ChE department

AUBURN UNIVERSITY

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Auburn University is the largest, most comprehensive university in Alabama and is the state's major graduate school for students in engineering, agriculture, physical and biological sciences, veterinary medicine, and many other areas of study. During the fall quarter of 1989, the College of Engineering had 3,769 students, placing it among the top twenty largest colleges of engineering in the nation.

Auburn first offered courses in chemical engineering in 1913, and the first class of MS chemical engineering graduates received degrees in 1919. The doctoral program began in 1974 and the professional mentors program in 1986. Women have been earning chemical engineering degrees at Auburn since the early days of the program.

The program at Auburn has consistently attracted large numbers of excellent undergraduates. In 1989, the chemical engineering department had a freshman class of 123, the fourth largest in the United States as measured by the enrollment survey taken at the 1989 AIChE meeting in San Francisco. A freshman class of that size translates into a senior class of about eighty, which is significantly higher than the expected 1990-91 graduating class of about fifty.

Auburn has one of the largest graduate programs in the Southeast. It experienced dramatic growth during the 1970*s* and 1980*s* and is becoming a significant program at both the doctoral and the master's levels. There are twenty-seven new full-time graduate students as of fall 1990—an increase from the previous average of twenty new graduate students per year. Approximately three-quarters of these new students are earning their PhD*s*. The total fall 1990 full-time graduate enrollment is eighty, and there are fifteen part-time graduate students working toward a master of chemical engineering degree.

Auburn chemical engineering students are heavily recruited. Last year, more than 125 companies interviewed BS, MS, and PhD chemical engi-

neers through the University Placement Office, and more companies are expected next year. Employers respect and recruit Auburn graduates for their strong work ethic, high standards, and high levels of motivation.

Auburn has a history of student excellence. The high quality of entering freshmen at Auburn (with average ACT scores of 27.1 and average SAT scores of 1202) has consistently ranked the department at or near the top of Southeastern public university chemical engineering departments. Similarly, the quality of graduate students is high, with the average GRE quantitative score above 750 (out of 800). The proportion of women in the undergraduate program has risen significantly during the past decade. Minority enrollment is small, but growing; about ten percent of the undergraduates are black.

Both the graduate and the research programs have shown impressive growth, with the total value of extramural research continually exceeding five million dollars. Annual research expenditures were $2.5 million in 1988-89, with approximately eighty percent coming from federal agencies.

The department has had seven NSF grants in the past three years. As reported in the 1989 American Chemical Society Directory of Graduate Research, our department published 103 refereed articles in 1987-88, which ranks Auburn 16th among public chemical engineering departments in the United States. Refereed publications for this year will be significantly more than in 1988.

The department received the Dow Outstanding Chemical Engineering Department Award each year since 1983. We also were awarded the Exxon Centennial Outstanding Chemical Engineering Department Award for the years 1984-1990.

The department is principally located in Ross Hall, with additional research, lab, teaching, and office spaces in several nearby buildings. Currently, the department has thirty-one research or teaching laboratories. Tennessee Eastman recently invested a substantial amount in our undergraduate laboratories, allowing us to begin upgrading and improving the facilities.

Prominent research centers which Auburn directs include the Space Power Institute (SPI), the Consortium for Commercial Applications of Space, the Pulp and Paper Research and Educational Center, the Molecular Genetics and Biotechnology Center, the Advanced Manufacturing Technology Center, the National Center for Asphalt Technology, the Alabama Microelectronics Science and Technology Center, the Highway Research Center, and the Water Resources Research Institute.

The Space Power Institute and the Consortium for Commercial Applications of Space, which conduct space-related research programs, were established as the academic focus for the nation's space power program. Auburn is the lead university in a multi-university consortia funded by NASA and other federal agencies. Terry Baker and Bruce Tatarchuk are heavily involved with Auburn's space research. In recognition of its contributions to space research, NASA designated Auburn as a Space Grant University.

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At the request of pulp and paper industry leaders, the college of engineering established the Pulp and Paper Research and Educational Center (PPREC) in 1985. Industry leaders felt Auburn's significant contributions to the industry and its location in the heart of the pulp and paper manufacturing area made it the ideal university to direct the project. The goal of PPREC is to conduct research on improving productivity and profitability in the industry, to provide highly-skilled engineers, to further the application of science and advanced technology in the industry by conducting fundamental applied research with emphasis on quality and cost efficiency, to be a continuing educational resource for the industry, and to provide a facility for developmental activities in pulp and paper manufacture. The PPREC is one of the leading paper research and educational centers in the South. A. Krishnagopalan is the acting director of PPREC and coordinator of the Pulp and Paper Instructional Program in chemical engineering.

