Media Reviews

American Chemical Society Directory of Graduate Research. By The ACS Committee on Professional Training; American Chemical Society: Washington, DC, 1997. xv + 1708 pp. 21.4 × 28.3 cm. $65.00 HB ISBN 0-8412-3544-9.

The latest edition of this standard reference work, published biennially since 1953, contains a wealth of data on 692 academic departments or divisions (compared to 685 in the 1995 edition) in universities and colleges in the United States and Canada that offer graduate degrees in twelve chemistry-related fields: chemistry, chemical engineering, biochemistry, pharmaceutical/medicinal chemistry, clinical chemistry, polymer science, toxicology, marine science, forensic science, materials science, and environmental science (the last two fields are new with this edition). A frequently consulted source of up-to-date information on U.S. and Canadian academic research and researchers, the *DGR* is continually relied upon by undergraduates and their faculty advisors in selecting a graduate school suited to their particular interests and talents. It is also a *sine qua non* for libraries, academic institutions and their chemistry and chemistry-related departments, chemically oriented businesses, and researchers needing to know who is carrying out research critical to their own.

In each of the twelve sections arranged according to field, the institutions are listed alphabetically. For each department, information on the degrees offered, fields of specialization, chairperson's name, telephone and fax numbers, and web sites are followed by an alphabetical list of faculty members. For each researcher, the following information is provided: year of birth, academic rank, degrees received, major postdoctoral appointments, field of research, specific subjects of current research interest, telephone and fax numbers, e-mail addresses, titles and complete reference citations in reverse chronological order of articles published during 1995 and 1996 (91,515 citations compared to 80,081 in the last edition), and the names of those completing master's and doctoral degrees under the faculty member's supervision during the period, along with the thesis titles. Information is also given on interdisciplinary programs when departments listed in the directory are engaged in joint administration of graduate programs with other departments or colleges of the university.

Special statistical summaries appear in the introductory section for all the departments. These provide information on the number of doctor's and master's degrees granted in 1994–1995 and 1995–1996, and as of September 1996 the number of first-year and total graduate enrollments, the number of postdoctoral appointments, and the number of full-time and part-time faculty members. A 24-page faculty index of 12,030 names (compared to 11,922 names in the last edition) makes the directory user-friendly. The American Chemical Society maintains DGRweb (http://pubs.acs.org/dgrweb), a searchable Internet database of faculty and institutions listed in the *DGR*.

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Instruments of Science: An Historical Encyclopedia. By Robert Bud and Deborah Jean Warner (Eds.) Garland Encyclopedias in the History of Science Vol. 2; Garland Reference Library of the Social Sciences Vol. 936; The Science Museum, London and The National Museum of American History, Smithsonian Institution in association with Garland Publishing, Inc.: New York & London, 1998. Illustrations. xxv + 709 pp. 18.4 × 26.0 cm. $138.00 Hardbound. ISBN 0-8153-1561-9.

This authoritative volume, whose editors have been awarded the 1998 Paul Bung Prize of the Hans R. Jenemann Foundation for an outstanding publication in the history of scientific instruments, resulted from a collaboration between two national museums - the Science Museum in London, where Robert Bud is Head of Research (Collections), and the National Museum of American History, Smithsonian Institution, Washington, where Deborah Jean Warner is Curator of Physical Science Collections. Consequently, it draws on the strengths of these institutions' object, archival, and picture collections.

This valuable sourcebook was written by 223 scientists, instrument designers, and historians, including Nobel laureates R. Bruce Merrifield and Joshua Lederberg, and Dexter History of Chemistry awardees Robert G. W. Anderson, Seymour H. Mauskopf, John T. Stock, and Ferenc Szabadváry, from fifteen countries (with the United Kingdom and the United States predominating, with 95 and 75 contributors, respectively). It contains 327 entries, some with multiple authors and most about a thousand words in length, alphabetically arranged from Abacus to X-ray machine, describing instruments relating to the mathematical sciences from antiquity onwards, the natural philosophy of the seventeenth and eighteenth centuries, physics, chemistry, and the newly emerging life sciences of the nineteenth and twentieth centuries, as well as the applied and engineering sciences so increasingly prominent in the present day. It explores devices designed for cutting-edge research as well as those for routine testing. A number of the contributors have had firsthand experience with the instruments about which they are writing. For example, British atmospheric scientist James E. Lovelock, famed as the proponent of the Gaia hypothesis that the Earth is a complex, interdependent system, authored the entry on the electron capture detector, which he invented in 1957 and used to demonstrate that synthetic gases such as chlorofluorocarbons (CFCs) had spread globally throughout the atmosphere, leading to the discovery of the hole in the ozone layer.

