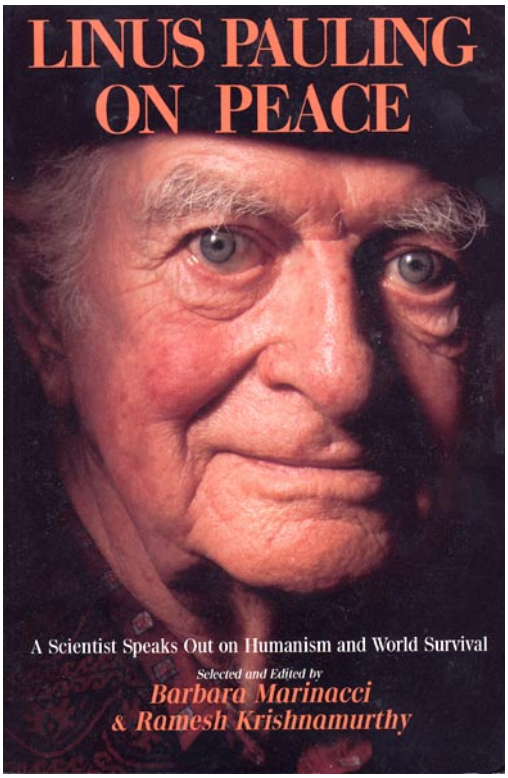
Media Reviews

Linus Pauling on Peace: A Scientist Speaks Out on Humanism and World Survival. Selected and Edited by Barbara Marinacci and Ramesh Krishnamurthy. Rising Star Press: P.O. Box BB, Los Altos, CA, 94023, USA. Rising.Star.Press@Worldnet.ATT.net , 1998. 296 pp, 15.0 × 22.7 cm. $17.95 softcover. ISBN 0-933670-03-6.



As we approach the millennium it is appropriate that we consider and reflect upon the multifaceted activities and contributions of Linus Pauling, whose life spanned virtually the entire 20th century. Pauling was born in Portland, Oregon on February 28, 1901 and died of cancer on his ranch near Big Sur, California on August 19, 1994. His life, both scientific and personal, was characterized by controversy, and almost everything about him was larger than life. The only person to have received two unshared Nobel Prizes (chemistry, 1954; peace, 1962), this internationally acclaimed scientist, educator, humanitarian, and political activist was characterized by the magazine *New Scientist* as one of "the twenty greatest scientists of all time, on a par with Newton, Darwin, and Einstein." He has been called one of the two greatest scientists of the 20th century (Einstein was the other) as well as the greatest chemist since Antoine-Laurent Lavoisier, the 18th-century founder of modern chemistry. His *magnum opus*, *The Nature of the Chemical Bond* (1939) is considered one of the most influential and frequently cited scientific books of our century. His advocacy of megadoses of vitamin C for the common cold, cancer, and AIDS is the controversial work for which he is best known to the general public.

Less well known to both laypersons and many scientists, however, is Pauling's evolution, encouraged by his wife, from an ivory-tower scientist to an ardent and articulate public spokesman on technological issues and the social responsibility of scientists. The book under review is dedicated "To the Memory of Ava Helen Miller Pauling, without whose influence there would have been no *Linus Pauling on Peace*." Early in Pauling's long and brilliant career he made a moral choice to devote half his time to working for world peace. According to his eldest son and namesake, Linus Pauling, Jr., M.D., who wrote the introduction, "My father devoted a large portion of his life to this urgent educational campaign - through hundreds of speeches, articles, debates, and interviews. His personal impact on public opinion is incalculable."

