We offer six elective courses—the students must take two. Three are aimed at graduate work; chemical equilibrium, applied chemical engineering mathematics, computer simulation. Three are more general; polymer science and engineering, statistical design and analysis, petroleum refinery engineering.

Our junior and senior laboratories are parts of definite course sequences. In this way, the theory and techniques the student learns in class are also studied physically in the laboratory. The students measure transport properties in the junior laboratory; the emphasis in the senior laboratory is on synthesis and application of students' knowledge to open-ended problems in chemical engineering.

Our students are taught how to use the computer as sophomores, and we are presently engaged in including computer applications in every undergraduate course. We have direct teletype input to the CDC 6500 and IBM 7094 so students can call programs at any time to calculate course problems.

Approximately one-fourth of our students participate in the Purdue Cooperative Engineering Education Program, spending alternate semesters in formal class work and in one of 44 industrial companies. The association with industry and actual problems is a very valuable addition to education. We find our co-op students appreciate the fundamental flavor of their academic work.

CHEMISTRY IS IMPORTANT

Chemistry, of course, is the distinguishing feature of a chemical engineering program, and competence in chemistry as well as physics and mathematics is the mark of a chemical engineer. Although we are often in the noisy minority concerning the role of chemistry in engineering, we firmly believe the difference is a necessary one. This tends to give us flexibility and identity as well as a spirit of independence from the remainder of engineering disciplines on campus. This attribute is of value in the performance of our job as liason between engineering and chemistry.

Looking back over these paragraphs and comparing them to the comments we have all heard, it is plain we are not "all things to all people." We have problems, certainly—of time, facilities, financing. These we live with and strive to change, as did our predecessors and as will those who follow us.

But we do believe scholarly activity and teaching at a university must go hand-in-hand. We do believe the best education is one based on science and engineering fundamentals. We are convinced we must show the student the best way to use these fundamentals and implant in him the desire to continue to learn throughout his professional career.

ChE views and opinions

ON THE RECRUITMENT OF CHEMICAL ENGINEERS

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Professor Metcalfe in his excellent article "Where Are The Engineers" proposes that we reverse the trend of "declining acceptance of engineering as a course of study" by "stronger recruitment and greater retention of entering students."* This is a very popular viewpoint. The "grass roots" approach is strongly endorsed by the AIChE, as has been pointed out by Kuebe and Kovacs "More Chemical Engineers Necessary: A Problem in Career Guidance."**

* T. B. Metcalfe, CEE, 2, 142, (1968).

**W. R. Kube and W. L. Kovacs, CEP, 64, No. 68, 95 (1968).

Since past recruiting efforts have met with only very limited or, at best, local success, it seems appropriate to question the efficacy of this approach. (There may also be a question of ethics, but this is admittedly a highly debatable point.) Personally, I am unenthusiastic about recruiting activities because 1) in the long run, all competitive advertisement must be self-cancelling and 2) it has diverted our attention from the real problem; one does not find a cure for a disease by looking at the symptoms.

The average American engineering students of the forties and fifties were first-generation college students from 'blue collar' homes. The status of being an engineer and the attending salary were very meaningful to this "upward

Professor Henley urges:

- **Full implementation of ASEE Goals report, followed by the establishment of engineering graduate schools on a professional basis.**
- **More versatile undergraduate programs, designed to attract the sons and daughters of college graduates and to encourage newer graduate research areas.**
- **Stronger chemical engineering graduate programs in environmental, microelectronic, biomedical, or ocean engineering.**
- **AIChE disapproval of graduate work in deparftments that have less than thirty graduate students and ten faculty members.**
- **The requirement of one year of introductory undergraduate work in the U. S. before admission of foreign students to graduate school.**

mobile" segment of the population. It is my contention that one of the primary defects of our present engineering programs is that we are still attracting primarily this shrinking segment of the college population. We are failing to 'trade up.' We are not attracting the sons and daughters of college graduates. The engineering college at too many of our 'prestige' universities has become the campus stepchild.

