

NC STATE

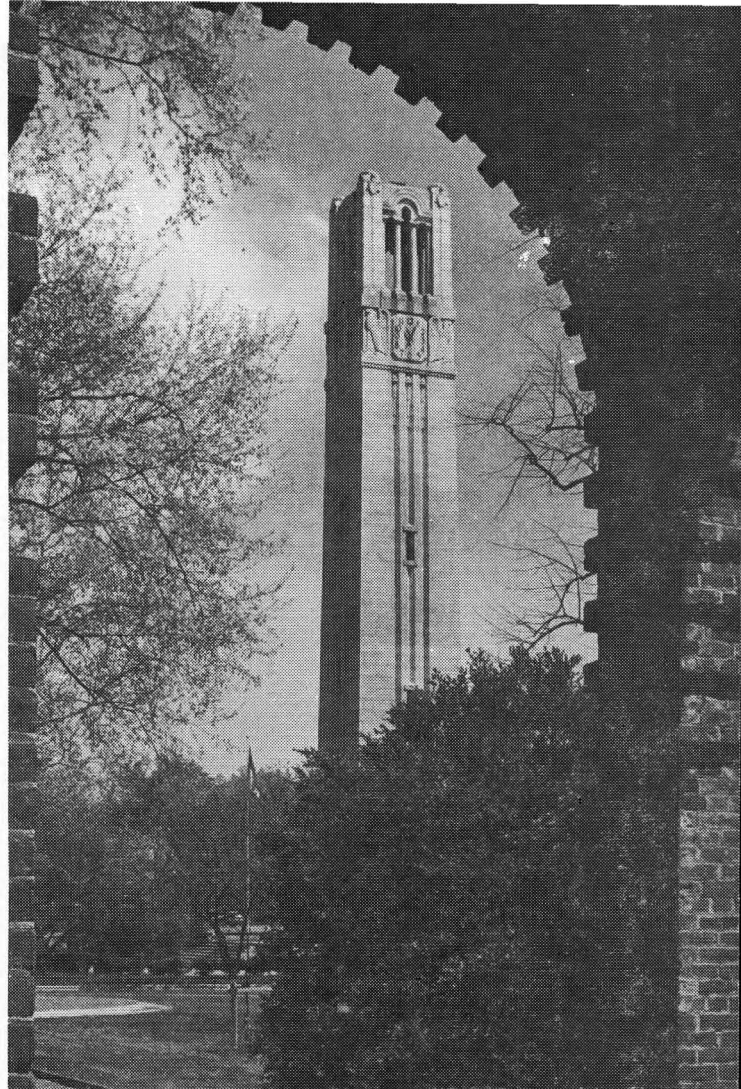
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TO SEE THE CHEMICAL Engineering Department at N. C. State in perspective, it helps to know something about the region in which we are located.

You can find grits, greens, and southern hospitality in and around Raleigh; you may also find the New York Philharmonic, Beverly Sills, the Royal Shakespeare Company, the Marx Brothers, and the Rolling Stones. Raleigh is the capital and the cultural center of North Carolina. It lies at one apex of the Research Triangle, a region bounded by lines connecting North Carolina State University at Raleigh, the University of North Carolina at Chapel Hill, and Duke University at Durham. Within the Triangle—about 12 miles from Raleigh—is the Research Triangle Park, a 5,500 acre campus for industrial and government research laboratories, including the National Environmental Research Center of the U. S. Environmental Protection Agency, and the new National Center for the Humanities. More Ph.D.'s per capita live in the Triangle area than anywhere else in the country.

While Raleigh itself is a relatively small, attractive, and uncongested city, the close proximity of the major universities and research institutions in the Triangle affords a range of activities normally found only in major population centers. The leading performers in the world regularly appear in series and individual concerts of orchestral and chamber music, dance, drama and musical comedy, jazz and rock. Classic film series and first-rate college athletics—particularly the heated rivalries of Atlantic Coast Conference football and basketball—also provide much entertainment to area residents.

Moreover, since Raleigh is situated near the geographical center of North Carolina, all of the recreational and scenic attractions of the state are within easy driving distance. The Blue Ridge and



The Bell Tower, traditionally the symbol of North Carolina State University.

Great Smoky Mountains offer some of the most spectacular scenery in the eastern United States, and North Carolina's shoreline contains many of the most unspoiled and uncrowded beaches along the Atlantic coast.

