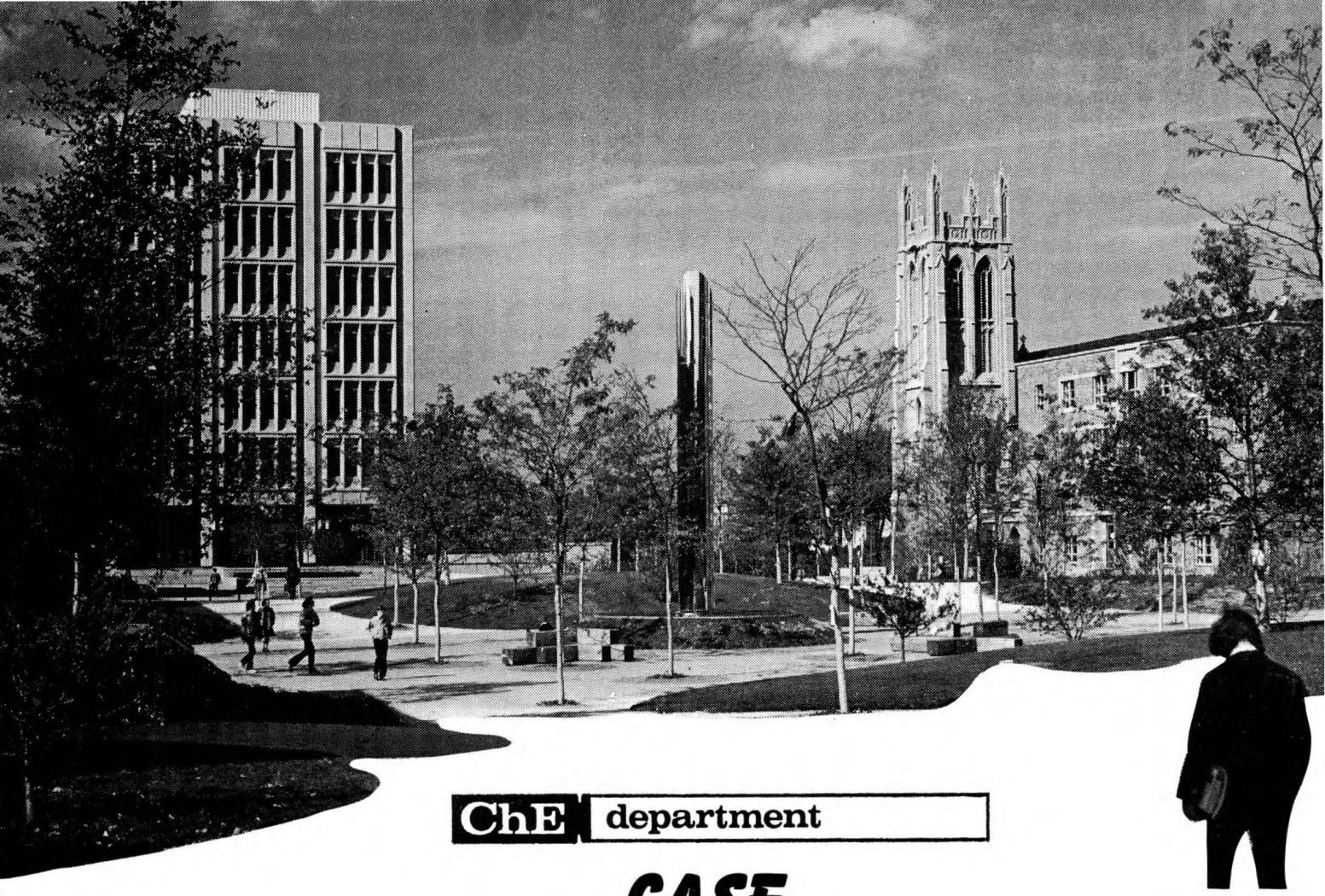


ChE department

CASE

JOHN C. ANGUS
Case Institute of Technology
Case Western Reserve University
Cleveland, Ohio 44106

IN 1884, THE CASE catalog announced the introduction of "Chemical Technology" as part of the chemistry curriculum. This was the first appearance of Chemical Engineering at Case. The first degree labelled Chemical Engineering was awarded by Case in 1909, but it appears that the curriculum itself was not called Chemical Engineering until 1913.