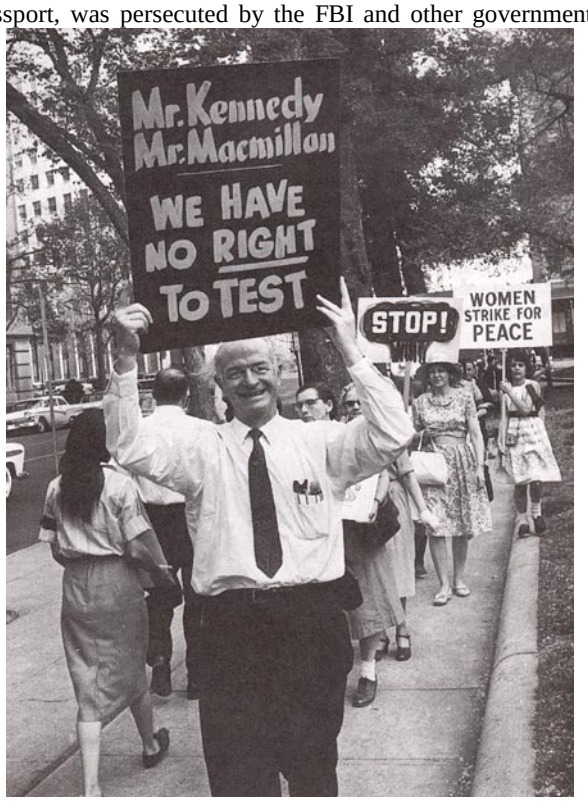
Shortly before his death Pauling wrote, "Up to now .... there have been no general anthologies of my written words to provide lay readers with an overview of the many different interests that I have pursued during my lifetime." Fortunately, in the following year Barbara Marinacci, a consultant with the Linus Pauling Institute of Science and Medicine who knew Pauling personally for many years (she is the sister of his son-in-law) and was editor of his book *No More War!* (Dodd, Mead & Co., 1958, 1964, 1983), produced a representative anthology of excerpts, about one-fifth published there for the first time, ranging from a sentence to several pages in length, from more than 100 sources, including publications and a number of unpublished manuscripts, notes, and interviews. The book, *Linus Pauling in His Own Words: Selections from His Writings, Speeches, and Interviews* (Simon & Schuster, 1995), was begun before Pauling's death, and he provided the introduction.

Unfortunately, because this anthology included all major fields of Pauling's endeavors, only about a quarter of his activities on behalf of peace, which he considered among the most important of his contributions to humanity, could be included. In Marinacci's words, "there just wasn't enough space for most of Pauling's words regarding peace, humanitarianism, and the scientist's essential role in society, along with his observations about and proposed solutions to serious world problems. That's why I wanted to do this second book now - apart from the fact that it was Pauling's own first preference."

For this new anthology, *Linus Pauling on Peace*, Marinacci collaborated with Ramesh Krishnamurthy in selecting, arranging, and annotating the material to make it more accessible and engrossing. Her Indian-born coeditor is Project Director of the Oregon State University Library Special Collections, where he has been working with the Ava Helen and Linus Pauling Papers since 1989. He is also editor of *The Pauling Symposium* (Oregon State University Press, 1996) and an activist in organizations involved in international peace, security, environmental issues, and human rights. The book was published to coincide with the opening of "Linus Pauling and the Twentieth Century," an international multimedia exhibit sponsored by Soka Gakkai International, which debuted in San Francisco in September 1998 and is scheduled to travel to various cities around the world - a highly appropriate tribute to this world traveler and world-peace advocate.

Although Pauling accomplished great and wonderful things and acquired world renown, it is indeed unfortunate that,

because of his political activities on behalf of civil rights, nuclear disarmament (which earned him the Nobel Peace Prize), and world peace, he was denied research grants and his passport, was persecuted by the FBI and other governmental



Linus Pauling (left) with the author of this review.

in 1949). All these activities and more are chronicled in his own dynamic and inspiring words in this anthology. His battles with political and ideological enemies, although eventually resulting in his ultimate vindication, consumed much of his time and energy. In his wife's words, "It is just a shame for Linus to be wasting his talents in this way." However, Pauling was willing to pay the price; he stated unequivocally, "I have not regretted my peace activism, although this has damaged my reputation as a scientist among certain people and institutions."

Because all readers, especially younger ones, may not be familiar with the periods in which Pauling voiced his diverse political stands, Marinacci and Krishnamurthy provide introductions to the book's six principal parts - "Education and Science in a Democracy" (25 pp, the shortest section), "War, Peace, and Dissent" (35 pp), "In the Nuclear Age (45 pp, the agencies, was defended and supported only halfheartedly by the California Institute of Technology (to which he devoted almost four decades of his life), and was snubbed by the American Chemical Society (which he had served as President longest section), "Peace through Humanism" (33 pp), "The Scientist in Society" (39 pp), and "Future Prophecies" (41 pp) - as well as commentaries preceding the more than 60 individual selections. Also, selections by Pauling, "Prelude: A Scientist's World" (from *No More War!*, the source of many of the selections) and "Postlude: Make Your Voice and Vote Count!" (from a commencement address given at Cook College, Rutgers University) precede and follow the principal parts. A 15-page "Interlude: Partnership in Life and Peace Work: Ava Helen and Linus Pauling," featuring Pauling's own words about his crucial partner in his humanitarian and social activism and their family life is included between Parts II and III.