THE UNIVERSITY AND THE DEPARTMENT

NORTH CAROLINA STATE University was founded as a land-grant college in 1887, and currently has an enrollment of about 15,000 undergraduates and 2,500 graduate students. The School of Engineering is one of the ten largest in the United States. The technical resources on campus, including a million-volume library, and the ease of interaction with the other Triangle universities provide a stimulating environment for study and research.

The Department of Chemical Engineering—the only ChE department in North Carolina—occupies 40,000 square feet in Riddick Engineering Laboratories, located in the center of the main

campus. The current department enrollment is roughly 375 undergraduates and 50 graduate students, the latter working for M.S., M.Ch.E. (non-thesis), and Ph.D. degrees. The undergraduate enrollment represents a nearly three-fold increase in three years, and has imposed considerable stress on classroom and staff resources; nevertheless, all departmental courses are still routinely taught by faculty members.

The most prominent of the department's research facilities is a \$2.4 million computer-controlled fluidized-bed coal gasification and acid gas removal pilot plant—as far as we know, the only facility of its kind in the world—located in a three-story high bay area in Riddick Laboratories. The facility was constructed by Acurex Corporation under contract to the EPA, and was brought on-stream in the summer of 1978. During construction of the plant, an associated instrumental laboratory for exhaustive analysis of gas, solid, and liquid feed and effluent streams was assembled, and a dedicated microcomputer was installed for data logging and processing.

Other department facilities include well-equipped laboratories for research in polymer science and engineering, membrane transport processes, crystallization and other separation processes, phase equilibrium thermodynamics, and infrared imaging thermography. A 10-MW Pulsar nuclear reactor located in a neighboring building serves as a source of short-lived radioisotopes for tracer studies, and a Co-60 gamma source is available for studies of radiation polymerization. The Department has its own fully-staffed machine and electronics shops, and faculty members and graduate students have ready access to such specialized equipment as electron transmission and scanning microscopes maintained by the University's Engineering Research Services Division.

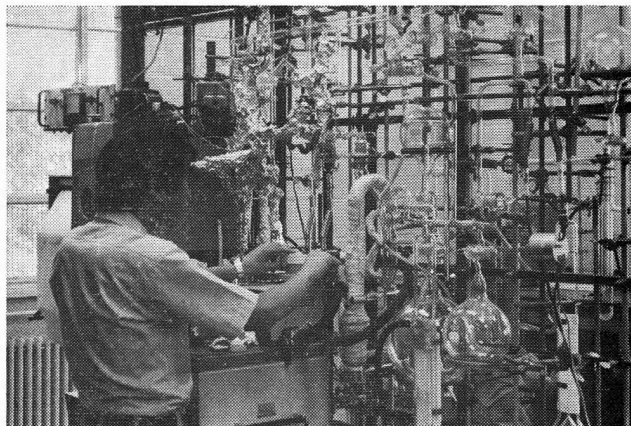
HISTORY

THE ORIGINS OF ChE at N. C. State are somewhat fuzzy. To the best of anyone's knowledge, the Department was founded sometime in the period 1923-25 by E. E. Randolph, a professor of chemistry, who served as Department Head until

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1945. In 1935 the Consolidated University of North Carolina was formed, and all engineering degree programs in the State, including a ChE program at Chapel Hill, were moved to Raleigh.

In 1941, J. Frank Seely, an alumnus of the University, joined the faculty after a two-year internship with Texaco. Frank is still here, occupying the positions of principal undergraduate advisor and principal source of wisdom and com-

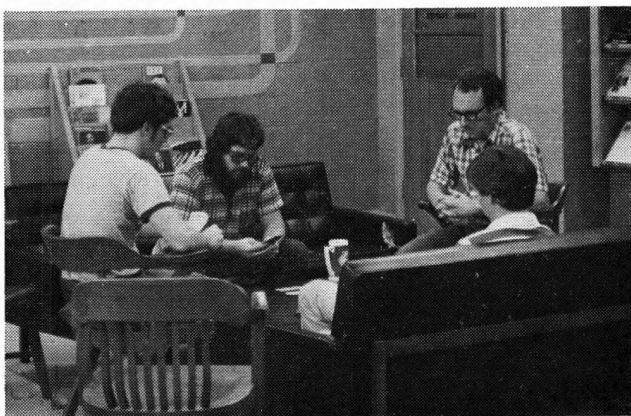


Dr. H. Kubota, a postdoctoral research associate from Gunma University, Japan, performs research on gas transport in high polymers.

