Chemical Product Design

By E.L. Cussler and G. D. Moggridge, Cambridge University Press, Cambridge, U.K., 2001, 229 pp., $30.00.

This book delivers a very readable treatment of the important aspects in the design and development of new chemically related products and devices. The book covers specialty chemicals such as pharmaceuticals and coatings, but it also considers microstructured products (based on complex fluids) and devices that perform chemical operations. The book is packed with examples, anecdotes, case studies, and illustrations. This bounty makes it easy for the reader to understand how the concepts being discussed can be applied to real problems and real situations. The numerous illustrations and the conversational writing style make this book one that advanced undergraduate students could easily comprehend.

The book contains seven chapters. The first introduces the field of chemical product design. The authors give a working definition of product design and make a compelling case for its importance. The balance of the chapter then introduces the "product design procedure," which is a four-step methodology for product design. This procedure is analogous to Douglas' hierarchy for conceptual process design, and it serves as the organizational structure for the rest of the book.

Chapter 2 is devoted to the first step in the product design procedure. This step, entitled "needs", explains how to identify the needs that the product should fill. The emphasis is on both identifying all of the needs and also converting qualitative product attributes (such as smoothness of a beer) to a relevant quantitative specification (such as force of contact lubrication) whenever possible.

After the needs have been identified, it is time to think about how to fulfill those needs. The third chapter, "Ideas", discusses ways to generate ideas for numerous different products that could satisfy the needs and then ways to sort and screen those ideas down to a manageable number for further consideration. The chapter briefly discusses brainstorming and problem-solving styles, and it presents a useful concept-screening matrix. The desired outcome from application of these tools is identifying five or fewer ideas for further development. That further development, termed selection, is the third step in the product design procedure and title of the fourth chapter in the book.

Chapter 4 focuses on more detailed analyses of the remaining options so that the best option can be identified. The chapter considers two cases. The first case involves product selection on the exclusive basis of technical criteria. The second case includes both technical and less exact criteria such as consumer reaction. The discussion of selection by technical criteria shows how thermodynamic, transport, and kinetics principles can be used to advantage in product design. The emphasis is appropriately on making quick, order of magnitude estimates to determine the limits of feasibility. Inclusion of qualitative and less exact criteria is handled by using a more refined product selection matrix. At this stage, one also includes an analysis of the risks associated with each choice. The desired outcome is the identification of the best one or two product ideas to manufacture.

I was surprised that the suggestions for further reading at the end of Chapters 3 and 4 did not include any books or articles on idea generation, problem-solving, or decision analysis. *Strategies for Creative Problem Solving*, by Fogler and LeBlanc, which is in the Further Reading list in Chapter 2, would have been at least one book to which interested readers could have been referred.

Chapters 5–7 discuss manufacturing and economics. The material presented differs from that found in chemical process design texts, because the issues and tasks involved in product design are different. The authors include a very nice treatment of microstructured products and of devices, along with the expected treatment of specialty chemical products such as pharmaceuticals. The treatment of economics in Chapter 7 covers both product economics and conventional process economics for bulk, commodity chemicals. This chapter also clearly articulates the distinctions between product and process economics. These differences include the comparatively shorter lifetime of a high value-added product, the importance of time to market and the cost of product development, and the relative unimportance of raw material costs for specialty products. The authors use net present value as an economic indicator to judge the profitably of a proposed new product. Chapter 7 provides some examples that illustrate the determination of net present value, and by so doing it enables the reader to identify the information required and the methodology for using that information. The chapter does not tell the reader, however, how to obtain or estimate reasonable values for some of the required information (such as manpower needed).

Having taught chemical process design for several years, I can see that the material in this book could easily and profitably be integrated into a senior design course. In fact, integrating product design with the traditional process design course would provide a more current, more complete, and more interesting design experience for chemical engineering students. I recommend *Chemical Product Design* to all chemical engineering design instructors.

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Catalyst Design, Optimal Distribution of Catalyst in Pellets, Reactors, and Membranes

By Massimo Morbidelli, Asterios Gavriilidis, and Arvind Varma, Cambridge University Press, Cambridge, U.K., 2001, 227 pp., $60.00.

Chemists and chemical engineers involved in the design and analysis of catalysts comprising precious material components will find significant value in Cambridge Series in Chemical Engineering's new offering *Catalyst Design, Optimal Distribution of Catalyst in Pellets, Reactors, and Membranes*. In their new text, Morbidelli, Gavriilidis, and Varma provide a very focused study of the general problem of the use of the precious components of catalysts. The basis concept of catalyst effectiveness or catalyst utilization, that is, the result of combined transport and reaction issues, is the index or objective function to be maximized when the utilization of pre-