As a group, we appear to be caught in a quagmire of reactionary thinking, and I fear that unless we take a few risks and make fundamental changes, our programs will not attract the type of students we want and industry needs. Unfortunately, too many of the students we have now in engineering have a clearly defined, bread-and-butter attitude toward their studies. *We need a few hippie types !*

As Professor Metcalfe clearly points out, the growth has moved away from the traditional engineering fields. Chemical engineering is losing its viability, and the sitution is deteriorating, not improving. It is sad to note that the number of chemical engineering departments that have been able to make contributions to, or to mount significant programs in the newer fields such as environmental, microelectronic, biomedical, or oceanographic engineering is close to zero. What is even more deplorable is the large number of departments which have started programs in these areas and failed, or even worse, have inadequately staffed and funded programs. By and large, we have not succeeded in creating an environment in which new programs can become self-sustaining.

Having stated, in a general way, the malaise from which we suffer, I would like to briefly pinpoint some of the more serious illnesses in our current graduate and undergraduate programs and some of the things we can do to correct them. Most of these problems are cited and documented in the ASEE Goals Study whose critics have chosen to adopt an "I'm all right Jack" attitude even though it is abundantly clear that we are not attracting the type and numbers of students the industry needs.

- **Graduate Programs** — The majority of graduate programs are too small, too fragmented, and too undernourished to offer its too-few sturents an exciting educational experience, or the opportunity to do meaningful research. Too many of the student research projects produce information which is new to the student, but of questionable value to the skilled practitioner. The student knows this, and is discouraged by it. As a symptom of this situation, consider the desultory chemical engineering seminar as it exists at too many institutions; student participation is practically nil; the majority of the staff does not attend.

The bread-and-butter aspects that characterize undergraduate education at many schools has infiltrated a large number of the graduate schools. The situation is appreciably aggravated by the high percentage of foreign students at many schools. It is my contention that the majority of the Asian foreign students should be admitted to graduate school only after first completing one year of indoctrinary undergraduate work in the United States. The very large percentage of foreign students (greater than 20 percent) at some schools is unhealthy; they cannot be assimilated. A young professor from a university in Missouri told me that when he tried to recruit one of his own seniors for graduate school the boy turned to him and said, "Gee, Professor, I thought graduate school was only for foreign students!"

Many of the difficulties stemming from the lack of excitement and intellectual stimulation at many engineering schools could be surmounted by increased institutional specialization and a more general pooling of resources. A five man department with research specialties in fluid dynamics, control theory, air pollution, kinetics, and mass transfer probably has no viable program in any of these fields; a department with five men working on related catalysis problems

Our average graduate has had the benefit of neither a sound cultural nor a good scientific education. He is as ignorant of lasers and holography as he is of music and poetry.

should achieve a leading position in its field. (As a point of fact, I do not believe that the AIChE should permit graduate work in departments that have less than thirty graduate students and ten faculty members.)

We should also recognize that students who are taking three or four stiff courses cannot simultaneously do good research. We are making a rat race out of our graduate programs by overloading the students to the point where they have no time for outside reading or the pursuit of intellectual interests.

• **Undergraduate Programs** — Too often these represent academic straight jackets and, as such, are outmoded and rejected by the type of students we would like to have. Our average graduate has had the benefit of neither a sound cultural nor a good scientific education. He is as ignorant of lasers and holography as he is of music and poetry. His education lacks versatility.

The undergraduate students' lack of versatility is a major contributing factor to the inability of graduate engineering departments to move into new academic and research areas. Whether we like it or not, we are trapped in a cycle which has proven veritably impossible to break. It is very difficult to convince a chemical engineer graduate student to do research on anything except heat, mass, and momentum transfer, control, or kinetics.

I believe that many of the major problems discussed here can be alleviated by the full implementation of the Goals Report, followed by the establishment of engineering graduate schools on a professional basis. Michigan State's success in attracting an increased number of students following a major curriculum reform holds a lesson for all of us.* The recent liberalization of course requirements at Michigan, Northwestern, Minnesota, Ohio State, Pennsylvania, and Lehigh are salutory. Failure to make major changes in our programs and our approach to engineering education must result in a continuing erosion in the quality and quantity of students attracted into engineering in general and chemical engineering in particular.

*C & E News, Aug. 28, 59, (1968).

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