Random Thoughts . . .

HAPPY ANNIVERSARY, *CEE*

Richard M. Felder

In June 1962, the first issue of *Chemical Engineering Education* came out of the University of Connecticut (subscription price = $2/year), and I simultaneously came out of the City College of New York with my brand-new B.Ch.E. *CEE* and I have meandered along in a loose but enjoyable association since then. In the summer of 1969 I began my academic career at North Carolina State University and saw *CEE* for the first time, and my first contribution to the journal appeared in the Fall 1970 issue. I'm pretty sure you don't remember it (most likely because you weren't born yet), so I'll show it to you later. My first column, which dealt with the Impostor Phenomenon, ran in the Fall 1988 issue. Someone whom I've never identified decided to name the column series "Felder's Filosophy." I threatened violence, and the next 100+ columns were "Random Thoughts."

Comparisons between the articles in the earliest issues of *CEE* and those in recent issues fall into three categories: *same old same old*, *nobody saw it coming*, and *somebody saw it coming*. In the first article of the first issue, "Some thoughts on the trends in chemical engineering education," Barnett Dodge summarized and then sharply disagreed with a proposal by the president of the Carnegie Corporation to make the undergraduate engineering curriculum general, covering basic math, science, and humanities, and to move engineering content to a graduate degree program. Dodge argued that first, engineering students should be taught up front that solving real engineering problems requires mixing basic science and rigorous mathematics with simplifying assumptions, mathematical approximations, and empirical correlations; and second, keeping engineering students away from real engineering problems for three or four years will drive many good students away from the field. That debate has a familiar ring, doesn't it?

In contrast, the next article in that first issue was "Introduction to computer technique in stoichiometry," by Francis O'Connell, who suggested that digital computers might eventually have some useful applications in chemical engineering education. O'Connell described how he had his students program the trial-and-error solution of a material balance problem using machine language on an IBM 650 computer. I'm guessing that most readers considered the idea an interesting novelty, but thought that as in Kansas City, computers had gone about as far as they could go. Wrong! Seen many *CEE* articles about slide rules, adding machines, typewriters, and mimeographs lately?

And then there was a December 1962 article by Bryce Anderson, "Programmed learning in chemical engineering education." The idea was to present course material in a sequence of short steps, with each step consisting of one or two sentences and perhaps a figure followed by a question. The student would fill in the answer on a worksheet or feed it into a mechanical "teaching machine" and get feedback before advancing to the next step. Anderson noted that this teaching technique facilitated active student engagement, reinforced learning by providing immediate affirmation of correct responses and correction of wrong ones, and enabled students to learn at their own pace. Technology was being developed at the time to feed the information directly into a digital computer, which Anderson predicted would become the default approach to the technique. Today, computer-based multimedia tutorials are readily available in all subjects, and in the future they will inevitably dominate instruction in distance courses, MOOCs, blended learning, and flipped classrooms. In short, in the third issue of the first year of *CEE*, Bryce Anderson

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essentially forecast modern technology-based instruction and demonstrated a clear understanding of the cognitive basis of its probable effectiveness. He just had to wait three or four decades for the technology to catch up with him.

I'll skip over the next 53 years of *CEE*, pausing only to note three patterns of either change or consistency in the journal:

- The content of technical articles shifted from empirical treatments of historically traditional subjects (unit operations, fuels and combustion, polymers, metallurgy, engineering graphics) to engineering science (transport phenomena and computational fluid dynamics, materials science, computer-based process simulation and control), to an increasingly broad range of applications in non-traditional ChE fields (biotechnology, environmental science, alternative energy sources, microtechnology, nanotechnology, information technology,…).
- Articles on teaching methods slowly shifted from "We did this and it seemed to work well and the students liked it" to "We did this and it worked and here's how we know it worked" to "We did this, and here's why modern brain research says it should work, and here's how we know it worked."
- In the early years of *CEE*, articles stressed the need to (1) modernize the unit operations lab, the capstone design course, and the first year of engineering; (2) do something about serious under-enrollments in chemical engineering, a few years later do something about serious over-enrollments, and repeat; and (3) teach all first-year math courses ourselves because these students don't seem to have learned anything when we get them. Sounds like your last departmental faculty meeting, doesn't it?

Finally, I promised—or threatened, depending on your point of view—to share with you my very first contribution to *Chemical Engineering Education*, which appeared in the Fall 1970 issue. A slightly abridged version follows.

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A graduate student in your seminar on existential reaction engineering bursts into your office and announces that he has formulated a proof of man's nonexistence based on the known effects of diffusion in tubular reactors. All other thoughts are forgotten as visions of publications, promotions, awards, and enduring fame dance in your head. (You would, of course, acknowledge helpful discussions with the student in a footnote somewhere.) You casually express an interest, and the student promptly erases the irreplaceable notes on your blackboard and offers the following demonstration:

Consider a laminar flow tubular reactor in which a single first-order reaction occurs. Now

1. *Radial diffusion brings the reactor closer to plug flow, and therefore increases conversion. On the other hand*
2. *Axial diffusion brings the reactor closer to a stirred tank, and therefore decreases conversion. But*
3. *Radial diffusion can be represented as axial diffusion using the Taylor model. Therefore*
4. *Radial diffusion both increases conversion (from 1) and decreases conversion (from 2 and 3). The only way this can be the case, however, is if*
5. *Radial diffusion does not affect conversion at all. But we all know it does, and consequently*
6. *Radial diffusion does not exist. Moreover, by applying a coordinate transformation which maps the radius onto the axis and vice versa, it can easily be shown that axial diffusion also does not exist. In short,*
7. *There is no such thing as diffusion in tubular reactors. But everyone knows there is, and therefore*
8. *Tubular reactors do not exist. But I am certain beyond all possible doubt that tubular reactors exist, which can only mean that*
9. *I do not exist. Q.E.D.*

Sadly, you realize that any enduring fame you get will have to come from your process to manufacture sand from glass (patent applied for). Meanwhile, it's almost time for lunch, so you decide to ignore the student's philosophical fallacies and simply advise him where his engineering analysis (Steps 1–4) falls down. What do you tell him?

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And that's that. It's just one more illustration that in 50 years some things haven't changed in *CEE*: once a wise guy, always a wise guy. ❒

All of the *Random Thoughts* columns are now available on the World Wide Web at *http://www.ncsu.edu/effective_teaching* and at *www.che.ufl.edu/CEE.*