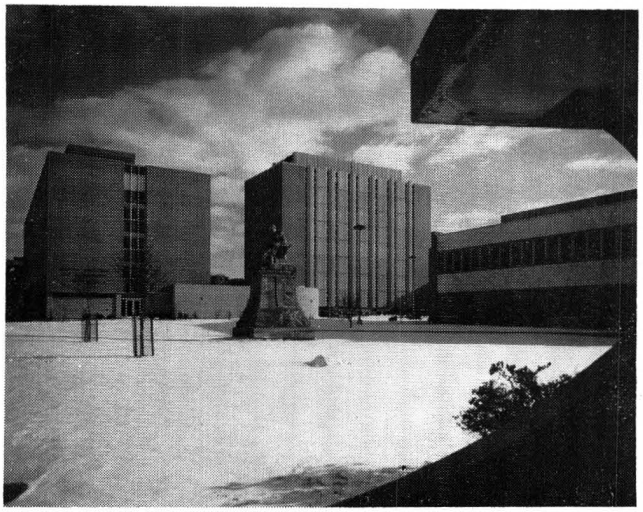
ChE department

DREXEL



The Anthony J. Drexel Statue—framed by (left to right) Matheson Hall College of Business Administration, Disque Hall Science Tower and the modern Library Center.

D. R. COUGHANOWR, *Head*

A Bit of History

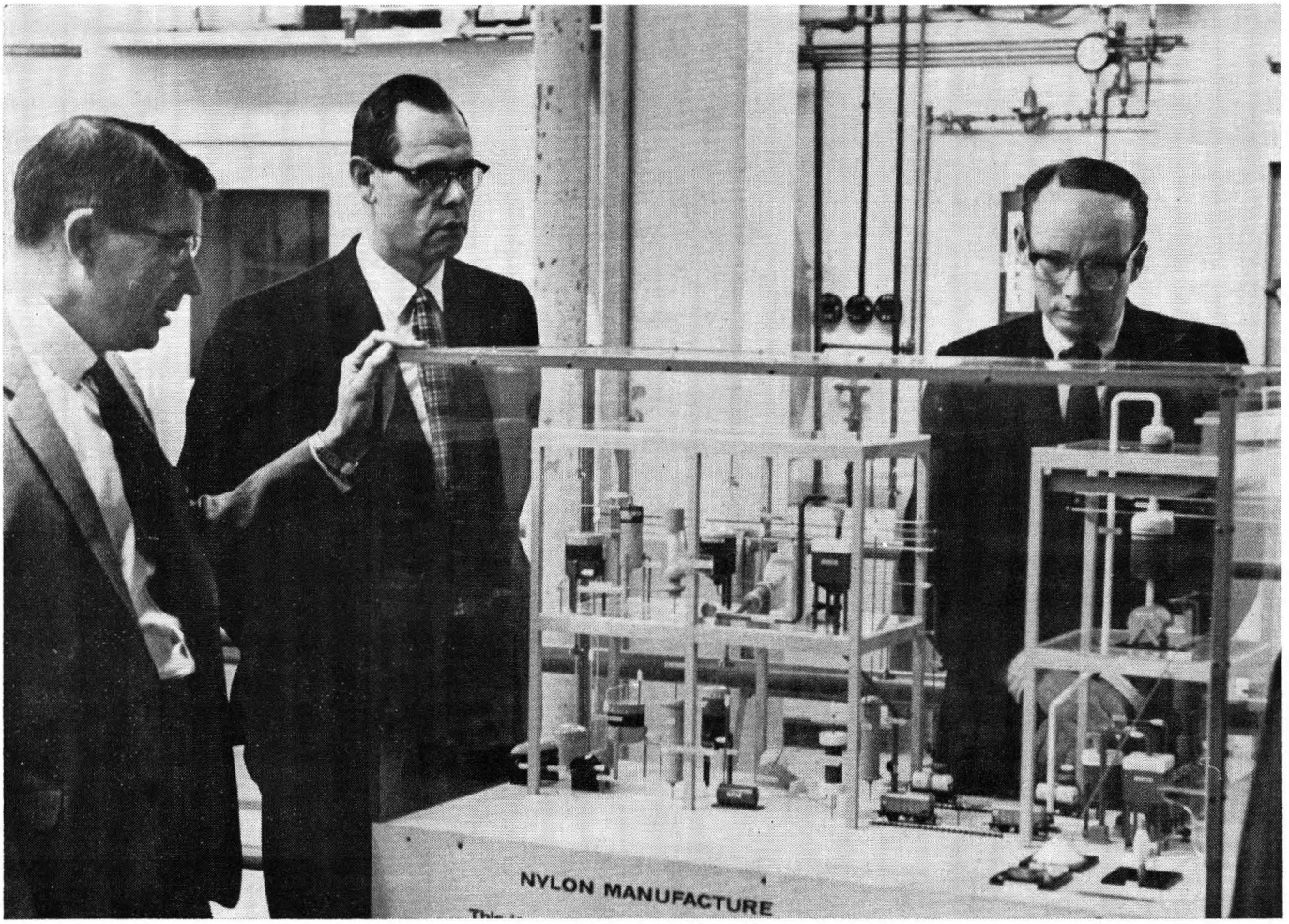
For most of its 76 years, Drexel has been known primarily as an undergraduate institution supplying industry in the East with a steady stream of engineers. A capsule history of the Institute will set the stage for a discussion of its Chemical Engineering Department and the changes which have occurred in it during the past few years.

