OUR MISSION  OUR PURPOSE  OUR IMPACT

ENGINEERING
2003 ANNUAL REPORT

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2 DEAN’S REPORT ON THE SCHOOL
3 AWARDS
4 UNDERGRADUATE
6 GRADUATE
8 BIOMEDICAL
10 CHEMICAL AND BIOMOLECULAR
12 CIVIL AND ENVIRONMENTAL
14 ELECTRICAL AND COMPUTER SCIENCE
16 MECHANICAL
18 ALUMNI AND DEVELOPMENT
20 BOARD OF ADVISORS
OUR MISSION  OUR PURPOSE  OUR IMPACT

The mission of the Tulane University School of Engineering is focused on providing outstanding opportunities for learning and discovery in engineering and computer science. In last year’s annual report, “Excellence in Education, Innovation in Research,” we described our many achievements in these areas during calendar year 2002. It is now our pleasure to publish this report covering calendar year 2003. As you will see, it was by all measures another excellent year. In 2003, we welcomed our strongest incoming classes ever at both the undergraduate and graduate levels as measured by cumulative SAT and GRE scores, our externally funded research expenditures rose by more than 17%, total giving to the School’s annual and endowed funds more than doubled, and our students and faculty again received national and international recognition for their many outstanding achievements.

But our purpose goes beyond the production of exceptional graduates and pioneering publications and patents. There is a third aspect of our mission that receives far too little publicity. Without much fanfare, Tulane engineering students, faculty, and staff have devoted an enormous amount of time and energy to outreach activities that impact the community. In this year’s annual report, we have chosen to highlight some of these activities that took place during the past year. Of the many outreach projects in which the Tulane School of Engineering was involved in 2003, I would like to make note of two that I believe exemplify our community impact: the annual Tulane Engineering Forum and the organization “Building Louisiana Science and Technology” (BLaST).

The Tulane Engineering Forum is an excellent example of our commitment to continuing education, and economic development and its value to the community and the region are clearly demonstrated by the more than 300% increase in registered attendees since the inaugural forum that was held in the fall of 2000. The 2003 Tulane Engineering Forum focused on advanced technologies for economic development. In 2004, it will focus on advanced technologies for homeland security.

BLaST, an initiative that was started in 2003 in partnership with the Bruce J. Heim Foundation, the University of New Orleans, and the New Orleans section of ASME, is focused on the promotion of science, mathematics, engineering and technology in our K-12 educational system. Its inaugural event, the Louisiana FIRST LEGO League robotics competition, was held in November 2003 and attracted 15 middle school teams from Louisiana and Southern Mississippi.

We again hope that you enjoy reading about the achievements of our school during the past year. It is a school that takes enormous pride in its outstanding graduates, its innovative research, its entrepreneurial spirit, and its impact on the community.

Nicholas J. Altiero
EXCELLENCE IN TEACHING AND PIONEERING NEW RESEARCH

2003 OUTSTANDING RESEARCHER AWARD RECIPIENTS

The Outstanding Researcher Award is based on the quality and quantity of research led by an individual or individuals. In addition, the award recipient(s) must contribute to the mission of the university in graduate education, training and mentoring, including that of graduate students and post-doctoral scholars.

This year’s winners have gained national and international recognition for their work, as evidenced by honors and awards, journal editorships and participation in editorial boards and national and international scientific committees.

Professor Stathis Michaelides

In the area of Computational Fluid Dynamics, Professor Michaelides has recently developed a novel computational method (J. Computational Physics, vol. 195, pp. 602-628) to treat large groups of interacting particles. The new code uses a combination and the desired attributes of three numerical techniques: the Lattice Boltzmann Method, the Immersed Boundary Method and the Direct Forcing Scheme. The method is capable of handling deformable particles, any flow configuration and any type of interactions between the particles. The computer code that employs this novel method has been named Proteus, after the mythical Greek hero who was able to change his face and form at will, as well as predict the future.

In the area of Environmental Flows, Professor Michaelides’ team continued their work on sedimentation and resuspension processes in aquatic environments. This work answers several fundamental questions associated with the flow of particulate matter in rivers, in particular the transport of pollutants that attach themselves on the small surfaces of particles.

Professor Daniel De Kee

Professor De Kee’s research activities are in the areas of viscoelastic diffusion and rheology, where he studies the flow properties of complex structured systems.

In the area of mass transport, Professor De Kee’s group is studying the non-Fickian diffusion of organic materials through (nanocomposite) polymeric barriers. In particular, they are interested in the effect of mechanical deformation on the diffusion process.

In recent Ph.D. theses, students considered the effects of imposed deformations on the barrier properties of polymers used in the protective clothing, geomembrane and packaging industries. This work involved designing the apparatus, developing mathematical models relating mass flux to time via mesoscopic as well as continuum mechanics theories, performing tests using representative organic chemicals and mixtures thereof, and successfully comparing the data with the model predictions.

Recent work in the area of polymer processing involves the extrusion of polymer clay nanocomposites. Such materials are lightweight and exhibit excellent mechanical as well as barrier properties.

2003 LEE H. JOHNSON EXCELLENCE IN TEACHING AWARD RECIPIENT: DR. DANIEL LACKS

The annual Lee H. Johnson Excellence in Teaching Award goes far beyond just lecturing effectively. The award honors those educators who provide mentorship to our undergraduates as well as those who find new ways to understand, analyze and teach even the most well-established concept.

The 2003 recipient, Dr. Daniel Lacks, consistently sponsored research projects for undergraduates, and remarkably, published papers in the most prestigious journals with almost all of his undergraduate research students.

Dr. Lacks has taught every single course in the Chemical Engineering Curriculum. With such a perspective, he devised innovative new methods to look at entire aspects of chemical engineering. His teaching effectiveness can best be summarized by a student’s comments on one of his course evaluations: “I learned process control, but I couldn’t say when because I had such fun and the material was presented so well.”

