ACKNOWLEDGMENTS

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from our READERS

Lynn responds to Fredrickson

Sir: Dr. A. G. Fredrickson's essay "The Dilemma of Innovating Societies" (CEE, Summer 1969) points out a number of the problems facing our society today. The effects of increasing pollution, exploiting wilderness areas, and a rapidly expanding population are steadily making the world a less pleasant place to live. It was therefore a disappointment to see Dr. Fredrickson weaken the strength of his message substantially by overstating it in an emotional tirade against straw villains of his own construction.

It is, for instance, unconvincing to denounce the effects of man's activities on our environment by proclaiming a higher-than-human set of values. There is no reason to think that nature prefers alligators to algae, condors to crickets, or any of these to mankind. Such preferences are human value judgments and should be defended as such. The holier-than-thou stance only beclouds the issue.

If Dr. Fredrickson really questions the relative happiness of today's farmer astride his air-polluting tractor I would suggest that he try spending a summer of 12-hour days plowing behind a mule. A good look at Van Gogh's "The Potato Eaters" might also be instructive. The issue clearly is not one of slowing down technological innovation but rather of directing innovative efforts to the solution of the problems that are now becoming pressing.

It may be that society should have foreseen the urgency of these problems one or two generations ago. However, one should remember that 20-20 hindsight is a common virtue and also that no amount of castigation will change the events of the past. Emotional polemics directed against over-simplified whipping boys are highly favored today by political extremists of the left and the right, super-conservationists, gung-ho developers, and many others with a Cause. The trouble with such tactics is that they alienate those whose support might be won by a rational approach.

If the need to solve the problems arising from the growth of population and technology is real, and I believe that it is, then well reasoned arguments to this effect can surely be found. It is clear that we have or can develop the technology to solve these problems if we can get general agreement within our society that they need to be solved. Attaining such agreement will require persuasive leadership, factual knowledge, and considerable persistence. I submit that very few will be persuaded by being told that they are simpleminded votaries of the Cult of the Product, believers of the Creed of Technology, and preachers of the Gospel of Growth.

Scott Lynn
University of California, Berkeley

Corrections from Lee

Sir: Enclosed please find a corrected copy of the short article entitled *Transport Phenomena: Equations of Change*, which was printed in the summer, 1969 issue of CEE. Please note that equations 7, 9, 11, 15, 16, 17, 19, 20 are corrected, where originally either a small p (for pressure) is missing or is mixed up with ρ (for density).

V. J. Lee
University of Missouri

Editors Note: CEE regrets that Professor Lee did not correct this error on the galleys he received.

Praise from the Veep

Sir: I certainly appreciate receiving the copy of **Chemical Engineering Education** and was particularly interested in seeing the articles involving Stu Churchill.

A. L. Conn
Vice-President, AIChE

(Letters Continued on page 207)

equations for representing activity coefficients (van Laar, Margules, Wilson, NRTL, etc.) are discussed. Consideration is given to multicomponent mixtures and to systems with partial miscibility. The significance and uses of the Gibbs-Duhem equation are given special attention.

Section seven is an introduction to the theory of liquid solutions. Brief attention is given to the lattice theory of simple mixtures and of polymer solutions; emphasis is placed on the theory of regular solutions, on applications of corresponding states theory, and on the "chemical" theory of associated and solvated solutions. All theories are regarded critically; advantages and disadvantages are pointed out.

Sections eight and nine are concerned with the solubilities of gases and solids in pure solvents and in solvent mixtures. Physical and chemical effects on solubility are pointed out and special attention is given to the importance of the standard-state fugacity of the solute.

The course ends with a brief discussion of the uses of thermodynamics to describe systems at high pressure. Special emphasis is given to the important role of the partial molar volume. Vapor-liquid, liquid-liquid and gas-gas equilibria are considered.

As outlined above, the course appears to contain a lot of material. However, experience has shown that well-prepared first-year graduate students can handle the course without difficulty provided their total course load is not large. Typical first-year graduate students at Berkeley usually take only a total of two lecture courses plus one seminar course per quarter. Careful reading of the text (which was available in mimeographed form until its recent publication) is augmented with reading of "classical" original articles which are kept on reserve in the College of Chemistry library. Eight problem sets give the student practice in applying what he has learned to the solution of practical phase equilibrium problems. All problem sets are corrected by a teaching assistant and the more difficult problems are discussed in class.