Drexel Institute of Technology, founded in 1891 by Anthony J. Drexel, Philadelphia financier and philanthropist, was originally named the Drexel Institute of Art, Science, and Industry. It rapidly progressed to college status and granted its first Engineering degrees in 1915. Today, Drexel consists of five coeducational colleges: Engineering and Science, Business Administration, Home Economics, the Graduate School of Library Science, and the Evening College.

The Institute, which is located about one mile from the heart of Philadelphia, is a next door neighbor of the University of Pennsylvania. A visit to the Main Building at 32nd and Chestnut, which was completed in 1891, can be a pleasant surprise to the visitor who will see from the statuary and paintings surrounding the Great Hall that the founder had a sincere desire to blend art, science, and industry.

During recent years, an impressive building program transformed the area into a modern, well-landscaped campus which complements Philadelphia's redevelopment of Center City. The most recent construction is a nine-story science building. A modern library building, which has an excellent collection of scientific books and journals, also is a "laboratory" for the Graduate School of Library Science. The University City Science Center, a cooperative venture among universities and medical schools in the area to foster research, provides a digital computing facility through a time-shared system.

Today the enrollment of 11,000 students includes about 4,000 in the College of Engineering and Science. Drexel's location in a metropolitan and industrial area has helped make its cooperative education program, in operation since 1919, one of the largest in the U.S. The cooperative program, which is required of all engineering students, consists of a five year program in which six terms are spent in industry and 12 terms in college. The industrial part consists of 3 periods of 2 terms each during the sophomore, junior and pre-junior year. In general, industry is very pleased with the co-op program and finds that it adds considerable maturity to the student. Teaching the upperclassmen who have had co-op experience can also be maturing for the teachers, for there is need to demonstrate that the theory has relevance to real problems.



Professors Coughanowr, Tallmadge, and Thygeson (left to right).

Drexel's Chemical Engineering Department

Last year (1966-67) there were awarded 34 BS degrees and 8 MS degrees. The total undergraduate enrollment in Chemical Engineering currently is about 400 students, with a senior class of 50 members. Two years from now, a senior class of 70 is expected. Chemical Engineering at Drexel represents about 16% of the engineering enrollment. The Department is one of the older departments of Chemical Engineering in the United States, starting as a department of Chemistry and Chemical Engineering in the 1920's, and being first accredited by ECPD in 1936. Dr. Frank Fletcher, who was department Head from 1948 to 1963, is well remembered by alumni as a dedicated teacher.

Dr. Charles Huckaba who was Head from 1963-1967 was instrumental in developing a new undergraduate curriculum and in extending the part-time MS program to a full-time MS program in 1963 and a PhD program in 1966. Dr. D. R. Coughanowr, who became Head in 1967 after eleven years at Purdue, found a faculty of six members who were enthusiastic about the new developments. In spite of recent setbacks arising from the increasing involvement in the Vietnam War, such as tight budgets of governmental granting agencies and the cancellation of graduate student deferments, Drexel's faculty expect to keep the research developing through what is hoped to be a short period of uncertainty.

The commitment of the department to a doctoral program is a significant step, and the program is now at a crucial stage at which its success will depend to a great extent on the quality of faculty and students. At this time doctoral programs have also been approved in Chemistry, Physics, Applied Mechanics, Materials Engineering, Environmental Engineering and Science, Biomedical Engineering and Science, and Electrical Engineering. As strength develops in other departments and areas, PhD programs will be initiated there too.

Some words of justification seem to be in order for initiating another doctoral program in Chemical Engineering when there are now about 115 departments offering the doctoral degree. One reason, which has been accepted rather widely by many departments, is that a graduate program is needed to attract the younger faculty members who can keep the undergraduate program up to date in a rapidly changing technology. Whether or not a PhD program is needed to do this is certainly open to debate, and industry has been deeply concerned about the increasing fraction of potential engineers who are siphoned off for graduate work and eventual teaching.