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UNDERGRADUATES IMPACT LOCAL YOUTH

Aproximately 22 undergraduate students were involved in all phases of the FIRST LEGO League competition held in New Orleans during the fall of 2003. This competition was aimed at children from nine to 14 years of age. Dr. Annette Oetting (mechanical engineering department) was instrumental in coordinating the volunteers who helped make the tournament possible. Associate Dean Jack Grubbs served as the master of ceremonies.

The FIRST Program’s LEGO League is an international program that combines hands-on, interactive robotics with a sports-like atmosphere. Teams consist of up to 10 players who, over the course of 8 weeks, strategize, design, build, program, test and refine a fully autonomous robot capable of completing the various missions of the Robot Game. The students also conduct research developing compelling presentations related to a problem or opportunity facing the world today.

In addition to its role as one of the organizers of this event, Tulane Engineering sponsored and mentored two teams, one from the New Orleans Center for Science and Math and one from Lusher Alternative Extension School. Although this was the first year for the LEGO League in Louisiana, an impressive 15 teams of students participated.

Through the Tulane University Science Scholars Program (TSSP), administered in the School of Engineering, a select group of high school freshmen, sophomores and juniors have the opportunity to take courses from Tulane professors in the engineering, science and mathematics departments. These students take an exam in math and science before they are admitted, and once accepted, they study with professors over the course of eight Saturday morning classes each semester. A significant number of the TSSP scholars that later enroll at Tulane enter engineering.

Our student chapter of the Society of Hispanic Professional Engineers (SHPE) stays actively involved in community outreach in the New Orleans area. During a recent national convention of SHPE held in New Orleans, student chapter members from Tulane, LSU and UNO invited 78 students from the New Orleans Center for Science and Math to tour five engineering labs on the Tulane campus. These high school students also attended informative workshops, listened to speakers and boarded a flight simulator supplied by the U.S. Navy. The Pre-College Days sponsored included Boeing, ExxonMobil, NASA and the U.S. Coast Guard.

Currently, 55 engineering students are enrolled in The Louis Stokes Louisiana Alliance for Minority Participation (LS-LAMP), a comprehensive, statewide coordinated program aimed at increasing the number and quality of minority students earning baccalaureate degrees in science, math, engineering and technology. Since its inception in 1996, Tulane engineering professors have mentored 111 students.
THE BRAND NEW FRESHMAN YEAR EXPERIENCE

The engineering class of 2007 had a very different freshman year experience from that of their predecessors. Under the leadership of Professor Cedric Walker, their first year in college was marked by a series of enhancements designed to bring them closer to engineering people and places.

As Walker explains it, “Until now, our freshmen never met practicing engineers or saw our research labs. Many had no classes in the Boggs Center, and most never had a one-on-one conversation with an Engineering faculty member.”

With funding from the Provost’s TIDES (Tulane Interdisciplinary Experiences) Program, all of this changed last August when new initiatives were put in place.

To begin the year, every freshman was taken to lunch by a faculty member. This one-on-one attention is the beginning of a positive learning experience. The students can ask questions and get answers they can’t get in a classroom setting.

The freshmen performed hands-on experiments (designed by Engineering grad students) to introduce them to the school’s research laboratories.

A lecture by Larry Wink (E’78) on How to Build a Roller Coaster on Top of a Swamp was followed by a field trip to the new Batman ride at Six Flags, including a private inside-the-mechanisms tour of the park. This kind of exposure to engineering in action excited the students and sparked many questions.

Students attended a redesigned weekly lecture series to help the freshmen see the School of Engineering as their academic home for the next four years.

Other off-campus tours included small-group plant visits to local industries. These tours, hosted by School of Engineering alumni, included Intralox, Trinity Marine, Entergy, Pellerin-Milnor, Tulane’s new virtual reality robotic laparoscopic surgery suite, the Motiva Refinery in Norco and CII Carbon.

For several years before these initiatives began, freshman-to-sophomore retention was only around 65% on a name-by-name basis. Preliminary results show retention of more than 70% for the Class of 2007.

The program’s objective is to increase our students’ exposure to the research they will participate in, and the careers they will enter as professional engineers. By sparking their interest, and then keeping them interested, the school will better serve its students. This hands-on approach is one way that Tulane is working to encourage tomorrow’s leaders, today.
COLLABORATIVE INTERDISCIPLINARY RESEARCH EFFORTS

The School of Engineering is a major player in six interdisciplinary research centers that serve as a substantial link between the educational and research missions of Tulane University and provide the essential physical and intellectual infrastructure to carry out their missions.

Recent funding from the National Institute of Health in excess of $1,200,000 was awarded to the Center for Computational Science at Tulane and Xavier Universities (CCS) for research on biocomputing and integrating molecular/organ-level function.

Research activities focus on multi-scale biomedical investigations of the heart, lung and bone. The general approaches developed will be applicable to the study of many physiological systems. Each project involves essential interactions that span the molecular to the macroscopic scales, which induce organ-level responses.

The School of Engineering is also deeply involved in interdisciplinary activities in the environmental and energy areas, through its substantial participation in the Center for Bioenvironmental Research at Tulane and Xavier Universities (CBR) and the Entergy Tulane Energy Institute (ETEI) that is housed in the A.B. Freeman School of Business.

The overall goal of CSS is to foster collaborative research and education related to investigations of biomechanical and bioelectrical systems that span multiple scales. In particular, the focus is on the importance of molecular events, and the subsequent control of large-scale dynamic processes that are instrumental to physiologic functioning. This involves developing expertise in the mathematical modeling, computer-based simulation and analysis of systems where molecular phenomena interact with processes that are characteristically modeled using macroscale approximations. These interactions result in complex behavior that cannot be understood by the analysis of either molecular or continuum events alone.