Since the book is intended for a general rather than a scholarly readership, the editors have made minor editorial changes to reduce redundancies, added transitional words or sentences, blended individual fragments, and employed italics and different fonts for clarity. Although sources for the selections are not always identified in the text, they are listed in a separate seven-page section titled "Notes on Sources." The editors have also provided an insightful six-page foreword summarizing Pauling's life and career, a useful eight-page timeline of Pauling's "peace, political, and humanitarian activities and awards," along with "Selected References" (2 pp) containing items from 1922 to as late as 1995, and a handy eight-page double-column index.

Twenty-two photographs of Pauling throughout various stages of his life (ten were selected by his daughter Linda Pauling Kamb), some with posters in peace marches or with other pacifists such as Albert Schweitzer, Bertrand Russell, and the Dalai Lama are provided. Ironically, one shows Pauling and his wife dancing at a banquet given in 1962 to honor the United States' Nobel laureates by President John F. Kennedy in the White House, outside of which, earlier that same day, they had picketed to protest Kennedy's resumption of nuclear testing.

This vivid self-portrait of an extraordinary scientist and humanist who possessed one of the greatest minds of our time makes a perfect complement to Marinacci's first anthology as well as to the full-length biographies such as Thomas Hager's *Force of Nature: The Life of Linus Pauling* (Simon & Schuster, 1995) or Ted and Benjamin Goertzel's *Linus Pauling: A Life in Science and Politics* (BasicBooks, 1995) that appeared shortly after Pauling's death. It would be unfortunate indeed if, because it is published by a small press with limited advertising opportunities, it fails to receive the publicity and exposure that it so richly deserves.

It is interesting to speculate what further discoveries Pauling might have made had he not been deflected from his goals by shortsighted, self-serving, mercenary, or jealous opponents. He never, however, became embittered. In one of his last interviews (April 1, 1994), in response to our question as to how he was able to retain his positive outlook on life, he told us, "I suppose it's partially genetic ... actually the result of my having been pretty successful in my own career, and, of course, my feeling that we ought to be smart enough, we human beings, to solve our problems, whatever they are."

In his day, as Marinacci and Krishnamurthy's anthology makes evident, Linus Pauling bravely and vigorously opposed the Korean War, the various Arab&endashIsraeli wars, the Grenada and Panama "strikes," the Vietnam War, the Persian Gulf War, and other conflicts with the courage and passion of an Old Testament prophet. As we conclude this review, war rages in the Balkans and other places around the globe. The need for abiding world peace is as urgent as it ever was during Pauling's lifetime, and we are now sorely in need of his courageous and outspoken clarion voice.

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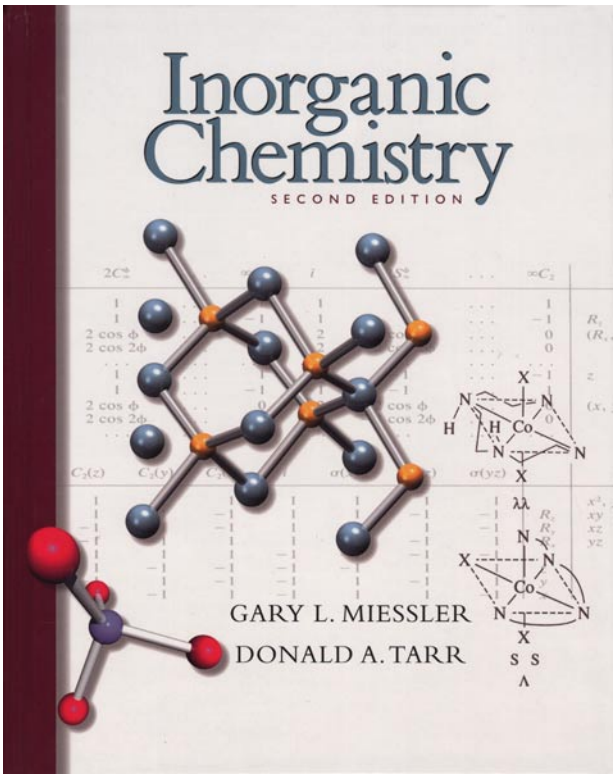

Inorganic Chemistry, 2nd Ed.. By Gary L. Miessler and Donald A. Tarr. Prentice-Hall: Upper Saddle River, NJ, 1999. Figures, tables, charts. xiv + 642 pp, 21.0 × 26.0 cm. $92.00. ISBN 0-13-841891-8 (Photo reproduced with permission from Prentice-Hall, Inc).