I believe that a more pertinent reason for offering the PhD here is that Drexel is in a location which abounds in both chemical industry and people desiring higher education. In the year 1966, colleges within a radius of 50 miles of Philadelphia produced about six percent of the national output of degrees in Chemical Engineering in each category of BS, MS, and PhD. In relation to the number of chemical and petroleum companies in this area, the educational opportunities seem to be in short supply. For those who follow news of educational trends, it is no surprise that the PhD output from public supported institutions now exceeds that of private institutions. There has also been some neglect on the part of many eastern states in providing support for higher education. To pick one example, which is familiar to the writer, the state appropriation per capita for higher education in Pennsylvania is about one-half that of Indiana. For this reason, it is believed that both private and public institutions have a responsibility to provide more educational facilities in the centers of population.

Undergraduate Program

Although considerable attention was given in the previous paragraphs to the new graduate program, it should be understood that the basic policy at Drexel is that of achieving a balance between teaching and research. All faculty members are expected to teach both undergraduates and graduates. An important qualification of the Drexel faculty is good teaching.

The undergraduate curriculum in Chemical Engineering is representative of a modern curriculum and includes courses in thermodynamics, unit operations, transport phenomena, kinetics, control, and design. Early in the curriculum, all students take common core courses in engineering concepts, digital computer programming, and basic thermodynamics. Analog computing is introduced through courses in kinetics and control.

Two unique features of the Chemical Engineering curriculum worth mentioning are associated with the courses in laboratory and design. A systems engineering approach has been used in organizing the second of the three laboratory courses in Chemical Engineering. The implementation of this required a completely new construction of equipment and modernization of the laboratory space. The idea is to provide the student with a process involving several integrated unit operations. For example, one of these integrated processes, which will be referred to as the inorganic line, consists of a solids feeder, mixer, evaporator, heat exchanger, filter, and dryer; this train of equipment can be used to demonstrate the separation of a soluble and insoluble salt. In addition to operating and testing separately the individual pieces of equipment, the student is able to see the inter-relationships which exist between processing units. The inorganic line which is well instrumented with transducers and automatic controllers, also provides experiments which involve dynamics testing and controller tuning. A paper describing the inorganic line will be presented at the Los Angeles ASEE meeting in June. An organic line is also being constructed which is capable of an esterification process and includes a reactor-still, a distillation column, and an extractor. This line provides examples of mass transfer operations and chemical reaction not covered by the inorganic line.

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These integrated processes provide a valuable extension to the experience acquired in the first laboratory course which is concerned mainly with bench-scale studies on transport phenomena. The third course is much less rigid in that there are no "canned" experiments to be done. The student may select some particular part of the equipment and do a more thorough study of its characteristics. In this way, he gets some of the flavor of research and development.

The design course, which is offered in the senior year, has a unique factor which is partly due to Drexel's location in an industrial com-

munity. Three design engineers from local industry are appointed as adjunct faculty to assist in this course by giving some basic lectures and special tutorial sessions to teams of students working on specific design projects. This approach to design has worked very well and the industrial contact gives added meaning and timeliness to a course which often fades in other schools.

Graduate Program

With the addition of the PhD program, the potential for high-level research is at the door step. The philosophy is to provide a balance between basic science-oriented research and engineering applications. Major fields of current research include process dynamics and control, fluid mechanics of entrained films occurring in withdrawal for both Newtonian and non-Newtonian liquids, thermodynamics of mixtures, novel drying systems, reaction kinetics, heat transfer, and combustion.

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The graduate courses are generally mathematically oriented. Six of the courses, which are considered core courses for all students, include applied mathematics, thermodynamics, transport I (viscous flow), transport II (turbulent flow), systems engineering, and kinetics. These are offered each year. Most of the other courses, which generally are related to the research interests of the faculty, are offered about every other year. Areas of specialization not covered by the present research interests of the Chemical Engineering faculty are offered by other departments. For example, the Chemistry Department has a very good sequence of courses in polymers, which some of the graduate students elect. The course requirements for an MS degree require a total of 45 quarter-credit hours (30 semester-credit hours) which includes 15 in Chemical Engineering, 6 in mathematics, 15 in electives, and 9 in thesis research. At the present time, all students, part-time and full-time, are required to write a thesis. All candidates for the PhD must have course work equivalent to the MS requirements, but beyond this, specific course requirements are established by the candidate's doctoral committee. A reading knowledge of one foreign language is required of the PhD candidate.

There are currently about 30 part-time and full-time graduate students in Chemical Engineering, with three of the full-time students working toward the PhD. A gradual decrease in the number of part-time students during the past several years has been balanced by an increase in full-time students. About one-half of the graduate courses are offered in the late afternoon and evening to accomodate those employed by industry. It is anticipated that the part-time program will increase as those students no longer eligible for deferment as graduate students select industrial positions rather than full-time graduate appointments.