The course provides a good partial foundation for subsequent graduate courses in separation operations, in process design and in medical engineering. For those students interested in doing research in molecular science and engineering it provides background and perspective for subsequent courses in statistical mechanics and in advanced chemistry, physics, and materials science.

The often-praised versatility of the chemical engineer, his ability to tackle a wide variety of new problems, is in large measure due to his knowledge of applied physical chemistry. Berkeley's course in phase equilibrium thermodynamics aims to contribute to that knowledge while at the same time providing the student with some of the skills for the practice of conventional chemical engineering.

LETTERS (Cont'd from p. 167.)

AN ADVENTURE IN TEACHING

Sir: During a recent conversation one of my graduate students described a course he was taking. The professor wrote everything down on the blackboard. He defined each symbol of every equation. Definitions were given of each technical word. Discussion was limited to students asking for clarification of the professor's handwriting. And then he added, "It wasn't like the Rate Processes course you taught last year". That had been an exciting learning experience for him. It had been the same for me.

I was teaching the second quarter of Rate Processes to first-year graduate students of varied backgrounds. In the first quarter we had covered the Momentum Transport section of "Transport Phenomena" by Bird, Stewart, and Lightfoot (BSL). This quarter I decided to teach Energy and Mass Transfer by the "row" approach. As the authors point out in the preface this alternate approach is suitable for graduate students. It emphasizes the type of transport and the analogies between the transport phenomena. Realistically it also eliminated the possibility that only a week or two at the end of the quarter would be left for Mass Transport.

The first topic covered was methods for predicting thermal conductivities and binary diffusivities. Since this touched on the area of my doctoral research, I added current literature methods to the text material and the students evaluated:

- Variation of thermal conductivity for sulfur dioxide, carbon tetrafluoride, and tungsten hexafluoride over the temperature range of 0 to 1000°C.
- Comparison of thermal conductivities of ammonia, carbon tetrafluoride, and hydrogen at three elevated pressures with experimental values.
- Variation of the binary diffusivities of tungsten hexafluoride and hydrogen fluoride over the temperature range of 0 to 1000°C.

Three lessons were learned from this exercise. First, beware of phase changes when computing transport properties (melting point of tungsten hexafluoride is 2°C and critical point is 178°C). Second, use of available sources of or estimation techniques for intermolecular force parameters. Finally, a feel for the accuracy of generalized correlations for transport properties.

Shell balances for simple energy and mass transfer problems (Chapters 9 and 17) came next. This was followed by the equations of change for nonisothermal systems and also the equations of change for multi-component systems. The latter topic stirred everyone's interest. One of the reasons, I guess, was because it was so difficult. Another reason was that we had finally arrived at equations which encompassed all of the fluxes that would normally be encountered in any problem. In other words these equations presented the whole story.

Up to this point the course had been interesting but very conventional. All of us had learned some new ideas. But the real breakthrough was to come. Unscheduled. Unexpected. A real example of serendipity in teaching.

An AIChE meeting was scheduled for St. Louis in approximately the middle of the quarter. I was planning on attending and was trying to figure out what the students should do in my absence. Sounds familiar, doesn't it? What I hit upon was to assign each student a paper to review. Since mass transfer seemed to be the area of highest interest, most of the papers were in this area. (See list of papers assigned). Some related to the students interests as I was aware of them. None were by BSL because this would have been unfair in the light of the review I requested. Here are the things I wanted them to include in a written review and also in a fifteen minute presentation before the class:

- Put the important equations and boundary conditions of the paper in BSL notation. Are these equations in BSL or what equations in BSL are they related to?
- What are the basic assumptions in the starting equations and do the authors clearly state them? What are the unstated assumptions?
- Prepare a clear diagram showing problem solved. Show concentration, velocity, or temperature profiles in diagrams.
- State the three most important contributions of the paper.
- Should BSL include results in revision of the textbook and why?