Unfortunately, the first edition (1991) of this excellent textbook by two chemistry professors at St. Olaf College, Northfield, MN, did not receive adequate reviews. As in the earlier edition, the authors emphasize molecular orbitals and symmetry in order to explain many aspects of the bonding, structure, and reactivity of inorganic compounds. In contrast to more traditional, lengthy, and encyclopedic textbooks such as Cotton and Wilkinson's *Advanced Inorganic Chemistry* or Greenwood and Earnshaw's *Chemistry of the Elements*, which present the descriptive chemistry of the elements according to periodic table groups, this book is a balanced blend of theory and facts, organized on a topical basis. Nevertheless, considerable descriptive chemistry is integrated into the book's sixteen chapters, many of which begin with historical background material.

In addition to selecting what they consider the most appropriate and interesting topics for an upper level undergraduate inorganic course, Miessler and Tarr have succeeded in making their text accessible to students by increasing the number of examples and exercises within the chapters. Answers to the examples are included in the chapters themselves, while answers to the 90 exercises are relegated to one of the nine appendices (The others present valuable data: ionic radii; ionization energy; electron affinity; Pauling electronegativities; absolute hardness parameters; C_A, E_A, C_B, and E_B values; character tables; and electron-dot diagrams and formal charge).

Numerous problems (338 in all) conclude every one of the chapters except for the first. Answers are not provided so the problems may be assigned as homework. A solutions manual is available from the publisher. In order to encourage use of the literature by both students and instructors, the authors have retained the extensive references of the first edition, many to historic or classic papers or books, and they have increased the number of problems taken from recent articles, which are cited in the problems. References cited in the text (some as recent as 1998) appear at the bottoms of the pages, while general references are given in single paragraphs just before the problems. Numerous equations and reaction schemes, as well as 361 figures and 132 tables, are provided. An extremely detailed (7 quadruple-column pages in small type) index facilitates location of material. Despite the addition of new material, the text of the new edition is only 20 pages longer than that of the first.

Chapter 1, "Introduction to Inorganic Chemistry" (13 pp, the shortest chapter), briefly surveys the broad scope of the field ("If organic chemistry is defined as the chemistry of hydrocarbon compounds and their derivatives, inorganic chemistry can be described ... as the chemistry of 'everything else'") and also deals with the big bang theory and nucleosynthesis. Following Chapters 2, 3, and 4, "Atomic Structure," "Simple Bonding Theory," and "Symmetry and Group Theory" (with examples of applications to molecular vibrations and chirality), respectively, Chapter 5, "Molecular Orbitals," applies group theory to the construction of molecular orbitals.

Chapter 6, "Acid-Base and Donor-Acceptor Chemistry," discusses various acid-base concepts, emphasizing applications of molecular orbitals to acid-base interactions. Chapter 7, "The Crystalline Solid State," a chapter new to this edition, deals with semiconductors, superconductors, and other modern topics in solid state inorganic chemistry. Chapter 8, "Chemistry of the Main Group Elements" (52 pp, the longest chapter), surveys the periodic table (using traditional as well as suggested IUPAC group designations) and is the chapter closest in approach to what is considered descriptive chemistry. It includes recent developments in cryptands, crown ethers, boranes, carboranes, fullerenes, and carbon nanotubes.

The chemistry of the transition elements is dealt with in the next six chapters, the first four of which, Chapters 9-12 ("Coordination Chemistry I-IV"), deal with structures and isomers, bonding, electronic spectra, and reactions and mechanisms, respectively, of classical transition metal complexes. The treatment of coordination chemistry has been rearranged, with the descriptive portions and nomenclature occurring earlier than in the first edition. In Chapter 9, the IUPAC rule of placing anionic before neutral ligands in

formulas is not consistently followed, and the charges are omitted from the formulas in Figure 9-1. In Chapter 10, group theory is applied to coordination compounds. The discussion of terms and microstates has been moved from Chapter 2 to Chapter 11 to precede immediately the interpretation of spectra of coordination compounds, its most common use, and has been written so that it can still be used with the discussion of atomic spectra for those wishing to follow the organization of the first edition.

