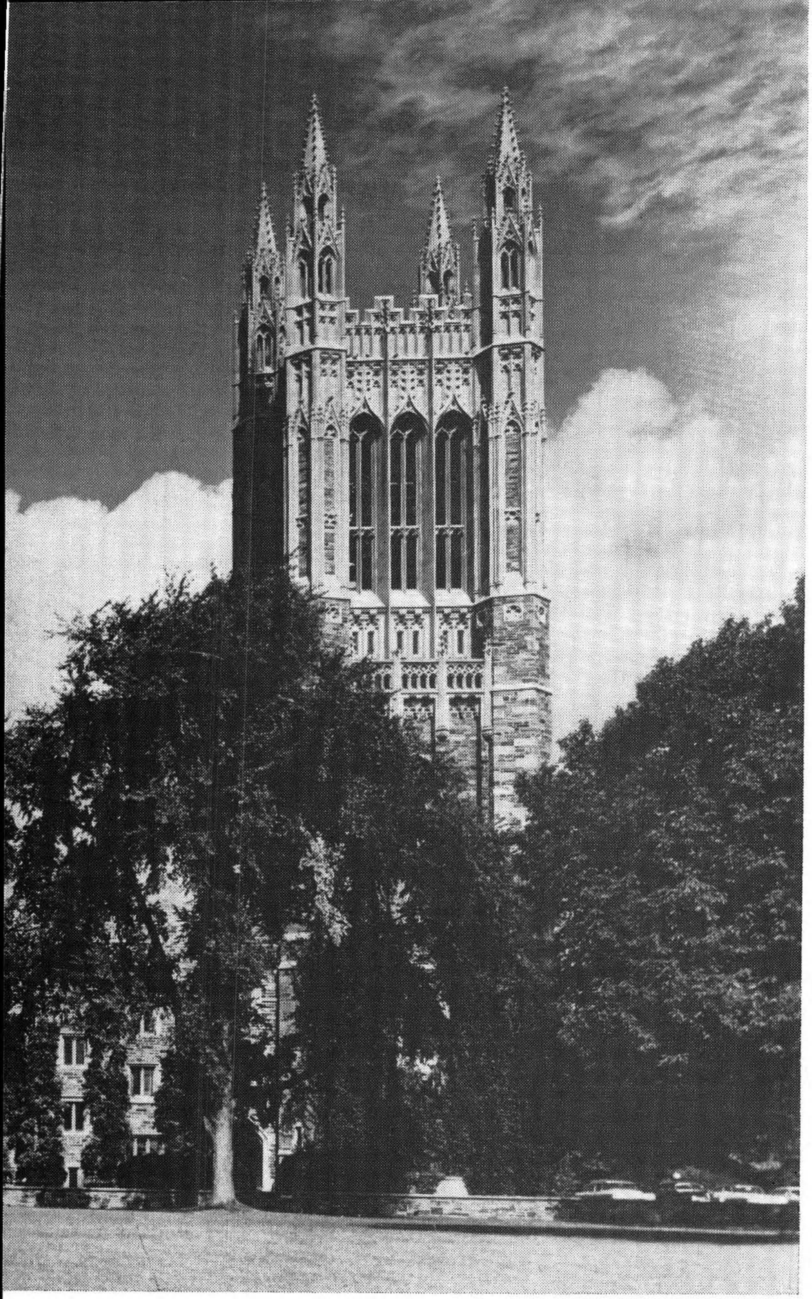

ChE department

PRINCETON

This article on a top-rated department was written for CEE by "A. Committee"

"[In the face of financial adversity] we are determined to maintain the quality of Princeton as a university committed to providing excellent undergraduate and graduate programs in carefully selected fields." These recent words of the current Provost and President-designate provide a succinct statement of Princeton's agenda for the 1970s.

Much of Princeton's attractiveness derives from its size—less than 5000 graduate and undergraduate students—and its location—a town of 25,000 in exurban New Jersey, between New York and Philadelphia and fifty miles from each. The University's unique character, however, stems from dual objectives: (1) to provide an undergraduate education of high quality with the close student-faculty interaction usually found only at small liberal arts colleges, and (2) to attract faculty and graduate students who will make significant, original contributions to fundamental knowledge.