This apparatus, which was built for elongating polymeric membranes, features mobile heads and fixed heads on a screw system, allowing for diffusion measurements of nanocomposite membranes under tension.

The Mechanical Engineering Department houses two of the six centers, the Southcentral Regional Center of the National Institute for Global Environmental Change (NIGEC) and the Research Institute for Security Engineering (RISE). Please refer to page 17 of this report for further information on these centers.

The Tulane Institute for Macromolecular Engineering and Science (TIMES) involves faculty in engineering and science, who collectively identified the need to establish collaborations with local industry, which is heavily oriented toward petroleum production and refining.

TIMES' mission is to contribute to the research needs of the polymer industry as well as industries that use polymers, by conducting world-class basic and applied research of long-term relevance to the industry, through contracts, grants and focused research, and to disseminate this knowledge through publications, seminars and education.

Since 2002, TIMES has received more than $5 million through the NASA Glenn and Langley Research Centers. Research activities of interest to NASA that are carried out include silica polymer nanocomposites; self-assembling and bio-inspired systems; diffusion through membranes; processing and characterization of high-performance polymers such as polyimides; on-line, real-time monitoring of polymer properties during processing; failure mechanisms in polymers for microelectronics applications; and advanced materials for lightweight photovoltaics.
PROFESSIONAL DEGREES OFFER STUDENTS MORE OPTIONS AND GREATER FLEXIBILITY

Until the spring semester of 2004 all Engineering Ph.D. and M.S. students were admitted into and maintained enrollment in the School of Engineering Graduate Division. The semester prior to the students’ receiving of degrees, their records were transferred to the Graduate School, the school that has traditionally conferred these degrees for all schools of the University. In the fall semester of 2004 the admission process for Engineering Ph.D. and M.S. degree programs was transferred from the School of Engineering Graduate Division to the Graduate School.

The Graduate School has always been a friend to the School of Engineering. A very effective working relationship was cultivated and has been maintained over the years, and we look forward to the continuance of this relationship. These newly combined efforts will continue to provide the most effective services to create the most positive experience for our students at Tulane.

The Graduate Division will continue to administer the professional master’s degree programs geared toward practicing professionals. These include the Master of Engineering and Master of Computer Science. The degree requirement for both of these programs is thirty (30) credit hours of graduate course work.

We are also very pleased to announce that the School of Engineering has joined the A.B. Freeman School of Business at Tulane’s Houston, Texas campus and will introduce several new programs, one being the Master of Engineering Management (MEM). This degree is a graduate-level, practice-oriented degree, offered jointly by the School of Engineering and the A.B. Freeman School of Business. The objective of the studies leading to this degree is to provide practicing engineers with advanced, current and broad knowledge in engineering, as well as the knowledge and tools of management that are essential in today’s workplace. Students in this program will typically have an engineering or science background, will have some work experience and will have an interest and ability to manage teams and technical projects. Thirty-two (32) credit hours of graduate course work is the requirement for this degree. Sixteen (16) course credit hours will be taken in engineering subjects and sixteen (16) course credit hours will be taken in business and management subjects.

Other programs the School of Engineering is looking forward to offering at the Houston campus include an executive Master of Engineering degree, as well as short courses for engineers and non-engineers. These programs will be aimed at practicing engineers and scientists.

More information about all of the graduate level degrees offered by the School of Engineering can be obtained by calling us toll free at 877.319.0101 or visiting our website at www.eng.tulane.edu/graduate/programs.php.

Research Expenditures

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SENIORS GAIN PRACTICAL EXPERIENCE & GIVE MOBILITY TO DISABLED INDIVIDUALS

Innovative thinking starts with a team name and continues through a year-long team design project. Greenwave Design, Team Blue and Team Yam Wars are three of the twelve teams in Dr. Dave Rice’s class. Each fall biomedical engineering seniors form teams. Each team is matched with a client who has problems with work, school or everyday life.

**Greenwave Design**

“Lizzy is a wisp of a girl, weighing only 26 pounds,” observed Debbie Pavur, associate director of Newcomb Nursery. “Using the regular toilet would be much better than using her potty chair. The staff hoped to avoid the possibility of the other children viewing her as a baby.”

**Jen Leight, Mary-Margaret Seale, Bo McGehee, and Chris Hough**, members of team Greenwave Design, took this as a challenge. The nursery’s step stool could help, but it was wobbly and the single step was too big. The team designed a platform with a broad top, two steps, and sturdy handrails that would fit the limited space around the toilet. They added non-skid feet and a non-slip, cleanable, water-resistant surface of sanded epoxy. It was colored purple, Lizzy’s favorite. It passed safety inspection, supporting the full weight of an adult. Now Lizzy can use the toilet along with her classmates. And the platform can be left in place all the time, freeing the staff significantly.

**Team Blue**

Team Blue, comprised of Stephen Holmberg, Terrell Green, Elizabeth Novick, and Nick Bacque, met with Charlie Taylor, a physical therapist with Ochsner Home Health Corporation. He described a problem: When using oxygen therapy, elderly clients are tethered to a bulky source and are unable to move around without draping the supply lines over furniture or getting them entangled with their feet, cane, or walker. Ultimately the team decided on a reel system, similar to air hose handlers at service stations, that would take up and confine the slack while providing continuous oxygen flow. The reel was equipped with a spring rewind system and a locking mechanism to hold the tubing in place without tension until it was time to release (with a simple tug) the lines to position them at a new length. This system should improve the mobility of and reduce some of the risk to home oxygen users.

**Team Yam Wars**

Tatiana, a preschooler, has Rett syndrome, a form of autism. She has limited balance and strength. Her family wants her to bicycle with them for both mental and physical development, but she was too big for a child’s trike and too weak to use a full-size bicycle. Allison Atkins, Occupational Therapy, Children’s Hospital, contacted us for help.