CURRICULUM

The undergraduate curriculum approved for 1991 consists of 204 quarter hours: 82 in chemical engineering, 39 in chemistry, 23 in mathematics, 8 in physics, 3 in engineering science, and 46 in liberal arts, humanities, and social sciences. Chemical engineering courses in the basic curriculum include mass and energy balances, thermodynamics, computers in

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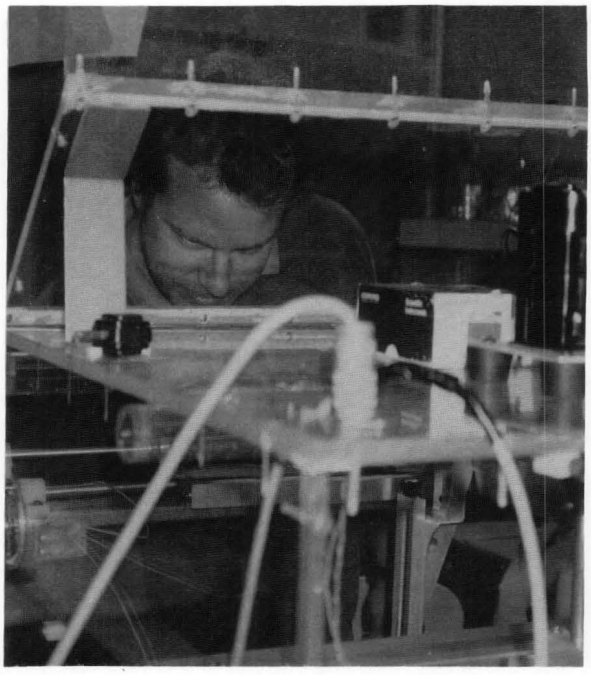
chemical engineering, fluid mechanics, heat and mass transfer, stagewise operations, reaction engineering, process design practice, computer-aided process design, process dynamics, digital process control, process economics, computer-aided process simulation, and hazardous materials management.

For students who wish to pursue special interests, the department offers options in biochemical engineering, computer-aided design and control, environmental chemical engineering, pulp and paper engineering, and pre-medicine/pre-dentistry. These options offer electives appropriate to each area plus electives in advanced materials. Students take an intensive series of laboratory courses that includes transport and thermodynamics, stagewise operations, computer-aided process control, process simulation, process design, pulp and paper engineering, surface and colloid science, senior projects, and undergraduate research. The program features numerous projects in the senior year that build upon knowledge gained in previous years' study.

The Doctor of Philosophy and the Master of Science degree programs are based on strong chemical engineering fundamentals, specialized courses, and research. Research opportunities are frequently interdisciplinary and include collaborative research in chemistry, materials engineering, electrical engineering, forestry, microbiology and genetics, pharmacy, *etc.* Core courses for the Master's degree program include transport phenomena, chemical engineering analysis, chemical engineering thermodynamics, and reaction engineering. Elective courses, directed reading, special topics, seminars, and a thesis complete the program.

For the PhD degree, students must complete the MS core courses plus advanced courses in numerical methods, process control, and catalysis. They must also complete the requirements of a minor, consisting of a series of courses outside of chemical engineering. The heart of the PhD program is a dissertation describing the student's original research.

The Master of Chemical Engineering Degree is a professionally oriented non-thesis degree designed for working chemical engineers to allow them to update and broaden their knowledge of the field.



Bob Himes sets up the Langmuir-Blodgett deposition apparatus.

RESEARCH FOCUS

The department has a broad and varied research focus, and most faculty members perform research in more than one area (see Table 1). **BRUCE TARTARCHUK** conducts research in catalysis and microscopic surface interactions occurring at and between solid surfaces. As part of his research, he measures fundamental surface properties using state-of-the-art spectroscopic probes. The spectroscopic probes permit the measurement of reaction, adsorption/desorption phenomena, molecular vibration and structure, and non-destructive depth-profiling of reactions at buried interfaces. Since two materials always contact at an interface or a surface measurement, understanding and control of these phenomena provide a powerful means to control surface reaction phenomena. Tatarchuk's research has application to the study and improvement of heterogeneous catalysis, thin film protective coatings, thin film solid lubricants, and new generation high energy density and high power density composite fibrous electrode material.

