consider how history can bring economic, political, and social perspective to corporate downsizing, reductions in fundamental research, pollution, superfunds, government red tape, globalization, maturation of glamour industries into makers of commodity products, and the ill preparation of some college graduates to enter the workplace (asssuming jobs are available).

By contrast to these essayists, most of whom are far removed from the lab bench, reaction vessel, and business world, Morrison was a captain of industry. Associated with Union Carbide Corporation from 1906 until his retirement in 1930, he had held leadership roles in countless associations, councils, societies, and government agencies. His book, sponsored by the American Chemical Society, was to celebrate 300 years of chemical achievement in America. It was to be written in simple language so as to give the reader "a better understanding of the part that applied chemical science has had in raising the plane of living to a higher level than that enjoyed by any previous generation."

In CSMW, the section on Public Interface came nearest to meeting my expectations. Here, Helen Samuels and Joan Warner-Blewett show the increasing complexity of preserving the record of our chemical past. W. B. Jensen forcefully deals with the barriers to communication between chemist-historians and professional historians. Robert Bud discusses the problems museums face in capturing the attention of the viewing public long enough to enhance its understanding of science. Christopher Hamlin shows how the study of past environmental disputes makes it quite difficult to see contemporary disputes in terms of "good guys and bad guys." Suzanne White traces the intricacies of regulating chemicals in food in a rapidly changing society since World War II and the resulting conflicts between large and small processed food manufacturers, regulatory bodies, and public advocates for nature's way. Finally, as a capstone, E. W. Brandt uses case histories to show how history can help industry communicate with the public, particularly in times of crisis.

I believe that most people in the chemical professions are very much aware of the widening gulf that lies between a vast and often hostile public on one side and relatively small numbers of chemical scientists and engineers, historians of science and technology, and industrialists on the other. Since bridging that gulf is going to be primarily the responsibility of those of us on the chemical side, an imperative first step will be to find better ways to communicate with each other and to meld our individual strengths in science, history, engineering, education, communication, and business into a workable, cooperative whole. *Herbert T. Pratt, 23 Colesbery Dr., Newark, DE 19720-3201*

Ideas in Chemistry. A History of the Science. David Knight, Rutgers University Press, New Brunswick, NJ, 1992. vi + 213 pp. Paper (Typeset), $18.00.

Don't judge a book by its cover or its title. The adrenalin-stimulating cover blurb says: "In this unconventional history of chemistry, David Knight takes the refreshing view that the science has 'its glorious future behind it.' Today chemistry is primarily a service science." Refreshing? A cold beer on a hot day is refreshing: this provocative view of contemporary chemistry is anything but refreshing to a chemist and chemistry teacher. We are eternally young and vigorous, and we refuse to listen to anyone who says we are middle-aged. We must put aside our defensive attitude and listen to David Knight, who has many interesting things to tell us about history and chemistry.

As for the title, Derek Davenport, in his review in *Chemical and Engineering News* (May 24, 1993, p. 32), says that "it takes considerable chutzpah to title a book of 200 or so pages 'Ideas in Chemistry' and even more to subtitle it 'A History of the Science'." Knight discusses the aim of the book in the first chapter and contrasts this book with other histories:

> All these (other) writings will nevertheless give us a history of chemical ideas, whereas this book is about ideas in chemistry, where they are realized not merely in scientific books and papers, but also in apparatus, in laboratories and institutions, and in dyes. This is not a blow by blow account of the progress of chemistry, which it would be foolish to attempt in one small volume, but rather an attempt to pick instructive episodes in a more or less chronological order to see what roles chemistry has played over its long history.