Since the graduate program is so new, it is considered wise to have a continuous evaluation of its goals and accomplishments during the initial phase of its growth. Suggestions are also being examined which will provide unique programs that closely mesh with the research activity of industry. For example, the proximity of industrial plants and laboratories might afford an ideal situation for the use of industrial scientific facilities for highly specialized research. The key to this approach is finding programs which can lead to results which are relevant to industry and which are suitable for publication in the leading technical journals.

The Faculty

The current faculty of seven members have all received their doctoral degrees in Chemical Engineering. The list of faculty, along with the universities from which they received their doctoral degrees, includes Donald R. Coughanowr (University of Illinois), John A. Tallmadge (Carnegie-Mellon University), Elihu D. Grossmann (University of Pennsylvania), John R. Thygeson (University of Pennsylvania), Robert A. Heidemann (Washington University), Lester S. Kershenbaum (University of Michigan), and John Marek (Illinois Institute of Technology). This Spring, our first postdoctoral fellow, Dr. R. Bowrey, will arrive from Australia. Plans call for a steady expansion of the faculty to twelve members, and it is expected to recruit them from a wide geographical area and from fields of specialization which can initiate new areas of research. There is also an excellent opportunity for faculty

members to engage in research projects sponsored by the programs in Environmental and Biomedical Engineering. Since the teaching schedule is light during the summer term, most of the faculty spend this time on research at Drexel or in industry.

The Alumni

As in many private schools, the alumni form a strong link between the present and the past. Many major industrial companies in the Philadelphia area have a high percentage of Drexel graduates in their employment. For the readers of this journal, a list of some of the Drexel Alumni who have found their way into college teaching might be of interest. These include Dr. Herbert Toor, Head at Carnegie-Mellon; Dr. Ralph Troupe, Head at Northeastern; Dr. Vincent Uhl, Head at the University of Virginia; Dr. Coleman Brosilow of Case-Western Reserve; Dr. Charles Dryden (deceased) of Ohio State; Dr. Joseph Estrin of Clarkson; Dr. Elihu Grossmann of Drexel; Dr. Richard Sasin of Drexel (Chemistry); Dr. John Thygeson of Drexel; and Dr. Robert Wagner of Worcester Polytechnic Institute. Many other alumni hold responsible positions in industry and government.

Some interesting differences between a large state university and a private school have come to my attention. For example, the enrollment of a state school seems almost unlimited. A private school, on the other hand, can soon be in financial difficulty by taking more students than the existing physical plant can absorb. This is especially true in cities where land is scarce and costs are high. The policy at Drexel at this time is to maintain the undergraduate enrollment at its present level. The growth of the full-time graduate program does not have any ceiling at present since the question is somewhat premature. However, it is necessary that this growth be accompanied by outside financial support. One cannot justify, nor long maintain, subsidizing graduate work with undergraduate tuition. However, this does not preclude the seeding of new areas, which has been generously done at Drexel. At the undergraduate level, there is no question of the staff needs for teaching; however, at the graduate level, the research activity will depend to a large extent on outside financial support. Ideally, the faculty should spend about equal time on teaching and research. Since the normal teaching load here is 12 credits, this means that the teacher with the ideal mixture of teaching and research would teach about two courses per term.

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In closing, I should like to touch upon a problem which has gained a lot of national attention, namely student unrest over their place on the totem pole of academic priorities: teaching and research. Students and some teachers often look upon the development of a graduate program, especially at a school which has been primarily associated with undergraduate education, as a threat to their importance. I believe that Chemical Engineering has escaped some of the accusations reported in other disciplines, such as graduate student instructors, large sections, etc. Some reasons for this include its small size relative to other branches of engineering and the fact that there are few service courses to teach to students of other departments. These are also some of the reasons one uses to explain the high cost per student contact hour that shows up on administrators' lists of comparative teaching costs. Part of my answer to students' doubt about a developing graduate program is that more attention will be given to them rather than less. Rather than fewer faculty teaching them, there will be more. As more teachers with a wider spectrum of research interests join the faculty, there is the opportunity to teach more courses, some of which are electives in their field of specialization.

In this brief discussion, considerable time has been spent discussing Drexel as a background of its Chemical Engineering Department. The basic reason for this is that many of the progressive changes, especially those associated with the graduate program, are tied directly to the general policy of the Institute. It is hoped that this article has shown that Drexel's development of graduate work in other disciplines, such as Chemistry and Physics, and the fostering of good libraries and computing facilities will enhance the development of Chemical Engineering.