ChE classroom

A Course In CHEMICAL ENGINEERING EQUIPMENT

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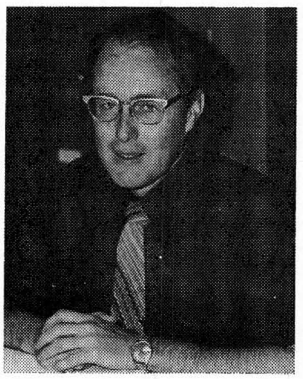

Bill Wilcox is Professor and Chairman of the ChE Department at Clarkson College of Technology. He received his B.E. from the University of Southern California in 1956 and Ph.D. in Chemical Engineering from U.C. Berkeley in 1960. He then spent 2 years at TRW Semiconductors and 6 years at the Aerospace Corp. Prior to coming to Clarkson in 1975 he was Professor of Chemical Engineering and Materials Science at USC.

IN 1976 CLARKSON sent a questionnaire to its alumni classes of 1959, '64, '69 and '74. Of the 123 chemical engineers that responded, 64% indicated that they thought their education should have included more applied practice and less theory. About 27% thought that their training was weakest in communication skills. No consistent trend in the responses was noted over the years of graduation.

The strong message to emphasize applications generated considerable discussion here. The science faculty interpreted this as a need for more science laboratory work, while our dean saw it as a call for more design work, and some faculty as an indication that the alumni didn't really know what was best. Consequently another survey was made of industrial recruiters, seniors, faculty, and alumni classes of 1952, '57, '62 and '67. They were asked to evaluate the importance of 14 educational parameters to career "success". "Laboratory assignments" was ranked last by the engineering alumni and 11th by the engineering recruiters, thereby killing that interpretation of the earlier survey. The alumni ranked "learning of communication skills" a very strong first, while the recruiters rated it equally high but exceeded slightly by "learning of technical knowledge." "Technical knowledge" was ranked 2nd by the alumni. Both groups ranked "learning to solve problems independently" as 3rd and "project exercises" as 4th. It is also interesting to note that "success" by members of the two older classes correlated most strongly with high ratings for the importance of "communication skills." The correlation coefficient was about 0.32. A negligible correlation was found for the two younger classes.

In considering how one might respond to the above results in ChE, I concluded that one applied area that has been increasingly neglected is the specification and selection of equipment. This is particularly distressing when it is realized that nearly all engineers are involved in the purchase of equipment at some time in their careers. The problem in teaching a course in equipment is that the modern Ph.D.-holding and research-oriented faculty member is seldom really qualified to do so. Rarely have we had any real experience in specifying and selecting industrial-scale equipment. It is virtually impossible to become familiar with the literature dealing with all types of equipment, much less to stay current with unpublished developments and innovations. Therefore, a course was designed in which roughly half of the class time was devoted to presentations by industrial equipment vendors and half to presentations by students.

INDUSTRIAL SPEAKERS

NINETEEN PRESENTATIONS were made by representatives from companies which manufacture and market equipment. Topics are summarized in Table 1. Naturally each speaker emphasized the advantages and strengths of his equipment and his company, but this was not done in an objectionable or overly biased fashion. Most

speakers recognized that the students knew little about their equipment and first introduced general operating principles. Some speakers presented economic comparisons of different types of equipment. The presentations most enjoyed by the students were those involving motion picture films, actual pieces of equipment, or working models of equipment. The presentations tended to run over 1 1/2 hours, which was too long for most students. In retrospect a 15 minute break would have helped to maintain interest.

Several "fringe benefits" accrued from having these visits by representatives from industry. In most cases they had been unfamiliar with Clarkson, and this served as an introduction not only to our department but also to Clarkson's Industrial Distribution program, which prepares students for careers in technical sales. (This introduction is especially meaningful when it is noted that most of the speakers held very responsible positions—one was president and part owner of his company, 3 were vice presidents, 9 were sales managers, and 4 were chief engineers or the equivalent.) Another benefit was to demonstrate to our chemical engineering students that technical sales is a respectable career. (Previously they appeared to regard technical sales as about the same as selling used cars.) During the course of the semester each of the 36 students was given the opportunity to have lunch with a speaker, thereby permitting informal career discussions. Added fringe benefits were discussions of the importance of foreign sales of equipment, the growing usage of stainless steel and other expensive materials, methods of interacting with vendors, ethics and legal aspects of equipment sales and performance, and OSHA regulations, especially those dealing with noise generated by equipment. In addition, some of the speakers spoke to our student AIChE chapter or presented a graduate seminar.