**Melanie Ross, Mike Seymour, Will Yancey, and April Austin** of Team Yam Wars answered the call. After analyzing the problem, they proposed creating an intermediate-sized bicycle with outrigger wheels and trunk support. Modifying an existing mass-produced bike reduced the costs immensely. The outriggers were placed and sized so that they provided better balance and a stronger structure than the usual training wheels. A wide seat and trunk support with harness helps position Tatiana for sitting. For safety, the team provided foot support at the pedals (for braking), padding for the frame, and a crash helmet.

Appearance is extremely important, so the team paid special attention to matching tire, padding, and frame color. Tassels, basket, and horn completed the accessories.

Through problem investigation and analysis, the senior biomedical engineers have been able to help the community. “The students feel that this course is all about helping disabled individuals,” states Kirsten Lewus, teaching assistant for the class. “They get a lot more out of it than they realize.” By forming a plan, setting goals, and working directly with the client, the teams learn a great deal about what their future holds as engineers.
SHOCKING DISCOVERIES HELP PATIENTS WITH HEART DISEASE

Defibrillation is the process of delivery of a strong electric shock to the heart to terminate the most lethal arrhythmia called fibrillation. Fibrillation is a severe cardiac rhythm disorder that leads to a loss of coordinated contraction of the heart – blood is therefore not pumped and death ensues unless there is an immediate intervention with an electric shock.

However, while the majority of patients that undergo defibrillation suffer from coronary disease, research on the mechanisms for defibrillation has mostly focused on normal hearts and rarely on hearts with ischemic disease. This is due to the fact that during acute ischemia the electrophysiological properties of the tissue change rapidly, which renders experimental evaluation of defibrillation difficult. In addition, experimental methods cannot provide information about the electrical behavior in the depth of the heart wall.

Over the past year, Dr. Natalia Trayanova has been using 3D modeling of defibrillation and arrhythmogenesis under the conditions of acute ischemia to provide mechanistic insight into the interaction of the electric shock with the ischemic heart. Dr. Trayanova has worked in the Computational Cardiac Electrophysiology Lab to develop an anatomically accurate model of the electrical behavior of the ischemic rabbit heart.

One of the main conclusions of her study is that following 10 minutes of partial occlusion of blood flow to the heart, the vulnerability of the heart to electric shock decreases. The figure below presents some of the findings. It shows maps of transmembrane potential on the surface of the heart under normal and ischemic conditions.

Even before the shock, propagation of the activation in the heart differs in ischemia. The recovery of the ischemic tissue from excitation is faster (less red color). This leads to differences in the shock-induced potentials in the heart (8ms panels), as well as in the propagation of the post-shock wave fronts in the heart (22ms and 72ms panels).

Under ischemic conditions, the post-shock activation wave front fails to propagate through the heart shortly after the end of the shock (dashed red arrow in 22ms panel), while in the normal heart this wave front returns to the site of origination and establishes an arrhythmia.

These findings are important in understanding why defibrillation threshold changes in patients with ischemic cardiac disease.
NEW CELLS ACT AS MINIATURE PHARMACIES & EXISTING CELLS CHANGE FOR THE BETTER

ENGINEERS LET CANCER CELLS HEAL THEMSELVES

Directed by W. T. Godbey, Assistant Professor in the Department of Chemical & Biomolecular Engineering, the Laboratory for Gene Therapy and Cellular Engineering focuses upon the delivery of genetic material to alter the function of cells. Cancer poses a huge problem to the population worldwide, with carcinomas affecting the linings of organs such as the bladder, colon, rectum, prostate, and adrenal glands.

Most carcinomas are characterized by an overexpression of the Cox-2 gene, which is thought to aid the tumor cells in being resistant to apoptosis, a natural form of programmed cell death. New cell types can be manufactured to act as biological chemical plants or pharmacies, and existing cell types can be coaxed into changing their behaviors with the aim of improving physical condition.

Work in the Godbey laboratory has focused on this property to target many common cancers such as prostate, breast, and bladder carcinomas. Through a gene therapy technique known as expression targeting, Godbey is able to single out tumor cells and have them produce suicide proteins. “It is the ultimate irony for the cancer cells – literally,” states Godbey. “The very property that helps these cells resist death is the same trait that is responsible for their selectively killing themselves with our treatment.”

Funded by startup funds from Tulane University and a grant from the Louisiana Board of Regents, Godbey has been able to establish his cancer treatment as a significant therapy for bladder carcinomas in mice by demonstrating that treated bladders retain similar morphologies to normal bladders, as opposed to untreated or partially treated bladders which are nearly solid from tumor progression and cherry-red from tumor-induced angiogenesis (fig. 1). His research is being applied to other tumor models and other animal systems in an effort to someday introduce the technology into the clinical arena.

The project is currently concluding murine studies on Tulane’s uptown campus and is ready to move into primate studies for pre-clinical investigations. The Tulane Primate Center may present a readily accessible avenue for preparing the treatment for phase I clinical trials. Godbey has an established collaboration with Anthony Atala, a noted tissue engineer and urologic surgeon at Baptist Medical Center in Winston-Salem, NC, a part of the Wake Forest University Medical Center. Conducting clinical trials through the Tulane Medical School is also a possibility for this work. Ultimately, the goal of this work is a pharmaceutical that can be used to treat victims of a variety of cancers.

DEPARTMENT ADDS “BIOMOLECULAR” MONIKER

The year 2003 was one of significant change for the Department. After more than a century of operation as the Department of Chemical Engineering, we changed our name to the Department of Chemical and Biomolecular Engineering. The name change was realized after considerable thought and consultation with our University constituencies and our Board of Advisors. It was done to reflect the dynamic nature of the profession, that we are engineers who tinker with molecules and develop processes and products from an understanding of molecular phenomena. And just as we have been richly rewarded by being the engineering equivalent of chemistry, we stand to benefit by developing strengths as the engineering equivalent of modern biology.