The Case ChE program was one of the very first in the country. Similar developments took place throughout the 1880's and 1890's at Tulane, University of Illinois, University of Pennsylvania, Massachusetts Institute of Technology and the University of Michigan. It was not until 1922 that the American Institute of Chemical Engineers could even agree on a definition of what Chemical Engineering was. When the AIChE instituted accreditation in 1925, the Case program was one of only fourteen to be approved.

The men responsible for the founding of ChE at Case were Professors Charles Mabery and Albert W. Smith. Mabery, an early leader in petroleum research, was department head from 1883 to 1911. Smith, department head from 1911 to 1927, was a key figure in the early history of the Dow Chemical Company. It was under his leadership that ChE emerged as a separate course of study.

For many years the department was integrated with Chemistry in a Department of Chemistry and Chemical Engineering. In 1962, the ChE activities were severed from Chemistry and became the Chemical Engineering Science Division of the School of Engineering. In 1972, we became the Department of Chemical Engineering.

The completion of the $2,500,000 renovation of the Albert W. Smith Building in January, 1976 signals the beginning of a new period of growth of ChE at Case.

TRADITION OF ACCOMPLISHMENT

THE DEPARTMENT HAS had many well known and influential ChE's associated with it over the years. Herbert H. Dow, a Case Tech graduate of 1888, founded the Dow Chemical Company, which has become one of the world's largest chemical enterprises. Dr. Albert W. Smith worked closely with Dow and made many contributions which were crucial to the survival and growth of the company. Among these were the first American production of carbon tetrachloride and the synthesis from this of chloroform. Professor Smiths' sons, Kent H. Smith, and A. Kelvin Smith, and F. Alex Nason, were co-founders of the Lubrizol Corporation, the world's leading manufacturer of lubricant additives. They are Case ChE graduates from 1917, 1922 and 1922 respectively.

Throughout the years 1927 to 1956, the chairmen of the department were Professors William R. Veazey, Carl F. Prutton '20 and William Von Fischer. All were very active within the U.S. chemical industry.

This tradition of accomplishment has continued to the present time. Today, Case graduates are found in responsible positions throughout the American and world chemical industry and in academia. A very few examples of the many that could be cited follow. Dr. Durga Ambwani, who received his Ph.D. in 1968, is the cofounder of the Asia Development Corporation. Dr. Paul Friedl, a Case B.S. and Ph.D. Chemical Engineering graduate, developed the new IBM 5100 table top computer. Dr. Glenn Brown, Ph.D. 1958, is Vice President for R. and D. of SOHIO. Shunji Kumazawa, M.S. 1965, is General Manager of Technical Development for Toray Industries, one of Japan's leading corporations. Richard Knazek, a Case B.S. Chemical Engineering graduate of 1962, was chosen as "One of the Ten Most Outstanding Young Men in the U.S." by the U.S. Jaycees in January, 1976 for his medical research.

Our most recent graduates are also doing well. Two members of our 1976 senior class, Mr. Donald Feke and Mr. Max Gorensek, won National Science Foundation Graduate Fellowships. (Only fourteen were awarded to ChE's in the entire U.S.). Mr. Feke also won one of the three Electrochemical Society summer fellowships in 1976.

A total of 1686 B.S., 280 M.S., and 117 Ph.D. degrees have been awarded by the department since its founding.

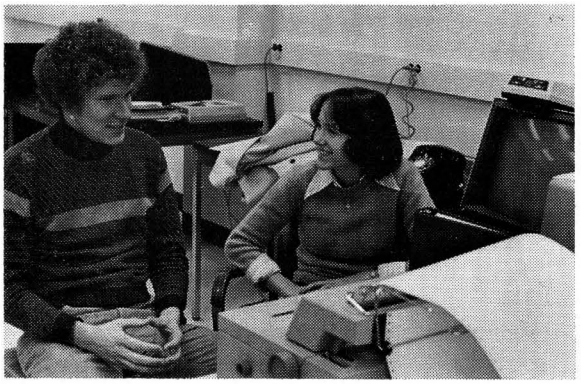
We have attempted to steer a middle road between the extremes of pure empiricism on the one hand and engineering science on the other. As a result the ChE B.S. program has no strong "idealogical" bias.

THE DEPARTMENT TODAY

• **Faculty and Staff**—The staff is comprised of eight professors, two adjunct professors, one adjunct lecturer, six research engineers, one technician and an administrative and secretarial staff of three. A listing of the faculty and their major technical interests is given in Table 1.