mon sense to both students and faculty members. In November 1945, Edward M. Schoenborn took on the department leadership after ten years at the University of Delaware, three of them in fruitful collaboration with Allan Colburn. Kenneth O. Beatty jr. joined the faculty in the fall of 1946, after several years at Dow Chemical, four years at the University of Rhode Island, and nearly three years at the University of Michigan, where he earned his Ph.D. under Donald Katz.

At about this time, a curriculum modernization was undertaken, and emphasis shifted from courses in topics like water demineralization and gas engineering to such innovative areas as unit operations, thermodynamics, and reaction kinetics. Following an inspection by B. F. Dodge in 1948, the program was fully accredited, and authorization to award the Ph.D. was granted in 1949.

A number of faculty members no longer in the department came during the 1950's, including F. P. Pike (now retired from the University of South Carolina), Don Arnold (Kerr McGee), F. M. Richardson (N. C. State Department of Engineering Research), Bob McAllister (Dean at Lamar University), Russ Hazelton (University of Louisville), John McGee (Department Head at



The noon bridge game in the AIChE student chapter lounge is a department fixture.

Tennessee Tech), and Tom Godbold (Vanderbilt). It was also in the 1950's that James Ferrell, the current Department Head, earned the department's first Ph.D. under the direction of Professors Beatty and Richardson. Jim left the campus for a tour of duty in industry and returned in 1961, shortly before Donald Martin (from N. C. State), David Marsland (from Cornell) and Edward Stahel (from Ohio State) also joined the growing staff.

In 1965 the legendary Warren McCabe came to N. C. State after retiring as Dean of the Faculty at Brooklyn Polytechnic Institute. "Mac" remained active in research until his second retirement in 1975, and his periodic visits continue to be a source of pleasure to us.

A series of changes took place in the late 1960's, beginning in 1966, when Ed Schoenborn stepped down as Department Head and was succeeded by Jim Ferrell. In 1967 the University was awarded an NSF Science Development Grant, which served as the basis for recruiting the eminent polymer chemist Vivian Stannett, who received his doctorate at Brooklyn Polytechnic Institute. Shortly thereafter, Harold Hopfenberg came from MIT by way of Vietnam.

Later arrivals, their schools, and the years they came include Richard Felder (Princeton, 1969), Ronald Rousseau (LSU, 1969), James Helt (Iowa State, 1976), William Koros (University of Texas, Austin, 1977) and Peter Fedkiw (University of California, Berkeley, 1979). The faculty is rounded out by the presence of two joint appointees: Robin Gardner (Penn State, 1967), who spends most of his time in the Nuclear Engineering Department, and Michael Overcash (Minnesota, 1972), who resides in the Department of

Biological and Agricultural Engineering, and by Henry Smith, who graduated from this Department in 1938, received his Ph.D. from the University of Cincinnati, and came back in 1965 to assume the position of Associate Dean for Research and Graduate Programs. In 1975-76 Stannett became Dean of the Graduate School and Martin was appointed Head of the Department of Computer Science, positions they still occupy, although Stannett also actively continues his departmental research activities.

In 1976, the department inaugurated a rotating visiting professorship. We were fortunate to obtain as the initial occupant of this position, Professor Peter Danckwerts, Shell Professor of ChE and long-time Head of the ChE Department at Cambridge University, who was with us for the 1976-77 academic year. We have subsequently enjoyed visits from Dr. John Petropoulos of the Demokritos Nuclear Research Center, Athens, Greece, in the Spring of 1978, and Professor Giulio Sarti of the University of Naples, in the Fall of 1978.

DEPARTMENT RESEARCH ACTIVITIES

A UNIQUE FEATURE of the department is the frequency of intra-department collaboration, with the collaborators shifting from one project to another.

Beatty and Ferrell have long-standing interests in heat transfer and fluid dynamics. Ferrell has contributed a number of papers on the heat pipe and heat transfer in molten salts, and Ferrell and Stahel wrote the annual IEC heat transfer review for several years. Beatty's interests are currently focused on the use of infrared imaging thermography as a research tool in heat transfer, fluid flow, and biomedical engineering.

