Catalyst

A Publication of the Rice University
Chemical Engineering Department

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Letter from the Chairman

Dear Alumni and Friends:
The inaugural issue of this newsletter, *Catalyst*, marks an important milestone in the history of our department and coincides with the launch of a major growth initiative.

In 2001, we celebrate the 80th birthday of chemical engineering at Rice University with a renewed commitment to excellence in research and teaching. With the help of a select advisory board and the full support of our university administration, we recently formulated a comprehensive strategic plan to guide the growth of all aspects of our educational and research programs. The implementation of this plan is already under way. Four new faculty members have joined the department since 1999; several more will be recruited in the next few years. A major renovation of our teaching and research laboratories is nearing completion, and our graduate and undergraduate curricula have been restructured to meet the changing requirements of the industrial and academic employers of our graduates.

It is our sincere hope that this newsletter will catalyze a close and productive interaction between our department and you, its alumni and friends. Through the pages of *Catalyst*, we'll keep you informed of our progress and solicit your participation in our efforts to reshape the department and redefine its research and educational missions. Curricular improvements, student recruiting, research collaborations and community outreach are but a few of the many areas where you can contribute.

We invite you to begin that participation by completing the feedback form on the back page of this newsletter. Tell us about yourself, announce recent achievements or awards, give us your opinion about our educational programs and let us know how you might want to involve yourself in our adventure in growth.

Then, stay tuned as we prepare to celebrate our 80th anniversary this fall. We're planning an array of exciting events for alumni, friends and current students.

Please plan to join us.

Kyriacos Zygourakis
Professor and Chair

In this Issue…

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Strategic Plan Provides Blueprint for Growth

The Rice University Department of Chemical Engineering has launched a major initiative to prepare itself and its graduates for leadership positions in the 21st century. At its heart is a long-range strategic plan prepared with the help of an advisory board of academic, industrial and professional experts (see p. 7).

The plan, developed after many months of collaboration among board members, departmental faculty and university administration, represents "the most comprehensive, robust and workable blueprint for growth I've seen in years of work with universities across the nation," observes Dave Bonner, Ph.D., director for technology at the Rohm and Haas Company and chairman of the advisory board.

Designed to maximize resources and effort in all areas essential to the department's success, it outlines future direction in faculty and graduate student recruitment and development, research, curriculum redesign, facility renovation and cooperation with industry.

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Faculty Highlights

Jacqueline L. Goveas

Matteo Pasquali

With the addition of two new faculty members and two more who will join the faculty this summer, the Department of Chemical Engineering has made great progress toward fulfilling its faculty recruitment goals.

As Kyriacos Zygourakis, department chair, points out, "We have been very fortunate in our faculty development initiative to attract four individuals who represent the best and the brightest of their generation."

New faculty

Jacqueline L. Goveas joined the faculty as an assistant professor in January 1999. A primarily theoretical researcher, she studies the dynamics of complex fluids, focusing on the effects of flow in homogeneous polymer melts and surfactant solutions. This work has many applications in the industrial processing of complex fluids.

Goveas received her B.S. in 1991 from The University of Texas-Austin and her Ph.D. degree in 1996 from Princeton University. She joined Rice after completing post-doctoral studies at the University of California, Santa Barbara.

Matteo Pasquali has been an assistant professor in the chemical engineering department since January 2000. His research areas include microstructured liquids, free surface flows and computational modeling of processing flows. Theoretical and computational modeling of flow and transport in microstructured liquids, he says, will be an important tool for designing commercial processes that can produce defect-free products at high rates with minimal environmental impact. Pasquali's experimental work focuses on quantifying the effects of flow on the conformation of DNA molecules (which qualitatively behave as "ordinary" polymers). The results of his research could be used to improve models of transport in polymeric liquids.

A 1992 graduate of the University of Bologna, Italy, Pasquali received his Ph.D. degree in 1999 from the University of Minnesota and completed post-doctoral studies at the same university.

Nikos V. Mantzaris and *Michael S. Wong* will join the faculty as assistant professors on July 1. Mantzaris received his undergraduate degree in chemical engineering in 1994 from the National Technical University of Athens, Greece, and his doctoral degree last year from the University of Minnesota. His research focuses on understanding, optimizing and controlling the behavior of biological systems by developing appropriate mathematical models and studying them using both analytical techniques and computer simulations. Specific problems of interest include tumor-induced angiogenesis, antibiotic production by filamentous fungi and human kidney stone formation.