• **Students**—There are 135 undergraduates majoring in ChE at Case and 25 resident graduate students. We have experienced a significant increase in undergraduate ChE enrollment in the past year, although not such a dramatic upturn as seen at some institutions. We have not, however, had a decline in the average SAT scores of our entering freshmen. They have, in fact, been slightly increasing, counter to the national trends—The average mathematics and verbal SAT scores for the 1976 freshman class were at the 99th and 95th percentile respectively. Combined mathematics and verbal SAT's run about 1250. ChE has a reputation on the campus as being one of the more demanding curricula and we consistently attract excellent students.

• **Research**—There is a very active graduate research activity underway. Research expenditures in the Department totalled $465,700 during the past year, a very high figure for only 8 full time faculty. An unusual feature of the present



Undergraduates in the Diamond Shamrock Computer Room.

One unusual feature of the graduate program is the Instructional Television Network (ITN). Courses are offered from the campus live or on videotape to employed engineers in the Cleveland area.

research support is that about half of it comes from private industry.

The largest single effort is an industrial project for the development of a new gas treating process conceived by Professors Adler, Brosilow, Gardner and Dr. William Brown, a recent Case graduate. The new process has substantially lower investment and operating costs than competing processes and promises to have a major impact in the chemical and related industries. Another large project involves the catalysis of coal gasification, done under the direction of Professors Gardner and Angus with ERDA support.

A project of great potential is a joint computer development effort with the IBM Corporation on applications of APL in ChE. "A Programming Language" (APL), while devised and implemented between 1960 and 1965 by IBM, has required the present generation of computer systems for full utilization of its capabilities. The result is a powerful notational scheme that allows coding at a much higher level than FORTRAN, and is similar to the notation of matrix algebra. Hierarchical systems which interface an APL host to experiments are being developed. By using small microcomputers coded to execute APL commands, data acquisition and computation on acquired data bases can run efficiently. Real time control functions are being studied as well. The APL project is directed by Professor Mann.

An unusually strong effort is underway in laser application studies including laser doppler flowmeters, transport property measurement by light scattering and laser holographic machining. This work involves Professors Edwards, Mann and Angus. The university effort in environmental engineering is centered in ChE. There are several projects in industrial wastewater treatment, e.g., ozone treatment and cyanide disposal. Professors Prober and Melnyk direct this effort. We also have an active research effort in membrane processes, surface transport and interfacial dynamics under the direction of Professor Mann.

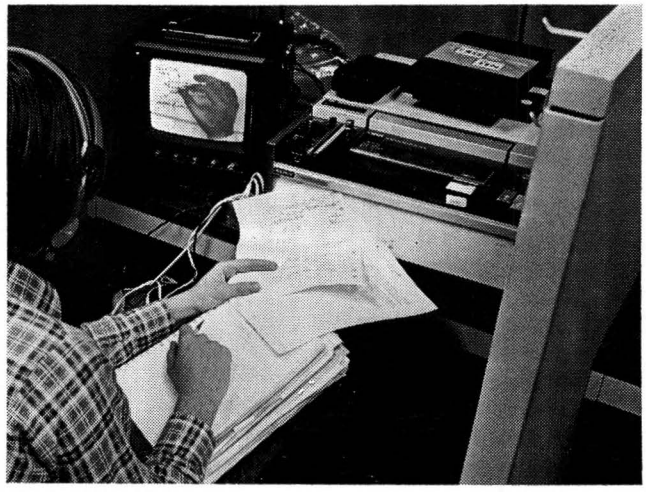
We have always had a strong program in systems and control. One aspect of the present work is the development of inferential control schemes and their application to onstream distillation columns and reactors at Exxon, Marathon and Mobil Oil Companies. This work is directed by Professor Brosilow.

• **Industrial Support**—Industrial sponsored contract research is done through the DICAR Corporation, a for profit corporation owned by the university. This arrangement permits us to accept non thesis and confidential research from industrial companies. The work is mainly in process development and is conducted in part by full time research engineers.

Unrestricted grant support from various companies is also received. These include: Air Products Co., Atlantic Richfield, CWC Industries, Diamond Shamrock, Dow Chemical Co., duPont Corporation, Lubrizol Foundation, Monsanto Corporation, PPG Industries and the Procter and Gamble Fund.

