less prestigious programs. Several factors may explain this phenomenon. On the one hand, the data suggest that the consistently high rankings of elite programs are due to the large number of graduates that those very same programs put into the discipline each year. While they place some graduates in other elite schools, most descend into mid-level schools or less renowned institutions where they continue to subjectively rank their alma maters as the very best. The high number of elite school graduates at all levels also seems to enable them to play a disproportionate role in shaping opinion within the discipline.

There is another way of explaining the relative stability in the ranking of elite programs over time. Obviously, there are not enough faculty from elite schools at middle and lower level programs for them to maintain the high ranking of their alma maters without some support from their non-elite colleagues. Tradition may be a partial explanation for the non-elite's acceptance of their inferior status. Elite schools have been accorded high esteem for decades, and these traditions typically have gone unchallenged.

A more likely explanation, however, is that the non-elite, in a classic example of Marxian *false consciousness,*[8] have adopted their elite peers' assessment that the latters' programs and faculties are superior. Buttressed by only a few subjective government surveys and contact with a handful of individuals from elite programs, the non-elite have not only accepted but also even promoted the notion that elite graduate programs are deserving of high esteem, whereas others, including their own, are not.

Ultimately, I think it should be asked: Are the eight highest-ranked programs indeed the best PhD programs in chemical engineering, or do they comprise an "academic elite" with a large number of faculty members in the discipline and an obvious interest in perpetuating the present ranking system? I believe that data suggest that the latter is true.

Two final comments seem in order. First, I contend that because of their subjectivity, current ranking systems are a detriment to the discipline. They may impede professional mobility, reward status over achievement, and result in programs of lesser renown being bypassed, even though they may merit as high or higher recognition than do those of the elite. Second, I believe that current, subjective ranking systems incorporate serious distortions and misrepresentations. Because they have the potential to do as much harm as good, I recommend that as they are presently constituted, subjective systems of departmental ranking should be routinely ignored.

Jeffrey H. Bair
Emporia State University
Emporia, KS 66801

1. *Changing Times,* p. 64-67, November (1983)
2. Jones, L.V., G. Lindzey, and P.E. Coggeshall, *An Assessment of Research-Doctorate Programs in the United States: Engineering,* National Academy Press, Washington, DC (1982)
3. Bair, J.H., W.E. Thompson, and J.V. Hickey, *Curr. Anthropol.,* **27**, 410 (1986)
4. Berelson, B., *Graduate Education in the United States,* McGraw-Hill, New York (1960)
5. Caplow, T., and R.J. McGee, *The Academic Marketplace,* Anchor-Doubleday, New York (1965)
6. Gross, G.R., *Am. Sociologist,* **5**, 25-29 (1970)
7. Schichor, D., *Am. Sociologist,* **5**, 157-160 (1970)
8. Marx, K., and F. Engel, *The German Ideology,* International Publishers, New York (1967) ❐

ChE *book review*

CHEMICAL AND ENGINEERING THERMODYNAMICS
Second Edition

by Stanley I. Sandler; John Wiley & Sons, New York; 622 pages and 5-1/4" diskette, $59.95 (1989)

Reviewed by
J.P. O'Connell, D.J. Kirwan
University of Virginia

This is the second edition of a text for undergraduate chemical engineers. As the author's preface points out, the objectives of both editions are the same: 1) to develop a course relevant to other parts of the curriculum, such as separations, reactors, and design, and 2) to present sufficient detail in a way that leads to good understanding and proficiency of application.

Distinctive treatments of the first edition included introduction of the mass, first, and second law balance equations in the same way (this may demystify entropy for some students). Also, treatment of the variety of phase equilibrium situations among solids, liquids, and vapors is more complete and more categorized than in other texts.

The major change from the first edition is the inclusion of BASIC programs for calculating 1) thermodynamic properties and VLE for pure and for multicomponent systems from a cubic EOS, 2) low-pressure VLE from activity coefficients from group contributions, and 3) equilibrium constants and stan-

