BOOK REVIEWS

Laminar Flow and Convective Transport Processes: Scaling Principles and Asymptotic Analysis

By L. Gary Leal, Butterworth-Heinemann, Boston, 1992, 740 + xviii pp., $79.00

Gary Leal has written an important new text for a first chemical engineering graduate course in transport processes. The emphasis, as indicated by the subtitle, is on methods of scaling and asymptotic analysis for laminar flows of Newtonian fluids. The field equations are rigorously derived, and ten subsequent chapters cover the entire range from creeping flow to boundary layers, including an elegant treatment of the mechanics of bubbles and drops. As one would expect from the author's research contributions and review papers, the exposition is lucid and complete. Indeed, a number of examples are worked out in far more detail than one normally finds in an advanced text, much to the benefit of the student. The book could be used profitably in any graduate program, although most students will have an inadequate background in vector analysis and will require supplementary instruction. It provides a particularly good introduction to matched asymptotic expansions and domain perturbations as tools for the solution of transport problems.

According to the preface, this book evolved from Leal's graduate course in fluid mechanics and *thermal* transport processes. The topics included and excluded have been carefully chosen, and they invite discussion of what is appropriate in a course for chemical engineers. I would insist on at least three topics which are not covered, possibly at the expense of some of the material which Leal considers to be essential. I feel that chemical engineers should be introduced to mass transfer at high rates, where the coupling between mass and momentum transport at the boundary causes the usual analogy between mass and heat transfer to break down. This topic can be added to a discussion of boundary layer flows with little effort, as long as only binary systems are considered. I feel no transport course today is complete without some discussion of numerical methods; I lean towards introducing variational methods and then developing finite-element techniques. Finally, I feel that chemical engineers should be introduced to turbulence in a conceptual framework which goes beyond that in the typical undergraduate course. This is much more difficult to do in the limited time available in the first graduate course.

I have been dissatisfied with the available texts for a first graduate transport course, and in recent years I have not assigned one. Rather, I have recommended to the students that they purchase one of a number of basic texts for their personal libraries and as a reference for some topics in the course. Leal's book comes closer than any other to meeting what I consider to be the students' needs, and it does cover many of the topics which I consider to be essential. I would now place this text at the top of my recommended list.

The book seems to be relatively free of major proofreading errors, although there is an amusing transition to misplaced Greek characters on p. 219. Figure quality is just adequate, but the typeface is relatively easy to read.

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Perspectives in Chemical Engineering Research and Education

Edited by Clark K. Colton, Academic Press, San Diego, 1991, 606 pp., $99.95

The chemical engineering profession came into being in the 1880s simultaneously in Europe and America. The oldest continuous academic program in chemical engineering began in September 1888 at the Massachusetts Institute of Technology, and this volume is a record of a symposium held in 1988 to mark the centenary of that department.

It is worth noting that the new profession at the time had a poor reception in England as a review in *Nature* (Vol. **21**, January 29, 1880, p. 298) of George Davis's first book attests. In the review on the book titled *Sizing and Mildew in Cotton Goods* by G. E. Davis, C. Dreyfus, and P. Holland (Manchester: Palmer and Howe, 1880), the following comments were made: "The application of a certain kind of science to a certain kind of commerce is rapidly producing a literature of its own. It is not long since that we had occasion to notice a work which treated of the manner in which silks could be 'weighted' by chemical means, and the volume now before us is the second of its kind which is concerned with the relations of chemistry and mycology to the manufacture of cotton goods. It is hardly worthwhile to take up valuable space by noticing the merits or demerits of a book such as this, the object, or at least the tendency, of which is to show the manufacturer how, by the application of certain scientific facts and principles, he may seek to perpetuate a system which, we honestly think, is simply a gigantic fraud."

There is no evidence of similar backwoodsman-like thinking in the United States, which perhaps helps to explain why the profession developed so quickly and so successfully there. A chronicle of that success story is well told by L. E. Scriven in the opening chapter of *Perspectives in Chemical Engineering Research and Education*. His article, "On the Emergence and Evolution of Chemical Engineering," is a concise (people might read it!) history of the profession as it was practiced and taught. As would be expected from Scriven, the chapter is full of gems and should be required reading for all undergraduates of the subject. The book is worth buying for this chapter alone.

The remainder of the book is divided

into eight sections where the state of affairs in various technical areas is discussed in more detail. The last section contains a single, thought-provoking chapter by Morton Denn on the "Identity of our Profession," in which he argues that the profession has been undergoing evolutionary, rather than revolutionary, change in recent years. Denn points out that chemical engineering has traditionally been viewed as the engineering profession that deals with applications in which physical and chemical rate processes are limiting, and argues that this is the unchanging paradigm to this day. Much of the material in the eight technical sections of the book are certainly consistent with this view. It is amusing, however, to see that the same cast of characters that gave birth to the Amundson Report, *Frontiers in Chemical Engineering* (published in 1988!), which argues that our profession is going through revolutionary changes and is in need of a new paradigm, are here on record (pp. 573-586, and elsewhere) as stating the opposite.