The firm and long-standing commitment to the "teacher-scholar" idea may seem romantic, even anachronistic, to those weaned at the multiversity but the University's success in meeting its objectives is undeniable. As one peruses the catalogue, he cannot but be struck by the imposing number of distinguished faculty members in subjects as disparate as Astrophysics, Music and Economics. Yet the entire faculty is small enough to meet once a month to act on matters of University business. Such cohesiveness (and democracy) is particularly important to the School of Engineering and Applied Science, as is the Administration's strong commitment to the importance of technology in modern society.

Despite a growing, national bias against technology, there is a grudging recognition of the requirement for technically trained people, willing and able to apply their skills to a broad range of national and international problems. Equally pressing is the need for a technologically aware, educated citizenry. A tentative step in the latter direction is underway at Princeton, which is attempting to make the School of Engineering and Applied Science more accessible to students who are not planning engineering careers. The School intends to mount courses that will draw substantial elections from the student body as a whole. Though quantitative, these courses will place the opportunities and problems of a technological age into an historical and sociological perspective.

Instruction in engineering at Princeton dates back to Cyrus Fogg Brackett and, indeed, the School will observe its first centennial during 1973. The Department of Chemical Engineering was founded in 1929 by Sir Hugh Taylor, then Chairman of the Chemistry Department and later Dean of the Graduate School. Taylor's choice for

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the first chemical engineering faculty member was his former student, Joseph C. Elgin. Standing witness to the wisdom of that choice is Joe Elgin's distinguished career as a chemical engineer and as Dean of Engineering from 1955 until 1971.

One of Joe's prime achievements as dean was the conception and building of the Engineering Quadrangle, first occupied in 1962. While local critics may decry the Quadrangle's exterior as deriving from the Women's State Prison style of architecture, the interior is modern and functional and the whole surrounds a lovely interior courtyard. The latter is replete with towering birches and pines and is graced by a modern bronze sculpture of startling aspect ("That thing has at least six rear ends," was the pungent assessment of the late Richard Wilhelm). Twice during the past year the student AIChE chapter has hosted the faculty and staff of the Department for broiled hamburgers in the courtyard, just upwind from that sculpture.

The Chemical Engineering Department initiated the first engineering doctoral program at Princeton in 1942 and graduated its first PhD in 1947. A quantum jump in the strength of the graduate program, as well as the major part of the faculty's expansion to its present size, took place during Dick Wilhelm's chairmanship from 1955 until his death in 1968.

THE FACULTY

The Departmental faculty spans a wide spectrum of backgrounds, personalities and research interests. Five took their terminal degrees in chemistry, one in mechanical engineering, and one in physics. Seven have spent a significant portion of their careers in industry; several spend summers in cooperative industry-university programs; active consulting practices serve to keep many attuned to contemporary problems and opportunities in industry and government.

The close-knit, integrated character of the University is accentuated in the microcosm of the Department where the student/faculty ratio is particularly low—about 6:1 counting both graduate and undergraduate students. An easy informality exists between students and faculty, and the relationship is closer to one of companions in learning than of pupil and master. In the Departmental research laboratories one frequently sees faculty members, undergraduates and graduate students working together. The same familiarity extends to the tennis and squash courts; to several annual, intra-departmental tests of alcoholic capacity; and to the Department's most recently organized sub-unit, a rock music group called "Pegasus".

Egalitarian principles govern the assignment of both graduate students and of seniors for independent work. For example, assistant professors comprise approximately 30% of the current faculty and supervise approximately 30% of both graduate and undergraduate dissertation research. Both groups of students are given a wide latitude in their choice of research topics and for many years the split between experimental and theoretical work has been roughly 50-50.

THE GRADUATE PROGRAM

The Department offers two programs of graduate study, one leading to the degree of Doctor of Philosophy, the other to that of Master of Science in Engineering. Although most of the 50 to 60 students in residence are doctoral candidates, the number of students who elect to terminate at the masters level has risen in recent years reflecting changing patterns of need in industry and research organizations.

The only requirements for the masters degree are the successful completion of six courses, not specified except that they must be at the graduate level, and the submission of an acceptable thesis. These requirements can be met readily in one calendar year.