Chapters 13 and 14, "Organometallic Chemistry" and "Organometallic Reactions and Catalysis" respectively, provide a useful introduction to organometallic compounds, their spectra, and reactions, with emphasis on catalytic cycles and their application to industrial chemistry. In Chapter 13, sandwich, cluster, carbonyl, nitrosyl, hydride, dihydride, alkyl, carbyne, ferrocene, metallocene, and fullerene compounds are discussed, and group theory is applied to the infrared spectra of organometallic compounds. In Chapter 14, organometallic reactions involving gain or loss of ligands (ligand dissociation and substitution, oxidative addition, reductive elimination, and nucleophilic displacement) and involving modification of ligands (insertion, carbonyl insertion, hydride elimination, and abstraction) are discussed.

The authors think that seeking similarities in the chemistry of different types of compounds can be an extremely valuable exercise that can lead to a more thorough understanding of the type of compounds being compared and may suggest new chemical compounds or new types of reactions. Therefore they have included a very interesting Chapter 15, "Parallels Between Main Group and Organometallic Chemistry," which emphasizes Roald Hoffmann's isolobal analogy and similarities between main group and transition metal clusters. The text concludes with Chapter 16, "Bioinorganic and Environmental Chemistry," which discusses the role of compounds such as porphyrins and other iron compounds; magnesium, cobalt, and nitrogen compounds; zinc and copper enzymes, in biological processes and metals such as mercury and lead as well as nonmetals such as sulfur, nitrogen oxides, and ozone in environmental problems.

I am pleased to recommend heartily this thoroughly updated and revised edition of a relatively brief and user-friendly survey of inorganic chemistry with its strong coverage of molecular symmetry and group theory as well as inclusion of important chemically and socially relevant topics.

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Van Nostrand's Scientific Encyclopedia. 8th Edition (software). CD-ROM, published by John Wiley. Glenn D. Considine, Douglas M. Considine and Terry G. Nash (eds.) ISBN 0-471-29323-7. $295.

The classic *Van Nostrand's Scientific Encyclopedia* is now available on CD-ROM. The inherent advantages of such a format are the search capabilities a computer provides and the ease of electronically transferring information from the encyclopedia to a personal document. This has been the trend in recent years as people begin to rely on easy searching and the copy-paste features of CD-ROM-based material. In principle the search features would allow students to find information on a number of topics quickly and easily, and may even show them unexpected relationships. For example, when searching for "laser" it is possible to find a number of interesting applications for lasers as well as their history and technical details of the laser operation. In a text version of an encyclopedia, the information would be spread across different entries and thus some information might be missed.

The CD-ROM encyclopedia uses "Folio Viewer" to achieve this. This provides a number of searching features, as well as a table of contents, a browsing mode, and text export. Unfortunately, the interface is complex, with several interacting frames that make it somewhat clumsy and confusing. The system imposes a steep learning curve on one hoping to achieve any kind of complex search. The interface screen is cluttered and includes a search menu and a search input box at the bottom of the page. Each one seems to be slightly different, depending upon the "view" chosen. After some time interacting with the software, the arrangement became clearer, but I think that most users will simply avoid this in favor of the alphabetical index (which provides no advantage over the book).

The software does not provide for easy cutting and pasting to other documents. The export feature does allow the user to select an entry for output, but the output is in ASCII, so that any character formatting (e.g., subscripts and superscripts) in the article is lost. The Windows "cut" function also only works with ASCII text (again, character formatting is lost). Figures and equations are nearly impossible to copy and export, yet these are the features most likely to be used in a student report or in a handout. (I expect one could use a screen-capture program to obtain these images.) This difficulty may be intended to protect copyrights, yet using the occasional figure under the "fair-use doctrine" is common, and needs to be supported to make the product more useful).

The complexity of the user interface is unfortunate because I find the quality of the individual entries to be quite high. Obviously it is not possible for a reviewer to read each entry, but the chemistry-related entries are extensive and seem to be well-written. My only criticism of the encyclopedia's content is of the quality of the figures used. The CD-ROM format is uniquely suited to multimedia, but this advantage is not exploited. The level of the content is quite high, but is still accessible to beginning students. Most entries start with one or two general paragraphs, and then move on to more detailed information. This style allows the *Scientific Encyclopedia* to be usable at both the high school and college levels. In fact, chemistry professors will also find the information useful. In particular, the information would aid in developing course work for nonscience majors because one of the strengths of the CD-ROM is the ability to relate theoretical details to practical applications of technology (once the search methods are mastered).