In between the big issues discussed at the beginning and end of the book, there are sections on: Fluid Mechanics and Transport; Thermodynamics; Kinetics, Catalysis, and Reactor Engineering; Environmental Protection and Energy; Polymers; Microelectronic and Optical Materials; Bioengineering; and last but not least Process Engineering. Each section contains two or three expository chapters that make accessible and enjoyable reading. In general, the authors have put their subject matter in both an historical and broad scientific context that is absent from most technical papers and textbooks. This provides a framework for viewing the current state of the art as well as future needs and opportunities.

It is unfair to cite only a few authors since so many are deserving of mention. Nevertheless, I cannot resist mentioning a few personal favorites. I found the three papers on fluid mechanics and transport phenomena very interesting not only for their technical content but also for raising the issue of teaching nonlinear dynamics and analysis to chemical engineers. This was picked up as an item for discussion on pp. 109-122. Large chunks of modern chemical engineering revolve around nonlinear models, which should obviously be treated in a proper context in order to extract the maximum information from them. Even thermodynamics and distillation can be put in this setting to good effect. Few chemical engineering departments, however, teach a course on this subject. It would be nice to think that this book can be used to justify the wider teaching of nonlinear analysis to chemical engineers.

I also found the three chapters on thermodynamics most enjoyable. In recent years there have been impressive strides made in the area of statistical mechanics and there is a general consensus that the future looks bright for molecular theory and simulation. It is also not hard to imagine quantum mechanics finding its way into the chemical engineer's toolchest over the next 10–20 years just as statistical mechanics has in recent decades.

Alex Bell's paper on reaction engineering (as well as the other chapters in that section) prove that the subject is not dead, in spite of its obituaries in other parts of the literature. John Seinfeld writes informatively about environmental issues and identifies many interesting opportunities for research. Matt Tirrell does likewise for polymers. The chapters in Sections VII and VIII on Microelectronic and Optical Materials, and Bioengineering, respectively, are quite accessible to the nonexpert and provided this one with a good perspective of those fields. The final technical section on Process Engineering is closer to home for me and provides an accurate picture of where things currently stand. Art Westerberg's article, in particular, explains how fast computers and new algorithms have revolutionized the field in the last 10–15 years. Jim Douglas touches on an important point that needs raising, namely, once the profession has shifted completely to the microscopic viewpoint we will have to re-invent process engineering in order to develop and build the new processes. Reuel Shinnar also has valuable things to say about this in the discussion on pp. 114, 256 and 577. The question is, who is going to teach engineering to the next generation of chemical engineers?

The only criticism I have of the book is the amazing omission of a section on separations, which are not mentioned anywhere except in passing. Separations have always been, and will continue to be, of such importance to the chemical engineering profession that it is quite incredible to find practically no mention of them, particularly in view of MIT's great contributions to the subject.

A different reviewer would have cited a different collection of chapters for special mention, but I think the overall impression would be the same. The editor and authors have put a tremendous amount of work into this book. They have created something unique which will be of enduring value. My own thinking about the profession has been influenced greatly by reading *Perspectives in Chemical Engineering Research and Education*, and it is hard to imagine anyone not finding many interesting facts and views between its covers. The book admirably achieves its goal of setting the field in *perspective*, and to borrow a phrase from the late P. V. Danckwerts, the book is a lot less boring than its title suggests.

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Envisioning Information

By Edward R. Tufte, Graphics Press, Cheshire, CT, 1990, 126 pp., $48 postpaid

For the second time in a decade, an unusual book, written and published in an unusual manner, offers expert guidance in the ways of *cognitive art*—the schemes by which we represent factual information visually. Edward R. Tufte, Professor of Political Science and Statistics and a Lecturer in Law at Yale University, has produced a sequel to his landmark 1983 creation, *The Visual Display of Quantitative Information*. Praised by nearly everyone who reads it, the earlier book presented both a history of data graphics (with many illustrations of the best and worst examples on record) and Tufte's unique guidelines for "doing it right." Called a "tour de force" by Princeton's John Tukey, *The Visual Display of Quantitative Information* remained the subject of scholarly reviews seven years after its publication and has sold nearly 140,000 copies.

Envisioning Information is a colorful descendant of *The Visual Display*. . . It deals with the best (and worst) ways to represent "the rich visual world of experience and measurement" on a flat page ("Escaping Flatland" in Tufte's