There are no course requirements for the doctoral degree, but the candidate must demonstrate a broad grasp of chemical engineering in the general examination, an ability to translate scientific material in a modern foreign language, and competence and creativity in research not only in the dissertation but also in the preparation of a major research proposition in an area of chemical engineering different from that of the dissertation. The candidate must present a regular departmental seminar on the dissertation and

Following is a current faculty roster along with primary research interests and a hopefully not too immodest mention of monographs, books and awards.

R. P. Andres—Associate Professor. Kinetics of gas phase reactions; nucleation phenomena, molecular beams.

R. C. Axtmann—Mobil Professor of Chemical Engineering for Environmental Science. Environmental studies; energy conversion; radiation chemistry; Mossbauer effect. Editor of and contributor to "Rescuing Man's Environment: Nine Essays on Environmental Reform."

J. K. Gillham—Associate Professor. Polymer chemistry; mechanical spectroscopy of polymers.

E. F. Johnson—Professor and Director of Graduate Studies. Automatic process control; thermonuclear power generation; chemical kinetics. Author of "Automatic Process Control."

M. D. Kostin—Associate Professor. Chemical kinetics and thermodynamics; bioengineering.

L. Lapidus—The Class of 1943 Professor and Chairman of the Department. Optimization and control; numerical methods. Author of "Digital Computation of Chemical Engineers," "Optimal Control of Engineering Processes," "Numerical Solution of Ordinary Differential Equations." AIChE Professorial Progress Award (1966); ASEE Distinguished Lecturship in Chemical Engineering (1965).

B. Maxwell—Professor and Chairman of the Polymer Materials Program. Mechanical behavior and properties of polymers. Designer of the Rheometer that bears his name.

D. F. Ollis—Assistant Professor. Catalysis; field ion microscopy; biochemical technology; enzymes.

L. Padmanabhan—Assistant Professor. Optimal control and stability.

L. Rebenfeld—Visiting Lecturer with the rank of Professor and President of the Textile Research Institute. Structure and properties of polymeric fibers.

D. A. Saville—Associate Professor. Fluid mechanics; interfacial phenomena; electrohydro-dynamics.

W. R. Schowalter—Professor. Fluid mechanics; rheology; multiphase flows. ASEE Distinguished Lectureship in Chemical Engineering (1971).

N. H. Sweed—Assistant Professor. Separations; parametric pumping;: reaction engineering.

R. K. Toner—Professor and Assistant Chairman. Co-author of "Conservation of Mass and Energy."

J. C. Whitwell—Professor. Physics and chemistry of fibers; statistics. Co-author of "Conservation of Mass Energy." Western Electric Fund Award for Excellence in the Instruction of Engineering Students (1972).

G. L. Wilkes—Assistant Professor. Physical chemistry of polymer materials; biological materials.

Professor J. C. Elgin, former Dean of the School of Engineering and Applied Science, teacher, scholar, recipient of the W. H. Walker Award of the AIChE (1957) and the Lamme Award of the ASEE (1969), is retiring this June after 43 years at Princeton.

defend the dissertation and the proposition in a final public oral examination. Each candidate must also serve one term as a part-time assistant in instruction. Since no work is required of the student beyond the meeting of his or her degree requirements, the residence time for the doctoral degree is relatively short, typically three and a half years from the baccalaureate.

The variegated research interests of the faculty are, of course, reflected in the broad range of research conducted by graduate students for their dissertations. Some of the researches are conducted in cooperation with related programs and agencies such as the Textile Research Institute, the Polymer Science and Materials Program, the Center for Environmental Studies, and the Program in Applied Mathematics.

