Chemical Engineering at the . . .

UNIVERSITY OF CONNECTICUT

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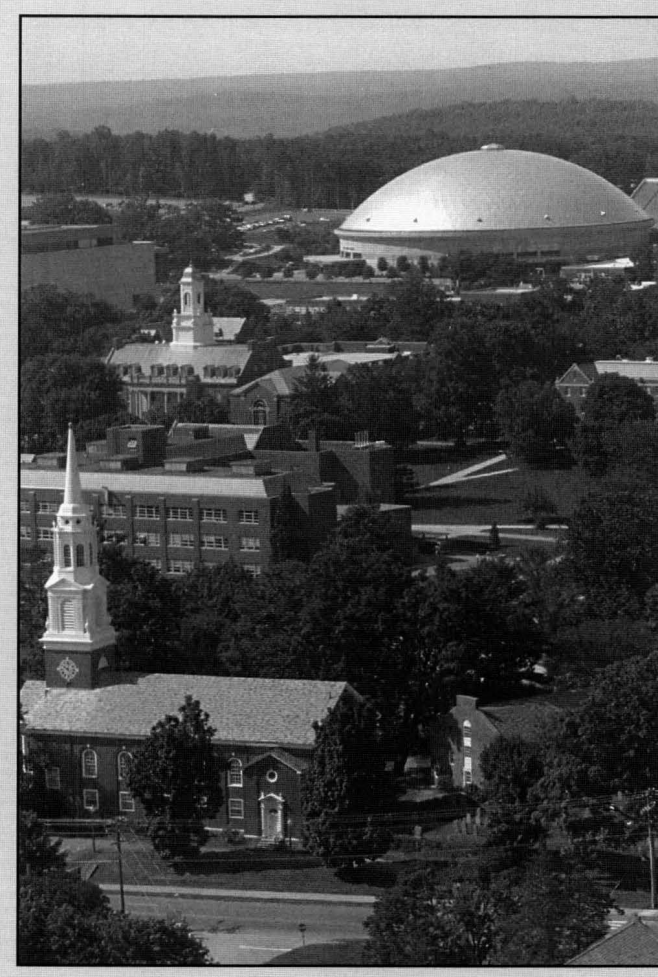
The University of Connecticut, commonly referred to as UConn (not to be confused with the Yukon), is comprised of about 24,000 students at the main campus and at five branches across the state. The Chemical Engineering Department is located on the main campus in Storrs (20 miles east of Hartford) in a delightfully rural part of eastern Connecticut. The main campus has about 12,500 undergraduates, 3,500 graduate students, and 1,200 faculty members.

The Department prides itself in providing an excellent program in both teaching and research and in giving personal attention to individual students. Our size allows us to provide excellent research facilities and academic programs and to promote easy accessibility and interaction between students, faculty, and staff. The Department has concentrated its resources and expertise in five major areas of research: polymer science, biochemical engineering, environmental engineering, catalysis/reaction engineering, and process modeling, control, and optimization. Current research activity is particularly strong, with more than fifty graduate students, plus many post doctorates, visiting researchers, and undergraduate students who work with our faculty. Present external funding is about $1.8 million per year and has significant industrial participation.



Aerial view of the University of Connecticut campus. The large dome structure is the home of UConn Big East Basketball.

HISTORY OF THE DEPARTMENT

The Department of Chemical Engineering was officially started in the fall of 1959 with the appointment of **Albert H. Cooper** as the first professor and Head of the Department. He was charged with developing a curricu-