In keeping with their historical approach, the editors have included instruments that no longer figure in modern conceptions of science, including early modern drawing instruments and sectors used in mathematics and geometry, the spheres and astrolabes of astronomy, and the cross-staffs and sextants of navigation. However, the encyclopedia is thoroughly up-to-date, for it includes recent developments in biology and biotechnology that confound our traditional ideas of an instrument, such as four widely used laboratory organisms crucial in biological research - *Escherichia coli, Neurospora, Drosophila,* and the mouse. (The importance of the computer in modern life is underscored by the amusing fact that when I first encountered the word "mouse" here, I assumed that it referred to the plastic device that I am clicking and dragging as I compose this review, rather than a furry little rodent.) The importance of applied science is reflected by the

inclusion of instruments used for routine testing and monitoring in sites such as hospitals, petroleum refineries, and airplane cockpits.

Each signed entry explains how the particular device works, how it is used, and who developed it, and it includes a bibliography of up to five articles or books (some as recent as 1997) and, in many cases, a photograph or diagram of the instrument. The devices were selected from texts on the history of science, trade catalogues, museum collections, and treatises on modern scientific practice. Cross-references to other entries are indicated in boldface type, and a detailed index (37 double-column pages) facilitates location of material.

Inasmuch as chemistry is "the central science," many of the entries will be of interest to practicing chemists and chemical educators. Among those of particular interest to us are Balance, Chemical; Battery; Burette; Blowpipe; Calorimeter (with a sectioned diagram of Lavoisier's instrument); Chromatograph; Colorimeter; Distillation; Differential Thermal Analyzer; Electrophoretic Apparatus; Furnace; Galvanometer; Gas Analyzer; Melting Point Apparatus; Microscope, Ultra-; Osmometer; pH Meter; Polarograph; Potentiometer; Polarimeter; Polymerase Chain Reaction; Pyrometer; Refractometer; Spectrometer, Atomic Absorption, Mass, and Nuclear Magnetic Resonance; Spectrophotometer; Spectroscope; Thermobalance; Thermometer; Vacuum Gauge; Van Slyke Gasometric Apparatus; Vapor Density, Boiling Point, and Freezing Point Apparatus; and Viscometer. I read the Slide Rule entry with a touch of nostalgia. Although the volume contains entries on the Bunsen absorptiometer and furnace, the simple but ubiquitous Bunsen burner is not included. Items in everyday use in chemical laboratories such as the beaker, condenser, flask, funnel, test tube, wash bottle, and water bath (*bain Marie*) are lacking, but they may have been considered too simple for inclusion.

Instruments of Science is the first reference book to address the immense historical range of instruments and also the first to consider applications, innovations, and costs. Its emphasis on twentieth-century devices and disciplines makes it especially valuable to students and scholars of modern science and technology, and the beauty of some of the antique instruments makes it a valuable guide for collectors, dealers, and curators. Chemical educators will find it ideally suited for reference, browsing, or reading, and a great source of lecture material.

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Critical Safety Incidents. A videotape prepared by the Learning and Teaching Centre, University of Victoria, Canada. Videotape and 8-page guidebook. $60 (Canadian) in Canada, $65 (US) for U.S. and foreign orders.

This brief videotape deals with a fire in the Chemistry Department at the University of Victoria (Canada), and its aftermath. The videotape was prepared by members of the Learning and Teaching Centre and the Chemistry Department at Victoria, recognizing that the lessons to be learnt would be widely applicable, and that basing a safety videotape on a real fire would lend particular weight to its message.

The Learning and Teaching Centre at Victoria has a long tradition of providing resources and advice to help instructors work effectively. While they have previously produced several "Critical Incident" videotapes (used at hundreds of universities worldwide), this is the first to discuss a physical emergency. This new departure has to be judged a success.

The fire around which the videotape is based started in a waste bin in a teaching laboratory, and was discovered on a Sunday morning. The videotape focuses on the steps taken by those most directly involved with the fire and its consequences: the research worker who found it, members of the fire service called to the scene, and the departmental safety officer. While film of the area involved in the fire shows that structural damage was not severe, the disruption caused to the operation of a department undoubtedly was. Had the fire gone unnoticed for longer, the damage might have been extensive, and injuries to researchers possible.