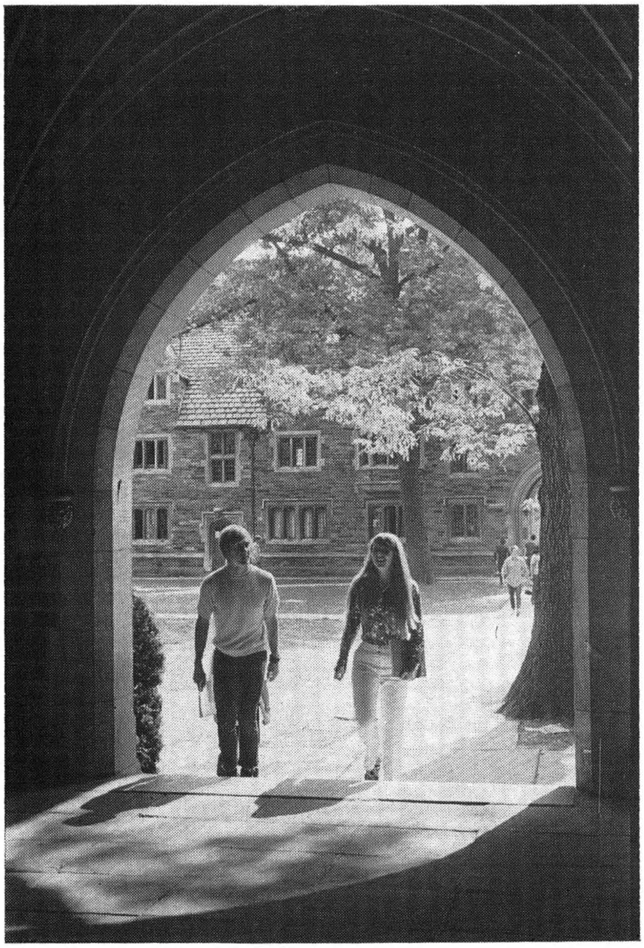
Although the doctoral program is firmly focused on research, to assure continuing intellectual growth all students are encouraged to take courses regularly both within and without the department. No grades are reported for departmental courses; an internal record of performance is maintained only for first year courses so as to help the student in preparing for the general examination.

The graduate students come from a wide variety of backgrounds and schools, except, by longstanding departmental policy, they do not include Princeton undergraduate alumni. Roughly a third are foreign nationals and males predominate in numbers, but not in talent nor in beauty.

Unmarried graduate students live at the Graduate College, a handsome Gothic complex in which students of all disciplines have opportunities to interact intellectually and socially. Medieval customs persist there; for example, students wear academic gowns (some of uncertain hygenic condition) at the evening mean.

Married graduate students live in University apartments at one of two sites on the perimeter of the campus. The residential character of the University and the relatively small size of the Graduate School (circa 1400) make possible the housing of most of the graduate student population on or near the campus.

A large fraction of the graduate alumni have entered teaching and now may be found on most of the faculties of the major departments of chemical engineering in the United States and Canada.



A non-inclusive list of distinguished teacher-alumni might count Cohen of Pennsylvania, Deans of Rice, Dranoff of Northwestern, Gilbert of Nebraska, Grethlein of Dartmouth, Hanratty of Illinois, Lamb of Delaware, Manning of Tulsa, Prausnitz of Berkeley, Quinn of Pennsylvania, Schiesser of Lehigh, and Weaver of Tulane.

Even larger numbers have gone into industry where many have risen to high levels of corporate responsibility. Others have joined consulting organizations, national laboratories or governmental units, while some have become business entrepreneurs, financial specialists, lawyers, physicians, and clergymen. Finally, there is a persistent report that a Princeton PhD in chemical engineering now serves as short-order cook at a pancake house in Providence, although no strong effort has been made to verify the rumor.

THE UNDERGRADUATE PROGRAM

An undergraduate chemical engineering student has many interests. As do his peers, he wants to participate in extracurricular activities, and he does. He will be found on the athletic field, in band and glee club, in undergraduate government, and he has distinguished himself in all of these and similar groups. However, his principal reason for attending college is to obtain an education, and so naturally his primary concern is with the curriculum.

The undergraduate chemical engineering curriculum may be considered as a tree with 38 components. The roots are eleven courses in mathematics, chemistry, and physics. These supply the theoretical sustenance for the main trunk of eight required departmental courses in the areas of mass and energy balances, staged operations, transport phenomena, thermodynamics, kinetics, and design. Such a program provides the student with the necessary education to enter graduate study or to begin an industrial career. The remaining 50% of his curriculum is either elective (complete freedom of choice) or selective (choice within categories). At least nine of these choices are technical, and the student may utilize them in one of two ways.