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The Making of the Chemist: The Social History of Chemistry in Europe 1789–1914. By David Knight and Helge Kragh, Eds. Cambridge University Press: Cambridge, England; and New York, 1998. Figures, tables, maps. xxi + 353 pp. 18.0 × 25.3 cm. $80.00; £50.00. ISBN 0-521-58351-9.

The European Science Foundation (ESF) is an association of 62 major national funding agencies devoted to basic scientific research in physical and engineering sciences, life and environmental sciences, medical sciences, humanities, and social sciences in 21 countries. It acts as a catalyst for the development of science by bringing together leading scientists and funding agencies to debate, plan, and implement pan-European scientific and science policy initiatives.

In 1993 the ESF sponsored a scientific program on "The Evolution of Chemistry in Europe, 1789–1939," which explored the historical development of European chemistry from a variety of novel standpoints. This exploration occurred in the form of three series of workshops, in which leading scholars participated. These series dealt with the chemical profession; communication, texts, and laboratories; and chemical industry. Each workshop dealt with different time periods, and each resulted in one or more publications. One workshop of the first series, dealing with the application of science to industry during the period 1789–1850, the time of the First Industrial Revolution, was held in Liège, Belgium in 1994. It resulted in this collection of 18 chapters by 19 chemists and historians of chemistry or science from 13 countries (5 from the UK, two each from Belgium and Italy, and one each from Denmark, France, Germany, Greece, Lithuania, The Netherlands, Poland, Portugal, Spain, and the USA).

Unlike many multiauthor symposium-type volumes, which are often disparate collections, this book features closely integrated essays because, during workshop sessions, the contributors discussed precirculated drafts of the chapters to elicit connections and parallels as well as differences in the course of professionalization of chemistry in the various countries. David M. Knight, Professor of History and Philosophy of Science at Durham University, England, and Helge Kragh, Professor of History of Science at Aarhus University, Denmark, have provided a preface and an afterword, respectively, which masterly summarize the contents and conclusions of the individual chapters and thus give an overview of the entire volume.

Although chemistry dates from the practical work of ancient artisans, as a *science* it matured relatively lately compared to the classical sciences of mathematics, astronomy, and physics, which played major roles in the Scientific Revolution of the 17th century. The corresponding Chemical Revolution did not occur until the publication of Lavoisier's *Traité élémentaire de chimie* (1789), the commencement of the period dealt with in the volume under review. Thus chemistry, soon considered the most fundamental, fashionable, and useful of the natural sciences, began to emerge in Europe as a distinct and mature science and profession only at the inception of the 19th century. In England by 1820 chemistry was an autonomous science of great prestige (Sir Humphry Davy became President of the Royal Society), but chemists still had no corporate identity. As chemistry developed, frequently from an ancillary position in medicine, pharmacy, or industry (e.g., Liebig's world-renowned laboratory at Giessen began as a pharmaceutical-chemical institute), chemists, who were destined to become the largest of scientific groups, gradually established themselves as professionals, but very differently in different countries because of their diversities in geography and mobility, history, government, industrialization, employment opportunities, economics, and other factors.

In keeping with these differences, the book, like Gaul, is divided into three parts: 1) "The Big Three," France, Germany, and Britain, where the major institutions and developments were located (7 chapters, 127 pp); 2) "Medium Developed Countries," Italy, Russia, Spain, Belgium, Ireland, and Sweden, where some eminent chemists worked and important events occurred (6 chapters, 99 pp); and 3) "On the Periphery," Greece, Portugal, Denmark, Norway, Lithuania, and Poland, which were then essentially importers of chemistry, with different connections to the major or medium countries (5 chapters, 94 pp). Although much has previously been written about chemistry in the three major countries and in some of the medium ones, little has been available, especially in English, about the peripheral countries. Travel, translation, and political alliances all played a part in the transmission of chemistry across national borders.