Ferrell, Felder and Rousseau are the principal and co-investigators on an EPA-sponsored study of coal gasification and acid gas cleanup, research centered on but not confined to the previously mentioned pilot plant facility. Their studies include research on the thermodynamics and kinetics of individual plant operations, evaluation of alternative acid gas removal processes, and development of methods and systems for sampling and

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analysis, monitoring and control, data acquisition, and data base management.

Ferrell and Rousseau are carrying out fundamental studies of adsorption phenomena, and have worked on the development of adsorbant materials for use in protective overgarments. Felder, Ferrell and Koros are studying the use of polymeric interfaces for *in situ* monitoring of stack emissions; Felder and Ferrell recently received a patent for the development of a probe that permits continuous unattended monitoring in dirty or corrosive stack environments for long periods of time. Felder and Rousseau have written a stoichiometry text, *Elementary Principles of Chemical Processes*, published by Wiley in 1978.

Rousseau collaborated with McCabe in research on nucleation and growth phenomena in crystallization operations, and he has continued in this field since McCabe's retirement. A recent outcome of this research is a process to use selective nucleation to separate solutes from doubly saturated solutions. Rousseau and Schoenborn studied vapor-liquid equilibria in systems containing non-volatile salts; Rousseau has extended this work to formulate predictive models, and currently is also investigating phase equilibria of acid gas absorption systems.

A monumental body of work in the field of polymers and membrane transport processes has emerged from the efforts of Stannett, Hopfenberg, Stahel, and Koros, working individually and in various combinations. Stannett is an author or coauthor of over 200 papers on most aspects of polymerization, including applications in fiber and wood and paper science. Hopfenberg and Koros conduct research on the transport of gases and liquids in polymers. Hopfenberg has investigated membrane separation processes, including ultrafiltration and reverse osmosis, and is currently working on the development of selective ion separation processes, membrane barriers for the controlled release of drugs, and liquid membrane technology. Stannett and Stahel carry out research on radiation-initiated polymerization, including pilot plant studies.

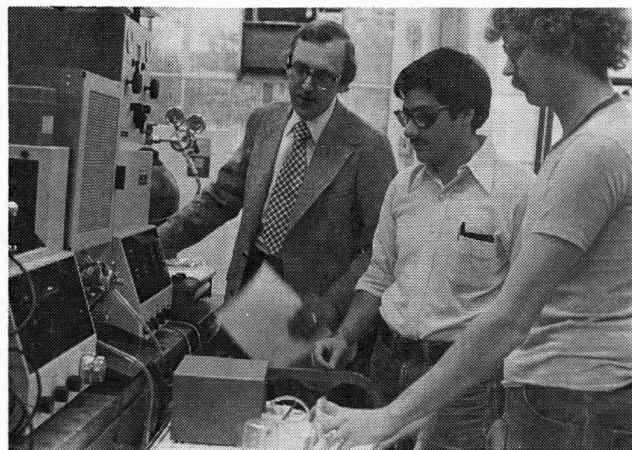
Stahel and Felder have both worked in the

field of photochemical kinetics. Stahel is currently performing research on atmospheric pollutant production, and, jointly with members of the NCSU Plant Pathology Department, on the design of chemical reactors for use in the study of pollutant uptake rates and pollution effects on plant growth.

Marsland's interests center on engineering economics, particularly as applied to pollution abatement and control, and on computer solutions of the partial differential equations of transport phenomena. Gardner studies industrial radioisotope applications, and he has used radiotracers to perform fundamental research into particulate size reduction operations.

Among the newer members of the faculty, Helt is interested in nucleation phenomena in crystallization, lubricating oil rerefining processes, and ChE applications of nuclear fuel cycles; Koros is conducting research on the sorption and transport of gases in glassy polymers, with applications to residual monomer removal and the design of gas separation processes; and Fedkiw's principal interests are in the field of electro-chemical engineering, including electrorefining and selective ion recovery.