While we will always embrace the core skills that a chemical engineering education involves, we will attempt to seamlessly integrate new concepts and provide our students additional opportunities in the rapidly growing fields of biotechnology and advanced materials. We are confident that this strategic direction will positively impact our undergraduate recruitment and retention efforts, provide additional employment opportunities for our students, and enhance our research visibility.
**NANO TECHNOLOGY HAS A BIG EFFECT**

Nanotechnology is a unifying theme that has brought together a number of faculty and their students in collaborative work. These collaborative efforts are made exciting and relevant by the recognitions earned by faculty working in this area.

**Dr. Yunfeng Lu**, for example, was chosen by the National Science Foundation to represent the U.S. in a 12-member delegation to Japan. The delegation consisted of young faculty members in all engineering disciplines whose work in nanotechnology shows extreme promise and distinction. Dr. Lu visited several academic and industrial laboratories and has initiated collaborations with Japanese researchers and with other members of the U.S. delegation.

**Dr. Daniel De Kee** and **Dr. Brian Mitchell** direct research in the TIMES center to address nanotechnology in the development of novel polymer-ceramic nanocomposites.

The CBE department is playing a leadership role in defining directions in nanotechnology for the University. The nanotechnology projects in the department range from the development of photovoltaic and thermoelectric devices to the study of nonviral gene delivery carriers using nanotechnology, the development of new environmental remediation technologies, the creation of novel hydrogels for drug delivery applications and the development of novel mesoporous carbon materials.

The blending of biotechnology and nanotechnology is an especially redeeming feature of departmental activities. **Drs. Kyriakos Papadopoulos, Vijay John** and **Lu** collaborate with **Dr. Godbey** to interface nanotechnology with gene delivery techniques (see page 101). Additional collaborations have evolved with the Medical School, the Chemistry Department and the Mechanical Engineering Department.

In 2004, the Department will be bringing on board **Dr. Hank Ashbaugh**, whose research expertise lies in computational simulations of nanostructured materials. The Department’s strategic directions lie in building highly research-productive groups that span nanotechnology, biotechnology and advanced materials. Students working in these areas will be given tremendous opportunities to participate in multidisciplinary collaborative efforts that blend strong components of both theory and experiment.

**ADVANCEMENTS IN ADVANCED MATERIALS**

The panoply of materials and their potential high-tech applications generally referred to as “advanced materials” are currently a central research theme for several groups in the Department. **Professors Richard D. Gonzalez, Ashbaugh, De Kee, John, Lu** and **Mitchell** and their students are investigating diverse topics with wide-reaching applications:

**HIGHLY POROUS CATALYTIC MATERIALS**
**SYNTHETIC GELS THAT ABSORB BIOLOGICAL AGENTS**
**DIFFUSION THROUGH MECHANICALLY STRESSED POLYMERS**
**HIGHLY INTERFACIAL HYBRID NANOCOMPOSITES**

From computer simulations to corrosion studies, metals to macromolecules, asphalt to xerogels, these investigators are synthesizing, characterizing and modeling materials that will lead to energy, environmental, defense, consumer product, aerospace, transportation, and information storage applications.

Their work is supported by exceptional facilities: atomic force microscopes, thermal analysis modules, a transmission electron microscope, and polymer extrusion and injection molding equipment, all of which have been secured directly through federally and state-funded grants the investigators have written. The synergy between these groups is further evidenced by such activities as participation in the **Tulane Institute for Macromolecular Engineering and Science**, co-authorship on publications and presentations, and collaboration on the development of a federally funded center in polymeric nanocomposites.
DEPARTMENT CHAIR DEMANDS EXCELLENCE

“Our goals and our responsibilities are derived from one another,” says Dr. Vijaya Gopu, the new Chair of the Civil and Environmental Engineering Department. “As a teaching university, our mandate is to provide students with the fundamental knowledge essential for professional development and lifelong learning. That, then, is our primary goal.”

Dr. Gopu understands the importance of lifelong learning, firsthand, with a career in Engineering that has spanned four decades. He graduated from Andhra University in India, First Rank with Distinction with a B.Eng in Civil Engineering. He then went on to receive an M.S. and Ph.D. in Structural Engineering from Colorado State University.

Before coming to Tulane University, Dr. Gopu was the Department Chair at the University of Alabama in Huntsville and Associate Director of the University Transportation Center for Alabama. Prior to that he served as an endowed professor at Louisiana State University. During his tenure at LSU, Dr. Gopu served as Program Director at the National Science Foundation for the Structural Systems and Engineering Program. At NSF he launched a new initiative on Advanced Technologies for Housing in collaboration with the Department of Housing and Urban Development under President Clinton’s PATH program; and has served on numerous federal interagency working groups and committees.

Dr. Gopu was named Teacher of the Year and Educator of the Year by the CEE Department at LSU and received the Educator of the Year Award from the Society of Professional Engineers in Huntsville.

He served as visiting professor at the Royal Institute of Technology, Stockholm, Sweden, and visiting scientist at Forintek, Vancouver, Canada.

“My passion for building systems and materials has kept me excited about structural engineering for so many years,” Dr. Gopu continues. “And it’s this passion that I want to pass on to the students at Tulane.”

And what better place than New Orleans to start? The roadway, drainage and coastal preservation systems that keep the city dry have been, more often than not, products of Tulane Engineering graduates and faculty.

“As a research university, our goal is the application of knowledge. And that takes the form of laboratory research and discovery in the field,” says Gopu. The graduate levels are focused on this second goal.

The CEE department is in the process of upgrading the environmental, geotechnical and structural engineering research laboratories. In particular, a new structural testing facility and a polymer composite manufacturing facility have been proposed and are awaiting funding for construction. These new facilities, in conjunction with continuing participation in research efforts funded by the National Science Foundation, Environmental Protection Agency, Department of Transportation and other federal and state agencies, will allow the department to continue to grow as a nationally recognized leader in the fields of civil and environmental engineering teaching and research.

