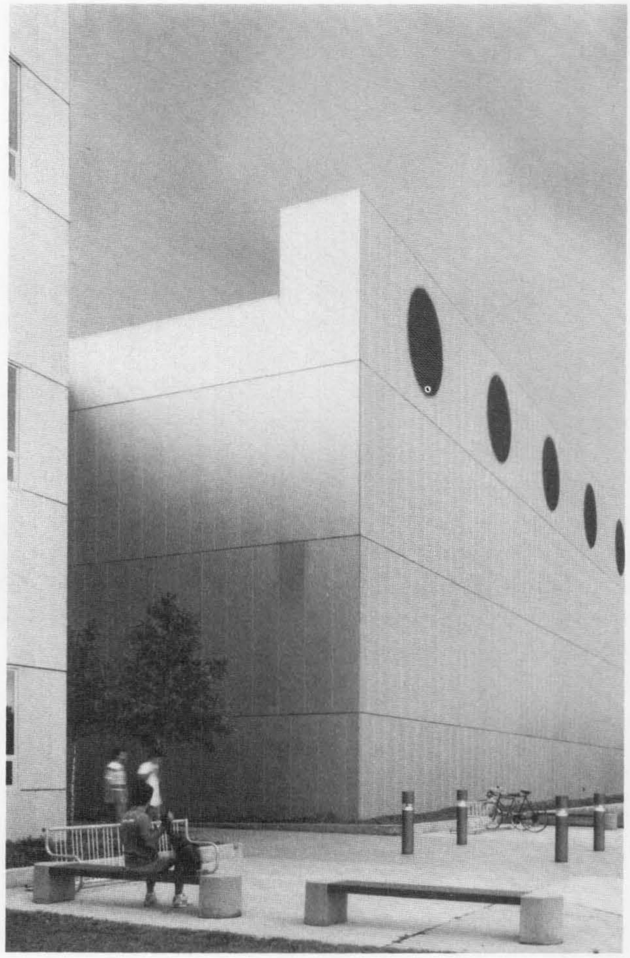
FAMU/FSU



Central atrium (above) and laboratory wing (right) of the FAMU/FSU College of Engineering

B.R. LOCKE, P. ARCE, M. PETERS
FAMU / FSU College of Engineering
Tallahassee, FL 32316-2175

The Chemical Engineering Department at the FAMU/FSU College of Engineering is part of a unique program that developed through collaboration between Florida Agricultural and Mechanical University (FAMU), a historically black university, and the Florida State University (FSU), formerly the Florida State College of Women.

FAMU was chartered in 1887 and has traditionally focused on a strong undergraduate education in basic studies, business, engineering technology, and agriculture. It currently enrolls about 9,000 students from a wide geographical area.

The roots of FSU go back to 1851, although it was not until 1947 that the State Legislature granted it university status. Total current enrollment is about 28,000 and includes students from most states in addition to 105 foreign countries. There are approximately 4,500 graduate students at FSU.

Although the College of Engineering is young (it was authorized by the 1982 Florida State Legislature), it has experienced an extraordinary rate of growth. Student enrollment has increased by an average of fifteen percent per year over the last three years. ABET-accredited undergraduate degrees are offered in all departments: chemical, civil, electrical, industrial, and mechanical engineering. MS degrees are offered in all of the disciplines except industrial engineering, and PhD degrees are offered in chemical and mechanical engineering. The college currently enrolls over 1800 undergraduate students and 200 graduate students. It has approximately seventy full-time professors.

Engineering students can enroll at either FAMU or FSU. They must, however, satisfy both the general education requirements of the school in which they are enrolled and the specific requirements of the Engineering College. All engineering classes are taken at a single engineering complex, which is convenient to both campuses, while courses in basic studies, sciences, and mathematics are taken at the student's respective university. The degree is granted by the College of Engineering through the university where the student is enrolled.

