Interdisciplinary Research: materials

Nanopantography | Nanomagnetic Storage | Piezoelectrics
Within the past five years, the Cullen College has received three NSF-NIRT awards totaling more than $3.3 million. In this issue of Parameters, we highlight the interdisciplinary effort behind each of these projects as well as the associated research findings and upcoming developments. We also communicate how some of these projects have been catalysts for other successfully funded research endeavors.

In addition to a prolific research program, a great institution is also defined by the quality of its student body. In this issue, we feature students who are excelling in national and regional competitions as well as academic, research and outreach activities. At the Cullen College, we are committed to our mission to educate engineers as next-generation leaders and we are proud to share their stories and accomplishments with you.

Warm regards,

Joseph W. Tedesco, Ph.D., P.E.
Elizabeth D. Rockwell Endowed Chair and Dean

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Frank J. “Fritz” Clapton
Associate Dean for Graduate Programs & Computer Facilities
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6 Nanopantography
A fabrication technique being developed by University of Houston researchers could be integral in achieving the ability to mass-produce billions of nanotech devices in hours.

8 Nanomagnetic Storage
A nanopatterned medium recording method could facilitate unprecedented data storage capacity and allow researchers to circumvent the superparamagnetic limit of conventional magnetic recording technology.

10 Piezoelectrics
Researchers are exploring an effect at the nanoscale that could allow them to fabricate and enhance piezoelectric properties—materials that generate electricity when placed under physical stress—without using piezoelectric elements.

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University of Houston Cullen College of Engineering
New UH Petroleum Program

Devon Energy Corp. and Marathon Oil Corp. have committed $1.6 million to the UH Cullen College of Engineering in support of its developing undergraduate program in petroleum engineering. The new program, expected to be approved by the Texas Higher Education Coordinating Board and launched in fall 2009, will include a modular curriculum allowing students to specialize in areas such as reservoir engineering or petroleum geology. Devon’s $1 million pledge will support student research laboratory and other needs of the program. Marathon’s pledge of $600,000 is unrestricted.

The program will have a strong focus on the technical aspects of petroleum engineering—computer systems, data mining and database management as well as leadership, entrepreneurship and project management. The new Bachelor of Science degree in petroleum engineering is considered a cornerstone in the university’s goal to become a leader in energy research and education.

$1.6M Committed to New UH Petroleum Program

UH Professors to Help Modernize Libya’s Infrastructure

A knowledge transfer program led by local university professors is among the components of a $50 million dollar capital improvement plan managed by AECOM Technology Corporation and the government agency, Great Socialist People’s Libyan Arab Jamahiriya Housing and Infrastructure Board. During the next year, some 100 engineers will travel to Houston to participate in the program. The curriculum will combine study on wastewater treatment, road and bridge systems and residential development along with language immersion and field trips to infrastructure within the city.

The National Science Foundation has awarded the University of Houston $960,000 in funding to the Cullen College of Engineering as part of its S-STEM (Scholarships in Science, Technology, Engineering and Mathematics) Program. The funding will be used to provide scholarships to community college transfer students as a means of improving retention rates.

$1M Chair Established

William C. Miller Jr. (1955 BSPE) has given the college a $1 million gift to establish an endowment for engineering faculty. Once fully funded, the William C. Miller Endowed Chair of Engineering award will be given annually to deserving faculty to advance teaching and research at the college. Miller is an independent oil operator currently managing his San Antonio-based business, W.C. Miller Operating Company, which he has run for more than 60 years.

$1M Chair Established

National Academy Member Joins College Faculty

Benton Baugh (1967 BSME), national academy member and president of Houston-based Radoil Inc., has joined the college as an adjunct professor. Baugh’s appointment brings the total number of national academy members in the college to eight. One of the highest honors to be held by an engineer, Baugh is currently among 2,394 active, foreign associate and emeritus members named to the National Academy of Engineering.