WE STIMULATE CURiosity AND A THIRST FoR ANSWERS YET UNIMAGINED

“Fifty years ago, who could have foreseen the advancements in materials science?” asks Dr. Gopu. “With today’s technology at their fingertips, there’s no telling what kind of break throughs will be made. But we can be sure that Tulane faculty and graduates will be on the cutting edge.”
CEMENTING TULANE’S NAME IN HISTORY

Prior to World War II, America’s construction with concrete remained limited—concrete has great strength when compressed but, originally, was not suited to withstand great tensile stress. At this time, Tulane’s Professor Walter Blessey (the namesake of the department’s renovated offices) initiated research to remedy this tensile-stress problem. Blessey’s research was sponsored by New York’s Raymond International, Inc., a worldwide design and construction company. Europeans were working on the addition of prestressing tendons within the concrete to allow for greater tensile strength, and Blessey set out to test these theories.

In the late 1940s and early ’50s, research continued in New Orleans on the use of prestressed concrete in offshore drilling platforms. During that time, Professor Gustav Magnel, of the University of Ghent in Belgium, visited Tulane to present a lecture on prestressed concrete and captured the attention of a young Tulane Civil Engineering student named Robert Bruce, who would go on to choose prestressed concrete as the subject of his Master’s thesis and Ph.D. dissertation.

In 1955, Bob Bruce won a Fulbright Research Grant to study at the Magnel Laboratory at the University of Ghent. He pursued research in the prestressing of lightweight concrete and went on to work for the Raymond company.

When he returned to Tulane in 1962, Dr. Bruce was named Principal Investigator for prestressed concrete research for the university. Today, he continues the work begun over a half-century ago at Tulane, including tests in 2003 on 96-ft. girders.

Dr. Robert Bruce is the holder of the Catherine and Henry Bob Chair in Civil Engineering. His work with flexural, fatigue and shear behavior of prestressed concrete contributed to the construction of the Lake Pontchartrain Causeway and other major structures with the U.S. Department of Transportation Federal Highway Administration and various state departments of transportation.

STUDENTS LEARN CONCRETE LESSONS IN ASCE COMPETITION

Whatever floats your boat could have been the motto of the annual Deep South Regional Conference hosted by Tulane University, March 27-29.

Tulane Engineering’s student chapter of the American Society of Civil Engineers (ASCE) played host to more than a hundred students from ASCE chapters across the South. Participating universities included Mississippi State University, Arkansas State University, University of Tennessee, Louisiana Tech, Louisiana State University, University of Mississippi, McNeese State, University of Louisiana in Lafayette and Southern University. The competition consisted of three parts: Surveying Competition, Steel Bridge Construction and the infamous Concrete Canoe Competition.

In the Surveying Competition, students were required to survey Tulane’s academic quad. Scores were based on time and accuracy. The Steel Bridge Competition tested students’ abilities in structural design, fabrication and construction, requiring that an original bridge be built to span a 25-foot wide expanse and withstand a 2,500-pound load. The teams’ bridges took a beating from the judges before the day was over. “Our bridge was designed and fabricated entirely by students, a marked difference from most schools in the competition,” notes civil engineering student Jeremy Mart i n.

The ultimate challenge was the Concrete Canoe Competition, held at Bayou St. John near City Park. Students worked for months to design and fabricate each team’s canoe. But floating the 400-pound construction was only the beginning. These canoes were built...for speed. “The students have got to display true teamwork from the design phase through the race itself,” says Paul Ziehl, Assistant Professor and advisor for Tulane’s ASCE chapter. “If they don’t get wet, that’s one level of success – academic success. But winning the race, well, that’s a whole different story!”

In the end, Tulane’s team won third place overall with a strong showing in the canoe competition. “It was a lot of fun,” said team leader Kirsten Baldwin Metzger. “We came in as the favorites, having won the last two years in a row.” Co-leader Sarah Oral added, “Our design was excellent, but we just couldn’t pull out the three-peat.”
**MICRO-MICROPHONES: THE NEXT BIG THING**

As a member of the Engineering Research Center for Wireless Integrated Microsystems (WIMS) based at the University of Michigan (U-M), Dr. Dale Joachim explores the design and fabrication challenges in small-scale acoustic direction-finding (SS-ADF) sensors. This project's objective is the realization of a tiny, direction-finding sensor all-inclusive of the power source, processing electronics and wireless communication.

**NEW MICRO-COMPUTER ARCHITECTURE USES LOW POWER BUT GIVES HIGH VOLUME SIGNAL**

The elements of Dr. Joachim's project range from the microfabrication of a capacitive microphone to be used for direction finding to a direction-finding algorithm optimized for low-power use within the proposed microphone. With a new micro-computer architecture designed for low-power but relatively high-volume signal processing, such a micro-microphone would be capable of self-localization and communication. The targeted applications of these SS-ADF sensors are quite varied.

**POWERFUL COMPUTATIONAL INTELLIGENCE**

A National Science Foundation-funded project titled Computational Intelligence Based Power Systems Operation, funded for three years with an amount of $180,000, will result in a completely new technology for waveform analysis, according to NSF panel of experts. The application of an online observer using a variety of Computational Intelligence (CI) tools to characterize full range of power quality events will be a novel contribution to be made by investigators: Dr. Brij N. Singh as PI and Drs. Marin Simina and Jing Peng as Co-PIs. This is a very important area in power systems – real-time classification, location, and mitigation of power quality events leading to minimization or elimination of cascaded failures and blackouts.

The proposed CI tools coupled with the Discrete Wavelet Transform (DWT) technique will also provide the mechanism for forensics analysis pinpointing the origin of power quality disturbances. The application of IP-based sensing devices for real-time data communication is a novel idea to share vital information in distributed control of the power systems spread over thousands of miles.