Wong earned his B.S. degree from the California Institute of Technology in 1994 and M.S. and Ph.D. degrees from the Massachusetts Institute of Technology in 1997 and 2000, respectively. With research interests in nanostructure engineering, catalysis and separations, he will undertake studies to design and engineer materials with structural features (such as pore length and diameter, particle size and grain size) in the nanometer length scale. Successful development of nanostructured materials will lead to new catalysts for more efficient production of fuels and to potential biomedical screening devices.

Faculty retirements

Drs. J. David Hellums, Derek C. Dyson and *Sam H. Davis, Jr.* retired from their positions in the department in June 1998, January 2000 and June 2000, respectively. *Dr. Joe W. Hightower* plans to retire at the end of the 2000-2001 academic year.

Strategic Plan, continued from page 1

The Advisory and Development Board plays a key role in the department's future.

"Our starting point was the realization that the chemical engineering profession and our department are at a crossroads, ready to face a host of new realities," says Kyriacos Zygourakis, professor and department chair. "We addressed each major component of the plan with the idea of rebuilding the department so that it can become a national leader, ready and able to respond to the opportunities and challenges of our rapidly changing technological, economic and social environments."

A Strong Research Base

The core of the plan, Bonner believes, is the department's decision to focus its resources on building a strong reputation for its work in two primary areas of research: materials and computational engineering. Materials research includes the development of new nanomaterials, polymers and catalysts; computational engineering encompasses techniques for building mathematical models, dynamic simulation and process control and design.

"According to the landmark national report, *Frontiers in Chemical Engineering*, and all major governmental trend studies, these two areas will be at the forefront of the most exciting discoveries in the foreseeable future," Bonner explains.

The board's analysis indicates the department is ideally positioned to use the university's existing strengths in materials and computation "to nurture research that could very well revolutionize the definition of the chemical engineering profession, changing the way industry approaches its most basic problems," Zygourakis adds.

Building Strategic Alliances

According to the plan, the department's internal research thrusts will complement its strategic alliances on pollution control with faculty from the environmental science and engineering department and on biomaterials for tissue engineering with faculty from the newly formed bioengineering department.

"Both these departments grew from programs initiated within the Department of Chemical Engineering," says Zygourakis. "We already have many strong connections through research collaborations, joint participation in university-wide research centers and joint faculty appointments. Our new undergraduate curriculum, a very flexible schema which encourages students to build interdisciplinary skills, calls on these departments as teaching resources, again solidifying these alliances."

The Department of Chemical Engineering is also an active participant in a series of interdisciplinary research proposals capitalizing on relationships with a variety of other university departments, centers and institutes, he adds.

Faculty Development

One of the drivers behind the department's self-examination and redirection was the retirement of seven of its full-time faculty members.

"Like many engineering departments in universities across the nation, we experienced our major growth during the post-Sputnik era of the 1960s," Zygourakis recalls. "This means that many of our most respected colleagues, the ones who helped us build a reputation for quality education and research, reached retirement age in the mid- to late-1990s. We must use great care in selecting their replacements, since these young professionals will be the people to determine our future for many years to come."

Using the strategic plan as a guide, the department has recently hired four new faculty members with research interests in the areas of materials and computational engineering (see p. 2). It intends to hire three more faculty members over the next two years and is making plans to fund three new endowed professorships, bringing the total number of faculty positions to 15.

Next Steps

In the coming months, Zygourakis says, the department will focus on completion of extensive renovations to its undergraduate and faculty laboratories (see p. 6), which are integral to the plan. In the meantime, the chemical engineering advisory board will support full implementation of the strategic plan by working with the Rice development office to raise funds that will provide stipends to talented graduate students, Bonner notes.

"Our intent is to talk to anyone who will listen — corporations, alumni, university officials," Bonner says. "This board is amazing. All those top-level people are eager and ready and volunteering to do anything they can to support the growth and success of the Department of Chemical Engineering at Rice University. There's no stopping the board, because it believes there's no stopping Rice in its quest to secure its standing as one of this country's most prestigious academic institutions."

A Tradition of Innovation Sets

Read the history of the Department of Chemical Engineering at Rice, and you'll see many examples of scientific innovation and professional leadership. These examples will help guide the department's course as it opens a new chapter of its history.

Professor Bill Akers with the first left ventricular bypass device that was implanted in 10 patients in the late '60s.

"Like the chemical engineering profession, the department has grown in stature. From its embryonic beginnings as an adjunct to the chemistry department in 1912, it had become a major research and educational center by the end of the 20th century," says Kyriacos Zygourakis, department chair. "Like the profession, too, the department stands at a major crossroads at the beginning of the 21st century. Faculty retirements and the departure of four faculty members (who now constitute the core of the Rice bioengineering department) forced us to re-evaluate the department's mission and to define new areas for growth."