Grant to Fund Community College Transfer Program

The National Science Foundation has awarded $600,000 in funding to the Cullen College of Engineering as part of its S-STEM (Scholarships in Science, Technology, Engineering and Mathematics) Program. The funding will be used to provide scholarships to community college transfer students as a means of improving retention rates.

BP Gift to UH to Benefit From Training (MESET).

BP America has committed $750,000 to the University of Houston in support of energy-related programs and student scholarships during the next three years, making UH one of only a dozen institutions nationwide to receive direct educational support from the energy major.

“The University of Houston is among a core group of universities that we are interested in supporting because it provides quality energy-related programs and an exceptional talent pool from which we can recruit,” said Gabriel Conde (1985 BChE), business unit leader for Latin American Retail at BP. “We have been recruiting students from UH for over 20 years and it is important that we continue supporting recruitment and retention efforts at the university.”

BP has allocated $780,000 per year to the Cullen College of Engineering in support of its recruitment and retention efforts. The majority of the gift will support scholarships for freshman and sophomore engineering students as well as underrepresented students entering the college following participation in one of its two premier summer camps, Girls Reaching and Demonstrating Excellence (GRADe) Camp and the Monitoring and Enrichment Seminar in Engineering Training (MESET).

UH’s College of Natural Sciences and Mathematics and the Bauer College of Business will receive the remaining balance of the $250,000 annual donation for scholarship support and graduate fellowship programs to attract the highest caliber students and to support research.

College Programs to Benefit From BP Gift to UH

College News Briefs
Bright minds from departments across the University of Houston Cullen College of Engineering are behind research projects that could impact the way we live. Utilizing roughly $3.4 million in federal grants from the National Science Foundation’s Nanoscale Interdisciplinary Research Team Program, these researchers are joining efforts to engineer advanced materials at the atomic and molecular levels. These same materials may one day utilize our footsteps to power portable electronics, allow the mass production of nanotech devices or make possible new recording methods for improved data storage. These innovations could be reality in as little as five years thanks to teams of researchers from the University of Houston pooling their experimental and theoretical expertise to advance modern technology.
Dubbed nanopantography, the method has allowed UH researchers to fabricate minute features beyond what can be found in existing integrated circuits. For the last five years, the research team has worked to perfect the process that’s not only allowed them to successfully write at 10 nanometers, it could one day allow the rapid, large-scale production of nanotech devices. “Nanotech devices can be made with electron-beam lithography or with a scanning tunneling microscope,” said Demetre Economou, John and Rebecca Moores Professor of Chemical and Biomolecular Engineering. “However, the fabrication speed is extremely slow (a serial process) and it is not suitable for mass production. With nanopantography you could create nanopatterns of virtually any shape in any material, simultaneously covering the whole wafer surface within hours (a parallel process).” The research by Economou, Vincent Donnelly, John and Rebecca Moores Professor of Chemical and Biomolecular Engineering; and Paul Ruchhoeft (1998 MSEE, 2000 PhD EE), associate professor of electrical and computer engineering, has been featured in publications such as *Nano Letters* and *Applied Physics Letters*. Recently, the team filed a patent for the technology:

> Initially funded with a five-year, $1 million grant from the National Science Foundation’s Nanoscale Interdisciplinary Research Team Program, the grant was the first of its kind received by the college five years ago. Progress has since continued with a two-year, $100,000 grant from Texas Advanced Research Program as the team attempts to go even smaller.

> “What we need to do next is try to reduce the resolution even further to three nanometers,” Donnelly said. “This, by far, would be a record for writing nanopatterns with a parallel process.”

The researchers are working to better focus the ion beam, which helps deliver the high resolution, to write the smaller size. “We have demonstrated this can be done,” Donnelly said. “Now it’s a matter of understanding the process a little better.”

Nanopantography utilizes sub-micron-diameter electrostatic lenses built by standard photolithography and etching. Economou said, These lenses are placed on a substrate, the silicon wafer being written on, and positioned in a vacuum chamber as a broad ion beam is directed at the wafer. Each lens focuses an ion beam to a spot on the wafer surface. When the wafer is tilted, the focal spot is translated along the wafer surface allowing nanopatterns to be written in millions of places simultaneously.

