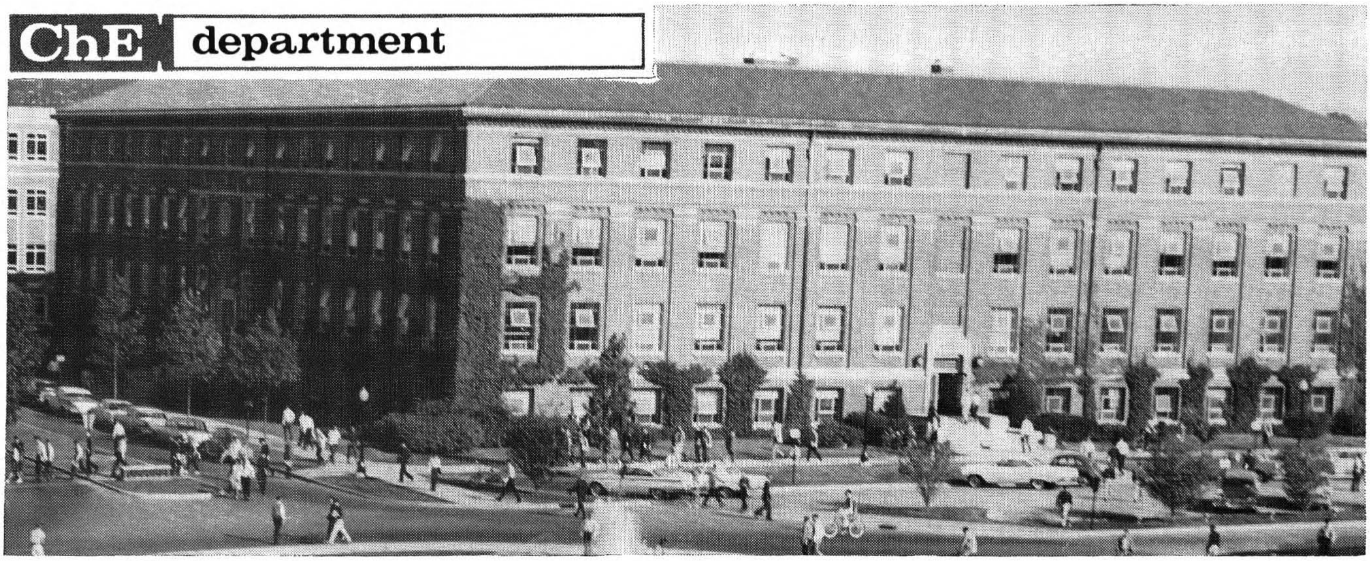

HAIL PURDUE!

CEE features a large state university that emphasizes both undergraduate and graduate education.

ROBERT A. GREENKORN, *Chairman*

"All that professors worry about is research and pubilcation."

"PROFESSORS SPEND TOO MUCH TIME IN CLASS."

"Students don't even know what a reboiler looks like!"

"Chemical engineers do not have enough mathmatics to keep up with other engineers."

"I NEVER HAD DIFFERENTIAL EQUATIONS — WHY DO STUDENTS NEED THEM NOW?"

"Economics is important; engineering is using money."

"Engineering is science."

"WE MUST HAVE DISTINCT DISCIPLINES!"

"Core programs are best."

And so it goes. When one collects a week's worth of comments from colleagues, students, industrial visitors, professors from other departments and other universities, and the man on the street, the sum equals quandary.

HOW DO YOU EDUCATE A CHEMICAL ENGINEER ?

What is the best way for a professional school to educate a young man or woman to become a chemical engineer? Obviously, there is disagreement among the people involved and opinions continually change. To use current jargon, we must try to optimize the situation. What follows outlines briefly our approach at Purdue and, though we are sure it is not a stationary point, we believe it is a sound intermediate one.