BALANCED CURRICULUM

WE HAVE ATTEMPTED to steer a middle road between the extremes of pure empiricism on the one hand and engineering science on the other. As a result the ChE B.S. program has no strong "ideological" bias. We require a total of 131 to 135 credit hours (depending on elective sequences). The ChE part of the curriculum includes courses in energy and mass balances, separation processes, transport phenomena, thermodynamics, chemical reactor design and a unit op-



Taking courses over the Case Instructional Television Network. Courses are televised to employed engineers in the Cleveland area.

erations laboratory. The ChE sequence is terminated with a two semester capstone course in Process Analysis and Design. This latter course makes extensive use of the computer aided design systems, FLOWTRAN.

The curriculum contains required laboratory courses in mathematics (computation), physics, chemistry, laboratory methods and techniques (instrumental) as well as the senior unit operations laboratory. In addition, all students have the option of doing an experimental undergraduate research project. This can be used to fulfill the 5 course elective sequence offered to all students. Other elective sequences, which are virtually "minor" fields, include Management, Polymer Science, Environmental Engineering, Computing, Systems and Control and Biomedical Engineering.

A full range of graduate courses is taught by the department as well. Both M.S. and Ph.D. degrees are offered. One unusual feature of the graduate program is the Instructional Television Network (ITN). Courses are offered from the campus live or on videotape to employed engineers in the Cleveland area. This program has been in existence now for several years and the department has recently had its first M.S. graduate, Mr. Monty Reed of the Timken Company, who did all of his course work over television.

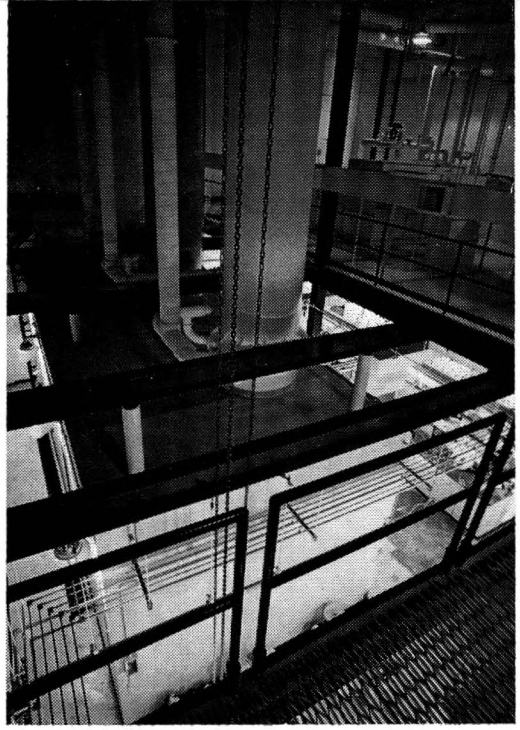
INSTITUTIONAL SETTING

THE ChE DEPARTMENT is one of the fifteen engineering and science departments that make up Case Institute of Technology. Case, in turn, is one of the major components of Case Western Reserve University. This latter institution was synthesized in 1967 from the predecessors, the old Case Institute of Technology and Western Reserve University.

Case Institute is a small selective college; we have only 1136 undergraduate students. The total enrollment of the university, including all the graduate and professional students is 8279. The endowment, capital plant and faculty make Case Western Reserve one of the countries largest private universities.

The university is set within a large complex of parks and educational and cultural institutions on the eastern side of Cleveland known as University Circle. This is especially fortunate, for our next door neighbors are the Cleveland Museum of Art and Severance Hall, the home of the Cleveland Orchestra.

The ChE faculty participate in a wide range of other professional activities in addition to their principal jobs of teaching. A few of these are listed to give an idea of the scope of these efforts.



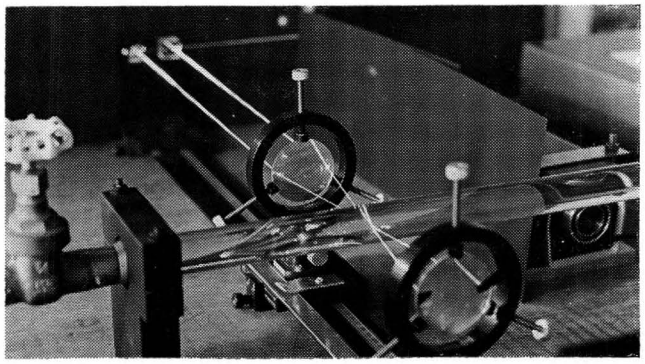
A top view of the high pressure test cells showing the large vertical vent stacks.