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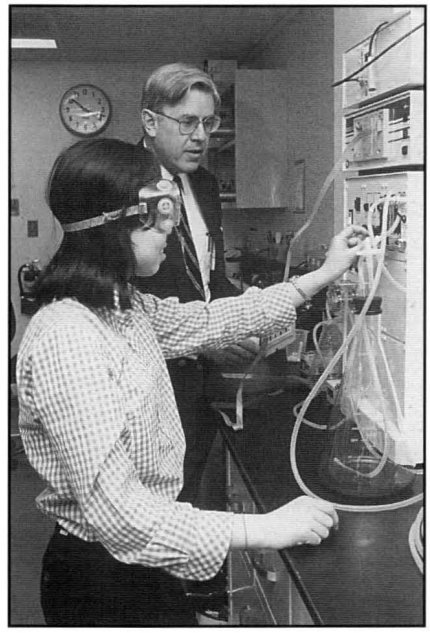
(Right) Bob Coughlin works with an undergraduate student on an independent study project to grow animal cell cultures in an air lift fermentor.



(Below) Mike Howard checks controller settings on the distillation column in the undergraduate laboratory.

lum and equipping the laboratory facilities that had been provided in the new Engineering Building II. The Department and the facilities had been authorized by the legislature several years earlier at the request of the President of the University and representatives of Connecticut industry who felt that this field (and aerospace engineering) were necessary to fill out the programs of the school and properly support the State's industrial base.

An undergraduate curriculum was adopted in 1959-60. Students were allowed to start the sophomore year in the fall of 1960 when they took "Chemical Process Principles." They went on to become the eleven graduates of the first class in 1963. The curriculum was modeled after those of several recognized departments and was quite standard for the time. The program was fully accredited at the first opportunity in 1964. At the same time, a list of advanced courses was adopted, and several students started graduate work in the fall of 1961. The first MS was awarded in 1963, and the first PhD was earned in 1964.

Cooper had a background in development work for several chemical companies in addition to his prior experience as the head of two other departments. He outfitted the laboratory as though it were a pilot plant. As a result, there were several pieces of equipment that were very large by laboratory standards, but were the smallest made with various industrial-type features and controls. The students told grisly tales of trying to get the rotary drum dryer and the spray dryer to come up to operating conditions in a day. Only the lab instructor had the courage to make a cup of coffee from the instant coffee powder that the class made in the spray dryer, and he took only a few sips. On the other hand, the original evaporator and distillation column are still in use today. They have been refurbished, however, and the column has been equipped with a modern control system.

The departmental faculty was really started in 1961. **Richard M. Stephenson**, who had joined the school as a Professor of Nuclear Engineering, moved into the department, and **Edward M. Bartholemew**, a Metallurgist, moved over from the Mechanical Engineering Department. **Roy J. Foresti, Jr., Richard C. Seagrave,** and **G. Michael Howard** also joined the staff. This initial period of departmental expansion was a challenging one. Seagrave and Foresti left for other opportunities. In January of 1963, Cooper stepped down, and **Leroy F. Stutzman** became Department Head. Stutzman continued an outstanding career that included being Head at Northwestern, starting the first chemical engineering program in Chile, and helping to found the Control Data Corporation. The real growth of the Department had begun.

C.O. Bennett and **Herbert E. Klei** joined the faculty in 1964. Bennett was the coauthor (with J. Myers) of the

standard textbook *Momentum, Heat, and Mass Transfer,* and had an extensive academic and industrial background. Klei was the second PhD from the department and had done much of his research while working for Chas. Pfizer & Co. Others with excellent credentials followed: **Donald W. Sundstrom** (1965), **Michael B. Cutlip** (1968), **James P. Bell** (1969), **Anthony T. DiBenedetto** (1971), **Robert W. Coughlin** (1976), **Montgomery T. Shaw** (1977), **Thomas F. Anderson** (1978), **Robert A. Weiss** (1981), **James M. Fenton** (1984), **Douglas J. Cooper** (1985), and **Jeffrey T. Koberstein** (1986).

