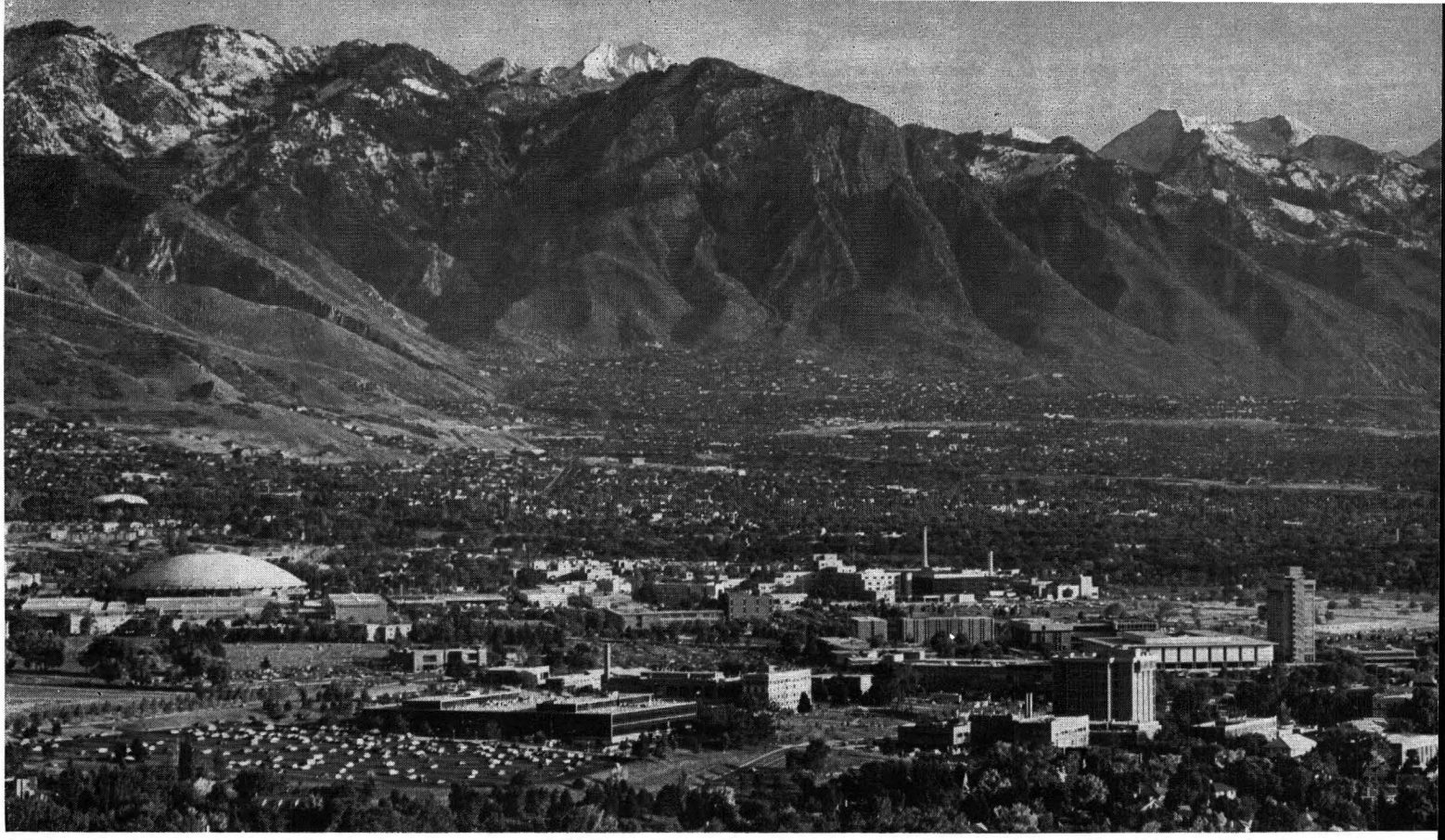

The central part of the University of Utah campus viewed from the northwest. The Merrill Engineering building, glass and aluminum, is below and left of center.