TABLE I
Subjects Covered by Industrial Speakers

- Agitation & mixing equipment
- Air filters (dust & particle removal)
- Compressors, fans and pneumatic conveyors
- Evaporators and crystallizers
- Filtration equipment
- Heat exchangers
- Particle sizing equipment
- Pressure and temperature regulators
- Pumps
- Recorders
- Vacuum pumps and dryers
- Valves
- Water analysis

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In attempting to more closely simulate an industrial environment, I wanted to avoid quizzes and examinations. The problem then was to ensure that the students would both attend the presentations and be attentive to the speakers. This was effectively accomplished by basing 1/4 of the grade on attendance and 1/4 on questions asked of the speakers. No attempt was made to grade the quality of the questions. This was greatly resented by those few students too self-conscious to expose themselves to ridicule for asking "dumb questions." The outside speakers were universally impressed by the interest shown by the students (they were not told that the students' grades depended on asking questions). Indeed it turned out to be necessary to limit the students to one question each per class period. Nevertheless a few students soon found that they actually enjoyed asking questions and would habitually exceed their "quota." In retrospect I believe it would have been better to grade the questions and to quiz the students later on material presented.

SPECIFICATION AND SELECTION MANUALS

EACH STUDENT WAS ASKED to prepare a manual on specification and selection of a different class of equipment (Table II). They were told to contact vendors via listings and advertisements in Thomas Register, Chemical Engineering Progress, the Chemical Equipment Catalog, and Instrument and Apparatus News. Subsequently each mail delivery brought great quantities of literature, much to the delight of the students. Additional information was obtained from books and from current magazines, such as Chemical Engineering. They were asked to include in their manuals descriptions of the different types of equipment, discussions of advantages and disadvantages, methods for sizing the equipment, a logic net for selecting the type of equipment, and an example selection and specification. Price data were also desired, but were generally not supplied

by the vendors, especially for custom-made equipment. Some assigned topics proved to be too broad and were accordingly reduced in scope at the discretion of the students.

I believe that feedback is vitally important for development of communications skills. Therefore the students were encouraged, but not required, to submit drafts of their manuals early and then to revise them for improved grades. The first drafts were disorganized, incomplete, and full of misspellings and incomprehensible sentences. Over 70% of the students did revise their manuals, at the very least correcting organizational and grammatical problems. However, because of the excessive procrastination of the students, most of the first drafts were submitted so late in the semester that little time remained in which to add new material. Seven of the students had no time in which to make even simple revisions. Two found excuses to delay preparation of their manuals until next semester. In retrospect I should have required frequent submission of portions of the manuals. One of our communications faculty has 100% success in having his students revise papers—he refuses to assign a grade until a paper is satisfactory.

As you can imagine, a great deal of my time was expended in marking these manuals. This time could have been reduced by:

- **More specific directions on how to organize and present a report, especially the proper format for citing references and for preparing a table of contents.**
- **Standard notation of marking papers, with a guide being given to each student. For example, a misspelled word could simply be circled, and a question mark used to denote an incomprehensible sentence or phrase.**

ORAL PRESENTATIONS

EACH STUDENT WAS GIVEN 25 minutes in which to present his or her manual and 5 minutes in which to respond to questions. An evaluation form was used by the other students and by me to judge the quality of each presentation. Most of the students took this evaluation procedure very seriously. Among other items, they judged how well the speaker held their interest, the clarity and probable utility of the material presented, and the English, confidence, and enthusiasm of the speaker. These evaluations of the oral presentations constituted 15% of each student's grade.

In addition to the specific points of evaluation made for each speaker, the audience was invited to make written comments on the backs of the evaluation forms. The students often detected faults that I had missed in the presentations. Occasional comments were made on personal appearance, although I had not specified dress for the presentations.

Since a few students did not take the evaluations seriously, in the future I plan to have each evaluator sign his name at the top of the form. To maintain anonymity the signatures will be cut off before the forms are given to the speaker.

TABLE II
Topics Covered in Students' Manuals

- **Agitators and mixers**
- **Boilers and heaters**
- **Classifiers**
- **Compressors and fans**
- **Controllers**
- **Conveyors**
- **Crystallizers**
- **Distillation columns (plate)**
- **Distillation columns (packed)**
- **Dryers**
- **Drying & filtration of gases**
- **Dust collection & particle scrubbing**
- **Evaporators**
- **Filtration equipment**
- **Flow measurement and control**
- **Gas chromatography**
- **Grinding, pulverizing, crushing**
- **Heat exchangers (air cooled)**
- **High pressure equipment**
- **High temperature equipment**
- **Level measurement & control**
- **Motors, gears, controllers**
- **Piping, tubing, joints**
- **Pollution control (SO_2)**
- **Polymer extruders**
- **Pressure measurement**
- **Pumps**
- **Refrigerators & cooling towers**
- **Safety equipment**
- **Tanks & vessels**
- **Temperature measurement**
- **Valves (gases)**
- **Valves (liquids)**
- **Water purification**

STUDENT EVALUATIONS

DURING THE LAST WEEK of classes a form was made available by which the students could evaluate the course anonymously. Eighteen (50%) responded.