This method, Economou said, can be used to write a variety of materials in any shape and nanosize dimension. “Basically, you can tell me what you want, what size, what shape and I’ll give it to you,” Economou said of the technology that could allow for the mass production of nanotech devices in five to 10 years. Beyond this potential, nanopantography could aid in the development of carbon nanotube electronics, and possibly give rise to televisions with higher resolution and brightness than the latest LCD or plasma technology.

For years, the semiconductor industry has led many of the advances in miniaturization technology. Yet, in a market where size is of great importance, what’s out there now is just not small enough. To stay competitive, industry experts must fabricate nanotech devices with dimensions near 10 to 20 nanometers—as much as three times smaller than the 45-nanometer feature size some are moving toward.

A method created by researchers at the University of Houston Cullen College of Engineering could offer a solution to this daunting dilemma.

Researchers Vincent Donnelly, Paul Ruchhoeft and Demetre Economou showcase their nanopantography instrument in the Plasma Processing Laboratory.
Small Research Has Big Impact

Although impact from recording technology being developed by Litvinov and his team is still a few years off, its influence at the university has been significant. The research has opened doors to several other interconnected, grant-funded projects related to magnetics and nanomagnetics totaling more than $52 million.

- A $200,000 grant from the National Science Foundation, awarded earlier this year, will help to establish a nanoeering minor at the college.
- The Texas Advanced Research Program awarded a two-year, $40,000 grant in May to help develop a method for fabricating tightly packed, nano-sized features with sharp corners resulting in more powerful, smaller computing devices.
- A three-year, $365,561 grant received from the National Science Foundation in 2007 could replace conventional semiconductor circuits with nanomagnets or magnetic cellular networks.
- The Office of Naval Research provided a two-year, $150,000 grant in 2006 to establish guidelines for nanoscale magnetic device design and protection.
- A three-year, $892,000 grant awarded in 2005 by the National Institutes of Health and the National Institute of Biomedical Engineering and Biotechnology is helping develop a sensor technology enabling rapid evaluation of the effectiveness of potential antiviral drugs by their ability to block a virus’ bond with a cell receptor.
- The Alliance for NanoHealth awarded researchers a one-year, $148,963 grant in 2005 to develop a sensor that could provide a foolproof cancer diagnosis, using nanoscale quantities of tissue obtained through noninvasive means.
- The Information Storage Consortium awarded Litvinov, Wolfe and Ruchhoeft a three-year, $150,000 grant in 2005 to develop a bit-patterned magnetic medium recording method allowing improved recording performance of magnetic bits.
- The U.S. Naval Research Laboratory and Naval Air Warfare Center Weapons Division.
- The Information Storage Consortium awarded Litvinov, Wolfe and Ruchhoeft a three-year, $150,000 grant in 2005 to develop a sensor technology enabling rapid evaluation of the effectiveness of potential antiviral drugs by their ability to block a virus’ bond with a cell receptor.
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A professor in the department of electrical and computer engineering, Litvinov is using building blocks so minuscule and beyond our realm of comprehension that they are often difficult to imagine. These components, however small, are aiding in the creation of a nanopatterned medium recording method. If successful, the research will facilitate unprecedented data storage capacity while shrinking the size of a disk drive. This would allow UH researchers to circumvent the so-called superparamagnetic limit of conventional magnetic recording technology—a point where further shrinking of magnetic bits in present day recording media makes bits unusable and unable to hold a magnetic charge, resulting in data loss.

In recent years, the data storage industry has been rapidly approaching this limit—about one terabit per square inch. Current storage density hovers near 150 gigabits per square inch, which means society could reach the superparamagnetic limit as early as 2011. However, work by UH researchers is expected to postpone this cap for another 10 to 15 years.

“There will be limits, but the desired density we want to achieve is 40 terabits per square inch,” Litvinov said of the end result, which may provide storage capabilities near the size of the human brain. “This will be a major step in technology development and will enable scores of applications not possible today.”