"Chemical engineering," explains Zygourakis, "has always been dedicated to providing the theoretical, computational and experimental tools that enable industry to transform scientific discoveries into products that change the way we live: from fuels and polymers to pharmaceuticals, computer chips and environmental technologies. Polymers, for example, were discovered in chemists' labs, but mass production of nylon and other synthetic fibers was the work of engineers."

"Our new research and educational mission," continues Zygourakis, "is shaped by the belief that chemical engineering is an 'enabling discipline.' The history of chemical engineering at Rice teaches us, however, that future success will depend on our ability to identify new research opportunities and move quickly to exploit them."

Exploiting Opportunities

Although a bachelor's in chemical engineering was among the degrees offered to the first class of Rice students in 1912, the arrival on campus of Arthur J. Hartsook in 1921 marked the true beginning of an independent program in chemical engineering. Hartsook was educated at the Massachusetts Institute of Technology, and his choice of Rice and Houston was not an accident. At MIT he had gathered information that convinced him that the city and its vicinity would, in time, grow into one of the foremost chemical engineering centers in the country and the world.

"The opportunity was right here, even then, back in 1921," remarked Hartsook in a 1970 interview. "Houston was already showing signs along its ship channel of developing into a major processing center for oil, lumber, cotton and sugar . . . . It did not take much vision to see a splendid future for the entire area."

Hartsook's investment paid off handsomely. By the 1940s, Houston had become the petrochemical and energy capital of the world, and Rice graduates began to fill many of the positions created by the growing industrial establishment along the Houston ship channel. For many of these graduates, the ship channel became the launching pad for important leadership positions, first in corporate headquarters in New York or other major U.S. financial centers and, subsequently, in key posts all over the world.

RICE

THE STAGE FOR CENG'S FUTURE

In 1947, the chemical engineering department received a mandate from Rice's President Houston to start a full-scale graduate program. The department responded to the challenge by hiring several professors who became leaders in their fields and by expanding its research output.

The 1950s and 1960s were years of almost exponential growth. In 1955, the department became a major player in the emerging field of nuclear energy, securing a grant from the Atomic Energy Commission to develop a program in nuclear engineering, supported by a radiation laboratory and a 10-watt operating reactor.

In the 1960s, the department was ranked among the top seven in the country. Capitalizing on Rice's location, a strong thermodynamics group led by Tom Leland and Riki Kobayashi developed new theories and an extensive database of thermophysical properties for the petrochemical industry. The department purchased the first digital computer ever installed at Rice (an LGP-30) and later acquired Rice's first solid-state programmable computer (an IBM 1620). Chemical engineering also "annexed" a sanitation laboratory program in civil engineering and began to address the broader problems of environmental pollution.

Perhaps the most significant example of a bold move into new areas, however, was the artificial heart project and the establishment of the Biomedical Engineering Laboratory in the mid-'60s. In partnership with Baylor's Department of Surgery, Rice chemical engineers led by Bill Akers were instrumental in developing the first left ventricular heart bypass device and carried out a large number of pioneering studies that solidified Rice's national reputation in the field of biomedical engineering. Among their early successes was the development of an implantable artificial lens for the eye that restored sight to hundreds of patients. Under the leadership of David Hellums, the biomedical lab evolved to become one of the strongest centers of applied cellular engineering research in the '70s and '80s.

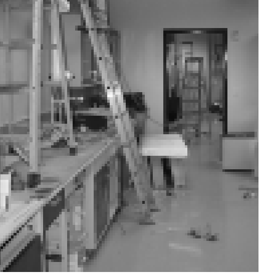
Lessons Learned

"What we learn from all these examples is how to exploit opportunities," Zygourakis says. "The pioneering entry of our colleagues into the field of biomedical engineering, for example, literally opened that field for major contributions by the chemical engineering profession nationwide. Today, bioengineering is one of the hottest areas. The artificial heart projects also demonstrated, perhaps for the first time, the importance of interdisciplinary work. Building an artificial heart is the perfect example of a complicated task that can only be solved if tackled in a systematic way by a team consisting of chemical, electrical, mechanical and other engineers working in close collaboration with clinical doctors and life scientists."

Past achievements set a precedent for the departmental rejuvenation occurring today. To extend this tradition into the future, the department must focus its research and teaching efforts in new areas that address the evolving needs of the chemical, environmental, biotechnological and electronic industries.