- **Professor Nelson Gardner's research group recently won the National American Chemical Society prize for the best paper on coal. Professor Gardner has also been selected twice as a National A.I.Ch.E. tour speaker and gave the opening plenary lecture at the U.S. Bureau of Mines coal catalysis conference last spring.**
- **Professor Edwards' research in laser doppler flowmeters has received international recognition. He was invited to give the opening plenary lecture at the Biennial Turbulence Symposium and was also twice selected as a Visiting Scientist by the Danish Atomic Energy Commission.**
- **Professor Adler will serve as Conference Chairman of the 1977 Engineering Foundation Biennial Meeting. Professor Angus recently returned from a sabbatical year at the University of Edinburgh where he was a Senior NATO Fellow and Visiting Lecturer.**
- **Professor Prober is editor of the CRC Press Monograph Series on Water Pollution Control Technology and was Coordinating Editor for the CRC Handbook on Environmental Control. Professor Brosilow is serving on the National A.I.Ch.E. Machine Computation Committee and recently spent a sabbatical year at the Technion in Israel. Professor Mann has given many invited papers on membrane dynamics around the country and will organize the symposium for the Colloid division of the ACS on "Application of Surface Science to Problems in Biology and Medicine".**
- **Professor Melnyk recently received one of the two national awards from the Technical Association of the Pulp and Paper Industry for excellence in research on wastewater treatment with ozone. Professor Bikerman, one of the nation's leading authorities on foams and surface phenomena, recently published a book entitled "Foams" (Springer Verlag).**

TEACHING AND RESEARCH FACILITIES

IN 1975, WE RECEIVED a $2,500,000 anonymous alumni donation to provide our department with a ChE building. The existing Smith Building on the Case Campus has been completely renovated for the ChE Department. We moved to our new quarters in January, 1976.

The Albert W. Smith Building includes: a large undergraduate Unit Operations Laboratory; an undergraduate projects laboratory; a computer room; a high bay area for process related research; three re-inforced concrete, vertically vented chambers for hazardous and high pressure research; graduate and undergraduate water pollution control laboratories; acoustically isolated room; constant temperature and humidity room;



A laser anemometer experiment of Professor Edwards' for measuring flow in pipes.

instrument room; two classrooms (one designed for television instruction); library-reading room and the normal complement of offices and research laboratories.

The four story building gives us approximately 30,000 square feet of net usable floor space.

The new facilities give us a unique opportunity to further strengthen the size and scope of the Chemical Engineering activities at Case. With the completion and equipping of the building, we have acquired absolutely first rate instructional and research space. Some of the special features of the facilities are outlined below.

We have just received a $185,000 grant from Diamond Shamrock Corporation for the equipping and maintenance of the Diamond Shamrock Computer Center within the ChE department. This is part of a larger university wide grant by Diamond Shamrock. The computer will be installed early in 1977 and will be tied into the campus wide minicomputer network.

The computer will be housed in the second floor computer room, designed for this purpose. The room has its own separate air conditioning unit, the outer room wall has a vapor barrier to permit better humidity control. Electric wiring is run directly from the mains to minimize perturbations from other electrical equipment. Seven phone lines are provided for further flexibility in connecting to other computer terminals and equipment in the building.

We have what we believe to be a virtually unique high pressure and pilot plant area for an academic ChE department. At the south end of the basement is a 2,515 square foot laboratory area known as the Annex. This two story open room is divided at the first floor level by a metal grating floor. The laboratory is designated for high pressure and hazardous work, and is used primarily for energy and coal related research.

The roof is fitted with two blow-out roof panels, each 6 by 38 feet, which will open at an overpressure of 25 pounds per square foot to protect the integrity of the structure. In case of a solvent spill or flammable gas leak, all electric power can be shut off except for explosion-proof lights and exhaust fan.

Six separate gases are piped into the room through high pressure lines from a gas storage shed outside the building. The lab is provided with walk-in and overhead hoods and all laboratory services.

Within the high pressure lab are three test cells for performing very high pressure and hazardous experiments. Two cells are 10 by 10 feet and one 6 by 10 feet; all have 10-foot headroom.