ChE department

CHE AT THE UNIVERSITY OF UTAH

NORMAN W. RYAN
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THE UNIVERSITY OF UTAH, located in Salt Lake City, occupies 1,500 acres and is bounded on the east by the Wasatch Mountains. Founded in 1850, it is the oldest and, with a student population of about 25,000, the largest institution in Utah's system of higher education. Its essential functions are served by a faculty of about 3,500, with roughly half being regular teaching faculty and half being adjunct, research, clinical, and visiting faculty. The governance of the university includes a Board of Regents and an Institutional Council (both appointed by the governor) to whom the university president reports.

The university is a complete university in the sense that it contains a good library and a set of professional colleges (including a renowned medical school) with supporting general education and scholarly departments, housed mostly in the colleges of science, humanities, and fine arts. This proximity allows interesting collaboration among the diverse professionals and scholars. The College of Engineering is one of the eleven academic colleges and consists of seven departments, one being the Department of Chemical Engineering.

All seven departments of the college are presently housed in the Merrill Engineering Building except for what has spilled over as the college has outgrown its building space. Research has expanded to fill the newly completed Energy and Minerals Research Laboratory Building, and a new classroom building (to be shared with an-

other college) will be available in about a year. The spillover will be reabsorbed, and current needs met.

There are rumors about hazards said to exist in associating with the University of Utah; namely, the seductiveness of the easily accessible outdoor life in mountains, canyonlands, and deserts. Other enticements to postpone one's urgent duties are afforded by the performances of a symphony orchestra, a ballet company, an opera company, a modern dance company, and several small theatre groups. All are resident in Salt Lake City, and most trace their genesis to the university campus. The locals tend to euphemize the risk of these "hazards" by praising the character-building effects of resisting temptation—but we tolerate (as we practice) yielding with moderation.

HISTORY

For the present purpose, history is either ancient (1905-1947) or modern (1947-present). In 1905, a program in chemical engineering was first listed among the offerings of the State School of Mines. The first B.S. in chemical engineering was awarded in 1907. By the middle 30's the Chemistry Department was administering the program, but the curriculum was still listed by the School of Mines and Engineering.

In 1943 George W. Minard, the first chemical engineer to be recruited, joined the chemistry faculty to supervise the chemical engineering program. Because Selective Service shanghaied his clientele, he took leave to serve in a local war industry, returning full time to graduate the class of 1947, and then resigning.

Modern history begins in 1947 with the fission of the College of Engineering and Mines into the College of Engineering and the College of Mines and Mineral Industries. E. B. Christiansen was retained as head of the new department of chemical engineering and was given the choice of affiliating with either of the two colleges. He chose engineering and, despite the fact that some of the top administrators withheld their blessings, hindsight has confirmed the wisdom of the choice.

Professor Christiansen, with some initial outside help in teaching, first concentrated on recruiting faculty and building a projects laboratory. Parts of the apparatus were assembled from war surplus equipment and parts were designed and, to a large extent, built by undergraduate chemical engineering students. After two years the laboratory was creditable, two new faculty members had joined the faculty, and 37 new BS degrees and the first MS degree had been awarded. The department was ready to apply for accreditation, applied, and was accredited in 1952.

During "Modern" times, the regular faculty has grown on the average of one every three years. Of the 15 members signed aboard, only two have left, one by resignation and the other by involuntary transcendental reassignment. Probably, unless the academic charter of the department is altered, the faculty will not be increased much more; future recruits will be replacing those who depart.

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The department has attained maturity. Its corporate goals, internally generated, are being acted on competently; its facilities, and now its faculty, are in a steady state of evolution; and its composite personality, which is both varied and dynamic, is progressive.