The research programs of the Department followed the interests of the faculty. Stutzman developed his interest in process modeling and control with Howard and then moved on to large-scale process simulation with the support of Control Data Corporation. Bennett did pioneering work in unsteady-state kinetics and catalysis studies and built a unique high-pressure research facility. He was joined by Cutlip, who also studied fuel cell reactions. Klei and Sundstrom led the way for chemical engineering involvement in biological waste treatment, bioprocessing, and environmental concerns. Bell was the first "polymer person," and his work on adhesives and composite materials was soon complemented by DiBenedetto's. Coughlin brought an applied chemistry focus to the department, with impressive creativity in applications of kinetics, interfacial phenomena, and bioprocessing. Howard, Stutzman, and Cutlip were also active in developing new teaching techniques and applying computer technology to assist learning.

These beginnings were the base for the Department's present areas of research interest in the broad fields of polymer science, biochemical engineering-biotechnology, environmental research-hazardous wastes, catalysis-surface science-chemical reaction engineering, control-expert systems, electrochemical engineering, and thermodynamics.

In the last several years, we have been able to strengthen our Department with the addition of young faculty and also faculty in residence. **Luke E. K. Achenie** joined the faculty in 1991; at the same time, **Suzanne S. Fenton** was appointed Assistant Professor in Residence. **Robert J. Fisher** was appointed Associate Professor in Residence in 1992, and **Can Erkey** and **Joseph J. Helble** came aboard as Assistant Professors in 1995. A list of the current faculty, together with their research interests, is given in Table 1.

A student Society of Chemical Engineers was formed with the first class and in 1965 it became the student chapter of the American Institute of Chemical Engineers. A chapter of the national honor society, Omega Chi Epsilon, was established in 1983. These student organizations have worked to expand the professional interests of their members through many industrial speakers and plant trips every year. They have sent speakers and delegates to regional and national AIChE meetings and have an outstanding history of winning prizes in technical paper presentation competitions. Most recently, Beth Sos won the New England regional under-

TABLE 1
UConn Faculty and Research Interests

Luke E.K. Achenie (PhD, Carnegie Mellon) • *Modeling and Optimization; Neural Networks; Process Control*

Thomas F. Anderson (PhD, University of California, Berkeley) • *Thermodynamics and Fluid-Phase Equilibria; Modeling of Separation Processes*

James P. Bell (ScD, Massachusetts Institute of Technology) • *Structure-Property Relations in Polymers and Composites; Adhesion*

Douglas J. Cooper (PhD, University of Colorado) • *Process Control, Neural Networks; Fluidization Technology*

Robert W. Coughlin (PhD, Cornell University • *Biochemical and Environmental Engineering; Catalysis; Kinetics; Separations; Surface Science*

Michael B. Cutlip (PhD, University of Colorado) • *Kinetics and Catalysis; Electrochemical Reaction Engineering; Numerical Methods*

Anthony T. DiBenedetto (PhD, University of Wisconsin) • *Composite Materials; Mechanical Properties of Polymers*

Can Erkey (PhD, Texas A&M University) • *Multicomponent Mass Transfer; Supercritical Fluids; Environmental Engineering and Pollution Prevention*

James M. Fenton (PhD, University of Illinois) • *Electrochemical and Environmental Engineering; Mass Transfer Processes; Electronic Materials*

Suzanne Schadel Fenton (PhD, University of Illinois) • *Computational Fluid Dynamics; Turbulence, Two-Phase Flow*

Joseph J. Helble (PhD, Massachusetts Institute of Technology) • *Environmental Engineering/Air Pollution Control; Combustion; Nanostructured Materials*