What a surprise I had in store when I returned from St. Louis! Fifteen minutes turned out to be woefully inadequate for any of the students to discuss their papers. I extended the time limit to an half hour. Even this proved inadequate. Discussion on some of the papers lasted as long as an hour after the formal presentation. This was exciting, I finally had to limit discussion so that all of the papers could be discussed within the quarter!

From this experience I gained new insight into what constitutes effective teaching. First, teaching was not my exclusive domain in the classroom. Students could teach one another and also they could teach me. In other words, teaching can be listening. How foreign that concept is among professors I've known. How foreign it was to me. Also, how threatening! Prior to this I felt that everything depended on my performance in the classroom. If I presented a well-prepared lecture, including good examples to illustrate the material, then students could learn. But I always had a gnawing feeling that there must be other ways and probably better ways of teaching. One of these is embodied in the concept of teaching is listening.

Secondly, students can evaluate themselves. Each student graded (anonymously) each talk. The average was their letter grade for the presentation. I was so awestruck by the talks I probably would have given them all A's. The students were more objective and gave an equal number of A's and B's. Grades which I gave on the written reports agreed very closely with those of the students.

Relevancy is an overworked word in today's student vocabulary. It denotes that classroom learning has meaning in or can be applied to the real world and its problems. Unexpectedly, this teaching adventure touched on something that was relevant to the students. We had all progressed to a common ground of understanding transport phenomena. With this each student attacked a paper in the literature and found that what we had learned applied to that paper. And each student could do his own thing within the guidelines laid down. Further each student had the opportunity to experience that greatest satisfaction of teaching; namely, to teach is to learn. Frankly, we need to share this sense of fulfillment with our students more often. In a future paper I'll tell how I did this with undergraduate students.

In closing let me share one of the other things my graduate student told me. He said that one of the students finished his report while I was away. He then cornered each of his classmates individually and went over his report with them soliciting questions and comments. As I recall his lecture was the best. More importantly, I know he had experienced an adventure in teaching.

PAPERS ASSIGNED

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Charles E. Hamrim, Jr.
University of Kentucky

(Continued on page 233.)

LETTERS (Cont'd from p. 208.)

Wills surveys publication frequencies

Sir: Publication of the results of their continuing research is a major responsibility of those holding academic positions in the field of Chemical Engineering. Frequently, and at least once a year during salary review, questions arise concerning these scholarly publications. Presumably both individuals and departments as a whole are evaluated. While it is possible to determine an average performance for an institution, for its component schools and departments, it is not ordinarily possible to compare individuals and departments with their peers (i.e., similar departments and disciplines at other institutions) even though this would be highly desirable. The deficiency in the use of peer-comparison is due to the lack of suitably detailed statistics for each discipline. The purpose here is to furnish the data necessary for peer-comparison in the field of Chemical Engineering.

Detailed reporting of publications by departments and by individuals is available for ChE for the two year period July, 1965 to July, 1967. The source of this information is the 'Directory of Graduate Research," published by the ACS. The information contained in this publication was solicited directly from all of the ChE departments in the United States offering graduate degrees.

While detailed information concerning publication records is available in the ACS "Directory of Graduate Research", there is no statistical correlation of these data. Given here is a correlation of these data. The publication records by professional rank are given in Figures

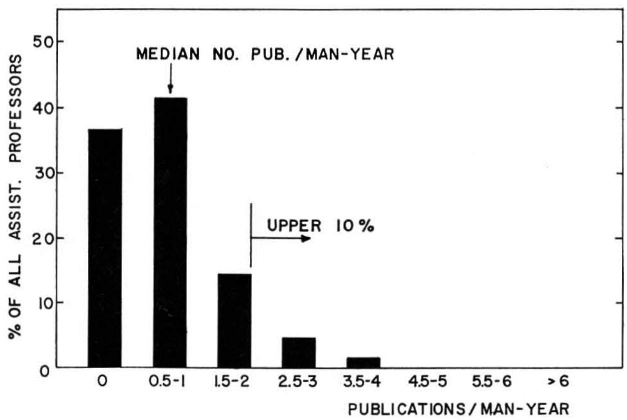

FIGURE (1) PUBLICATION RECORDS OF ALL ASSISTANT PROFESSORS OF CHEMICAL ENGINEERING

1, 2 and 3. Figure 4 gives overall departmental records. Table 1 gives additional information concerning the publication data.