To continue the arboreal metaphor, if he wishes to arrange his study like a clump of birch trees, he will develop another trunk running parallel with his chemical engineering major by taking his technical electives in a cognate or topical area such as pre-medicine; bio-engineering, or a similar subject oriented toward the life sciences; environmental studies; energy conversion and resources; engineering physics; another science such as chemistry; applied mathematics; or materials science, especially in the field of polymers; etc. In the past students have chosen all of these alternatives, but at the moment electives in the life sciences attract most of the students who wish to specialize in both chemical engineering and another field. Last year and this, a student in the senior class has qualified for both a BSE degree in Chemical Engineering and an AB degree in Biology.

However, a student may not wish to concentrate so heavily in a second field. He may use his technical electives in smaller groups of two or three or even singly to secure branches, as it were, augmenting his major interest in chemical engineering. Both groups of students will complete their programs with eight to ten non-technical electives chosen from any area of study within the University. These may be looked upon as the leaves which give overall attractiveness to the final product.

To complete this analogy, just as no two trees in a forest are identical, so are no two student programs the same. It is the intention of the Department to provide each of its students with a program tailor-made to his interests and career objectives, involving just enough rigidity to give depth and meaning to his study, and yet allowing adequate flexibility to permit him to make the most of his talents.

Students come to the Chemical Engineering Department from many social and economic backgrounds. Some students have definite ideas concerning their future careers; others are quite vague about what they wish to do; and nearly all change their focus during the four years. It is, therefore, important to keep as many doors open as possible, since past experience has indicated that Princeton's chemical engineering graduates continue in chemical engineering study to the MS or PhD degree, go on to graduate school but in some other field such as chemistry, business administration, law, or medicine, or enter industry directly upon graduation. Traditionally our students have come to us directly from public or private secondary schools, but in recent years we have had considerable success with students transferring from junior colleges or other universities at either the sophomore or junior level. We encourage this trend, for some of our best and most dedicated students in the recent past have been transfer students.

Although students and their programs differ widely, there are certain features of the curriculum worthy of special note. A significant portion of the senior year is devoted to independent work leading to a thesis. Each student is allowed to choose a topic which interests him and on which he works independently under the guidance of a faculty advisor who will have at most only three such students. This independent work has not infrequently led to a publication, but in any case it provides the student with the chance to bring together loose ends and to apply his theoretical background under his own initiative to a solution of a problem. If he is one of those students engaged in a topical program in addition to his chemical engineering studies, the independent work often bridges the two fields.

Since the University is best qualified to teach principles, it relies upon industry to give the student some experience with the world of application and practice. Students are required to have at least one summer of industrial employment, normally between the junior and senior years. Coming after a student has had most of his background courses but before he has made his final career decisions, this industrial experience is not only helpful as an adjunct to the classroom, but has proved of real value in orienting the student toward a successful career not previously considered.

Perhaps one of the most important educational benefits received by the chemical engineering student at Princeton is the opportunity to room with, eat with, study with, and relax with those whose major interests are other than his—in economics, literature, music, philosophy, art, politics, or any of the other fields of study available at Princeton. To be a member of a relatively small department in a modestly sized School of Engineering and Applied Science which itself is part of a large liberal arts university provides the student with a variety of experiences almost unattainable under other conditions. Our students have proved that they have the imagination and motivation to make the most of their opportunities. □

ChE book reviews

Introduction to Thermodynamics: Classical and Statistical, R. E. Sonntag and G. J. Van Wylen, John Wiley and Sons, Inc., 813 pages, (1971).

The relation of thermodynamics to textbook authors is similar to that of sex to movie producers: the same material can be presented again and again; there is no end to its fascination. Our libraries are packed with thermo texts and the flow of new ones continues unabated.

Professors Sonntag and Van Wylen from the University of Michigan have written a large book intended for engineering undergraduates who are being exposed to thermodynamics for the first time. Having previously written the successful texts *Fundamentals of Classical Thermodynamics* and *Fundamentals of Statistical Thermodynamics,* the authors have now combined the essentials of both of these earlier works into a new text suitable for students at the junior level.

As in their earlier books, the authors have written their text with remarkable clarity and simplicity; their style is lucid, straightforward and free of scholarly jargon and pomposity. The text speaks directly to the beginning student in language he can understand and read with ease. The sentences are short, to the point and free of

(Continued on page 73)