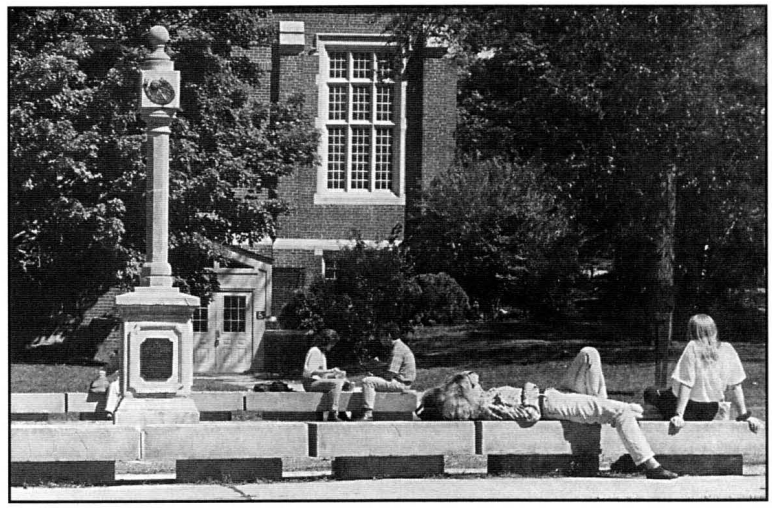
Robert J. Fisher (PhD, University of Delaware) • *Membrane Systems; Biochemical Engineering and Environmental Biotechnology*

G. Michael Howard (PhD, University of Connecticut) • *Process Systems Analysis and Modeling; Process Safety; Engineering Education*

Jeffrey T. Koberstein (PhD, University of Massachusetts) • *Polymer Blends/Compatibilization; Polymer Morphology; Polymer Surface and Interfaces*

Montgomery T. Shaw (PhD, Princeton University) • *Polymer Rheology and Processing; Polymer-Solution Thermodynamics*

Robert A. Weiss (PhD, University of Massachusetts) • *Polymer Structure and Properties; Ion-Containing and Liquid Crystal Polymers; Polymer Blends*



Study break at the plaza near the Castleman Engineering Building.

graduate student research competition in 1994. Connie Russ followed with another win in 1995 and went on to win the national competition at the annual AIChE meeting in Miami.

The student organizations have also sponsored a variety of picnics and social functions to foster student-faculty interaction. The faculty-student softball game at the annual picnic, as well as occasional basketball challenges, have always resulted in faculty victories. This record streak is not surprising since the faculty keep score and have been known to make up rules when necessary.

The size of the student body has fluctuated as national interest in chemical engineering has risen and fallen. The smallest graduating class of eight (1967) was followed by classes of about 20 for the next ten years before the enrollment boom produced more than 50 in the early 80s. The largest class was 57 (in 1986). The numbers now look like they will be in the mid-twenties once again. The number of MS degrees awarded has consistently been in the 10-13 range, and the number of PhDs averaged about 2 a year for the first 20 years, and now numbers 3 or 4.

The chemical engineering curriculum has not changed much over the years. Given its basic goals, this is not too surprising. We have always wanted our students to obtain a solid foundation in chemistry, mathematics, and physics, to understand the fundamental chemical engineering sciences, to learn the design process so they could apply the fundamentals, and to have an opportunity to study some topics of special interest to them and "learn how to learn" so they could deal with the next generation of knowledge. Thus, the names of the required courses are about the same. The content and methods of presentation have changed, however, with greater emphasis being placed on using computers to enhance understanding. Process dynamics and control has been added to the required list of courses that includes introduction, thermodynamics, transfer, kinetics, the lab, and design. A second required design course was added to ensure thorough student experiences in all aspects of this important curriculum area. The second semester of physical chemistry has been made optional, with other chemistry or biology courses being acceptable substitutes. This allows more flexibility for students in following specific interests. Organic lab has been reduced to only one credit. The elective courses have come and gone as faculty interests and topical issues have changed. Environmental, biochemical, electrochemical, polymers, process safety, and research projects are among the options available to the undergraduates today. Many students do elect a double major with Materials Engineering, which was introduced in 1976 to recognize the specialization that many students were already doing with their technical course electives.

