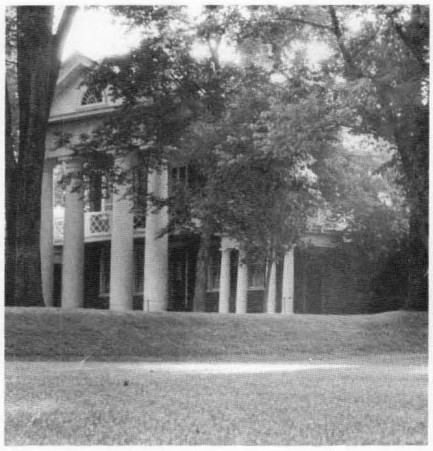
UNIVERSITY OF VIRGINIA



The beauty of Mr Jefferson's handiwork lives on: top photo is the historic "academical village" and bottom photo frames and reflects the elegance of e-school building.

View of the new (Phase 1) chemical engineering/biotechnology building.

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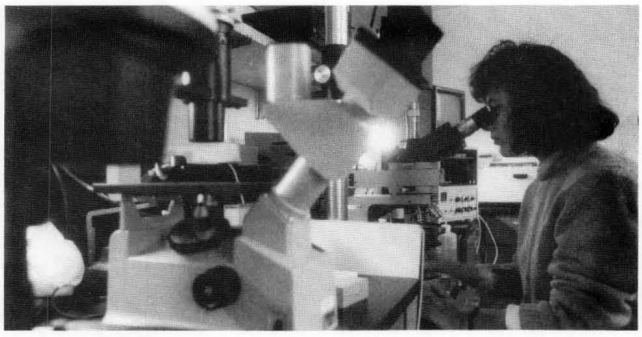
After retiring from public life, Thomas Jefferson's preoccupation was the founding of the University of Virginia as the first truly public university in the United States. He formulated its first curriculum, recruited the first faculty, and designed and supervised the construction of all the original buildings. Jefferson had a singular vision for the university: faculty and students would live together in the "academical village," an environment of unparalleled beauty where they, as equals, would pursue and expand knowledge. As he wrote to William Roscoe in 1820,

> *This institution will be based on the illimitable freedom of the human mind, for here we are not afraid to follow truth wherever it may lead, nor to tolerate any error so long as reason is left free to combat it.*

His legacy to the students and faculty at UVa includes the historic campus—known as The Grounds—containing perhaps the most famous and beautiful university buildings in the United States: the Lawn and the Rotunda. Jefferson also left UVa's students and faculty a unique and rich educational tradition. This article will attempt to convey how the Department of Chemical Engineering at the University of Virginia strives to fulfill Jefferson's educational vision.



The Center for Bioprocess Development with its state-of-the-art instrumentation.

The department is a blend of old and new. The "old" is UVa's long history of engineering in general and chemical engineering in particular. Jefferson had a strong personal interest in science and the "mechanical arts." The earliest

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. . fulfilling Thomas Jefferson's vision

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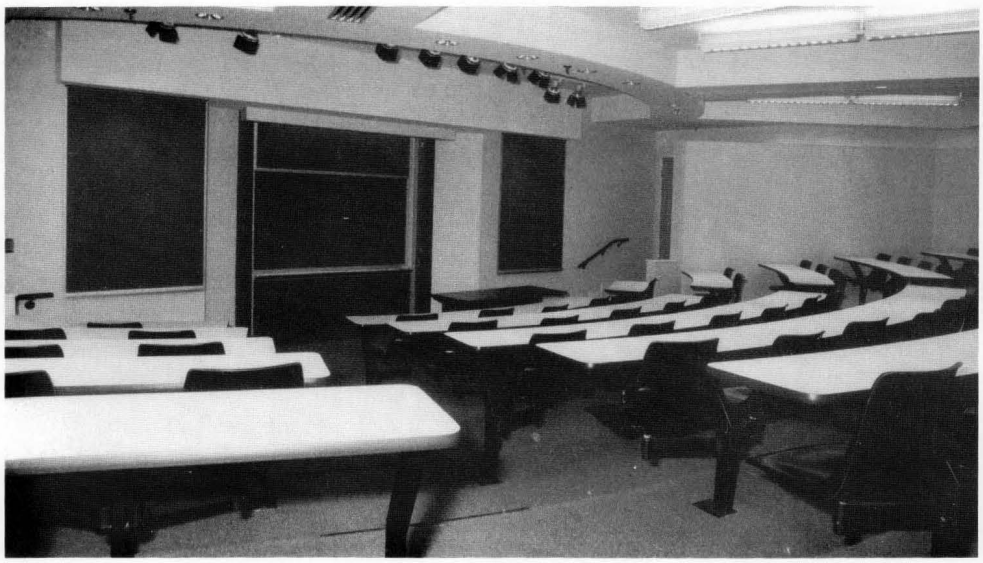
curricular plans for the university included instruction in military and civil architecture. Engineering courses were offered in 1827, about one year after the university's opening, and the School of Engineering and Applied Science was established in 1836. This makes it the oldest university-based engineering school in America.