Although nationally recognized as a major football powerhouse, FSU has traditionally also had strong programs in liberal arts and the basic sciences. With the appointment of a new university president (Dr. Dale Lick, a mathematician), along with the development of the National High Magnetic Field Laboratory and the Supercomputer Computations Research Institute, the expansion of the centers for Materials Research and Structural Biology, and the high quality of the physics, chemistry, biology, geophysics, and applied mathematics departments, FSU is poised to become one of the nation's top research and educational institutions. It is currently ranked among the top colleges by college-bound high school seniors as a desirable place to study.

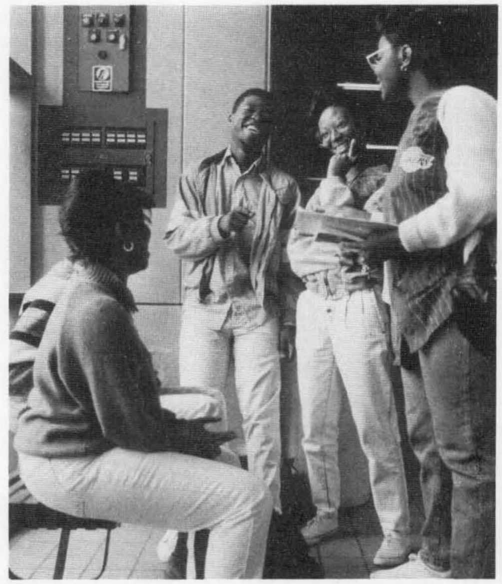
The home of the internationally known "Marching 100," FAMU is ranked high by college-bound minority students as an attractive place for pursuing higher education. Through the active recruitment efforts of its president (Dr. Frederick Humphries, a physical chemist by training), FAMU currently attracts a large number of highly qualified minority students who are eager to major in chemical engineering. Several FAMU students presently hold full "life gets better" scholarships, supported by industry, which provide full financial assistance for obtaining a bachelors degree as well as providing summer internships.

THE CHE DEPARTMENT

Fifty-five bachelors degrees, five masters degrees, and two doctorate degrees have been granted by the Chemical Engineering Department as of fall, 1992, and current enrollment includes approximately 250 undergraduate and 15 graduate students. Research and graduate-level activities began soon after the department was founded, and the PhD program was fully approved by the Board of Regents in the fall of 1989. The department has embarked on a new five-year strategic plan emphasizing research and education in newly developing areas of chemical engineering science and technology.

Undergraduate Program

The department is committed to providing a high quality and "modern" education in the basic principles and practices of the chemical engineering profession. In addition to maintaining a strong curriculum which incorporates the fundamentals of chemical engineering, the faculty believes that it is important to incorporate applications from the emerging areas of chemical engineering into the core courses. These include biotechnology and biomedicine, advanced materials (polymers, ceramics, and composites), computer-assisted process and control engineering, and surfaces, interfaces, and microstructures.[1-3] Also, because of the rapid changes and added complexities in the profession, greater emphasis is being placed on occupational health and safety practices in laboratories, environmental protection, waste minimization, and recycling. In addition, elective courses in bio[4] engineering, polymers, chemical-environmental engineering, advanced materials science and engineering, molecular engineering, and macromolecular transport[5] provide, in part, a more comprehensive study of the emerging areas in chemical engineering.



A familiar student gathering in the atrium.

As part of its growth plan, the department is currently adding modern developments to the undergraduate curriculum, including new developments in molecular structure, state-of-the-art instrumentation and experimental techniques, statistical methods and their rational application to process design (including design of experiments), and quality control.

All qualified undergraduates are strongly encouraged to participate in research projects through both the Honors Program and Directed Individual Studies. The Honors Program emphasizes research with faculty for the highly talented and motivated student.

The nationally accredited student AIChE chapter is an active group that sponsors a number of plant trips to local industries, arranges and schedules talks by professional engineers, and publishes a newsletter, *The Innovator,* twice a year that contains articles by both students and faculty. In addition, the student chapter is the focal point for information on graduate school opportunities and also schedules talks from visiting academicians on graduate research and education in chemical engineering.