Dmitri Litvinov intends to leave his mark on the data storage industry using a process visible to the naked eye only by high-powered microscopes.

Dmitri Litvinov
Professor of Electrical and Computer Engineering

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Assisting Litvinov, the lead investigator, is Jack Wolfe, professor of electrical and computer engineering; T. Randall Lee, professor of chemistry; Paul Ruchhoeft, associate professor of electrical and computer engineering; C. Grant Wilson, a professor at the University of Texas at Austin, and Diane Walker, executive director of magnetic media development at Seagate Technology. Funded by a $1.1 million grant from the National Science Foundation/Nanoscale Interdisciplinary Research Team Program, the project was recently extended by NSF to July 2009.

Using ion-beam proximity lithography, Litvinov and his research team are attempting to write one bit per single grain of crystalline, rather than practices currently writeing on close to 100 simultaneously.

Litvinov said the group has demonstrated the idea is possible. Their challenge is controlling the crystalline grains’ placement and size. To do this, researchers have to take the granular material—typically designed to be independent from one another—and redesign it.

“We redesign the materials so the grains are so strongly coupled to each other that, even though they are sort of individual crystallites, magnetically they are one,” Litvinov said. “They are indistinguishable.”

The team uses alloys such as cobalt and palladium, and layers them one-by-one on top of the crystal structure. The magnets, Litvinov said, originate from the interfaces within the layers. Patterned media is written on top of these magnetic multi-layers.

To help achieve this goal, the team is presently working on technology that will enable magnetic nanoparticles to assemble on a small scale beyond what is possible with ion-beam proximity lithography.

“This is going to enable some really cool possibilities,” Litvinov said. “You can imagine storing the whole Library of Congress on a Palm Pilot, a PDA (personal digital assistant) with a camera that records a video diary of your entire life.” All this is quite feasible with this technology.”
Driving this proposal is an effect found by the group at the nanoscale that could allow researchers to fabricate and enhance piezoelectric properties—materials that generate electricity when placed under physical stress—without using piezoelectric elements. This finding could potentially tap into wasted energy generated by vibrations from our cars and our footsteps. The energy could then be harvested to operate everyday items such as streetlamps and charge portable electronic devices.

“There are some of these materials given to us by nature, but the effect is not as strong, there are limitations,” said Pradeep Sharma, Bill D. Cook Associate Professor of Mechanical Engineering, of certain ceramics and crystal that presently have this ability. In order to fuel this free electricity, the research team is using macroscopic composites that gain properties from their structure rather than their composition to create the more powerful piezoelectrics.

“We are going beyond these naturally occurring piezoelectrics to design materials from the ground up,” Sharma said. “We are finding out through this process you give rise to giant piezoelectricity. These are basically piezoelectrics on steroids.”

The lead investigator on the $1.22 million grant from the National Science Foundation’s Nanoscale Interdisciplinary Research Team Program, Sharma is working with Ramanan Krishnamoorti, M.D. Anderson Professor of Chemical and Biomolecular Engineering at UH, Professor Boris Yakobson of Rice University and Assistant Professor Zoubeida Ounaies of Texas A&M University.

Since receiving the four-year grant in August 2007, members of the team of experimentalists and theorists have published a paper in the journal, Physical Review, discussing the giant piezoelectric effect from a theoretical approach. Here computations are used to understand the mechanics of materials at the atomic level. The process, called atomistic modeling, is helping to provide guidelines so researchers can select the best materials for use in creating these super charged piezoelectric nanostructures.

Utilizing electron microscopy—where a beam of electrons is used to produce enlarged images on a photographic plate—Krishnamoorti is working to pull nanoparticles combined with a soft material, such as plastic, apart. The particles are organized into a three-dimensional structure, and by applying a non-uniform strain, the team has been able to disrupt the material’s symmetry and allow them to behave like their naturally occurring, electricity-generating counterparts.