. . . . students who had done well in other Clarkson courses tended not to like this course as well as those who did poorly, although those doing well in this course tended to like it. I was delighted at this outcome since the course had, in fact, been designed for the average student who dislikes theory and who will work in industry without attending graduate school.

When asked how the course held their interest in comparison to other Clarkson courses, 58% replied "better", while 22% responded "less". Interestingly the correlation coefficient r with the prior grade point averages of the students was −0.44, and with midterm grades for this course +0.47. In other words, students who had done well in other Clarkson courses tended not to like this course as well as those who did poorly, although those doing well in this course tended to like it.* I was delighted at this outcome since the course had, in fact, been designed for the average student who dislikes theory and who will work in industry without attending graduate school.

A similar result was obtained when the students were asked how useful they thought the course would be in their careers. About 78% thought it would be more useful than other courses, while only 1 student thought it would be less useful. The correlation with prior GPA was −0.40 and with midterm grades +0.35. When asked if they would recommend that other students take this course in the future, 72% said "yes", 22% were undecided and only the 1 said "no". The correlation of this response with prior GPA was −0.33 and with midterm grades 0.35.

About 61% of the students indicated that this course required about the same amount of time as other Clarkson courses, while only the one student spent less time. About 38% thought the speakers from industry were more interesting than Clarkson faculty, while 22% found them less interesting. The student speakers were rated as about the same as the faculty. When asked to name their favorite speakers from industry, all but three industrial speakers were chosen by at least one student. Not surprisingly, 44% of the students were opposed to giving an exam while 28% were in favor. Those in favor tended to be those who most disliked being graded for asking questions in class.

When asked to rank the value of the different parts of the course, the best rankings were obtained by "Preparing your manual," and a close second by "Making your own oral presentation." "Outside lecturers" ranked next, followed by "Listening to other students' presentations" and "Asking questions of speakers." By no means, however, was there agreement on the rankings. Individual rankings for "Preparing your manual" ranged from first to fifth, for example. As might be expected the correlation r with prior GPA was −0.54 with number of absences, +0.31 with the number of questions asked, and +0.48 with grades on the manual. It was a bit surprising to see that the correlation with scores on oral presentations was −0.15, *i.e.* there was a slight tendency for the poorer students to make better presentations!

Finally, I would like to quote some of the favorable remarks made by the students. (The unfavorable ones have been summarized in the foregoing).

"This course was definitely the best ChE course I've taken. I feel that it might be of some use in my future." "It was one of the most informative courses that I have taken, since it was about the only course which is practical instead of all theory. There should be more courses that are not based on theory only, since I have no idea what some of the equipment looked like, even though I might have designed some of it." "I think the course is an excellent idea for developing oral and written communication skills for chemical engineers. Very little attention has been given to these skills in previous courses. It would be a big mistake for the Chemical Engineering Department to drop this course,* for communication is necessary in industry. Even if the student were to take a speech course his ability to give technical talks would not improve." "More lunches with speakers." □

*Nevertheless when the final grades were computed, the correlation with prior grade point average was +0.53. The average grade given in this class was 2.5/4.0 compared to an incoming GPA of 2.69/4.0.

*We will offer this course every two years as an elective for both junior and senior engineering students.

ChE letters

Dear Sir:

Following the premature death of George L. Standart, we have taken over the editorship of CHEMICAL ENGINEERING COMMUNICATIONS.

This journal will continue publishing full-length research articles and invited review papers, but particular emphasis will be placed on printing short communications and letters giving preliminary announcements of new theoretical concepts, new experimental data, innovative experimental techniques or novel concepts in data correlation. All conventional areas of chemical engineering will be considered as well as topics in bioengineering, fluid mechanics, the molecular theory of equilibrium and transport properties, applied mathematics and computer-aided design.

We wish to facilitate and encourage a prompt and lively exchange of ideas emanating from diverse areas of chemical engineering since we feel that this will help to sustain the vitality of the chemical engineering profession.

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