The department awarded approximately $15,000 of industrially supported scholarships to the top undergraduate students in the 1991-1992 school year.

Graduate Program

The department offers both a thesis and a non-thesis option leading to the Master of Science degree. The core curriculum required for both options includes advanced chemical engineering thermodynamics, transport phenomena, reactor design, and mathematical analysis, in conjunction with proficiency in computational skills such as numerical solution of engineering problems.

PhD students have the option of selecting graduate courses from a variety of choices that includes, among others, applied mathematics, advanced transport phenomena, macromolecular transport, statistical mechanics, polymer rheology, and computational techniques. A wide range of other advanced courses is available in the departments of chemistry, physics, biology, applied mathematics, and mechanical engineering.

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The department is strongly committed to building a solid graduate research program in both applied and fundamental areas. The faculty believes that graduate programs must be diverse, interdisciplinary, and flexible in order to prepare chemical engineers to handle the applications of a quickly changing technology.

FACULTY RESEARCH INTERESTS

Faculty members are actively involved in several areas, including polymer processing, biochemical engineering, materials research, semiconductor processing, macromolecular dynamics, reaction kinetics, molecular transport phenomena, expert systems, thermodynamics, and applied and computational mathematics. Many of these efforts are conducted in close cooperation with the Florida State University Supercomputer Computations Research Institute (SCRI), the Material Research and Technology Center (MARTECH), and the departments of chemistry, physics, biology and applied mathematics at FSU. Currently the department has seven full-time faculty members, one adjunct teaching professor, and four affiliate professors.

Pedro Arce joined the department in 1990 after completing his Masters and PhD at Purdue under the direction of D. Ramkrishna. He also has several years experience in teaching and research at the Universidad Nacional del Litoral (Sante Fe, Argentina). His research revolves around a variety of problems in material design synthesis and processing, with a strong emphasis on the application of fundamental principles, advanced mathematical methods, and physical theory closely coupled with computational techniques and experiments. The central theme of his investigation is an understanding of basic transport phenomena and physicochemical aspects involved in, for example, crystal growth, ceramics technology, polymeric gel media, and composite fluids. In the modeling approach, Dr. Arce uses advanced mathematical techniques such as operator-theoretic and group-theoretic methods, bifurcation theory, and asymptotic techniques in conjunction with the application of computer-aided functional analysis. In regard to complex and composite fluids, his objective is to study the nature of, and the role played by, the interparticle forces in order to yield models capable of predicting interfacial behavior, suspension stability, and "ordering" under the applied field. Hydrodynamic theories, statistical mechanics treatment of the microstructure, fractal theories, and computer-aided analysis are the main tools of this research. Dr. Arce also has an interest in active-learning techniques. For example, his efforts have led to the development of a technique called the "colloquial approach."[6]

Ravindran Chella joined the department in 1986 after doing postdoctoral work at the University of Pittsburgh. He obtained his PhD from the University of Massachusetts under the supervision of Julio M. Ottino. He also has a Master of Science Degree in Chemical Engineering from Rutgers University. His current research interests are primarily in the characterization of composites and polymer processing. He is also a member of MARTECH and much of his research is in collaboration with colleagues in the department of mechanical engineering. Moire interferometry is being used for the thermo-mechanical characterization of polymer and metal matrix composites. Boundary element methods are being used for stress analysis and characterization of composites under thermo-mechanical loading. The computational work is coordinated with experimental microstrain measurements, and numerical algorithms are being formulated to take advantage of the extensive facilities available at SCRI for vectorized and parallel computing, including a Cray Y-MP super-computer and a 64-K node Connection Machine. This is important for simulations involving complex geometries and nonlinear material behavior. In the area of polymer processing, laser-speckle techniques are being developed to obtain instantaneous velocity distributions over a plane in prototype two- and three-dimensional polymer processing flows relevant to extrusion and coextrusion. Experimental results are used in the verification and refinement of finite-element and boundary-integral models of the flow.