The Department of Chemical Engineering was established by several faculty from the Chemistry Department in 1908, the same year that the American Institute of Chemical Engineers (AIChE) was founded. The Masters program began in 1949 and the first PhD was awarded in 1961. Both our undergraduate and graduate alumni have distinguished themselves through outstanding contributions in many branches of industry and in academia.

The "new" is a recent significant change in personnel and facilities. Of the eleven full-time and one half-time faculty, four have joined in the last five years and six are new in the last ten years. John O'Connell joined the department as Chair in 1988 after twenty-two years at the University of Florida, while the other new faculty all began their academic careers at UVa.

Phase I of a new 50,000 ft^2 building was completed in March of this year. It houses the faculty offices and half of the chemical engineering research laboratories. The other research laboratories, all involved in various aspects of biotechnology, are currently located in 15,000 ft^2 of nearby space that was renovated in 1986. All faculty have active, funded research programs, with over $3M in current sponsored research grants. There are more than fifty graduate students, mostly PhDs, using state-of-the-art laboratory and computational equipment for advanced-level research in contemporary chemical engineering.



Two views of the new ChE building. Part of the lobby (dedicated in honor of Charles Brown, alumnus and a former CEO of AT&T) above, and the Mobil classroom, used for essentially all undergraduate and graduate chemical engineering courses, below. It features a state-of-the-art lighting system and seats 72, with handicap facilities for both listeners and speakers.

EDUCATIONAL PHILOSOPHY

The educational philosophy of the department reflects a commitment to continuing the Jeffersonian ideal of students and faculty as equal partners in the pursuit of knowledge. Jefferson's academical village began with sixty-eight students and ten faculty drawn together in an atmosphere of close interaction and learning. This continues today in the close relationships our faculty develop both with undergraduate and graduate students, leading to friendships that continue many years beyond graduation. In keeping with the idea of equal partnership in the educational process, academic titles are not used for faculty; they are addressed by the students as Mr., Mrs., or Ms.

THE UNDERGRADUATE PROGRAM

The engineering school at UVa is renowned for the quality of its undergraduate students. Several published surveys indicate that the average SAT scores of our engineering undergraduates are the highest of any public university in the country. Only one out of every six applicants is admitted, and a significant fraction is from out of the state.

All of the courses offered by the School of Engineering and Applied Science are taught by faculty—none by teaching assistants alone. This is only possible because UVa has the lowest student-to-faculty ratio (9 to 1) of any US public engineering school. Faculty are expected to maintain an "open door" policy of being available during all normal working hours (not just during posted office hours) to assist students in every aspect of their personal and scholastic development.

The undergraduate program is typical of ABET-accredited programs, with preparatory courses in mathematics, physics, chemistry, and computer science and engineering fundamentals, followed by traditional and modern chemical engineering courses. In addition, the engineering school has its own Humanities Division which focuses on technical reading, writing, and presentation. In recent years the department has graduated fifteen to fifty BSChEs per year. The faculty recognizes exceptional graduating students with a variety of academic and leadership awards.

In the final year, each undergraduate student is required to write a senior thesis with both technical and Humanities Division advisors. Students often use original research done in our laboratories for their thesis topics. Besides producing a detailed project plan and a final written document, students orally defend their thesis proposal and summarize their findings to their Humanities class. Currently, the best eight theses are presented to a panel of industrial and faculty judges in an Undergraduate Research and Design Symposium who select the winners of research awards. Chemical engineers have been prominent in these design symposia.

Students are very active in professional service and social organizations. The focus of chemical engi-

Table 1
Faculty and Research Interests

Giorgio Carta, Associate Professor
PhD (ChE), Delaware, 1984
separation technologies • bioseparations • adsorption and ion exchange

Peter Cummings, Professor
PhD (Math), Melbourne, Australia, 1980
physical properties and phase equilibria • optimization and synthesis of chemical processes • modeling of bacterial migration

Bob Davis, Assistant Professor
PhD (ChE), Stanford, 1989
heterogeneous catalysis • kinetic studies of selected probe reactions

Erik Fernandez, Assistant Professor
PhD (ChE), UC Berkeley, 1989
Nuclear magnetic resonance (NMR) characterization of biochemical reactors and mammalian tissues • NMR imaging of flow in porous media

Roseanne Ford, Du Pont Assistant Professor
PhD (ChE), Pennsylvania, 1989
application of chemical engineering principles to microbial ecology • bacterial chemotaxis • bioremediation

Elmer Gaden, Wills Johnson Professor
PhD (ChE), Columbia, 1949
biotechnology and bioprocesses • social impact of technological development