The book traces the social history of chemistry in these 15 European countries and how it became an autonomous and prestigious profession ("a group of people with a full-time vocation based on a shared training which is distinct to the group") and community. A number of factors were involved in this evolution:

- The founding of national societies, beginning with Britain's Chemical Society in 1841; however, Portugal's society was not founded until 1911.
- The publication of journals. Although the *Annales de chimie*, which began publication in 1789, played a prominent role in the spread of Lavoisier's "new chemistry," the really influential international journals published by national chemical societies such as the *Journal of the Chemical Society* (1861) and the *Berichte der Deutschen Chemischen Gesellschaft* (1868) did not appear until much later.
- The establishment of courses in universities and technical schools (a theme discussed by many of the contributors to the volume).
- The holding of national and international congresses. The famous Karlsruhe Congress, held in 1860, was the first of the international chemistry conferences that are now commonplace.
- The development of applied science from pure science, which became the generally accepted version of technical progress by the end of the century (e.g., Davy's miner's safety lamp, synthetic dyes, and high explosives).

Readers of this important book will follow a series of connected stories with familiar themes but unfamiliar features and will "encounter the pleasure of recognition and the sting of surprise as they encounter similar but different chemical cultures. They will learn a little chemistry, and a great deal about chemistry; and indeed about science in general." In short, the book shows how chemistry in particular and science in general transformed European society during the 19th century, which Knight has aptly called "the Age of Science." Because chemistry was primarily a European science during this century (it was not until after World War I that the center of chemical activity began to shift toward the United States), the book essentially surveys, examines, and analyzes the entire progress of chemistry during this time.

Replete with 17 tables, 12 figures, 2 maps (Europe in 1815 and 1914), and a 5-page (double-column) index, this

scrupulously documented (primary and secondary sources, some as recent as 1997 or even in press) volume will be of interest to historians of chemistry or science as well as to chemists concerned with the development of their science.

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Evolutionary Design by Computers. By Peter Bentley. Academic Press: Sidcup, Kent, England. ISBN 0 1208 9040 4. Includes CD-ROM containing programs and source code. £ 44.94.

Overview

The use of artificial intelligence (AI) methods in chemistry has become more common of late [1]. One subdiscipline of this, evolutionary computation (EC), concerns itself with applying the metaphor of natural evolution by natural selection to problem solving, specifically optimization.

Evolutionary Design by Computers is edited by Peter Bentley, an internationally known research fellow at University College London. Its focus is on "evolutionary design" the optimization and discovery of high-quality and possibly novel solutions to problems in design.

Relevance to AI/Chemistry Researchers

This book is aimed squarely at the EC research community, though in a manner that those with merely an interest in EC will find accessible. The sense of excitement currently in the field is conveyed very well by Bentley. However, though he does provide a sound overview of evolutionary computation, I do feel that the reader would do well to also consult one of the excellent textbooks available [2].

This book is a collection of contributions from the leading researchers in the evolutionary-design community. Each chapter either examines issues behind evolution and the creative design progress (e.g., David Goldberg's chapter: "The Race, the Hurdle, and the Sweet Spot"), or case studies on the applications of evolutionary design methods.

It is in the latter area where this book will be of greatest value to AI / chemistry researchers. Though none of the case studies concerns chemistry problems, they do constitute a repository of best practice in using evolutionary methods to solve difficult real-world design problems. As such, the book can be used as a source of ideas and inspiration for those trying to apply evolutionary methods to chemistry.

In summary, this collection provides an excellent overview of the state of the art in evolutionary design, and therefore it represents a highly useful resource for those with an interest in using evolutionary methods to solve design problems (chemists included), as well as those interested in evolutionary methods in general.

Relevance to Chemical Education

Given that this book is squarely aimed at the research community, it is not surprising that its relevance to chemical education is quite limited. In fact, given that the AI coverage in most chemistry courses is likely to be broad rather than deep in nature, a general AI text [3] would place EC in a much stronger setting, and would deal better with the important question of when evolutionary methods should be used instead of other AI approaches.

However, this does not mean that the book has no utility in the teaching of evolutionary and AI methods in chemistry. It could, for example, be used in coursework—an assignment based on a case study described in the text and how it could be applied to a chemical problem is a distinct possibility. In addition, the case studies could be used as the basis of student projects in the application of AI/evolutionary methods in chemistry.

Summary

This book is an excellent compendium of current work in the use of evolutionary methods for design. Even though it does not contain any material specific to chemistry, it does provide an excellent source of ideas. One example is the graph representation used in the design of robot morphology and controllers by Karl Sims; such graph representations could clearly be transferred to the representation and optimization of chemical structures.