David Edelson, a graduate in physical chemistry from Yale University, joined the department after a number of years spent in research at AT&T Bell Laboratories. His research interests are in the areas of chemical kinetics and reactive flows, and in the use of computation simulation and the development of expert systems for the elucidation of mechanism, identification of controlling processes, and prediction of the behavior of reactive systems. Dr. Edelson is also a faculty associate with SCRI, and together with colleagues in computer science, has been engaged in the prototype design of an expert system for the simulation of reactive flows.

Bruce Locke was hired as an assistant professor in 1989. He completed his Masters at the University of Houston under the supervision of Neal Amundson and earned his PhD at North Carolina State University under the direction of Ruben Carbonell. With strong backgrounds in both mathematical modeling methods and experimental development, Dr. Locke's general research interests are in combining experiments with fundamental principles in order to understand and improve a wide range of processes and phenomena. Combining four years of experience at the Research Triangle Institute (in North Carolina) in the area of aerosol physics and fine particle studies with work on macromolecular separation processes at North Carolina State, he now focuses on research in particle and macromolecular transport processes. Dr. Locke, in collaboration with Dr. Arce and colleagues in the departments of physics, chemistry, and biology at FSU, is seeking to improve the separation of large DNA molecules using pulsed field electrophoresis. He also has an underlying and continuing interest in applying chemical and biochemical engineering fundamentals to solving environmental problems. As part of this environmental interest, Drs. Locke and Arce are analyzing the combined reaction and transport processes occurring in pulse streamer coronas in order to improve design and operation strategies for air and water pollution treatment.

Srinivas Palanki joined the department in 1992 after completing his PhD at the University of Michigan under the supervision of Costas Kravaris and Henry Wang. As a graduate student he also spent a year at Merck and Co., Inc., working on optimization and scale-up of antibiotic fermentations. His primary research interest is in optimization and control of batch reactors with applications to biological processes. Since batch reactors do not have a process steady state, there are no conventional "steady-state set points" to which a conventional controller can be tuned. The major objective is to minimize an objective function at the end of the batch cycle. Due to batch-to-batch variations in complex processes such as biological fermentations, an *a priori* calculated operating scheme may lead to suboptimal performance. Using "geometric tools," Dr. Palanki is developing feedback laws for end-point optimization of batch reactors. This approach attenuates uncertainties and disturbances to the batch process and is independent of initial conditions. Coupled with state and parameter estimation algorithms, this approach provides the basis of an on-line adaptive optimization scheme. Dr. Palanki also has a strong interest in developing techniques for understanding and tracking key intracellular events which control the production of chemical of interest in batch fermentations and using these methods for optimal design and scale-up of batch fermentations.

FAMU/FSU enjoys a unique multicultural atmosphere that is fostering development of a first-class chemical engineering department. [The new dean], Dr. C.J. Chen, . . . is actively working on important projects for the future.

Michael H. Peters is chair of the department. He received his Master's and PhD degrees from the Ohio State University in 1979 and 1981, respectively, and his BS from the University of Dayton in 1977. His research interests are in the areas of macromolecular dynamics, molecular transport phenomena, and moelcular engineering. He is also a Faculty Associate with SCRI. His supercomputer computational research is being conducted in the general area of molecular and macromolecular dynamics. In the area of macromolecular dynamics, computer simulations, using Brownian dynamics methods, of coupled, internal translational and rotational motions of flexible macromolecules are being developed and tested. The significance of this work lies in the fact that internal macromolecular motions are often critical to the behavior and functionality of macromolecules. Some notable examples include biological macromolecules, such as DNA, t-RNA, and a variety of proteins and biopolymers, where internal flexibility or, more properly, the span of macromolecular configurational space, is critical the degree of functionality of the macromolecule. Other supercomputer computational research is being conducted in the area of Natural Nonequilibrium Molecular Dynamics (NNMD). In this study, the goal is to include the boundary and initial conditions of the problem as they "naturally" occur in the real physical system. There are some extremely useful applications of this method despite the seemingly gargantuan system size. One application under development is the transport and deposition of aerosol particles in the human lung airways (*e.g.*, bronchial and alveolar regions). Dr. Peters is also involved in research education in the field of molecular engineering and is currently working on a text entitled *An Introduction to Molecular Transport Phenomena.*