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geneous Heating at Constant Pressure," in review.
17. Churchill, S.W., and L.D. Pfefferle, "The Refractory Tube Burner as an Ideal Stationary Chemical Reactor," *Instn. Chem. Eng., Symp. Series* No 87, 279 (1985)
18. Pfefferle, L.D., and S.W. Churchill, "The Kinetic Modeling of Combustion of Ethane Inside a Refractory Tube Burner," *Proc. World Congr. III of Chem. Eng.*, Tokyo, **4**, 68 (1986)
19. Pfefferle, L.D., and S.W. Churchill, "NO_x Production from the Combustion of Ethane Doped with Ammonia in a Thermally Stabilized Plug Flow Burner," *Combust. Sci. Tech.*, **49**, 235 (1986)
20. Pfefferle, L.D., and S.W. Churchill, "Effect of Fuel Sulfur on Nitrogen Oxide Formation in a Thermally Stabilized Plug-Flow Burner," *Ind. Eng. Chem. Res.*, **28**, 1004 (1989)
21. Aris, Rutherford, *Introduction to the Analysis of Reactors*, Prentice-Hall, Englewood Cliffs, NJ (1965)
22. Collins, L.R., and S.W. Churchill, "The Decay of Turbulence in a Tube Following a Combustion-Generated Step in Temperature," *Ind. Eng. Chem. Res.*, in press
23. Collins, L.R., and S.W. Churchill, "Effect of Laminarizing Flow on Post-Flame Reactions in a Thermally Stabilized Burner," *Ind. Eng. Chem. Res.*, **29**, 456 (1990)
24. Strenger, M.R., and S.W. Churchill, "Formation of NO_x and Burnoff of CO During Thermal Quenching of the Products from Combustion in a Thermally Stabilized Burner," *Twenty-Second Symposium (Intern.) on Combustion*, The Combustion Institute, Pittsburgh, PA (1988)
25. Strenger, M.R., and S.W. Churchill, "The Intensification of Heat Transfer in Transition from Laminar to Turbulent Flow," *Proc. Ninth Intern. Heat Trans. Conf.*, Jerusalem, Vol. 6, p. 199 (1990)
26. Strenger, M.R., and S.W. Churchill, "The Prediction of Heat Transfer from Burned Gases in Transitional Flow Inside a Tube," *Num. Heat Transfer*, in press
27. Churchill, S.W., "Thermally Stabilized Combustion," *Chem. Eng. Tech.*, **12**, 249 (1989) ❒

REVIEW: Thermodynamics

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dard enthalpy change for reactions as a function of temperature. Further, the units are now essentially all SI. There has been some rearrangement of material that includes putting fugacity earlier and devoting more material to EOS and high-pressure phase equilibria. Finally, there are revised examples and problems.

Over the years we have used different editions of the text in our own teaching. A recent experience was with students whose first course was in the engineering core, so this book was used for a subsequent chemical engineering course in chemical thermodynamics. Our opinions on the success of the book are similar. In general, the examples and problems are very good—they are challenging but consistent with the text. The exposure to all combinations of phase equilibria is highly desirable. Also, the programs included in the second edition can be quite useful to students in addressing real (and therefore complex) systems, as well as fostering an exploratory mode of how nature actually behaves. This is especially valuable for students who must encounter the idealized or limited nonideal descriptions of physical chemistry thermodynamics.

The connections of the text to other courses is difficult to measure. Our experience is that differences of approach and notation usually overwhelm the similarities that may appear to students in later courses unless the same instructor is involved.

The text does achieve a significant level of detail, but this often leads to confusion about the fundamentals. The dilemma of how many formulae to put into the hands of students is solved by using extensive tables of equations for different cases. Often, the student's reaction is to try to use these tables to look up a formula rather than to quickly derive the one they need for a problem. Another effect of this is to inadequately distinguish between fundamental concepts, approximate relationships, and specific illustrations. The result is that students become unsure of which are the big things that should be focused on and remembered. It also leads to a great deal of the material being strictly mathematical, with little physical connections that are either macroscopic or molecular.

Teachers will undoubtedly have differences with the author about his selection of correlations—that is inevitable in this area. In any case, the correlations are often presented without indication of whether they are to be used in real work or whether they are merely illustrative. The corresponding states treatment involves graphs from Hougan, Watson, and Ragatz containing Z_c, but equations containing the acentric factor. While the treatment for mixtures is complete, it is quite mathematical and follows a considerable discussion of the fugacity of pure components, so the whole exposition appears less focused than it might be.

All of the above issues may be dealt with by an experienced instructor who is comfortable with this difficult subject. In particular, highlighting the important material and simplifying complexities will be necessary. This takes a high level of concentration and a willingness to sacrifice some of the rigor of the text—this might ask for more commitment from students than they want to give. They will also have to deal with the text and the teacher appearing to conflict with one another.

The qualities of the text are numerous. It has been adopted in a limited number of situations, according to the latest AIChE Education Survey, and it is worthy of serious consideration at least as a reference. ❒