Since the laboratory is located within a busy campus area, conventional venting of the cells through a blow out side wall could not be used. Instead, the cells are vertically vented through three separate 42-inch diameter steel stacks extending some 45 feet up through the Annex roof. This very unusual design may be useful in other similar locations; we would be happy to share our experience with others.

The computer will support terminals for interactive classroom use. It also will provide "hands

We have what we believe to be a virtually unique high pressure and pilot plant area for an academic ChE department.

We have just received a $185,000 grant for equipping and maintaining the Diamond Shamrock Computing Center within the ChE department. The computer will support terminals for interactive classroom use. It will also provide "hands on" experience for undergraduate and graduate students, provide data acquisition and processing for research experiments and will be used in a new computer controlled unit operations laboratory experiment.

on" experience for undergraduate and graduate students, provide data acquisition and processing for research experiments and will be used in a new computer controlled unit operations lab experiment.

The cells have 18-inch thick reinforced concrete walls, containing 20 tons of steel reinforcing bars and 115 cubic yards of concrete. The circumferential rods are welded into continuous members. The cells rest on a 20-inch thick reinforced concrete foundation pad which, in turn, rests on the underlying shale.

Entry to the cells is through rear doorways fitted with 1-5/8 inch thick steel plate doors. Visual access is via a port with a heavy sliding steel plate cover. Numerous pipe sleeves are cast through the concrete walls to permit entry of services.

The large cells are designed for bending and tensile stresses of 3900 lbs./square foot and the smaller for 9000 lbs./square foot. The cells will contain an explosion resulting from the rupture and ignition of a hydrogen cylinder or high pressure autoclave.

ENVIRONMENTAL AND LASER LABS

LABORATORIES FOR undergraduate instruction and graduate research in environmental engineering are on the third floor. The instructional lab has space and utility drops for five separate permanent experiments to demonstrate flocculent and zone settling, aeration, biological treatment and reverse osmosis. Within the lab are a preparation room and a holding room. These chambers, each 6 by 7 feet in internal dimension, are used for the preparation and storage of biological samples at controlled temperatures ranging from 0 to 35°C.

The entire south end of the second floor is taken up by a 2160-square foot graduate research laboratory designed for precision optical and laser application studies. This work includes laser doppler anemometry, light scattering and laser machining. Light-tight drapes divide the room into three separate dark areas. An enclosed wire cage storage area and 440 V, 100 A electrical service are provided in addition to the normal laboratory services.

An acoustically and electrically isolated chamber is placed within the large second floor laboratory. This room provides electrical isolation and sound attenuation of greater than 80 decibels for certain types of precise research.

Adjacent to the large second floor lab is a small constant temperature room. The room temperature is controllable to ± 1°F over the range 68 to 78°F; relative humidity to ± 2-1/2% over the range 40 to 70%.

TABLE 1

CASE ChE FACULTY

ROBERT J. ADLER, Ph.D. 1959, Lehigh University.
Chemical Reaction Engineering, Mixing, Mathematical Modelling, and Separation Processes.

JOHN C. ANGUS, Ph.D. 1960, University of Michigan.
Laser Applications, Coal Utilization, Electrochemical Processes, Crystal Growth.

JACOB J. BIKERMAN, Ph.D. 1921, University of St. Petersburg (Russia).
Foams and Colloidal Phenomena.

COLEMAN B. BROSILOW, Ph.D. 1962, Brooklyn Polytechnic Institute.
Digital Simulation, Automated Design, Control of Chemical Processes.

ROBERT V. EDWARDS, Ph.D. 1968, Johns Hopkins University.
Laser Applications, Photochemistry, Chemical Kinetics, Bioengineering.

NELSON C. GARDNER, Ph.D. 1966, Iowa State University.
Coal Gasification, Surface Chemistry, Thermodynamics.

ROBERT E. HARRIS, Ph.D. 1968, Northeastern University.
Process Simulation, Computer Aided Design.

THOMAS LIEDERBACH, M.S. 1961, Case Institute of Technology.
Career Development, Professionalism.

J. ADIN MANN, JR., Ph.D. 1962, Iowa State University.
Surface Phenomena, Membrane Technology, Laser Applications, Computation.

PETER B. MELNYK, Ph.D. 1974, McMaster University.
Wastewater Treatment, Process Simulation, Mixing.

RICHARD PROBER, Ph.D. 1962, University of Wisconsin.
Water Pollution Control, Ion Exchange, Membrane Processes, Electrochemical Processes.