whether a student knows *exactly* what to say is to hear a brief (approximately one minute) recitation of a poem. This recitation also provides the ultimate example of the claim that, with care and proper editing, any story or report can be fully presented in a very short period of time. It also helps the student see that poetry is successful because of its brevity and the ease with which the listener's mind constructs a full image from a few words. Who would not agree with such a characterization for Blake's

Tiger, tiger, burning bright,
in the forest of the night.

The use of images already familiar to a technical audience is also clearly a way to maximize impact and minimize delivery time.

Even with Blake and another example or two to lighten up the prospect of the following week's poem presentations, I am always uncertain of the students' attitudes toward this assignment. The challenge is clearly one of presenting the author's view in *only* his or her own words—a situation foreign to the analyst/ engineer. Not surprisingly, most students fail to rehearse sufficiently to present an unhesitant, logically continual delivery. A bright spot is that nearly all students have favorite poems. My first year's group caught me off guard: half the class recited interesting poems which they had written in high school (not college) English!

Perhaps we should try the same approach with graduate students. Would not our somnolent AIChE and ACS meetings profit by an occasional poetic rendering? As an example, a graduate student might recite *Fame's Penny-Trumpet* (Lewis Carroll, 1869) with a prelude that is still relevant for the 1990s: "Affectionately dedicated to all 'original researchers' who 'pant' for endowment." For a partisan view, we could hardly do better than the closing stanzas:

Deck your dull talk with pilfered shreds
of learning from a nobler time,
And oil each other's little heads
With mutual Flattery's golden slime:

And when the topmost height ye gain,
And stand in Glory's ether clear,
And grasp the prize of all your pain -
So many hundred pounds a year -

Then let Fame's banner be unfurled!
Sing Paeans for a victory won!
Ye tapers, that would light the worlds,
And cast a shadow on the Sun -

Who still shall pour His ray sublime,
One crystal flood, from East to West,
When ye have burned your little time
And flickered feebly into rest!

Doubtless, the now-attentive audience would offer other views.

FEEDBACK

"We learn by doing" seems to characterize most student evaluations; while each general assignment seemed plausible at the outset, the students usually saw the presentation possibilities and purpose much more clearly in retrospect.

What else to add? A semester of these round-robin presentations has several times led to enough group coherence that a student skit was suggested, as was the inevitable roast of the professor. In deference to pending exams, these suggestions were tabled. Clearly, I underestimated the theatrical interests of the students. Their enthusiasm for additional opportunities suggested that they may have come to look forward to oral presentations. On the next round, we will try the skit (memorize your own words), after the poems.

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ChE ***book review***

PROCESS DYNAMICS & CONTROL

by Dale E. Seborg, Thomas F. Edgar, and Duncan A. Mellichamp
John Wiley & Sons, New York (1989)

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Process control has been continuously evolving since its introduction in the chemical engineering curriculum during the late 1950s and early 1960s. Since then, each decade has been marked by a new textbook with significant market share. The 1965 book by Coughanowr and Koppel was perhaps the first of these. The market for this book was later split by the appearance of Luyben's book in 1973 and then largely supplanted in 1984 by Stephanopoulos.* The recent textbook by Seborg, Edgar, and Mellichamp

* By citing these, I don't mean to diminish the significant contributions of many others, including P. Buckley, N. Ceaglske, D. Eckman, P. Harriott, E. Johnson, D. Perlmutter, W. H. Ray, and T. Williams. These people and others wrote useful books that, for whatever reason, did not achieve broad acceptance as undergraduate course texts.

being reviewed here is clearly a successor to this list.

A Synopsis • This is a long and detailed book consisting of seven parts totaling 717 pages. The short first part describes motivations for process control, introduces block diagrams as a conceptual way to diagram the flow of information, and reviews aspects of process modeling. While there is a good bit of material here, one or two lectures should be enough for students familiar with dynamical modeling from their other coursework. The main point is that modeling for control purposes is different than modeling for process design or optimization. A different audience might spend more time reviewing this material at a more detailed level.

Part 2 of the book focuses on the transient behavior of linear system models. This is the part that contains the traditional detailed treatment of Laplace transforms, transfer functions, and the linearization of process models given as differential equations. This treatment does not reach for any high level of mathematical rigor, but it does include a rather complete discussion of how to execute the algebra for computing transforms and expanding by partial fractions. My students say that the discussion regarding linearization about an operating point is very helpful. Overall, these chapters are satisfactory from the point of view of the usual treatment of Laplace transforms. However, a course less mired in tradition could deemphasize the detail to focus more on the essential concepts of poles, zeros, and their qualitative effects on transient behavior.

Part 3 turns attention to the ideas of linear feedback control. Chapters 8 and 9 spend some time discussing practical issues of instrumentation and PID implementation. Subsequent chapters provide a conventional Laplace domain analysis of closed-loop stability, including the Routh condition, root locus, and some direct synthesis techniques. Relative to other books, an important addition in this text is the discussion of internal model control (IMC) in Chapter 12 and a comparison of IMC-inspired tuning rules with more traditional techniques such as Zigler-Nichols and Cohen-Coon. Chapter 13 is a nuts-and-bolts chapter that covers much of what is needed to tune and troubleshoot an existing control loop. This part contains very applicable material, even though the theoretical connections between time and frequency domain analysis are not well elucidated.