TABLE 1
Faculty and Research Interests

- **Terry K. Baker** *University of Wales*
  Heterogeneous Catalysis • Chemical Engineering of Composites • Heterogeneous Carbon • Controlled Atmosphere Electron Microscopy
- **Robert P. Chambers** *University of California*
  Biochemical Engineering • Biomedical Engineering • Pulp and Paper Engineering • Environmental Engineering
- **Christine W. Curtis** *Florida State University*
  Asphalt Chemistry • Catalysis • Coal Science and Conversion • Reaction Pathways
- **Mahmoud El-Halwagi** *UCLA*
  Process Design • Optimization • Process Control
- **James A. Guin** *University of Texas*
  Transport Phenomena • Catalysis • Coal Science and Conversion • Mass and Heat Transport • Reaction Kinetics and Engineering • Engineering of Asphalt/Aggregate Composites
- **A. Krishnagopalan** *University of Maine*
  Reaction Kinetics and Engineering • Pulp and Paper Engineering • Process Instrumentation • Process Control
- **Jay H. Lee** *California Institute of Technology*
  Process Control
- **Y. Y. Lee** *Iowa State University*
  Biochemical Engineering • Biotechnology • Biomass and Pulp and Paper Engineering • Reaction Kinetics and Engineering
- **Glennon W. Maples** *Oklahoma State University*
  Combustion • Energy Conversion and Use • Thermodynamics • Utility Systems
- **Ronald D. Neuman** *The Institute of Paper Chemistry*
  Interfacial Phenomena • Pulp and Paper Engineering • Solvent Extraction • Surface and Colloid Science
- **Timothy D. Placek** *University of Kentucky*
  Optimization • Process Simulation • Pulp and Paper Engineering
- **C. William Roos** *Washington University*
  Biochemical Engineering • Biotechnology
- **Arthur R. Tarrer** *Purdue University*
  Environmental Engineering • Catalysis • Coal Science and Conversion • Mass and Heat Transfer • Process Control • Reaction Kinetics and Engineering • Engineering of Asphalt/Aggregate Composites
- **Bruce J. Tatarchuk** *University of Wisconsin*
  Catalysis • Chemical Engineering of Space Systems • Reaction Kinetics and Engineering • Surface Science • Materials Science

Part-Time, Visiting, and Adjunct Faculty

- **George Emert** Adjunct - Auburn University Executive Vice President (Virginia Tech) Biotechnology • Biomass • Applied Microbiology
- **David Hart** Adjunct - of Rust Engineering (University of Alabama) Process Design • Plant Design
- **James P. Henley** Visiting (University of Mississippi) Application of Expert Systems to Process Control
- **Leo J. Hirth** Part-Time (University of Texas at Austin) Process Simulation and Design
- **Donald Vives** Part-Time (Columbia University) Thermodynamics
- **David Whitman** Visiting (Auburn University) Biomedical Engineering

TERRY BAKER performs research in composite materials, gasification/protection of carbonaceous materials, carbon filaments in energy storage devices, fundamental aspects of catalytic carbon formation, carbon deposition of metal catalysts, metal support interactions, and physical and chemical properties of small particles. His research in composite materials will have application to such things as production of a three-dimensional preform for use in automotive and aerospace structures. As part of his research with SPI, Baker is investigating the use of carbon composites in aerospace applications where materials are expected to survive and maintain their integrity in a variety of hostile conditions. He is also examining the use of carbon as electrode material in capacitors. In his metal support interactions research, he is studying ways of tailoring the structure of catalysts to control the pathways so that the yield of a desired product from a given reaction can be maximized.

