ChE **book review**

POLYMER SCIENCE AND ENGINEERING: THE SHIFTING FRONTIERS

National Academy Press, 2101 Constitution Ave., NW, Washington, DC 20418; 348 pages, $34.95 (1994)

Reviewed by
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In 1992 a committee was established by the Board of Chemical Sciences and Technology of the National Research council to assess the research frontiers in polymer science and engineering. In particular, the goals were to examine the recent advances in polymer research and to identify new thrusts in the context of current and long-term needs and concerns. This book represents a report on the committee's findings. Here the significance of their report, along with the key findings, are reviewed.

The report is based on certain underlying tenets and facts. First, the chemical industry, of which polymers make up a major portion, is one of two major U.S. industries with a positive trade balance. In order to maintain this trade position, the U.S. must continue its consistent and rigorous commitment to polymer research. Second, polymers are extremely versatile materials and have a wide range of applications. For example, the same polymer with different molecular features and processed differently can be used to make cheap articles such as toys and bags on one hand, while on the other it can be used to produce lightweight but high strength, stiff materials which can replace metal. Third, roughly 50% of chemists and chemical engineers are involved with polymers at some time during their careers, but educational opportunities at most universities are still lacking. Finally, the generation of a polymeric article with desirable physical properties is a complex function of polymer chemistry, processing, and structure. In other words, progress in the development of new materials requires a combined effort of chemists, material scientists, and engineers. These facts, which are emphasized throughout the report, serve as a basis for establishing the significance of polymer research and education and justifying the committee's conclusions and recommendations.

The report begins with a summary of the findings and recommendations. Five recommendations were given which in essence deal with the carrying out of polymer research and education.

- **Recommendation 1** is concerned with the importance of maintaining active corporate research groups, development of governmental policies which encourage long-term research, and nature of funding which promotes interaction between universities, industry, and national laboratories.
- In **Recommendation 2**, the importance of an integrated approach between polymer science and engineering and other areas, such as housing, medicine, transportation, etc., is emphasized.
- In **Recommendation 3,** specific areas of research for which a high priority of support should be given are listed.
- **Recommendation 4** deals with environmental issues, and it is merely suggested that a panel at the national level be appointed to handle these matters.
- Finally, **Recommendation 5** is concerned with the importance of collaborative efforts (both in research and education) within polymer subdisciplines and across the boundaries of other fields.

With the exception of the recommendation pertaining to environmental issues (I don't think that anyone knows what to do in this case) their recommendations are sound, informative, and concrete.

The remainder of the book consists of four chapters which serve primarily to support their major premises and recommendations. Chapter 1 (National Issues) discusses some of the direct societal benefits derived from polymer science and engineering and illustrates how it can contribute to the solution of some of the pressing problems facing the United States and the world. Yet, it points out some of the disturbing facts which could jeopardize the advantage the U.S. presently has in polymers. Most major companies have down-sized their polymer research and development activities. The past level of education in polymers of scientists and engineers has been extremely low. It is indicated that polymer science and engineering must become part of the core curriculum for chemists, chemical engineers, and material scientists.

Chapter 2 (Advanced Technology Applications) is concerned with how new classes of polymeric materials with unique applications are being introduced into two areas: health and medicine, and information and communications. This chapter serves to, more or less, illustrate the versatility of polymers and how they can be used in other areas of science and technology. Although most of the examples illustrate present applications, suggestions of future developments and needs are given.

Chapter 3 (Manufacturing: Materials and Processing) is primarily a review of existing polymeric materials and their properties. It is a very good overview of the classifications of polymeric materials and their applications. At the same time, it emphasizes the fact that final properties are a function of composition and processing history and thereby establishes the importance of developing process models to aid in design of processing conditions and methods. There is much to be done here both in the development of numerical methods and improved constitutive equations (in spite of what is reported concerning the value of the Doi-Edwards constitutive equation).

Finally, Chapter 4 (Enabling Science) starts with the premise that polymer synthesis provides the basis for all advances in polymeric materials. It then proceeds to give an overview of factors which can be controlled by the polymer chemist to give a polymer a desired set of properties. The chapter also contains an overview of techniques used to characterize polymeric systems.