FACULTY

There are thirteen live bodies on the active faculty, eleven regular, one senior research professor, and one emeritus still active in research. Since part of the efforts of several are devoted to nondepartmental duties, we report only about nine full-time-equivalent faculty. The thirteen members of the faculty (14 including a newly hired Assistant Professor) have earned their doctorates at ten respected universities. All have experience in industry and over half have taught elsewhere at the university level.

With respect to professional recognition at the national level, one of the faculty, a member of the National Academy of Engineering, is a past president of both the American Institute of Chemical Engineers and the American Institute of Mining and Metallurgical Engineers, two have been awarded the AIChE Founders' Medal, three have been directors of the AIChE, three are Fellows of the Institute, and one was the annual Institute Lecturer for the Institute's Diamond Jubilee year. One has received the NSF "Young Presidential Investigators" award.

The spirit has manifested itself in the last seven years in the regional AIChE student paper competition: first place five times, second place five times, third place four times. The Student Chapter Award of Excellence has come to Utah in seven of the last eight years.

Two kinds of prized recognition within the university are the awards for outstanding teaching, five to ChE faculty members, and outstanding research, three to ChE faculty members.

All but the newest recruits have served in the less prestigious but important offices and committees, national or regional, of the Institute, other professional societies, and governmental agencies. As is appropriate in a university where the principle of faculty governance of academic matters is nominally respected (though sometimes needing defense), all faculty serve, or have served, on policy, executive, and administrators' advisory committees.

The present faculty members are: Richard C. Aiken (Associate Professor), PhD, 1973, Princeton University; Alva D. Baer (Professor), PhD, 1959, University of Utah; Richard H. Boyd (Professor), PhD, 1955, MIT; E. B. Christiansen (Professor), PhD, 1945, University of Michigan; Donald A. Dahlstrom (Research Professor), PhD, 1949, Northwestern University; Noel de Nevers (Professor), PhD, 1959, University of Michigan; George R. Hill III (Eimco Professor), PhD, 1946, Cornell; Timothy Oolman (Assistant Professor, beginning Autumn, 1985), PhD, 1985 University of California, (Berkeley); David W. Pershing (Professor), PhD, 1976, University of Arizona; Norman W. Ryan (Professor Emeritus), ScD, 1949, MIT; Dale L. Salt (Professor), PhD, 1959, University of Delaware; J. D. Seader (Professor), PhD, 1952, University of Wisconsin; Edward M. Trujillo (Associate Professor), PhD, 1975, University of Utah; and A. Lamont Tyler (Professor and Chairman), PhD, 1965, University of Utah.

STUDENTS

Aside from striving together for an education focused on chemical engineering, our undergraduate students rely little on the campus to cultivate their social life. Most live off-campus, many have part-time employment in the city, and a significant fraction are married. Yet through their shared experiences in classes and in the undergraduate seminar, managed by the student AIChE chapter officers, they develop an impressive *esprit de corps*.

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Other interesting sightings of the spirit are made during the annual undergraduate student vs faculty (plus drafted graduate students) basketball game, the junior vs senior softball game, the annual student vs faculty doubles tennis match (in which the faculty remains undefeated), and the spring luncheon at which the seniors are guests of the faculty. On this last occasion the faculty experiences (and sometimes provokes), the students' traditional irreverence, which passes from calmly suppressed to delicately expressed.

With respect to statistical demography, we regularly graduate 35 to 40 students with the baccalaureate each year. The numbers of advanced degrees awarded during the last ten years were 81 Master of Engineering, 27 Master of Science, and 30 Doctor of Philosophy. Our present facilities and faculty enable us to handle a greater flow of graduate students.

UNDERGRADUATE PROGRAM

That the curricula of all the chemical engineering programs in the country are very similar follows from the wide consensus among faculties on the essential ingredients of the overall program. Outside that core of consensus we find differences in emphasis, depth, or diversity.