In the education of chemists, the book can play at best a supplementary role as a source of case studies and project suggestions rather than be used as a course's primary textbook.

That said, I strongly recommend this book to anyone who has an interest in the application of evolutionary methods to demanding real-world problems in design.

References

1. H. M. Cartwright, *Applications of Artificial Intelligence in Chemistry*; Oxford University Press: Oxford, UK, 1993.
2. Z. Michalewicz, *Genetic Algorithms + Data Structures = Evolution Programs*, 3rd ed.; Springer-Verlag: New York, 1996.
3. S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*; Prentice Hall: Englewood Cliffs, NJ, 1996.

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Factor Four: Doubling Wealth, Halving Resource Use. By Ernst von Weizsacker, Amory B. Lovins, and L. Hunter Lovins; Earthscan: London, England; 1998. 9 pounds 99 p. ISBN softcover 1 85383 406 8, xxix + 322 pp, 46 Figures, 15 color plates.

Doubling Wealth, Halving Resource Use: it seemed an unpromising title. As editor of the media reviews section of *The Chemical Educator*, I had already offered this book to another reviewer and received a rapid negative response. Perhaps they shared my suspicion that it would turn out to be a close cousin of those paperbacks which promise to tell you "How to become a millionaire in six weeks" or that "You too can develop the mind of a genius."

The publisher's promotional material on the back of the book also seemed to be drawn from the "Improve Yourself" stable. The book was apparently:

"One of the 1990's most important books..."

> "Ground breaking ..."

and

> "[a book which] opens up a new way of thinking about ... our long-term survival"

A little sheepishly, I can report that my fears of another help-yourself book were quite unfounded. This is a fascinating and potentially significant book; though whether it will truly become one of the 1990's most important books will depend upon whether the publisher can secure for it a wider audience.

Full of interesting facts and persuasive argument, it is never polemical, always readable and lucid. It is the paperback version of a report to the Club of Rome, but despite its guise as a technical report, the style is far from dry or pedantic. As the title suggests, the central theme of the book is that it is possible to reduce resource use but at the same time improve the standard of living of those in the industrialized world. The authors' argument is not founded primarily on ethical principles, but on a consideration of what design and science now make possible.

The text is closely argued, and illustrated with hundreds of individual examples of how poorly we use resources, and how, by changing our lifestyle, "less can mean more". Examples, selected at random, include the following tidbits:

- One third of all US household car mileage is generated in commuting to work.
- An 18-watt fluorescent lamp replacing a 75-watt incandescent bulb would, over its lifetime, save enough energy to power a typical car 1,000 miles.
- In modern wheat production around 1 calorie of energy input is needed to produce 2.5 calories food value, but in industrialized beef production as many as 35 calories input may be required for a single calorie output.
- At a Coors bottle-washing facility in Colorado, $2,000 spent in changing production methods so as to recycle waste saved $200,000 in chemical cost.
- Subsurface irrigation of crops can reduce water loss by 50% in hot climates; it can cut tillage energy costs by a similar percentage, reduce herbicide use, and increase crop yield.

These examples are not cited by the authors as a cause for hand-wringing concern over our use of energy and resources. Instead, the authors offer solutions, in many cases already implemented, which show how present standards of living can be at very least maintained and often enhanced through intelligent use of technology.

The book can be read at two levels: At one level, it is an engaging recital of how efforts to place a cap on energy and resource use have been increasingly successful. The discussion throughout is accessible to those with even a limited scientific background. The numerous examples with which it is illustrated would be of value to those teaching "Science for Nonscientists" courses at the university level.

At another level the book is a persuasive and powerful plea for intelligent resource use. It will doubtless have a strong appeal to environmental groups such as Greenpeace.

The book is not without its limitations. Most of the discussions of intelligent (or dumb) resource use are short, and only rarely present both sides of the argument in equal detail. At times one is left wondering, if the argument for reducing resource use is so clear-cut, why an alternative course of action should even be considered, let alone implemented by industry. The book is also a little rambling; there is so much the authors want to discuss, so many examples they wish to comment on, that at times it resembles a selection of newspaper articles with a common theme, thrown together into book form.

However, it would be churlish to be too critical. This book is positive, well thought out, easy to read, and persuasive. If you are intrigued by the progress and inventiveness of science, are concerned about mismanagement of the environment, or just enjoy collecting esoteric and obscure facts, you should get a copy.

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