The viewer is encouraged to put himself or herself into the position of those involved. The researcher and the safety officer describe their responses to the emergency; after each is interviewed, there is a short break in the presentation, during which it is intended that viewers address a number of questions under the prompting of a local facilitator. Some questions are presented on screen, others are posed in the leaflet that accompanies the videotape.

The questions are generally fairly straightforward; nevertheless, considering one's response to these in relation to one's own institution can be a sobering exercise. Any complacency that "it couldn't happen here" is likely to disappear rapidly. For example, when the fire service arrived, they requested details of the chemicals stored within the laboratory that contained the fire. In Victoria, these details were available, but would they be in every institution? In some cases, the necessary records might be held within the laboratory itself, and thus perhaps already destroyed by the fire.

I found myself asking: Could a fire start in a waste bin within my own laboratory in Oxford, as it had in Victoria? Would my research students delay in calling the fire brigade until they were convinced a fire had taken hold - a delay that might literally be a fatal mistake? Would they try to tackle the fire themselves? Might they assume an area was safe to move through because of the absence of smoke, without considering the possibility that dangerous levels of carbon monoxide might have been present?

In raising these questions, the videotape is thought-provoking and valuable. It does, however, have its weaknesses. The primary weakness is its reliance upon the viewer drawing the right conclusions. In a medium-sized or large chemistry department, the videotape would form the basis of a valuable discussion on safety, facilitated by the departmental or university safety officer. In a small department, which might have no suitable professional to guide the discussion, viewers may be less certain what conclusions should be drawn. More detailed written material would be of value for those who might watch the videotape without an expert at hand.

Overall however, the videotape has much to recommend it. It contains graphic footage showing the serious effects of even a fairly modest fire. In their own words we hear from those involved, and are encouraged to consider how they acted, and whether they should have done anything differently. Inevitably we are led to ask "Could it happen here?" and question what we would do to prevent a similar accident.

This videotape has a particular resonance for me. After completing an evening chemistry show at the University of Winnipeg many years ago, I disposed of waste chemicals (safely, I thought) in an outdoors waste-material skip; the contents of the skip caught fire in the night, triggering an emergency call to the Winnipeg fire brigade. As departmental Safety Officer at Oxford, I have a particular responsibility for, and interest in, safety. And for many years I was in charge of a pair of laboratories at the University of Victoria adjacent to the one that caught fire. Fires can and do happen; this videotape will help to raise awareness of their causes and prevention. It is a safety aid that many departments will find valuable.

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Applications of Artificial Intelligence in Chemistry. By Hugh M. Cartwright. Oxford University Press: Oxford, England, 1993. $12.95. 92 pages. ISBN 0-19-855736-1.

Hugh Cartwright's *Applications of Artificial Intelligence in Chemistry* reminds us that computer science is about ideas as well as machines. This well-written text, published in 1993, is still relevant; it provides the reader with an excellent introduction to the meaning of artificial intelligence (AI) and the many areas in chemistry where it can be applied. Tucked into the margins of the book are remarks that enhance the text without interrupting its flow. Although most of the examples are chemical, the text should be suitable for undergraduate students in any science.

The first chapter introduces the enormous potential of AI, "an attempt to reproduce intelligent reasoning using machines." Problems that lend themselves to solution by AI, such as playing chess, are discussed. It is pointed out that although the rules of chess are straightforward, an exhaustive search of all legal moves would be impossible to do fast enough. Similar demanding problems that arise in science are treated. The next three sections of the book describe how AI methods work, with particular emphasis on applications in chemistry.

The next chapter covers artificial neural networks, generalized learning machines based on a simplified model of the brain. The simple *perceptron*, described in detail, is a decision-making unit with several input connections; adjustment of these allows the perceptron to learn by trial and error. One of the chemical problems described is the use of light sensors to notice a 6-membered ring in a structure. Combining perceptrons into neural networks allows the solution of more complex problems such as the analysis of NIR spectra or the prediction of the secondary structure of a protein. An interesting margin remark tells of a pitfall encountered by a a neural network that accidentally learned how to tell when the sun was out rather than to how to identify tanks because the trial pictures of tanks were all taken on a sunny day.