We believe the major educational problem facing us is to prepare students not only for immediate entry into professional activity but for remaining effective in a rapidly advancing technological community. We believe students must be given an education solidly rooted in the fundamentals of science and engineering rather than a mere capability for manipulating current methods. To make certain they are capable of extending their scientific and engineering knowledge throughout their careers, they must be taught how to appy fundamentals to new problems.

Students must associate with teachers who are themselves students, engaged in day-to-day learning through scholarly activity. This requires a strong commitment of the faculty to individual and cooperative research, so the excitement of discovery and learning can cascade from individual professors into the graduate and undergraduate programs. We agree with those who believe it is not desirable, nor probably even possible, to separate research and teaching and still maintain the scholarly atmosphere necessary to prepare students for today's technology.

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RESEARCH INTERESTS ARE VARIED

Our faculty's research interests cover the areas of adaptive control, equilibrium properties of mixtures (both gas and liquid), surface reaction mechanisms of catalysis, transport in dispersed systems, rheologic and fluid flow studies with special emphasis on pulsatile flow and unsteady state systems, mathematical modeling and experimental analysis of process kinetics, and the physical and chemical characteristics of multicomponent systems.

Currently, for example, one of our staff members is forming a series of algorithms for the control of distributed systems; another is measuring partial volume at infinite dilution to determine the component properties of mixtures; a group is studying the meaning of the dispersion tensor in non-uniform, anisotropic porous media. A special laboratory is being built by one of our faculty for measuring the surface properties of catalysts. A few other examples of current research are: the effect of reactor surface on process kinetics; application of hybrid computer for chemical process simulation; the study of heat transfer to bubbles rising in fluidized beds.

In our research efforts we are loosely organized on a group basis so that professors who have a common interest may share projects, and, in addition, carry out their own individual research.

For example, we have a group collectively studying transport in dispersed systems. It happens that much of the mathematics and statistical modeling for individual studies in this area—those for porous media, dispersion of drops, and fluidization of solid particles—have a common base; here we work together. We go on from there to work individually. The result is a saving of time, sharing of experience, more efficient use of equipment—and, we think, a broadening of the experience open to students. The value of the system—for both students and faculty—is also amplified by the ability to have group seminars which become more workable because of the sharing experience.

Graduate studies are not simply a continuation of the scheme of undergraduate education at a more advanced level, such as might be achieved by a prescribed curriculum of advanced courses. Rather, each student works out his own program of self-education to meet his own special interests and needs. Apart from the student's efforts to become professionally competent, he seeks to develop and utilize his own intellectual and creative power and thus make his maximum contribution to society.

We are fortunate that the nine schools and departments in the Schools of Engineering at Purdue have the opportunity to engage in interdisciplinary research with each other and with several special organizations such as the thermophysical properties research center, the laboratory for applied industrial control, the jet propulsion center and the bioengineering group. Thus, our faculty and students are exposed to a broad category of facilities and problems.

UNDERGRADUATE PROGRAM IS IN SEQUENCES

We have organized the chemical engineering part of the undergraduate program into five sequences: transport; thermodynamics and kinetics; control; design, computer applications, and optimization; and electives. We are fortunate that our senior class usually numbers about 100, enabling us to offer a series of elective courses designed either to prepare students for graduate school or for more intensive study of topics not fully covered in the normal sequences.

While we have adopted the transport approach to teaching physical operations, we have turned it around. We teach stage operations first, the transfer operations, then the physics of transport phenomena—the integral balances before the differential balances. We believe the student will get a better hold on the whole subject this way.

For our control sequence, we have a somewhat unusual laboratory which features several micro experiments, an all-purpose experiment, and analog computing equipment which may be used for adaptive control of these experiments.

We have broken our senior design sequence into two courses—the first of which emphasizes the modern mathematical tools of economics and optimization while the second course includes the strategy of design and three different types of computational sections from which the student may choose: one emphasizing computer simulation; another, the more classical approach to the design of several small processes; the third, a large case study brought in by an industrial practitioner.

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