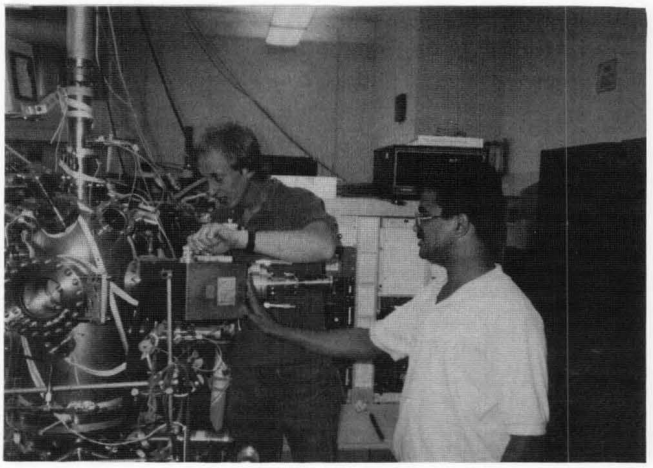
RONALD NEUMAN conducts research in surface and colloid science. Currently, he is studying monolayers, or monomolecular films, which can be used to model various interfacial systems and processes. Monolayer studies are important because physical, chemical, and biochemical process rates often are affected by materials, such as surfactants or surface-active agents, that concentrate at phase boundaries. By studying monolayers, Neuman can extrapolate information about interfacial behavior and interactions of surface-active molecules. Monolayers permit him to perform experiments on a well-defined controlled interfacial system. His unique approach to the study of monolayers or monomolecular films is his use of laser techniques. He is developing and applying advanced laser techniques to monolayers at fluid/fluid interfaces. Progress in obtaining fundamental information in classical surface chemical approaches has become more difficult, but Neuman eliminates this difficulty with the use of sophisticated, recently-developed laser techniques. These techniques hold promise for significant advancement in understanding the molecular processes underlying interfacial phenomena and systems. Neuman is also measuring the thermodynamics and transport properties of surface films. His research will have applications to solvent extraction, membrane technology, food emulsion technology, and papermaking.

A. KRISHNAGOPALAN is the primary researcher in the pulp and paper area. His research explores ways of increasing productivity and profitability in the industry. His major interests lie in computer-aided process control, advanced pulping

and bleaching technologies, paper coatings, and composite materials. He also hopes to develop an improved kraft digester control method. His new control approach will reduce errors caused by feedforward predictors and will allow the effect of certain process disturbances to be estimated and counteracted. He hopes to apply this type of controller to a large digester.

Computer-aided process simulation is the focal point of **TIMOTHY PLACEK**'s research. He is developing an Advanced Simulator for the Pulp and Paper Industry (ASPPI) to assist the engineer in decision-making and to increase efficiency in the industry. Placek decided to develop ASPPI in response to a lack of state-of-the-art technology in computer capability in modeling paper mills and pulp mills. Current software was developed for mainframe computers and does not translate well to the new microcomputers in use today. ASPPI's user interface allows the engineer to use mice and pointing devices on the screen to "blend" into and become part of the simulated process. It is also more user-friendly than other software on the market. It uses process terminology to represent specific areas; the engineer is allowed to use a name of his choice, such as the actual name of the piece of equipment. It also detects errors made during data entry, as opposed to the current software programs where the engineer must spot the errors after completion of simulation. ASPPI will give the engineer more complete control of the process, eliminate costly errors, and save time.

Christine Curtis, James Guin, and Arthur Tarrer are the principal investigators in coal science, energy conversion, and asphalt adhesion and absorption. **CHRISTINE CURTIS** works with NCAT to examine the causes of asphalt deterioration on highways and is studying asphalt adhesion in particular. She hopes to determine what part of the asphalt adheres to the rock, and once she identifies the components that adhere, she can modify, improve, and promote the adhesion process. She also hopes to modify the surface of the aggregate to increase the adhesion of the asphalt so the adverse affects of certain weathering conditions can be minimized. Curtis is also performing coal coprocessing research. She explores how hydrogen in solvent affects the coprocessing results. Through a model systems approach, she examines the fundamental chemistry involved in high temperature and pressures of coprocessing. With an actual systems approach, she changes the chemistry of the resid by catalytically reacting and pre-treating it to make the hydrogen-



Peter Lloyd (L) and Meenakshi Swaminathan check a specimen in the secondary ion mass spectrometer.

rich material more suitable for coal solvation. She hopes to improve the resid's ability to solvate coal and to transfer hydrogen to coal. She is studying model systems and exploring the interactions of various components in coal and resid on the molecular level in the presence of a catalyst.