In the third chapter are the knowledge-based systems (expert systems) that rely on stored facts. The essential components are discussed here: the knowledge base, the reasoning engine with a discussion of various searching strategies, and the human interface. When the knowledge obtained is combined with rules, the system can offer excellent advice on how to interpret data, monitor equipment performance, control instruments, instruct novices, and thus become a significant part of a large laboratory.

The final chapter introduces the genetic algorithm (GA) "to search for the optimum solution hidden in a wealth of poorer ones." The text explains that a GA uses a hill-climbing method that is less likely to be fooled by a local maximum as it relies upon randomized searches. The name of the algorithm is derived from its basis in the concepts of evolution. Solutions to a problem are *strings*, or chromosomes. Fitness of strings is evaluated and new populations are produced using reproduction, mating or crossover, and mutation operators. One application discussed is in the choice of a suitable synthetic route for a complicated organic molecule.

Cartwright's succinct introduction to AI is an excellent starting point for the reader who should be inspired to explore methods made possible by increasingly powerful computing ability.

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The Macrogalleria (web site). http://www.psrc.usm.edu/macrog/ Developed by the Polymer Science Department, University of Southern Mississippi.

The Macrogalleria, (http://www.psrc.usm.edu/macrog/) a "cyberwonderland of polymer fun," lives up to its name. Developed by members of the Polymer Science department at the University of Southern Mississippi, the Macrogalleria provides an example of the WWW delivering instruction in a new way that is sure to enhance classroom instruction.

The Website's homepage outlines the concept of the polymer shopping mall in a clear and easy to read manner. The mall consists of five levels of virtual stores; each houses a particular topic. The first level consists of traditional mall type stores; "Tons o' Toys," "Dollar Dungeon," "Food Court," etc., and in each store students see a description of the available products and information about which polymers are utilized as components of the products. The second-level stores are named for specific polymers, such as polypropylene, starch, and silicone. When students enter these stores they learn about the polymer, its uses, and the basics of its synthesis. At the third level the stores detail concepts of polymer physical chemistry such as crosslinking, thermoplastics, and glass transitions. The fourth level contains details of polymer synthesis such as Ziegler-Natta polymerization, the preparation of epoxy resins, and others. The fifth level, under construction at the moment, presents techniques for polymer analysis such as size exclusion chromatography.

Humor is used extensively to keep the exploration enjoyable. Consider a reference to a hot tub:

> "This hot tub, which is good for relaxing, or making several hundred gallons of split pea soup if the need arises, is also made of polymers. The surface is made of poly(methyl methacrylate). That's the same stuff as Plexiglas."

The beauty of the concept is that in addition to presenting valuable information, the Macrogalleria presentation uses extensive crosslinking to help students explore a topic in the breadth and depth they need or want. Students may go into the music store (level 1), discover that guitar pickguards are made from polystyrene, jump a link to the polystyrene page (level 2),

become interested in vinyl polymers (level 3) and want to know more about their synthesis through free-radical vinyl polymerization (level 4). Some shoppers may never leave the first floor and yet still gain an appreciation of the presence of both natural and synthetic polymers in our daily lives. More advanced students may pursue information on polymers at whatever level of sophistication they choose.

Navigation between the stores is easy; each store site includes a link back to the directory for that particular floor of the mall, as well as a link to the mall entrance (home page).

In essence, the student never needs a mall map (although these are readily available, and helpful for students who prefer a more ordered approach). Students hop between floors of the mall without having to find the escalator.

The sophisticated graphics can be both a joy and a problem. To view the site in its entirety requires the installation of two plug-ins, Macromedia Shockwave Director and Chemscape Chime to view and rotate the molecular models. Links to both download areas are included in directions on the home page. Once installed, the plug-ins do their job and truly enhance the explanations within the Macrogalleria. One drawback of the extensive graphics is that the pages may take more time to load than some students are prepared to wait. Hopefully, once they see the page on their screen, they will think that the wait was justified. Presenting the information as departments within a store, requiring shorter pages, would help. The many photographs enliven the pages; because I consider this a world-class Website, I hope that as the photographs are updated, a more diverse population will be represented in the photos that include people.

The homepage includes a link to site notes that describe the concept of this Website in detail for students and teachers. The authors have also made the material available on a CD-ROM (currently $30 plus shipping) for individuals who would prefer to work offline.

The site is a joy to explore - both as a means to learn about polymers and to see how interactive delivery can truly enhance instruction.

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