Samuel Riccardi, with a PhD from Ohio State University and over forty years of industrial experience at Olin Corporation, joined the department in 1988 as an adjunct professor. He devotes his time primarily to running the unit operations laboratory. He has also taught courses in design, thermodynamics, and industrial waste treatment. He has many interests in process and plant design, environmental control, and loss prevention in the process industries and has held positions in a wide range of areas including research and development, process engineering, pilot plant and manufacturing operations, plant and facility design, environmental control, and loss prevention.

After four years of academic experience at the University of Wisconsin-Madison, **John Telotte** was hired in 1985 as an assistant professor. He did his graduate work at the University of Florida under the direction of John O'Connell. His current research interests involve measurement and correlation of physical-property data and modeling of heterogeneous transport processes. The applications of these interests have been in the areas of biochemical processing, semiconductor processing, and indoor air quality. Ongoing research has been involved with both measurement and correlation of solubility data. A laboratory for complete thermodynamic characterization of dilute solutions has been set up and a solution theory has been developed that is generally applicable to solutions of a solute dissolved in a mixed solvent to analyze experimental data. Specific projects have examined amino acid solubility in mixed solvents and the effect of added salts on protein solubility and gas solubility in fermentation media. Initial work for semiconductor processing has focused on the measurement of diffusion coefficients of metalorganics in hydrogen and on viscosity measurements of these mixtures. This will be extended to the development of correlations for transport properties. His work in indoor air quality is concerned with the development of models for radon transport through soil, modeling of the dynamics of radon distribution inside buildings, and the development of construction techniques to minimize hazards due to radon infiltration.

Most recently, **Jorge Viñals** has been appointed as an affiliate faculty with the rank of Graduate Research Professor. He is a research scientist at SCRI. He has a Masters and a PhD from the University of Barcelona, Spain, and has worked several years at Carnegie Mellon University under the direction of Professors Mullins and Sekerka. His research interests are centered around theoretical studies of non-equilibrium phenomena. Current areas of research include theoretical and numerical studies of kinetic processes during first-order phase transitions, morphological instabilities and growth during solidification, and pattern formation following fluid-flow instabilities. Dr. Viñals' efforts on phase transitions seek to understand and generalize scaling properties and to implement renormalization group techniques to situations far from the equilibrium. His research methods include the application of perturbation theory, Monte Carlo simulation, and numerical solutions to diffusion or Langevin-type equations. He is also interested in investigating the steady-state stability and transient evolutions of problems such as cellular morphologies, dendritic solidification, and viscous fingering instabilities.

The department has three additional affiliate professors. Within a framework emphasizing nontraditional areas in chemical engineering and multidisciplinary efforts, they work closely with other faculty members in directing graduate and undergraduate students and in developing new areas of research. They are **H. Garmestani** (PhD, Cornell University, 1989; Assistant Professor in the Department of Mechanical Engineering), **P. Gielisse** (Ph.D., Ohio State, 1967; Professor of Materials Science in the Department of Mechanical Engineering), and **H. Lim** (Ph.D., Rochester, 1986; Research Scientist for the SCRI).