The difference between "chemical ideas" and "ideas in chemistry" is, unfortunately, extremely subtle; and a better title would be "A Biography of Chemistry", which

is in fact the title of the introductory chapter. History as biography is not novel; Spengler said in *The Decline of the West*, "For everything organic the notions of birth, death, youth, age, lifetime are fundamentals." But Knight has concluded that chemistry has aged to the point where the biography is pretty much complete, with little anticipated for its future. This point is certain to be the one that attracts the most interest (better, scorn), but there is a fundamental chronological problem in treating the history of chemistry as a biography. A biography of Washington, for example, might be divided according to the various roles he played, with chapters entitled, "The Surveyor," "The Farmer," "The Soldier," "The President," arranged in chronological order. Knight's biography of chemistry is divided into chapters named for particular roles that chemistry has played, as noted in the passage above, for example,"A Useful Science" or "A Deductive Science." Knight connects these roles to certain historical periods, and one might mistakenly conclude that the period when chemistry was a deductive science was different from the time when it was an experimental science. As Knight says in the first chapter, "Naturally at no time was chemistry simply inductive or deductive, and it has always been experimental." In the following list I have given Knight's choice of chapter titles followed by a short description in parentheses of the content and/or chemists that are discussed. As can be seen, some chapters really involve unique historical periods and others do not. Thus, for example, one could write as well about the experimental science in the 18th or 20th centuries as the early 19th, as Knight has done:

1. Introduction
2. An Occult Science (alchemy)
3. A Mechanical Science (Boyle; Newton)
4. An Independent Science (Priestley, Black, Lavoisier)
5. The Fundamental Science (vitalism, electricity and chemistry)
6. A Revolutionary or an Inductive Science? (Dalton, Davy)
7. The Experimental Science (Davy, Wollaston, Faraday, Berzelius)
8. A Useful Science (Davy, Liebig, Playfair, Perkin)
9. A Deductive Science (chemical structure: Dalton, Kekulé, van't Hoff)
10. A Descriptive, Classifying Science (Davy, Avogadro, Mendeleev, Rayleigh, Ramsay)
11. A Teachable Science (chemical education)
12. A Reduced Science (Ostwald, Crookes, the Braggs, Moseley)
13. A Service Science (late 20th century)

If we only criticize the title or the way that Knight characterizes historical periods, emphasizing some aspect of the period and ignoring others, then we overlook the worth of this stimulating and informative book. I believe that the way to appreciate the book is to read each chapter as a separate essay on an aspect of chemistry and to ignore chronology. Each chapter begins with a short discussion of the topic at hand—science education, or deduction in science, or the nature of a revolution in science—and then proceeds to illustrate the topic with examples from the history of chemistry. Now, more examples may be cited from other periods, but that does not vitiate the value of Knight's examples. The chapters (essays) are well written, informative and interesting. Along with scientific aspects of chemistry are discussions of religion, philosophy, sociology, political history, as well as other sciences. The changing nature of the scientific profession, the development of scientific societies, the publication of scientific journals, the availability of specialized apparatus are discussed along with the major theoretical chemical developments: atoms, structural formulas, periodic law, etc.

Chapters 2, 5 and 6 are particularly rewarding. I have noticed a peculiar quantitative effect when I try to understand alchemy. If I read too little I feel ignorant; too much and I feel lost. Knight seems to have a good sense of proportion and gives us insight into the "chemical philosophy," as well as the practical discoveries of the alchemists. His discussion of chemistry as the fundamental science (Chapter 5) involves a period in which topics such as heat and electricity, as well as some biological theories, were considered to be part of chemistry, and I found this essay to be especially enlightening. The discussion of the chemical revolution in Chapter 6, adapted from a conference paper of 1988, raises several interesting points about continuity and discontinuity in chemical ideas and suggests that there is much more to explore besides the end of phlogiston and the new nomenclature

The essay on chemistry as a useful science does not fit well with the time period which Knight assigns to it. He begins with a discussion of pure and applied science, and how gentlemen in England avoided things connected with "trade;" but he overlooks the experience in other nations in earlier times (practical investigations by Glauber, Boerhaave, Lavoisier) and the flourishing of industrial chemistry in later times. Knight tells us more than I care to know about Davy's investigations

of leather tanning but omits the important story of LeBlanc's process for soda production and its effect on the developing textile industry in Britain. Indeed, this may be the first commercial synthesis of a natural product, and the entire topic of synthesis of useful materials is virtually absent from the book. The agricultural research of Liebig and others mentioned in Chapter 8 ultimately led to the work of Haber in the laboratory and Bosch in the factory and the industrial synthesis of ammonia, which is ignored. Similarly, the lack of a synthetic dye industry in Britain after Perkin is discussed briefly, but the triumphs of synthetic organic chemists in the laboratory and the factory, leading to dyes, medicines, and plastics are not recorded.