John Gainer, Professor
PhD (ChE), Delaware, 1964
immobilized biocatalysts • two-phase aqueous extraction • oxygen transport in living systems

Jack Hudson, Wills Johnson Professor
PhD (ChE), Northwestern, 1962
dynamic behavior of chemically reactive systems • stability, periodic oscillations, and chaos • electrochemical engineering

Don Kirwan, Professor
PhD (ChE), Delaware, 1967
biochemical engineering • mass transfer, crystallization • Director of Center for Bioprocess Development

Doug LeVan, Professor
PhD (ChE), UC Berkeley, 1976
fixed-bed adsorption • thermodynamics of adsorption equilibria • modeling of fixed-bed adsorption systems • computer-aided design

Lem Lilleleht, Associate Professor
PhD (ChE), Illinois, 1962
nucleation of refractory vapors in microgravity environments • utilization of solar and other alternative energy resources

John O'Connell, Professor and Chair
PhD (ChE), UC Berkeley, 1967
applied molecular theory • strongly nonideal liquids • surfactant solutions

neering involvement is the student chapter of the AIChE, advised by John O'Connell. Last year the group was selected as a national Chapter of Excellence (no more than ten percent of all chapters are cited for this award). The major activities of the chapter include presentations during the semester by industrial speakers, a symposium on graduate school, the securing of industrial sponsorship to support attendance of about ten members at annual AIChE meetings and regional student chapter conferences. There are several social events for both faculty and students, and the chapter also has a novel outreach program called "Wahoo Wizards" (Wahoos being one of the nicknames for UVa sports teams) where students visit local elementary and middle schools to perform experiments that stimulate children's interest in science and engineering.

THE GRADUATE PROGRAM

The closeness that exists between undergraduates and faculty is paralleled in the relationships of graduate students and faculty. Graduate students undoubtedly benefit from the open-door policy at least as much as the undergraduates do.

The graduate program offers MS, ME, and PhD degrees. The two Masters degrees include a group of five core courses in the fundamentals of chemical engineering. The primary difference between them is that the MS requires a research thesis. There is also a special program for highly qualified students with degrees other than in chemical engineering. It begins with an intensive summer program covering the undergraduate-level material, followed by entrance into the regular graduate program.

The ME degree can be taken as a nonresident

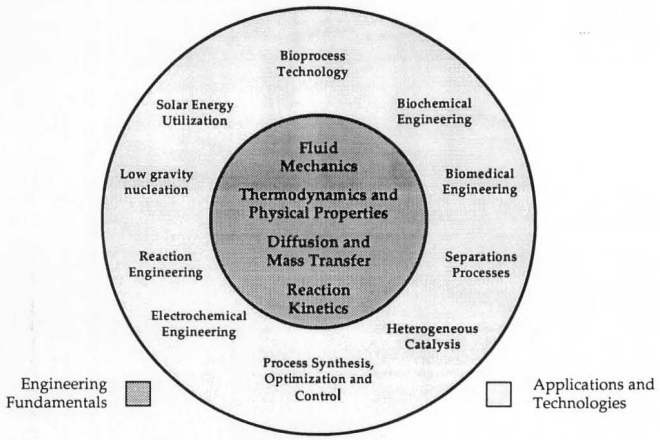


Figure 1. *Schematic illustration of faculty research interests divided into engineering fundamentals and applications. Placement of fundamentals at the center and applications at the periphery indicates how applications-oriented research depends on advances in fundamentals.*

...research interests range from applied chemistry, biotechnology, and chemical technology to mathematical modeling, molecular and process simulation, and design.

through the Virginia Cooperative Graduate Engineering Program (VCGEP). Each term, one of the regular graduate courses is broadcast via satellite throughout Virginia and the U.S. using one-way video and two-way audio capabilities. Many companies have established classrooms at their industrial locations in order to allow their employees to participate in this program. There are now more than thirty nonresident students enrolled in the ME ChE program through VCGEP, and more than a dozen ME degrees have been awarded in the last three years.

The chemical engineering faculty view research as an integral part of graduate education. The research interests range from applied chemistry, biotechnology, and chemical technology to mathematical modeling, molecular and process simulation, and design. Figure 1 illustrates how the ongoing research programs at Virginia cover the two broad categories of fundamentals and applications. The major fundamental research programs are:

Diffusion and mass transfer Gas-liquid and solid-liquid systems • transport processes in biological systems • homogeneous nucleation

Thermodynamics, physical properties, and adsorption Statistical thermodynamics • prediction of physical properties • fluid phase equilibria • adsorption equilibria • ion exchange • solubility of biochemicals

Fluid mechanics Low Reynolds number flow • surface-tension driven flow • multiphase flow and stability

Reaction kinetics Oscillations and chaotic behavior; heterogeneous catalysis

The programs in applications and technologies include:

Separations technology Fixed bed adsorption • ion exchange and chromatography • precipitation and crystallization • extraction • air pollution control

Bioprocess technology Immobilized enzymes, microorganisms, and cells • aeration and oxygen transfer • bioseparations • bioremediation

Biochemical engineering Modeling of metabolic processes • secondary metabolite regulation

Biomedical engineering Mammalian cell biocatalysis • metabolism in diseased tissues • enhanced oxygenation in living systems • NMR spectroscopy

Reaction engineering Bioreactors • multiphase reactors • flow reactors

Electrochemical engineering Corrosion • dynamics of electrochemical reactions

Heterogeneous catalysis Structural characterization of metal clusters • acid-base properties of solid oxides

Process synthesis, design, and control Mathematical modeling

and simulation • computer control • computer-aided process design.

Solar energy utilization Thermal energy conversion and storage • photovoltaics

While faculty direct independent research programs, there is considerable collaboration both within and outside of the department. Many of our faculty are involved in multidisciplinary research efforts at UVa.

Six faculty members from chemical engineering (Carta, Fernandez, Ford, Gaden, Gainer, and Kirwan) participate in the Center for Bioprocess Development along with several faculty from the Medical School and Department of Biology. Founded in 1987 under the sponsorship of Virginia's multi-program Center for Innovative Technology (CIT), the Bioprocess Center conducts research in biotechnology applications such as large-scale use of biological catalysts (microbes, cells, and enzymes) and novel processing for producing valuable products in medicine, agriculture, and the food, energy, and chemical industries. The center's annual budget is over $1M from federal agencies (including NSF and NIH), state funds through CIT, and fifteen companies.

Four faculty (Cummings, Ford, Fernandez, and Gainer) are involved in UVa's Biophysics Program, an interdisciplinary degree program with over forty other faculty members from the Medical School, the School of Engineering and Applied Science (Biomedical and Chemical), and the College of Arts and Sciences (Biology, Chemistry, and Physics). Jack Hudson participates in the Center for Electrochemical Sciences and Engineering which draws together faculty from chemical engineering, materials science, and nuclear engineering around the themes of corrosion, electrochemical reactions, and electrochemical phenomena. Its research support of several million dollars annually comes from a variety of federal agencies, CIT, and industry.

ENVIRONMENT

The university is located in the historic city of Charlottesville in beautiful Albemarle County, nestled in the foothills of the Blue Ridge Mountains. The area's mild climate, historical significance (three presidents—Jefferson, Madison, Monroe—all resided nearby), academic stature, and physical beauty attract a wealthy and culturally diverse population of about 120,000. The locale combines the amenities and attractions of a city with the charm and ambience of rural America. Furthermore, Washington, DC, and Richmond are both less than two hours away by car, while the Skyline Drive can be reached in less than one-half hour. The Charlottesville/Albemarle airport is serviced by several major airlines.

UVa is often regarded as one of the finest universities in the US, with outstanding undergraduate and graduate programs in the arts, law, medicine, business, and engineering. For the last two years it has been ranked by the *New York Times' "Selective Guide to Colleges"* as one of the three best universities in the U.S. In a recent *U.S. News and World Report* article surveying American universities, UVa was the only public university ranked in the top twenty.

The current enrollment is 17,000 students, with 7,000 of them in our graduate and professional programs. Thus, it is one of the smallest PhD-granting state universities in the country. Combined with the historical buildings and grounds, this gives the university the look and feel of a small private school.

Much of chemical engineering is now housed in the first phase of a new building designed specifically for chemical and biochemical engineering research. Its dedication was on April 25, 1992, with John M. Prausnitz of UC Berkeley giving the principal address. In keeping with Jefferson's view of close faculty and student interactions, the building's faculty offices are dispersed throughout the building, generally across the hall from their laboratories and graduate student offices. The second phase of this 50,000 ft^2 facility will house the bioprocessing research laboratories, the undergraduate laboratory and mechanical shop. Funding for both phases does not include any state-allocated money. The generosity of alumni, industry, and philanthropic foundations to complete this $11M building demonstrates how highly our program is regarded by these groups.

CONCLUSION

The goal of our department is to make measurable and distinctive contributions toward enhancing the quality of life consistent with the rich educational tradition entrusted to us by Thomas Jefferson. In doing so our objectives are to satisfy our public and private benefactors and stimulate growth in all of our students. Our energetic faculty members are strongly committed to both teaching and innovative research, deeply involved with undergraduates and graduates in a community of shared learning and research, and housed in a new building of architectural beauty that promotes scholarly and professional interactions in much the same way as Thomas Jefferson's beloved Lawn. We invite you to visit us and experience first-hand the ways in which chemical engineering at UVa is meeting its objectives and fulfilling Thomas Jefferson's vision. ❐