The department has prided itself on the faculty's interest in teaching and the students' perception that they have good teachers. This has carried over to our doctoral graduates, many of whom have chosen academic careers. Many undergraduates also have gone on to teaching careers. We hope that our textbooks and classroom innovations are partly responsible for this. Our most recent contributions include two of the most widely used academic computing packages available to chemical engineering programs. Mike Cutlip (with Mordechai Shacham of Ben Gurion University in Israel) is the coauthor of *POLYMATH*—a comprehensive set of mathematical analysis tools including curve fitting and equation solving for systems of algebraic and differential equations. Cutlip's favorite words, "user friendly," are well demonstrated in this excellent package. Doug Cooper has developed *PICLES* (Process Identification and Control Loop Explorer System), which is now used in nearly every process control course. This is an easy-to-use training simulator that provides hands-on experience with a series of dynamics and

control case studies. Color graphic displays and model fitting software enhance *PICLES*' ease of use.

GRADUATE PROGRAM

The graduate program in chemical engineering is oriented toward full-time study in which research is emphasized for MS and PhD programs. A core curriculum is complemented with courses in various areas of interest coinciding with our research programs. These areas tend to be interdisciplinary, so our students take course work in fields such as chemistry, polymer science, applied mathematics, biotechnology, computer science, and environmental engineering.

Jim Fenton works with a graduate student on a fuel-cell test unit.

The department offers graduate courses in thermodynamics, transfer operations, reaction kinetics and catalysis, process dynamics and control, water and air pollution control, polymer science, biochemical engineering, electrochemical engineering, and applied mathematics. There are no specific course requirements for any of the programs other than a minimum number of credits. Each program has an examination schedule designed to determine the level of proficiency in certain areas of chemical engineering.

SCIENTISTS-TO-ENGINEERS

Relatively few schools grant undergraduate degrees in chemical engineering in comparison to the number of schools granting bachelor's degrees in, for example, chemistry, biology, or mathematics. Students with undergraduate degrees in a discipline other than chemical engineering can enter the MS program under the scientist-to-chemical engineer provision. Depending on one's background, a minimum of additional undergraduate-level coursework is necessary to bring the student up to the equivalent of a BS in chemical engineering. Elective courses within chemical engineering and in other technical disciplines at graduate and advanced undergraduate levels build on and develop the student's scientific background and interest.

Students can complete such a program and gain a Master's degree in chemical engineering in about 24 months. Students who desire a doctorate then continue in the regular PhD program.

INTERDISCIPLINARY PROGRAMS

Graduate students are encouraged to participate in various interdisciplinary research centers and programs located at UConn. Several of these laboratories draw students and faculty from many departments, as well as visitors from other universities, to form nationally prominent facilities in particular areas of science and technology. Programs and centers of special interest to chemical engineering graduate students are listed below.

Biotechnology Center

The Biotechnology Center has several core laboratories available to our program in biochemical engineering and biotechnology. A core facility for fermentation and separations is located within chemical engineering and is used for research and joint team-taught courses between life sciences and chemical engineering faculty. With a strong interest in biotechnology, Bob Coughlin and Bob Fisher are the major chemical engineering participants in this Center.

Booth Center for Computer Applications and Research

This Center provides the physical and intellectual environment necessary to support a wide range of interdisciplinary projects involving computer-oriented research requiring the application of computer technology for their successful completion. Several chemical engineering faculty, including Doug Cooper, Mike Cutlip, and Luke Achenie, are involved with the Chemical Process Analysis Laboratory, one of nine research laboratories organized within the Booth Center.

Environmental Research Institute

The Environmental Research Institute (ERI) provides an interdisciplinary facility emphasizing the control and destruction of hazardous materials and wastes. Within the ERI is the Pollution Prevention Research and Development Center. This Center, under the direction of Jim Fenton, emphasizes waste minimization, "green" processes, and materials recycling and reuse. Chemical engineering research projects focus on industrial processes for minimizing gaseous, liquid, and solid wastes by investigating alternative processes or new separations. A number of chemical engineering faculty, including Mike Cutlip, Can Erkey, Joe Helble, and Suzy Fenton, have research interests with such an environmental focus and play an active role in this Institute.