FUTURE PERSPECTIVES

The faculty strongly believes that an interdisciplinary environment will provide the flexibility and the state-of-the-art knowledge required to develop successful chemical engineers for the future. The faculty also recognizes the crucial role played by research and graduate education in the overall performance of a successful program. Following studies to modernize

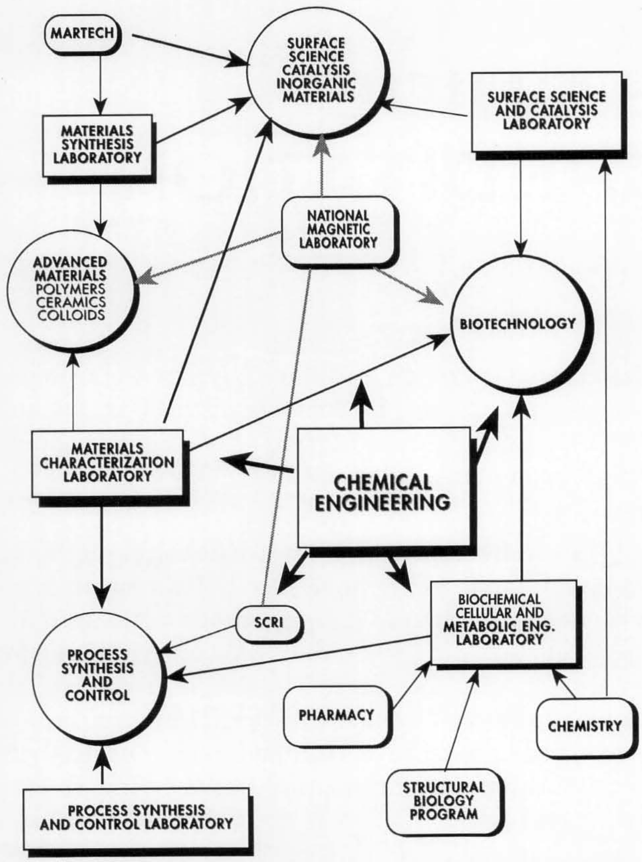

***Figure 1.** Present and future research focus for the ChE department at FAMU/FSU College of Engineering.*

and to re-orient the chemical engineering programs across the country,[1-3] the Department has formulated a strategic plan to focus on the development of research areas that will add to and supplement existing programs. These include developments in process control, surface science and catalysis, advanced materials, and biotechnology.

Figure 1 shows the four main areas of research mentioned above and the potential interactions that the different facilities and projects should display. One can see the important role played by the National High Magnetic Field Laboratory and the Supercomputer Computations Research Institute as well as the other first-class programs available at FSU and FAMU. It is the general philosophy of Dr. Jack Crow, director of the magnetic laboratory, that the university must integrate research at the lab with current programs in order to prevent the lab from becoming merely a user facility for outside researchers and to make it a valuable tool for building programs at the university. He has been successful at attracting internationally known experts in the areas of magnet design. J. Robert Schrieffer, 1972 Nobel prize winner in physics and former director of the Institute for Theoretical Physics at the University of California, Santa Barbara, joined the faculty in 1992. Also, Hans Jorg Schneider-Muntau, considered the best magnet designer in the world, joined the engineering faculty in 1992. Other well-known scientists have also joined the laboratory and become members of the faculty at FSU. They include John Miller (formerly at the Lawrence Livermore Laboratory), Dennis Markiencz (formerly at Intermagnetics General), and Steve Van Scriver (formerly at the Applied Superconductivity Center at Wisconsin). The lab will be located next to the engineering building, and both the chemical engineering and mechanical engineering departments have taken similar philosophies towards developing their programs to complement and fully utilize the lab.

The important role of SCRI is also crucial for the development of chemical engineering. FSU is one of the few universities in the United States to have both a state-of-the-art Cray Y-MP and a Connection Machine. The DOE-supported facility is currently used intensively by faculty in the chemical engineering department.

FAMU/FSU enjoys a unique multicultural atmosphere that is fostering development of a first-class chemical engineering department. The College of Engineering has appointed a new dean, Dr. C. J. Chen (ex-Iowa) who is actively working on important projects for the future of our college. In addition, the dynamic attitudes of the people involved in the various university research programs have created a critical mass of enthusiastic investigators who are driving the development of high-quality programs. With the current budgetary constraints facing most states (including Florida), few universities presently enjoy such a progressive atmosphere.

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