In Utah's chemical engineering, the most notable instance of emphasis is seen in the three-quarter senior projects laboratory. Two or three students, as a team captained alternately by the members, are assigned eight laboratory projects during the senior year. An assignment is typically a design problem which requires that the team operate laboratory equipment to generate the design data needed. With assignment in hand, the team identifies appropriate equipment (or some-

times must assemble it), learns how to use it, and determines what data to take. Next they schedule a group oral examination by a faculty supervisor, and when they persuade him that they understand the project, they proceed to the final frustrations: producing the data, using the data, and writing the report.

In the course of the year's projects, the student writes three detailed formal reports, and his other five reports are technical notes or letter reports. Every report is first read by a non-engineer who grades it for the mechanics of composition and sometimes rejects it with suggestions for improvement. When it finally passes the preliminary reading, it goes to the faculty supervisor who will judge its form and engineering content. A late report is downgraded significantly. On the other hand, a report reflecting unusual ingenuity in experiment or design is awarded a grade bonus.

Another emphasis, perhaps its distinctiveness already swept away by time's frantic broom, has been our use of computers in homework and laboratory instruction. In the laboratory, many experiments are monitored or controlled by microcomputers or minicomputers. In most departmental courses, computer time is made available for the students on the computer center's mainframe computer, and techniques requiring its use have become an integral part of the coursework. Of particular note has been leadership, through J. D. Seader, in instruction in the use of large process simulation programs such as ASPEN, FLOWTRAN, and CHEMSHARE. During the final quarter, each student is required to complete a technical and economic design optimization using one of these tools.

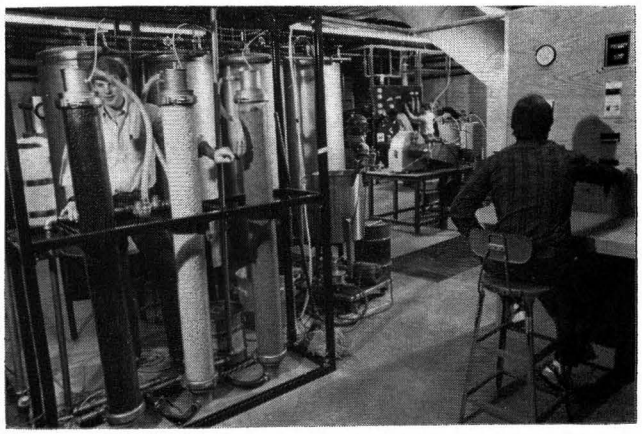
We do not treat the diffusional processes collectively as *transport phenomena* or under other non-descriptive titles. Rather we share with mechanical and civil engineering departments the teaching of common courses in engineering thermodynamics, fluid mechanics, and heat transfer. The students' class scheduling problems are greatly reduced. The required mass transfer courses are taught only in chemical engineering.

Many students desire some specialization, and we try to guide them in choosing the appropriate elective courses. To that end, we have established several informal options such as living systems, digital control, and management; or we may approve alternative schemes of electives proposed by them.

GRADUATE PROGRAM

Four advanced degrees are offered in the department: Master of Engineering (ME), Master of Science (MS), Master of Philosophy (MPhil), and Doctor of Philosophy (PhD). Each aspirant is limited with respect to which of the degrees he may apply for, depending on his performance in a combination diagnostic and screening examination. This preliminary judgment may be appealed later on the basis of the student's subsequent performance.

The ME degree, design-oriented, is popular with BS-ChE holders and graduates from related



View in the undergraduate Projects Laboratory.