Part 4 focuses on the frequency domain interpretation of the Laplace transform, with particular attention on the Bode plot, stability margins, and frequency domain identification. In my experience, students find this treatment repetitious of Part 3, and it is not clear to them what practical advantage is gained. An instructor might wish to give an integrated presentation of the topics of Parts 3 and 4. In particular, I like to use the IMC framework as a starting point for the quantitative analysis of model uncertainty and its effects on closed-loop performance. Moreover, some of the advanced control techniques like time-delay compensation and prediction are much better treated from the IMC viewpoint. This approach, however, requires some supplementary materials.

Advanced control techniques are covered in Part 5. This includes a solid introductory treatment of multi-loop methods for feedforward design, relative gain array, and decoupling. Other important topics are discussed in a cursory way, including adaptive control, statistical quality control, and optimization. Also mentioned are expert systems, batch processes, and ladder logic. This is one of the few texts to even attempt to include some of this material, but at the level given, it would be difficult for instructors to build these topics into their courses in a detailed form.

Part 6 is an extensive, self-contained 170-page discussion of digital control techniques. On the positive side, a course emphasizing digital techniques could use this material as an alternative to Part 3. In a more balanced course, however, there is again a problem of duplication and repetitiousness. For example, some implementation details for PID control are described here for the third time in the book.

Part 7 concludes the book with an overview of developing control strategies for processing systems with examples. This is an ambitious goal, and it is certainly material that can bring a course to a solid conclusion, but there are only 27 pages devoted to it.

The book contains a substantial number of end-of-chapter problems. My students have found these well designed for the most part. The wide selection of problems makes it possible to give out different problem sets each year, which is one way to beat the dormitory filing systems.

Commentary • It is clear that this is an ambitious book containing a large amount of information—clearly too much to be covered in a single undergraduate course. The Preface makes clear that this was by design and suggests that the book be read in a "modular" fashion. Segments on the frequency domain and digital control, for example, could be omitted or included at the instructor's discretion.

My own feeling is that this sound practical goal

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neering professionals in general, as they are at present, we may see calculators aimed specifically at chemical engineers. Such a series of calculators might consist of a common hardware core, with large-capacity plug-in modules of extremely specific information and operations which customize the calculator for particular professions.

My own view is that the computing component of the engineering curriculum should include serious treatment of advanced calculators and that their use in all aspects of engineering education (including student performance evaluations) should be encouraged. I do not suggest offering a course specifically on calculator usage for two main reasons. First, how could one justify the selection of one brand over another, or indeed the selection of calculators *per se* over, for instance, spreadsheets as a topic worthy of instruction? Second, the utility of such material would rely heavily on existing technology which quickly becomes outdated, leaving the graduate no further ahead.

Rather than viewing this as just another subject vying for attention in an already overcrowded curriculum, perhaps it should be looked at as a way of legitimately easing the teaching load, alleviating the drag caused by those students who are currently overloaded with mathematical tasks of dubious educational value. In particular, using advanced calculators could give the instructor an opportunity to place greater emphasis on "what if"-type problems from which the students can quickly grasp the effect of varying the parameter values on the outcome of a solution without significantly increasing the time required for completing the assignment.

Certainly, the future of calculators is aimed at more comprehensive and sophisticated utility for the engineering professional. We should take them seriously. ❒

Cooperative Study Groups

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Review: Process Dynamics

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has costs and benefits. The most evident cost is that a sequential reading gives a repetitious treatment of some topics. Material regarding PID implementation is found in at least three different parts of the book. Stability is treated in different parts with distinctly different approaches. Counting the degrees of freedom in a process is discussed in both the first and last parts of the book. A more subtle penalty is that this already large book doesn't have room for more detail on some important topics. Anti-reset windup, for example, is mentioned in passing. Thus, an instructor has to carefully plan an approach to the book and what parts to emphasize or omit. Students also have to be patient with the discursive nature of the book.

Of course, the positive side of modularity is that the book can be adapted to a variety of uses. This is a strong feature, given that process control courses are often by academics who are not experts in the field. This is enhanced by the large set of well-chosen, end-of-chapter problems.

References to widely available tools for computer-aided control analysis are given in a separate appendix. Unfortunately, these are not incorporated into the text or problems. Matlab and its associated toolboxes have been widely adopted in many universities. A low-cost student edition of Matlab is now available which would be a good supplementary text for a course based on this book.

Process control is a rapidly growing subject driven by advances in computing technology, needs for improved process automation, and new theory. This text gives a contemporary overview in an accessible, teachable format. I suspect that the ideal turn-of-the-century course will deemphasize complex variables in favor of statistics, optimization, and model predictive control. But in the meantime, this book is a worthy competitor for market dominance among existing process control textbooks. ❒