It should be pointed out that the estimates of publications should be considered as slightly inflated due to the reporting of items that ordinarily would not be considered publications. However, some editing has been done in this regard and the distributions and averages shown should be substantially correct. Also, the data correlated reflect the period 1965-67. The decreasing graduate enrollments of the past two years may well result in a reduction in the current rates of publication.

George B. Wills
Virginia Polytechnic Institute

Table 1. Publication Rates in 78 ChE Departments

Professors	Number	Pub. per man-yr.	Remarks
Assistant	229	0.73	11.3% published 2 or more papers/yr.
Associate	216	1.09	10.2% published 3 or more papers/yr.
Full	308	1.95	10.1% published more than 4 papers/yr.
Avg. (78 depts.)		1.27	9.0% of all depts. pub. 2.25 or more papers/yr.

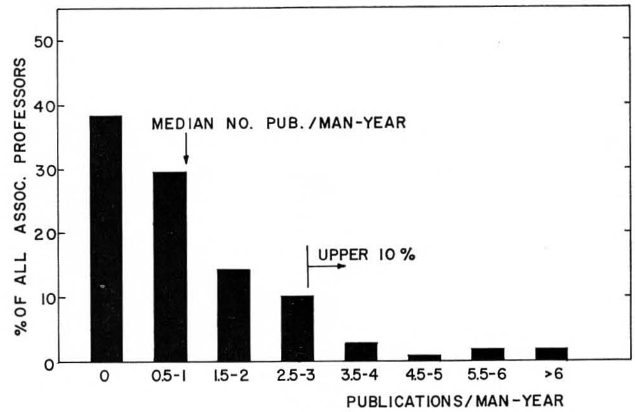

FIGURE (2) PUBLICATION RECORDS OF ALL ASSOCIATE PROFESSORS OF CHEMICAL ENGINEERING

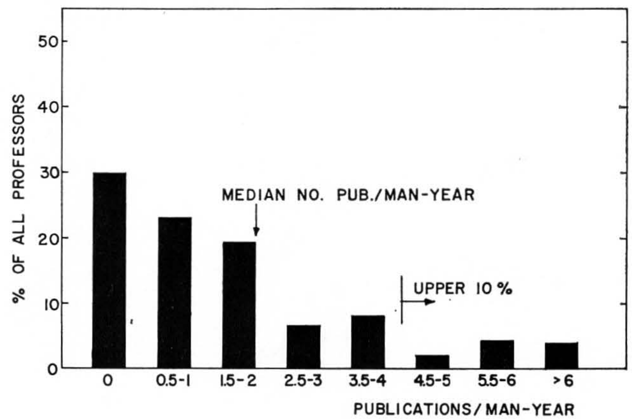

FIGURE (3) PUBLICATION RECORDS OF ALL FULL PROFESSORS OF CHEMICAL ENGINEERING

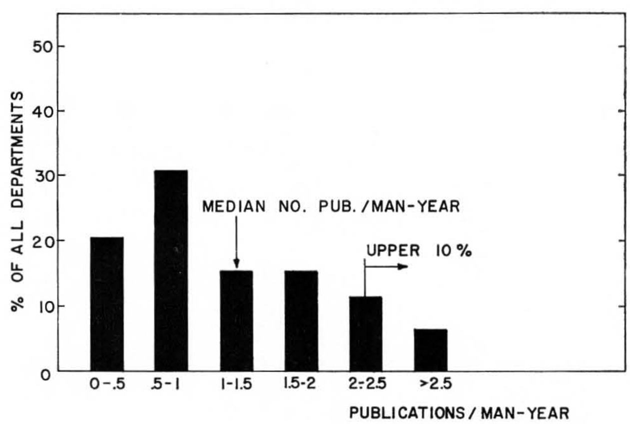

FIGURE (4) PUBLICATION RECORDS OF 78 CHEMICAL ENGINEERING DEPARTMENTS FOR 6/65-6/67 PERIOD