A number of awards and honors have accrued



Professor Ferrell, graduate student Victor Agreda, and laboratory technician Larry Hamel analyze a coal sample using an atomic absorption spectrophotometer.

to the faculty. Stannett received the first Silver Medal Award of the Paper Synthetics Division of TAPPI, the Education Service Award from the Plastics Institute of America, the Gold Medal and International Award of the Society of Plastics Engineering, and from the American Chemical Society, the prestigious Borden Medal of the

Plastics and Coatings Division and the Anselm Payen Medal of the Cellulose, Wood and Fiber Division. Hopfenberg won the first Alcoa Foundation Engineering Research Achievement Award given at North Carolina State University. Hopfenberg, Felder, and Rousseau have each won the Sigma Xi Faculty Research Achievement Award, and Hopfenberg and Felder have won Outstanding Teacher Awards and have been elected to the NCSU Academy of Outstanding Teachers.

Beatty has served as chairman of the AIChE Heat Transfer and Energy Conversion Divisions and the National Heat Transfer Conference Coordinating Committee, and with E. R. G. Eckert, organized the seven nation Assembly for International Heat Transfer Conferences. Ferrell has also served as chairman of the AIChE Heat Transfer Division, and Rousseau as chairman of the AIChE Forest Products Division.

OTHER FACULTY INTERESTS

A BROAD RANGE OF interests characterizes the non-professional activities of the faculty. An unusually high proportion of guitarists can be found: Ferrell and Felder play classical guitar, Hopfenberg is an ex-rhythm guitarist in a rock combo, and Gardner plays folk guitar, specializing in off-color ballads about various marine animals. Ferrell also makes exceptionally fine guitars, not to mention a white wine that must be tasted to be believed.

Hopfenberg is a formidable gourmet chef, whose forte is quick-stir Chinese cookery but who also tosses off Northern Indian, Northern Italian, and Southern Yonkers specialties with flair and zest. Rousseau, who comes from Baton Rouge and believes he is currently living in the North, is an ex-jock who likes Cajun music, whatever sport it is that Johnny Bench plays, Thomas Wolfe novels, and a type of cooking which he swears is authentic Creole from the heart of the Bayou, but which anyone who knows anything immediately recognizes as imitation Lower East Side Delicatessen. Gardner is the other department jock—mostly tennis, with a little lunchtime basketball for variety.

Seely is one of the few native North Carolinians to be found in Riddick Labs. His principal activities include golf and wandering around the United States. Several years ago a young assistant professor searching for a way to tell freshmen what ChE is all about thought of outlining the production of alcohol from corn—a process re-

putedly important to the economy of certain regions of North Carolina. The process was not described in Shreve or any of the other standard references. The young man thought of asking Frank Seely if he knew anything about it . . . and was rewarded with a recitation of feed compositions, catalytic agents, optimal operating conditions, and residence times to four significant figures. The young professor asked Frank how he knew all that, and the subject was abruptly changed.

Stannett is a chronic globetrotter, and the leading department raconteur. Schoenborn is another habitual world traveller, and is also a classical pianist. Overcash likes politics and junkets to the Far East. Beatty has devoted much time and energy to devising aids to the blind, including devices for typing and computer transcription of Braille, and multilevel polymer maps. Stahel is an avid sailboater and antique collector; he also occasionally designs palatial manors, which he then lives in.

Marsland is one of the prime movers and shakers of barbershop quartet singing in Raleigh and environs. Martin is active in local community affairs, and is also a Commander in the Navy Reserve; he looks magnificent when he wears his dress whites to class, and his happiness would be complete if only people would stop asking him to hail them a taxi when he stands in front of a hotel.

Helt and Fedkiw are hikers and campers. Koros is also a hiker, and an enthusiastic paddleboater. He makes superb coffee but he has the strangest ideas of what barbecue is supposed to taste like, and in other ways tries to project a Texas macho image; if he ever succeeds in intimidating his small dog into staying out of the living room he may convince the rest of us that it's legitimate. Felder is a devotee of Gilbert and Sullivan and Ursula LeGuin, and is a card-carrying hedonist. He has no known faults or eccentricities.

Most of the faculty consider themselves outstanding pool and poker players. They prove themselves wrong every year at the annual Christmas party in Frank Seely's basement. Marsland, Ferrell, Felder, Gardner, Hopfenberg, Beatty, and Stahel are passable bridge players, who have on occasion dropped by the department lounge to give the graduate student regulars a lesson or two. The uniqueness and individuality of the faculty is attested to by the fact that as of this writing, to the author's best knowledge, not one of them jogs! □