Natural piezoelectric materials produce electric polarization when a uniform strain is applied. “It has been shown both mathematically and physically that a non-uniform strain can potentially break the inversion symmetry and induce polarization in non-piezoelectric materials,” Sharma said. An occurrence—producing a stronger, more flexible material than what is given to us by nature—that researchers are further exploring in the lab.

The increased strength of the fabricated piezoelectrics has the potential to give rise not only to energy harvesting, but could also help engineer artificial limbs bearing a full range of motion and the ability to lift strong objects. One day, it may even allow aircrafts to mimic the movements of birds in flight.
Vincent Donnelly was named John and Rebecca Mossen Professor at the University of Houston. Demetre Economou received an Excellence in Research and Scholarship Award, the top research award given annually by the University of Houston. He also received the Fluer Daniel Faculty Excellence Award from the UH Callan College of Engineering. Michael Harald received the Richard A. Glines Award for best paper in the fluid dynamics division at the American Chemical Society’s 2007 Fall National Meeting.

Kishore Mohanty received the Improved Oil Recovery Pioneer Award at the 15th Annual Society of Petroleum Engineers/Department of Energy Improved Oil Recovery Symposium. He also received the Top Technical Paper Reviewers Award.

Michael Nikolaou received the Computing and Systems Technology (CAST) Directors’ Potter Paper Award from the American Institute of Chemical Engineers. Jim Richardson received the 2007 Best Applied Paper Award from the Texas Section Fall Meeting of the American Society of Civil Engineers.
In Print

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Faculty News

Visual Perception

Haack Ogston, chair and professor of visual and computer science, and Bruce Breitmeyer, UH professor of psychology, have published their third book in two years on visual perception and consciousness. The book specifically focuses on how the brain processes various visual stimuli at conscious and unconscious levels. Titled *Experimental Phenomena of Consciousness: A Brief Dictionary*, the book is a collection of consciousness phenomena in which awareness emerges as an experimental variable.

Water Filtration

Shanker Chellam, professor of environmental engineering, and UH graduate student Appala Raju Badireddy have demonstrated a new technique that reduces the biological fouling of water purification filters often caused by the growth of bacteria colonies and the formation of biofilms. Featured on the cover of the February 2008 issue of *Biotechnology & Bioengineering*, this new technique involves the use of a magnetic field sensor at least a hundred times more sensitive than anything currently available.

Novel Magnetic Sensors

Stanko Brankovic, assistant professor of electrical engineering, is attempting to develop a novel magnetic field sensor technology that will be key in the creation of a low-cost system to map magnetic objects quickly and accurately. The development of these cost-efficient, highly-sensitive magnetic nanodetectors could have wide ranging impact on everything from medical diagnostics to national defense.

Bridge to Transplant

Two mechanical engineering professors are among those creating a continuous flow ventricular assist device that would give individuals on the long waiting list for a heart transplant a second chance. Smaller and less costly than pulsatile devices now in use, the research team’s total artificial heart would replace the natural heart with two continuous flow pumps—tandem pumps that are dedicated to the heart’s pulmonary and systemic circulatory loops.

Throughout the next four years, professors Matthew Franchek and Ralph Gokemeijer will work alongside lead investigator, Dr. O.H. “Bud” Frazer, chief of the Center for Cardiovascular Support and Acute Care Research at the Texas Heart Institute, on the $2.8 million federal grant from the National Institutes of Health. Aided by Rice University professors, Texas Heart Institute physicians and MicroMed Technology, Inc., the group will use funding to create a more reliable artificial heart that emulates how the natural heart responds to physiological conditions within the body.

Professor Michael Nikolaou is part of an interdisciplinary team that will develop a self-teaching expert system for the analysis, design and prediction of gas production from tight gas reservoirs. The team, which also includes Lawrence Berkeley National Laboratory and Texas A&M University, plans to develop a web-based decision making system providing its users—exploration and production companies—the ability to mathematically model scenarios and develop predictions that can help them determine where to drill wells for natural gas and how to produce from those wells.