The book is readable by a diverse audience. It is useful for polymer research specialists searching for new ideas and applications. Chapters 3 and 4 are actually good overviews of polymeric materials and polymer synthesis and could be used as an introduc-

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tory supplement for a course on polymer processing where these particular topics are not covered. Researchers in other branches of material science in search of new materials will find the book of interest. Finally, leaders in science policy and funding will find the book informative. ❐

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ENGINEERING YOUR FUTURE: Launching a Successful Entry-Level Technical Career in Today's Business Environment

by Stuart G. Walesh

Prentice Hall, 439 pgs. (1995)

Reviewed by
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Engineering educators have been told repeatedly that our students have the technical skills to succeed, but often do not have the necessary communication, interpersonal, time management, and business skills needed. This book is an outstanding effort to help remedy that problem. It could be used as a text for a senior course, for self-study by young professionals, or as a resource in short courses.

After the introductory chapter, there is an excellent chapter on self-management. It includes a brief discussion on the differences between school and work (*e.g.,* tardiness is not tolerated). The fourteen pages on time management are too brief, but the author is able to condense an incredible amount of useful information into these pages. After further good advice, the author notes the importance of attitude—one can *choose* to be a winner. The chapter closes with strong arguments for participation in professional organizations and for becoming licensed. This emphasis reflects the author's civil engineering background, but is not inappropriate for chemical engineers in a volatile employment environment.

Chapter 3, Communication Skills, will prove useful to seniors (and professors) who think they have read everything there is to know about communication. The chapter starts with the novel idea that listening is a communication skill. The author states that writing best communicates facts and details, while speaking "clearly holds the power of persuasion." Note that this implies professors should use lectures for motivation and attitude adjustment, not to present facts and details. The section on writing contains both common advice and uncommon advice (*e.g.,* write the easy parts first). The section on speaking will also be useful to both inexperienced and experienced speakers. It contains a very good list on speaking in addition to useful comments on international audiences.

Chapter 4 on management of relationships is a continuation of Chapter 2. Topics in this chapter include: Maslow's Hierarchy of Needs, Theories X and Y, Delegating, Managing Meetings, Working with Support Personnel, Managing Your Boss (very brief), and "Caring Isn't Coddling." Although this is useful information, I doubt much of it will be appreciated by seniors or new engineers. The sections on support personnel and caring should be assigned to all students before any work assignments (COOP, summer job, or permanent work). This chapter would benefit from an exercise section.

Chapter 5 is on the organization of organizations. Since I would expect most engineers to be able to determine this rather quickly on their own, I suggest skipping this chapter.

Chapter 6, Project Management, is a gem, particularly for chemical engineers who often do not formally study these methods. The author starts with a simple chronological list, continues with the visually appealing Gantt chart, and finishes with a long section on the more complex and more powerful critical path method. The exercises at the end of this chapter will help the engineer understand these methods.

Chapter 7, Total Quality Management, is written for engineers with no knowledge of TQM. It should serve as a good introduction to TQM for engineers who will work in a TQM organization.

The next chapter, on decision economics, covers material that is traditionally covered in chemical engineering senior design classes. The author is clearly serious since this chapter has by far the most homework exercises. Chapter 9, Business Accounting Methods, is in some ways a continuation. It is probably worth reading since it will help new engineers interpret their company's profit-and-loss statements. Chapter 12 on design also overlaps with the usual senior design courses.

Chapters 10 and 11 cover the legal framework and ethics of an engineering career, respectively. Although written from the civil engineering point-of-view, they should also prove useful to chemical engineers. In fact, this viewpoint may be particularly useful given the civil engineer's heightened sensitivity to liability issues and professional responsibility. The examples are civil engineering examples, but any engineer can appreciate them.

The Appendices contain the ASCE Code of Ethics, the IEEE Code of Ethics, the College Placement Council Principles for Professional Conduct, and excerpts from the Boeing Company's Business Conduct Policy and Guidelines. The fourteen principles of the government code of ethics are included in Chapter 11. This wealth of information could be used in case studies to show that what may be ethical for one engineer could be unethical for another. There are also some good scenarios for discussion in the chapter's exercise section.

Chapter 13, Role and Selection of Consultants, and Chapter 14, Marketing Technical Services, are of much more interest to beginning civil engineers than chemical engineers. At some point, however, chemical engineers may find this information useful.

The conclusions of the last chapter, The Future and You, can be summed up in one sentence: Be flexible and ready for change.

How can a chemical engineering professor best use this book? First, read selected parts. Second, recommend it to students who are going to work, whether it is COOP, summer, or post-graduation. Third, consider using parts of it as a text in a senior seminar, or as a supplemental text in a senior design course. I estimate that the most important parts of this book could easily be covered in the typical one-hour-per-week senior seminar.

Overall, I think this is a great book for civil engineers and a good book for chemical engineers. ❐