The proposed method will also be extended for load modeling in the power system, which is imperative due to economic shift, whereby manufacturing industries are being replaced by service and hi-tech companies. In the foreseeable future, the proposed research should be even more profound in the evolving power system today.
The D-Day landings in Normandy were critically affected by weather with the massive operation once being postponed 24 hours based on forecasts. The need for effective and timely information on weather and sea conditions is just as relevant today to Naval, Marine and Special Operations missions. For example, in planning a beach landing a Seal Team needs to know about the possible sea state in order to plan the type of craft from which they can effectively operate.

In the age of PDAs and web-enabled phones, nearly instant access to information has become standard business procedure. But the satellite systems and supercomputer-based meteorological and oceanographic modeling programs used by the military are far more complicated than 20-minute delayed stock quotes and sports scores.

“A major problem is the effective delivery of such data across a narrow bandwidth to the field of operation,” says Dr. Fred Petry. Dr. Petry has been collaborating with the researchers at the Naval Research Laboratory located at the Stennis Space Center in Mississippi. Their combined efforts are focused on the development of the Tactical Environmental Data Services (TEDServices), a new active, web-based approach for provision of data to soldiers in the field.

The TEDServices design supports the automated management and bi-directional transport of meteorological, oceanographic and other environmental data/information in a method that allows for fast transmission over very narrow bandwidth connections.

“Troops will receive the very latest information on tides, wind gusts, fog or electrical storms in real-time via lightweight, form-a-rd-deployed data cache,” says Dr. Petry. This system can be integrated into a military unit’s Virtual Natural Environment (VNE) – a four-dimensional representation of the user-defined, battle-space environment. Using heads-up displays or portable VNE, war fighters, MetOC professionals, Tactical Decision Aids, applications and weapon systems will have immediate access to the constantly changing information – rain or shine.

HARNESSING THE POWER OF THE PLAYGROUND

All work and no play make Raj a dull boy.

Assistant Professor Raj Pandian doesn’t have to worry about that, since he began work creating electricity from playground power.

Dr. Pandian joined the EECS department in the fall. His fields of research are healthcare robotics and assistive technologies. But his latest invention involves what he calls human power conversion.

In an attempt to find low-cost, renewable energy technologies for developing countries, the human power conversion system is based on children’s play. For his prototype, Dr. Pandian put pneumatic cylinders under the seats of a seesaw and connected them to a small tank. As children go up and down, air is pumped through the cylinders and into the tank. After enough air has been collected, an inflator converts the energy of the compressed air into electrical power. This power is stored in batteries for later use.

This system can be used as a back-up source of electricity for schools and hospitals. “It can also be used to raise children’s awareness of energy conservation,” says Pandian.

This idea was selected by The New York Times as one of the outstanding inventions of the year 2003. He has filed for a patent on his device and has already been contacted by individuals and institutions working on renewable energy projects, all interested in his designs. Dr. Pandian is developing other prototypes, such as a merry-go-round and a swing.

Dr. Pandian, his son and another child play on the seesaw prototype.
You may have seen Hollywood's version of robotics in blockbusters like *I, Robot*, *A.I.*, or even *Star Wars*. But to see the practical application of that same technology, just look at Tulane University’s robotics lab in the Department of Mechanical Engineering. **Dr. Ho-Hoon Lee**, Associate Professor of Robotics, Mechatronics and Automation, is working on enhancing both the mobility and flexibility of robots in the workplace.

Dr. Lee is working with graduate and undergraduate students to build six sets of mobile robots with wireless-communication control and internet-based control. “I will train two teams of undergraduate students for robotic soccer. We will also use the mobile robots for graduate research such as formation control, cooperative control of multiple robots, auto-navigation control, and so on,” says Dr. Lee of his research. “It will also be extended to the control of autonomous underwater robot systems and autonomous submarine systems.”

Dr. Lee is also concerned with the control of flexible systems such as overhead cranes. These systems are typical examples of underactuated systems used in the field. They have fewer control inputs than the number of degrees of freedom. As such, they are considered one of the most challenging problems in the control community.

“I have developed a new design approach for the control of flexible link robots based on distributed-parameter dynamic models, which solves the major problems in the existing control,” says Dr. Lee. “In addition, I have developed a new concept of control design that guarantees accurate anti-swing trajectory control of overhead cranes with high-speed, load-hoisting control, thus realizing the first anti-swing trajectory control of overhead cranes that equals or surpasses the control of experienced human control in industry.”

**THE FUTURE OF ROBOTICS IS MOBILITY & FLEXIBILITY**

**THIS NEW DESIGN GUARANTEES ACCURATE SWING CONTROL OF OVERHEAD CRANES – SURPASSING EXPERIENCED HUMAN CONTROL**
Tulane is the host institution of the Southcentral Regional Center (SCRC) of the National Institute for Global Environmental Change (NIGEC). It is part of a network of six regional centers, with the other five located at Harvard, the University of Alabama, the University of Nebraska, the University of Indiana and the University of California.

The current specific goals of the SCRC of NIGEC are:

1. To improve our understanding and reduce measurement uncertainty with terrestrial ecosystem carbon exchange processes.
2. To improve our knowledge on the effects of multiple environmental changes associated with energy production on important terrestrial ecosystems in the region.
3. To reduce errors and uncertainty of data that are obtained from the monitoring of ecosystems.

The Graduate Alliance for Education in Louisiana (GAELA) will substantially increase the number of minorities entering Science, Technology, Engineering and Mathematics (STEM) doctoral degrees and joining the ranks of the professorate.

Alliance partners include: Tulane and Louisiana State University (the two Carnegie Research I universities in Louisiana and the institutions responsible for 94% of the minority STEM doctoral degree production in the state between 1994 and 2001), Xavier University of Louisiana, Dillard University, and Southern University at Baton Rouge and New Orleans.