The last two chapters concern the present century and reflect Knight's opinion that we are on the descending side of chemistry's trajectory. In the early days of the century, chemistry lost its position of importance in science to physics, as the physicists' explanations of chemical phenomena were adopted. Thus chemistry is "a reduced science" to Knight, meaning not quite as fundamental as before. Modern biology is based on organic chemistry and physical chemistry. In many instances, research could be classified as biochemistry or molecular biology. (See the recent discussion by P. G. Abir-Am, "The Politics of Macromolecules: Molecular Biologists, Biochemists, and Rhetoric," *Osiris*, **1992**, *7*, 164-191, on the power struggles between these disciplines.) Following Knight, should biology be considered a "reduced science?" Or should chemistry and biology be called "enhanced sciences" because they have been strengthened by contributions from other disciplines?

Further, Knight believes that chemistry has become "a service science" because other scientists have to know some chemistry, but the other sciences (e.g., biology, astronomy) are producing brilliant new discoveries while chemistry has become "not a senile science but a middle-aged one perhaps." I believe that one could look at the same evidence and call chemistry, as the American Chemical Society sometimes does, "the central science," sounding important, vigorous, fundamental, challenging. Chemistry now encompasses a vastly wider area of investigation and application. A colleague in my chemistry department publishes his research results in physics journals, and another publishes in ecology journals; they both call themselves chemists.

The importance of the question, "Is chemistry a service science or the central science?" depends on your professional outlook. The American Chemical Society is not likely to publish literature which urges students to become service scientists, nor to urge Congress to fund more service research. Every scientist must be on the cutting edge, pushing back frontiers, creating potential technological employment. A social scientist who can look at the question "objectively" should conclude, I think, that modern chemistry is a complex enterprise involving many people and interests, and that any short label must be an inadequate and misleading descriptor.

Knight recognizes that "any book is personal, and its structure may seem implausible or misleading," and invites us to do our own research and form our own history of chemistry. In his short epilogue he urges us to learn what historians have said recently, as well as to read the original scientific literature. He sees the history of science as a fresh and open field of study, comparable to early 19th century science, and much more exciting than his view of modern chemistry.

Knight's writing is lively and interesting, though occasional ultra-SAT words like "inosculated" and "rebarbative" appear. Indeed, the spelling is often "rebarbative," with numerous omitted ("eigteenth"), inserted ("Lavoilsier") and changed ("chanded") letters, as well as missing and added words. The notes are extensive and useful, the index short and idiosyncratic. For example, there are index entries for "Failure", "Fashion" and "Fraud", but it would be difficult to find the discussion about the discovery of the "noble gases" on page 139, because there are no entries for argon, helium, inert gas, nitrogen, noble gas, or Rayleigh.

I also noticed a few factual errors. The claim that coal gas was a valuable by-product of the making of coke (p.104) might be modified; in the U.S., coal gas and coal tar were burned as they formed, and water gas was used for lighting. G. N. Lewis's definition of an acid (p.169) is an electron-pair acceptor, not a proton donor.

Publishers invariably overstate the audience for a book, and the tradition is upheld here. The recommendation of the book to "a general reader" is unjustified because of the necessary scientific jargon ("Pauling's theory of resonance giving way to the study of molecular orbitals") which makes much of the book inaccessible; "a student" might do better if she or he knew some chemistry, but the book is not really a useful textbook for the history of chemistry. The readers who will derive the most from the book are the "scientist" and "historian of science," who will bring their own knowledge of chemistry and history to interact with Knight's novel presentation of the subject—a presentation which, as the cover blurb says, will "engage the attention of anyone interested in the interplay of science and ideas." *Martin R. Feldman, Department of Chemistry, Howard University, Washington, DC 20059.*