Natural gas in shales—known as tight gas—presents many challenges to exploration and production companies. In order to extract tight gas, companies have to drill wells and fracture rocks to create “superhighways” for the gas to escape. Exactly where and how to fracture these rocks, in a way allowing control of the flow of gas, is a major obstacle, said Nikolaou.

“We propose to take all related variables, along with whatever experience and data producers already have gathered, and create mathematical models to help producers determine where to drill wells for natural gas and how to produce from these wells and what production methods to use,” he said. “Our goal is to minimize the risks companies have to take.”

In a separate proposal, Professor Kishore Mohanty and his team are seeking to develop ultra-lightweight programs, and other non-damaging fracturing fluids, to minimize damage to gas shale reservoirs caused by hydraulic fracturing and increase the productivity of wells. Nikolaou and Mohanty will each receive $500,000 in funding for their portions of the projects.

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RPSEA to Fund Tight Gas Research

The Research Partnership to Secure Energy for America, a program funded by the U.S. Department of Energy, has selected two chemical engineering professors to participate in an Unconventional Resources Program. Their proposals, which would help reduce the risk associated with extracting natural gas from shales, were two of only 19 funded nationwide.

Water Filtration

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CONCRETE CANOE BY THE NUMBERS

Average Water Speed for 200-meter with 180 degree turn: 300+

Construction Hours:
Concrete:
½ inch thick
20 feet (Largest portion) 28 inches
Width:
Height:
Weight: 215 pounds

UH engineering students beat out 11 teams—including groups from Texas A&M University, the University of Texas at Austin and Rice University—to secure the title. “To compete and win regionals once could be a fluke, but to repeat proved that all the hard work put in has paid off,” said team captain Matthew Barnes, who graduated in May with a bachelor’s degree in civil engineering.

The competition incorporated five sprint and long distance canoe races held in Texas Corpus Christi Bay. Canoes were also judged on technical soundness, design and appearance through an oral presentation, engineering term paper and a physical display showcasing their work. Each group must design the car to meet specific calibration guidelines and provide preliminary performance data as part of the competition. The UH team defeated teams from Lamar University, Texas A&M University, Texas A&M-Kingsville and Texas Tech University.

Student News

CANOE TEAM CLINCHES SECOND REGIONAL WIN

The University of Houston’s concrete canoe team sank contenders at the Texas-Mexico Regional Concrete Canoe Competition last spring, taking home their second consecutive first place win.

Named Arevanche, which is Portuguese for “fluke,” but to repeat proved that all the hard work put in has paid off,” said team captain Matthew Barnes, who graduated in May with a bachelor’s degree in civil engineering. The sleek design of the boat and the team’s paddling skills are credited with the regional win, while the boat’s buoyant blend incorporated materials such as silica fume and man-made glass bubbles.

CHEM-E CAR

A team of University of Houston chemical engineering students captured first place at the 2008 Chem-E Car Competition during the American Institute of Chemical Engineers Regional Meeting last spring, beating out teams from four other schools to earn an opportunity to represent the region at the national competition in Philadelphia this November.

“It is exciting to see chemical engineering students from all levels work together as a team,” said Micky Fletcher (1975 MSc, 1978 PhD Chem), adjunct professor of chemical and biomolecular engineering and Chem-E Car faculty advisor. “The entire team put a lot of very good thinking together using fundamental engineering concepts, which included safety and the environment, and worked hard to achieve the objectives.”

The teams are challenged to build a vehicle powered by chemical reactions that is capable of traveling a specified distance while bearing a load. The UH team designed a hydrogen-powered car named “The Supercoog” that utilized the reaction between manganese dioxide and hydrogen peroxide to create oxygen. The oxygen reacted with hydrogen emitted from two attached balloons to power the vehicle.

Each group must design the car to meet specific calibration guidelines and provide preliminary performance data as part of the competition. The UH team defeated teams from Lamar University, Texas A&M University, Texas A&M-Kingsville and Texas Tech University.