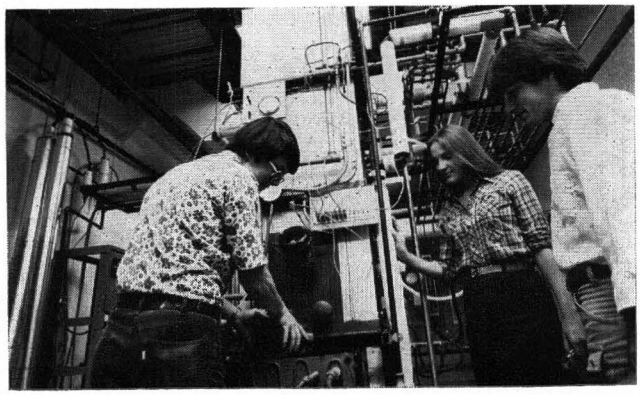
fields who want advanced treatment of chemical engineering, with opportunity for further study in related fields or mathematics. Much the same can be said for the MS degree, except that it is research-oriented and it is sometimes a first step to the PhD.

The PhD is a research degree for which candidacy is deferred until the aspirant passes a qualifying examination. That examination takes the form of preparing and defending a research proposal in which the prospective candidate is required to demonstrate originality and independent thought. The dissertation, with very rare exceptions, must exhibit an essential experimental component.

RESEARCH

Research in Utah's chemical engineering department is aimed at the education of degree candidates, with the faculty's role being maximally advisory, minimally supervisory. The benefits of the research in faculty development are regard-

ed as a bonus. Most (if not all) single-author publications by the faculty have not been designed to present new research findings, but rather have been intended to be either pedagogical, critical, or entertaining.



A furnace used in research on air pollutant formation.

The line of research of greatest longevity in the department has dealt with the rheology of non-Newtonian fluids, both the characterization of detailed fluid motion and its use in describing bulk flow. Related but independent projects have dealt with two-phase flow, with liquids and solids distributed in gases, with solids and gases distributed in liquids, and with fluid mechanics and heat transfer for flow in curved tubes with and without chemical reaction. In addition, a study of the fluctuating boundary layer in nominally "steady-state flow" was made.

The research having the longest period of continuous sponsorship, and consequently generating the largest number of advanced degrees, has studied the combustion of condensed fuels. The chief interest has been in the transients of ignition, oscillating combustion, and extinguishment. Much of the effort has involved the burning of solid composite rocket fuels, and some, the burning of the polymers and oxidants separately, with clear relevance to fires. This work qualified the University of Utah to host the *Thirteenth Symposium (International) on Combustion* on our campus in 1970.

The combustion research activity just mentioned has diminished in intensity. Meanwhile, another class of combustion projects has become the most active. This research involves coupled experimental and theoretical work on the control of acid rain pollutants (primarily NO, NO_2, SO_2, and SO_3) under conditions typical of those found in coal-fired industrial furnaces, boilers, and kilns; the direct combustion of biomass fuels; and the incineration of hazardous industrial wastes in rotary kilns.

As one would expect in a university so situated, there is active research, though with a lesser sense of urgency than expressed a few years ago, on coals, oil shales, and tar sands. They are characterized and variously processed to produce liquid fuels.

A recent subject of research which has been advanced notably in this department is computer-aided process synthesis and design. Methods have been developed for synthesizing multicomponent separation systems based on considerations of second-law analysis. Most recently, robust computational procedures based on homotopy continuation have successfully been applied to interlinked separation systems, with the surprising discovery of multiple solutions. □

POSTSCRIPT

If the reader has residual questions about chemical engineering at the University of Utah, he is invited to correspond with the chairman of the department, Professor A. Lamont Tyler.

ChE book reviews

APPLIED COST ENGINEERING, 2nd Edition
by F. D. Clark and A. B. Lorenzoni
Marcel Dekker, Inc., 368 pages, $32.50 (1985)

Reviewed by
James H. Black
University of Alabama

This book is a revised, updated, and expanded version of a very successful (six printings) predecessor. It is of particular use in explaining how to develop and use cost estimating tools, how to manage and use estimating data, how to avoid estimating pitfalls, and how to solve estimating problems. It also covers such topics as the use of estimates for cost control functions during the conceptual engineering, the detailed engineering, and the construction stages of project development. With the techniques described in this book, one can find out how to measure and forecast productivity and to control, rather than just report, costs. The book emphasizes cost estimating and

Continued, next page.