, is in deep trouble because of the automobile. Fortunately, solutions are described that could eliminate, or at least mitigate, ecological disaster.

Although *The Ecology of the Automobile* purports to be a global analysis, it focusses primarily on the current ills of American society. Given the diversity of global automobile experiences, the authors' focus on the United States is logical. Insightful examples are given of other countries' experiences to place the United States situation in relief.

Technically, the contents are organized into three roughly equal parts. Part One is a description of the problems of auto transport and deals with many well-known issues such as environmental concerns, health, social impacts and inequalities, and visual impacts. Part Two — Deconstructing Auto Hegemony — is an analysis of "the ideological assumptions shared by auto drivers and transport planners." Part Three examines the politics of automobility and identifies some potential solutions to the identified ills. The text is followed by an immense and useful 17-page bibliography.