Polymer Science Program

The Polymer Science Program at UConn is recognized as one of the top few in the U.S. Five of the thirteen faculty in polymer science are from chemical engineering. They in-

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clude Tony DiBenedetto, Monty Shaw, Jim Bell, Bob Weiss, and Jeff Koberstein, who is presently Director of the Program. Some twenty courses are offered in various aspects of polymer science and engineering. All are open to chemical engineering students. Research topics are diverse, following the interests of the faculty, and include polymer blend compatibilization, liquid crystalline polymer morphology, biomedical and biodegradable polymers, composite materials, new methods of polymerization, polymer-fiber interface studies, etc.

FACILITIES

Chemical engineering is centrally located in several buildings on the UConn campus in close proximity to the library, the computer center, the math-science complex, and the student union. The many general laboratories for graduate and undergraduate research are supplemented by specialized laboratories designed and equipped for work in biochemical engineering, kinetics and catalysis, polymer science, surface science, thermodynamics, process optimization and control, and electrochemical engineering. The department is highly computerized, with all faculty and students having access to various software packages, e-mail, and the World Wide Web through personal computers, workstations, and various mainframe computers. A separate building houses the Institute of Materials Science and contains a variety of research facilities for the study of the structure and properties of materials. Technical support facilities in the form of machine shops, electronic shops, glassblowing, and a photography laboratory are available to support our work.

The Engineering Network/Computing Services group within the School of Engineering provides essential distributed computing resources in support of research and instruction. Current enhancement of computing capabilities focuses on SUN workstations and network servers. Five general computing laboratories are located throughout the engineering building. Emphasis is on workstation access, computer-aided design, and computer graphics. The University Computer Center provides computing and telecommunications services throughout the University. A large IBM mainframe computer gives efficient computing, including vector processing, to engineering students. High-speed laser printing, e-mail, and the Web are all available. Personal computer labs that include graphics capabilities are also available to students.

In addition to the existing facilities, the State of Connecticut has made an unparalleled commitment to the University by enacting the UCONN 2000 program. This is a program to provide the University with a billion dollars over the next ten years to build and upgrade its facilities. This is a promise of future support for which we are very grateful.

LIFE AT STORRS

There is also life at Storrs outside the classroom and laboratory. Students, faculty, and staff participate in, or simply enjoy, every possible kind of intellectual, cultural, or recreational activity one can imagine. The unique location of the University of Connecticut provides a setting that has both urban and rural advantages. Boston and New York City are 80 and 140 miles away, respectively. Well-known skiing areas and historical sites of New England are within a short drive, and the Atlantic Ocean and Long Island Sound can be reached in about one hour. The Storrs campus is in a rural area surrounded by farmlands, forests, ponds, and streams, where recreational facilities abound for all outdoor activities.

The University offers all of the facilities and programs of a comprehensive institution. Music, art, and theater thrive at UConn. The University hosts an unparalleled selection of major touring musical and dramatic events, while The School of Fine Arts supports the Connecticut Repertory Theatre. The Storrs campus is the home of The William Benton Museum of Art, the Connecticut State Museum of Natural History, and the Dodd Center for archival research, among other facilities. The Gampel Pavilion is the home of UConn Big East basketball, and "HuskyMania" has swept through the Department, just as it has swept the state. There are twenty other varsity athletic programs and an active intramural sports and recreation program as well. Whether at work or at play, there are plenty of opportunities at UConn.

SUMMARY

The Department is pleased with the accomplishments that have been made in the past thirty-seven years. Since its inception and initial accreditation, the program in chemical engineering has been continuously fully accredited. We have been favored with good, hard-working students who have been a pleasure to teach and to work with. We look forward to the future with the leadership of our current Department Head, Tom Anderson, who is following the path laid out by Cooper (1959-63), Stutzman (1963-71), DiBenedetto (1971-76), Coughlin (1976-80), and Cutlip (1980-89) in working with a creative energetic faculty to offer the best possible academic programs and to provide technological leadership through our varied research activities. ❐