"We're choosing different fields than our predecessors, adapting our training and focusing our talents on materials and computational research," says Zygourakis. "At the same time, however, we will put to work the lessons we learned from them. We'll be using the same powerful enabling tools of our discipline, applying the same commitment to excellence and exhibiting the same determination to succeed."

"The history of chemical engineering at Rice teaches us, however, that future success will depend on our ability to identify new research opportunities and move quickly to exploit them."



Lab Renovation Supports Department's Educational and Research Efforts

The sound of sawing and hammering soon will stop as the Department of Chemical Engineering completes construction and renovation of state-of-the-art laboratory space in Abercrombie Laboratory. The project will add almost 11,000 square feet of renovated teaching and research space essential to achieving the educational and research goals of the department.

"The first three phases of our planned expansion include a 3,000-square-foot, state-of-the-art undergraduate laboratory plus design lab and some 2,500 square feet of space designed specifically to enhance the research efforts of our new faculty members," says Kyriacos Zygourakis, department chair (see p. 2). "The fourth phase will start next summer to renovate another 2,000 additional square feet of lab space for new faculty members."

Access to Advanced Teaching Tools

The undergraduate facility, financed with some $675,000 in university funding, includes a cluster of workstations used for design courses and experimental equipment for teaching such essential concepts as fluid mechanics, reaction engineering, catalysis and separation processes.

"The new laboratories will support our flexible undergraduate curriculum," Zygourakis explains. "The approximately 30-40 students who complete our undergraduate program every year will now have access to the most advanced teaching tools for developing the skills they will be using throughout their professional careers."

Facilities for the Faculty

New research space includes laboratories designed to support the materials and computational engineering efforts of new faculty members Jacqueline Goveas, Matteo Pasquali, Michael Wong and Nikos Mantzaris.

These facilities, which were designed, built and equipped at a cost of $2 million, will feature advanced computer workstations with multiprocessing capabilities, a high-speed video and image analysis system for fluorescent microscopy, FTIR spectrometer, X-ray diffractometer, thermal analysis and nitrogen adsorption equipment and catalytic reactors.

Pasquali, who joined the faculty in January 2000, says much of the equipment in his custom-designed laboratory will be used for analysis.

"I'll be doing a lot of fluorescent microscopy in my studies of the material properties of DNA," he explains. "The new lab will be great, because it integrates the operations of two high-powered microscopes, two low-light cameras and two computers with image processing and acquisition capabilities. The cabinets and optical tables will be vibration-proof to protect the work."

Wong, who will assume his faculty position in July, describes the lab being constructed for his use as "top-notch, a dream facility."

The university's electron microscopy facilities are among the best in the nation, says Wong, who studies nanomaterials. "The other equipment I will be using — diffractometers, spectrometers and porosimeters — are not particularly exotic," he adds, "but having them readily available in space designed specially for me will really expedite my work."

According to Zygourakis, the renovation project necessitated the installation of new air conditioning, electrical and plumbing systems. "Abercrombie is an old building," he explains, "but we've managed to bring it completely up to date with this renovation. Our students and faculty will now have the modern facilities they need for their education and research so that they can develop to their fullest potentials."

Keith Gubbins to Present Eighth Leland Lecture

Keith Gubbins, a world-renowned leader in the application of molecular simulation and statistical mechanics to problems involving thermodynamics and transport of fluids, will travel to Rice University in late March to present a lecture on computer simulations that model phase and chemical equilibria in nano-scale systems.

Gubbins, W.H. Clark distinguished university professor of chemical engineering at North Carolina State University in Raleigh, will give the eighth Thomas W. Leland Endowed Lecture, sponsored by the Department of Chemical Engineering, on Thursday, March 29, from 4 to 5 p.m. in Room 100, Keck Hall.

A member of the National Academy of Engineering, Gubbins received his bachelor of science degree in chemistry and his doctorate in chemical engineering from the University of London. He previously held academic positions at Cornell University and the University of Florida.

"Our lecturers are always foremost experts in their fields of specialty, skilled at presenting their material in ways that are useful to other professionals," says Walter Chapman, associate professor in chemical engineering, who is serving as this year's event coordinator along with Clarence Miller, the Louis Calder Professor in Chemical Engineering at Rice.

Adds Miller, "The Leland lectures represent an opportunity for friends and alumni of the department to gather for an evening of professional enrichment and social interaction."

The endowed lectures honor the memory of Professor Thomas Leland, a distinguished researcher and teacher who had been a member of the department from the early 1950s until his death in 1986.

For more information about this event, please call Diana Walker-Thomas at 713.348.4902 or visit our web site.

Visit Us on the Web!

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