JAMES GUIN's research applies transport phenomena and reaction engineering to the development of improved catalysts for coal and petroleum processing. Guin wants to learn more about the diffusion of large molecules in small pores of catalysts and membranes and to develop catalysts with improved pore size distribution for coal liquefaction. These catalysts have shown increased oil production using four different types of coal. He is also studying ways to prevent catalyst deactivation problems, a common problem in coal liquefaction. As part of his asphalt research, Guin is researching ways to prevent the absorption of asphalt into porous rock. Asphalt absorption can cause premature pavement failure, and he hopes to learn more about the fundamental chemistry of absorption in relation to the properties of asphalt and rock. He hopes to develop a model for asphalt construction which will help engineers construct better highways.

ARTHUR TARRER's interests lie in coal liquefaction, asphalt absorption, materials research, environmental control, and process dynamics and control. In his process research, he is developing reactor systems designed for difficult-to-control reactions. Generally, these are reactions that occur rapidly. For these reactions, it is virtually impossible to transfer reactive gases to the liquid phase fast enough to minimize undesirable reactions. Using control tech-

nology such as "bang-bang" technology, which involves switching the reaction rate from high to low and alternately switching the mass transfer rate from high to low, Tarrer will be able to control such reactions. These reactor systems will have applications to specialty chemical manufacturing, wastewater treatment, and many other processing areas. As part of his materials research, Tarrer is also developing new methodology such as techniques for testing the physical and chemical bonding strengths of asphalt pavements. He hopes to develop additives for asphalt that will reduce water-stripping and excessive absorption of asphalt into the pavement aggregate. In the environmental control area, Tarrer is working in conjunction with the EPA, the Department of Defense, and companies such as Dow Chemical and Exxon to develop waste minimization techniques to help the environment. He also currently operates a pilot plant facility that recycles about 100,000 gallons of waste oil by reprocessing it into reusable products such as specification grade fuel oil. One way that Tarrer uses his process control expertise is to interface digital programmable controllers to processing unit operations such as those used in waste oil recycling pilot plants.

GLENNON MAPLES conducts research in equipment failure detection techniques, equipment performance, and energy use. He hopes to develop methods to detect equipment failure and to evaluate the performance of the equipment, including how the variables relate to the desired output. His research in energy use allows him to measure the energy used by various machines and to evaluate methods of energy optimization.

ROBERT CHAMBERS and Y.Y. Lee are the principal researchers in the biochemical/biomedical area, and both also perform pulp and paper research. Some of Chambers' research involves enzyme engineering—alcohol detoxification in particular. Research is aimed at a fundamental understanding of the interaction of the multi-enzyme system with the physiological system of the body and on further development of the multi-enzyme system. Chambers is also investigating the use of semi-permeable microcapsules and semi-permeable hollow fibers for use as novel bio-reactors in the treatment of chlorinated organics present in the effluent produced in paper mills.

Y.Y. LEE's specialty is biochemical engineering, but he also conducts research in the areas of transport mechanisms in cellulosic biomass and energy conversion. Lee hopes to achieve a high-yield and efficient conversion of biomass into alcohols by way of novel bioreactor/separator systems. He is also developing a process in pulp and paper by applying a low-water processing concept. Two of the problems faced by the pulp and paper industry are how to minimize production losses and how to treat mill effluent so it will minimally affect the environment. Lee hopes to reduce the water input in the pulp digester and to use a sulfur-free pulping reagent to minimize negative environmental effects. This approach will greatly reduce polluted effluent and will result in reduced chemical costs, sulfur-free processing, increased production yields, unbleached pulp brightness, and adaptability.

C. WILLIAM ROOS' work is in the separation of high-value fermentation proteins. He hopes to identify and quantify the factors which limit the rate and capacity of solid-liquid affinity chromatographic systems for large-scale application to protein separation. He also hopes to develop a concept for separating proteins to combine affinity-complex formation with membrane separation.

MAHMOUD EL-HALWAGI performs research in process design, process control, and optimization. In particular, he is researching a unified approach to the synthesis of general separation networks, synthesis of reactor-separator networks, hazardous waste minimization through chemical process synthesis, and mathematical modeling and optimization of fluidized-bed combustors.

JAY H. LEE conducts research in process control, control structure selection for large-scale systems, design and control of chemical processes, and identification and inferential control via neural networks. He concentrates mainly on his process control research; his goal is to design modern process control systems that will make significant improvements in the economics, safety, and flexibility of plants.

LOOKING AHEAD

Because of the continued growth of the program at Auburn, plans are underway for a new chemical engineering building that will house state-of-the-art laboratories. Our large, well-funded research program can support many graduate students and we welcome applications from qualified students. We also encourage undergraduate applications to our program. ❐