The goals of the program are to recruit minority students into STEM doctoral programs at Tulane and Louisiana State Universities; affect significant change in the culture of graduate education at two of the State of Louisiana’s top research universities; and significantly increase minority STEM doctoral degree production. These goals will be accomplished by:

- Early identification and nurturing of promising students
- Recruiting doctoral fellows from participants in other pre-graduate training programs
- Fostering good faculty-student mentoring relationships
- Providing activities that focus on retention of minority students who are already enrolled in STEM doctoral degree programs

The GAELA program is supported by the National Science Foundation.

The mission of the SCRC is to provide sound and accurate scientific findings to enhance our understanding of the response of key ecosystems and important regional economic sectors to global environmental changes associated with energy production.

Among the recent developments in the projects funded by the SCRC is that, for the first time in six years, the Center will support a three-year research project within the Tulane University School of Engineering.

The Principal Investigator of the project is Dr. Statthis Michaelides, with Dr. Monique Leclerc of the University of Georgia as co-Principal Investigator. The title of this project is: Improvement of the accuracy of carbon flux measurements by using a combination of numerical modeling and field measurements; its subject is the reduction of uncertainty of measurements in ecological systems. Two other new projects complete the slate of newly funded research by the Center:

One is entitled Responses to climate change of C4 and C3 grass species native to South-central region to be performed in conjunction with investigators at Mississippi State University. The second covers Effects of climate change on multi-trophic interactions in agriculture and grasslands in the Southwestern United States, with investigators at Tulane University.

The National Institute for Global Environmental Change (NIGEC) was established to create, analyze, and implement advanced technology solutions for security problems. Through the institute, Tulane is addressing a broad range of homeland security needs by developing cutting-edge technologies through basic research and then transferring these technologies to users in government and industry. RISE was awarded $760,000 this year, bringing the total of external funding to more than $3.5 million, for research related to security engineering.

RISE researchers from seven departments are actively collaborating in the areas of computational algorithm development, infrastructure integrity, bioengineering, electromagnetic/directed energy, systems and sensor engineering, and ethics and policy. In addition, RISE members are establishing partnerships with other academic institutions, companies, and local and state government entities.

Faculty and graduate students in Mechanical Engineering are using input from multiple sensors, such as this thermographic image of Ph.D. candidate Valmiki Sookal, to improve methods for automatically identifying people and objects in a scene.

A sampling of the projects underway include: creating computer algorithms to detect, classify and identify objects (people, vehicles, etc.), developing design methodologies to enhance the security of major infrastructure assets (e.g., bridges), using models of living tissues to aid in response to a biological or chemical incident; and using optical technologies to enhance surveillance and biometric systems by improving the ways disparate information is measured, collected and interpreted.
HOMECOMING MIXES FOOTBALL AND FUN

This was the first year for a new format of the Society of Tulane Engineers (STE) annual meeting. In the past the annual meeting was held on the Saturday morning of homecoming with a jazz brunch. Now the annual meeting is held on Friday night of homecoming weekend in a cocktail party setting, with the annual meeting in the lobby of Lindy Boggs Center, thus freeing up Saturday prior to the game for tailgating hosted by the STE. Over the weekend, four different Engineering class reunions took place around town.

At the Friday night meeting, our alumni awards were presented.

Outstanding Alumnus: Albert Baldwin Wood (1879-1956), distinguished himself shortly after graduation in Mechanical Engineering in 1899 when he designed the pumps that, to this day, continue to drain the city of New Orleans and are also used in the Zuider Zee region of Holland, as well as Egypt, China and India.

Harold A. Levey Award: John J. Kelly III (ME, CS’87, Ph.D., CS’96) is the president of Model Software Corporation and an expert computer consultant.

2003 Hall of Fame Inductees:
William “Bill” Cavanaugh III (ME’61) is the Chairman and CEO of Progress Energy.

David R. Filo (Compt Eng.’88) is the Co-Founder and Chief Yahoo of Yahoo! Inc.

ENGGINEERING FORUM CONTINUES TO GROW

The 2003 Engineering Forum, Emerging Technologies for Economic Development, was successfully held on September 26 under the capable leadership of the officers of the Society of Tulane Engineers. STE sponsors the annual event, which offers Tulane alumni and other professional engineers an opportunity to earn continuing education credit and hear about the latest developments in industry.

Attendance exceeded all expectations and has more than doubled since its inception in 2000. Revenue from the forum also increased substantially this year. An added feature this year was the inclusion of an ethics session led by Norma Jean Mattei, Associate Professor of Engineering at the University of New Orleans. Attendees at this seminar were awarded seven professional development hour credits.

The committee hosted a cocktail party before the event to welcome speakers and sponsors and their guests. The gathering was held at the home of University President Scott Cowen.

The keynote speaker was internationally renowned John E. Breen, The Nasser I. Al-Rashid Chair in Civil Engineering, from the University of Texas at Austin. He gave a talk, courtesy of the Boh Lecture Series, on “Economic Factors in and from Bridge Building.”

Keystnote speaker Dr. John Breen and Bill Conway of Modjeski and Masters.

Bob Bruce and Bob Boh.

Dr. Bruce holds the Catherine and Henry Boh Chair in Civil Engineering, and is responsible for the Boh Lecture Series.

Bob Boh is the son of Henry and Catherine and Chairman of the Board of Boh Bros.
SPECIAL THANKS TO OUR GENEROUS ALUMNI

**Dr. Joseph Boston** gave the School of Engineering a charitable remainder unitrust, which will fund the *Joseph F. and Phyllis J. Boston Endowed Fund*. This fund will be used to create a chair or professorship in the Department of Chemical Engineering. A charitable remainder unitrust is an irrevocable trust paying income to the donor or whoever the donor specifies for life or up to 20 years, after which the remaining amount in the trust passes to Tulane.

“I have come to know the department very well...and it is an excellent department,” he said. “It is constantly striving to be the best it can be, and that is what is most important to me.”

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