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CHEMICAL AND BIOMOLECULAR ENGINEERING

Graduate student Michael Pilla received first place in the student poster competition at the 2008 Polyolefins National Meeting.

ELECTRICAL AND COMPUTER ENGINEERING

Undergraduates Jordan Koster, captured first place in the Institute of Electrical and Electronic Engineers Region 5 Web Design Contest. Graduate student Vikram Shete was awarded a travel grant from Global Wanneck Technology to attend the Institute of Electrical and Electronic Engineers Antennas and Propagation Symposium in San Diego, Calif. Graduate student Mirkan Singh won first place in the American Institute of Aeronautics and Astronautics/Adaptive Structure Showdown last March.

ROBOTICS

UH Cullen College of Engineering students were recognized recently for the design and performance of a robot entered into the 2008 Institute of Electrical and Electronic Engineers Region 5 Technical Professional Student Conference. The student robotics competition, held annually, challenges students to engineer autonomous robots capable of picking up three-cans of varied weights and delivering them to the appropriate colored box.

CHEMICAL AND BIOMOLECULAR ENGINEERING

Graduate student Mithun Singla, captured first place at the 11th Annual Earth and Space Conference. Undergraduates Michelle Thai and Mike Fernandez captured first place at the 2007 Design Competition for their WIZnet enabled remote laboratory project.

MECHANICAL ENGINEERING

Graduate student Peng Li, along with graduate advisor Christian Olabi (2004 BScEng), computer engineering graduate student, won the Distinctive Excellence Award in the WIZanet WizNet 2007 Design Contest for their WIZnet enabled remote laboratory project.

Student Accolades

PHOTOS

BY THOMAS SHEA
Choosing to pursue a degree in engineering can be a demanding path filled with complicated formulas and a taxing study schedule, leaving little time for extracurricular activities. However, many students at the University of Houston are choosing to go above and beyond the typical classroom experience by leading student organizations, participating in regional and national competitions, conducting pioneering research in advanced fields and mentoring current and prospective students. The following are examples of four such students who are challenging their minds by coupling internships, research and service projects with an already rigorous academic schedule.

Vinuta Kapoor has been building on the foundation she’s receiving at the UH Cullen College of Engineering since enrolling on campus for her first class. When the 22-year-old graduated this May, she’ll have experience from five different internships thanks to her early involvement with INROADS, a national organization that works to develop and place talented minority youth in business and industry. For the last three years she’s held posts with Frito Lay, and in June began work as a project control intern with Reliant Energy. The internship, she said, allow her to better prepare for long-term success in the field.

Rhys Forgie made a name for himself early on in life as one of the Forgie quintuplets, the second set of these multiples to be born in Canada. Now 20, Forgie continues to challenge himself and experience as much as he can while he’s here. Last year, his efforts at the UH Biomedical Optics Laboratory earned him the Cullen College’s Outstanding Teaching Assistant Award.

Ashleigh Williams (2008 BSCE) came to UH on an athletic scholarship, but her activities at the university have extended far beyond the soccer field. For roughly two and a half years, the Jersey Village native juggled practices, games and academics until a head injury forced her from the team’s active roster during her junior year. Rather than hang up extracurricular activities altogether, the 22-year-old found new ways to fill her time. She joined the civil engineering honor society, Chi Epsilon; the engineering technical society, Phi Sigma Rho; became a member of the American Society of Civil Engineers; interned for the Harris County Flood Control District; and participated in the ASCC’s 2008 Student Steel Bridge Competition. For the last two years, she’s paddled her way to national competitions in Seattle, Wash., and Montreal, Canada on the university’s concrete canoe team.

Mohamad G. Ghosn (2004 BSComE, 2006 MSBioE) hopes to become a professor once he finishes his dissertation in 2009, but the 27-year-old is not waiting for his degree to begin molding young minds. He’s been doing that since he was a youth himself.

Growing up in Lebanon, Ghosn excelled in math and science courses. Around the age of 15, he began tutoring neighbors, then individual students in his youth organizations. Today, he devotes time to MESET and GRADE camp held at UH for high school students every summer in addition to professionally running in the Greater Houston area for the last three years.

“It is a passion for me, guiding people with what I know,” he said. In the UH Biomedical Optics Laboratory, he guides undergraduates to discover new methods for noninvasive imaging of tissues. Through the use of optical coherence tomography, similar to an ultrasound, he is working to assess drug diffusion in tissues that might one day help to expand techniques for diagnosis and therapeutics. His work on this project and others has been featured in 11 professional publications. Last year, his efforts at the university earned him the Cullen College’s Outstanding Teaching Assistant Award.

Mohamed G. Ghosn
I was trying to swat a fly the other day when it struck me how fast and elusive it was. It takes an eternity for a creature of my great size to perceive the fly, process the information, send a signal to my muscles, then move my hand. The fly is a micromachine with short neural paths and tiny parts to activate. It must watch me as though I were moving in slow motion. It struck me that the fly has a world-view that’s incomprehensible to me. Our whole sense of time is molded to our limited range of responses.

And that’s just motion. Try vision. The electromagnetic spectrum runs from gamma and cosmic rays in the neighborhood of a billionth of an inch long, up to radio waves, which might be miles in length. Within that range, the wavelengths you and I see as light occupy an almost inconsequential range of 10 to 20 millionths of an inch. We look at the world through a tiny slit.

Our hearing likewise responds to a miniscule range of pressure waves in air. We hear from maybe 40 to 20,000 cycles per second when we’re young. Consider that ultrasonic rays to frequencies in the millions—that weather might vary in cycles per day or week—and you have an idea of what we’re missing. Imagine, if you dare, a creature capable of listening to the weather.

I once saw a 3-D I-MAX movie about 3-D vision—about how our two eyes create 3-D images in our heads. The movie included a very surprising stick. It showed stereopticon movies shot with the two cameras placed far apart. The result showed how the world would look, seen through the eyes of a giant.

Our eyes are only two-and-a-half inches apart. They give us a good sense of the three-dimensionality of nearby objects. For long distances, it’s as though we’re looking at a flat picture. Those images from widespread cameras provide immense depth of field as we view people on a long beach or cars a block away. We’re suddenly giants looking into a doll’s house.

I could go on. Our senses of taste and smell are restricted by our chemical receptors. You and I can feel temperature changes in a range of only about 100 degrees Fahrenheit—60 degrees Celsius. Beyond that our nerves either freeze or burn.

For four centuries now, we’ve been honing instruments to show us the world beyond that narrow slit of our perceptions. We’ve come very far. Yet, in the end, we read our meters and computer outputs from behind that slit. We seem forever forced to view the larger world that science shows us through a glass darkly.

That’s a pretty humbling limitation. It leaves me wondering how far the universe will prove to reach beyond the bunker of my own body. Perhaps even time itself is part of our body-imposed limitations. It leaves me wondering how far the universe will prove to reach beyond the bunker of my own body.

So Much More
That We Cannot See

John Lienhard wonders what the world looks like through the eyes of his instruments.

The Engines of Our Ingenuity is a nationally recognized NPR radio program authored and voiced by John Lienhard, professor emeritus of mechanical engineering and history at the University of Houston. After 20 years on the air, more than 2,400 episodes have run. The program airs at 7:35 a.m. and 3:55 p.m., Monday through Friday on KUHF-FM 88.7.

For more information about the program, visit www.uh.edu/engines.
Peter Strasser, assistant professor of chemical and biomolecular engineering, poses with a component of his fuel cell research. Earlier this year, Strasser and researchers from Stanford University and the Stanford Linear Accelerator Center received a nearly $2 million grant from the U.S. Department of Energy. The funding will support efforts to create a cheaper, more efficient hydrogen fuel cell that could not only significantly impact transportation, but also be used to power portable electronics. Learn more about Strasser’s research at the college’s online newsroom, www.eegr.uh.edu/news.