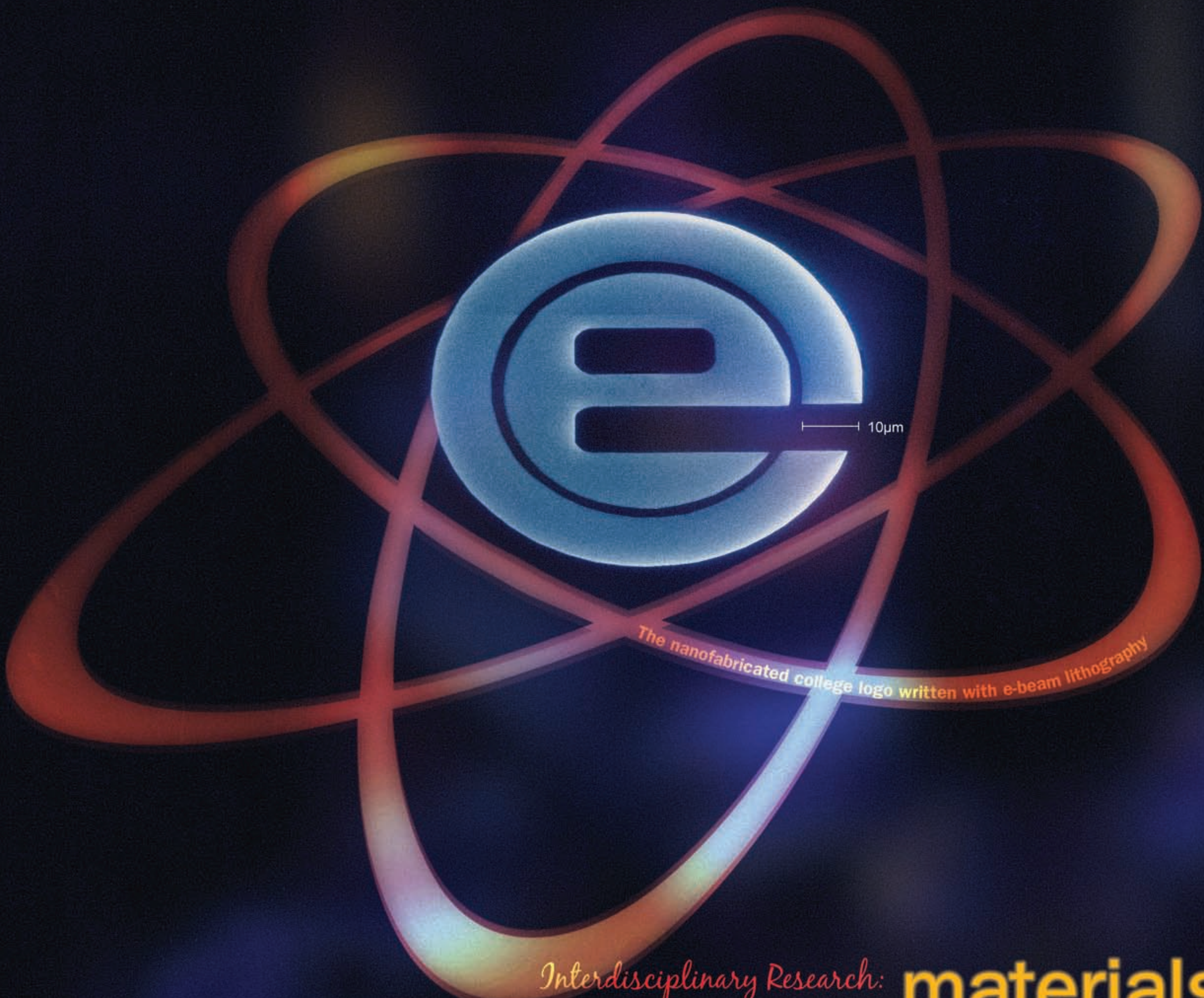
University of Houston Cullen College of Engineering

[ParamETErs]

Fall 2008



Interdisciplinary Research: materials

Nanopantography | Nanomagnetic Storage | Piezoelectrics

Dean's Message

PHOTO BY PATHIK SHAH

Materials research has long been a transdisciplinary strength of the University of Houston Cullen College of Engineering. Our researchers further science by developing and evolving materials technologies that bring us innovations such as nanopantography, super computing and the ability to harvest energy.

Because the very nature of materials research warrants expertise from a broad range of disciplines, our faculty have gravitated into niche interdisciplinary research teams to undertake some of the unique challenges presented by the next generation of advanced materials. Such efforts have been perpetuated by substantial funding from the National Science Foundation through its Nanoscale Interdisciplinary Research Team (NIRT) Program.

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 in 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

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

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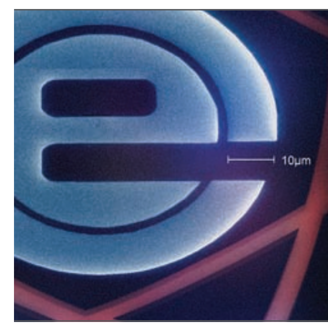


IMAGE PROVIDED BY TIM SHERLOCK

Interdisciplinary Research: Materials
UH researchers are using high-tech tools and methods to engineer materials technologies that could one day impact everything from the way data is stored to how nanotech devices are produced. Electron beam lithography, one of many such methods, was recently demonstrated in the college's Center for Nanomagnetic Systems to create the logo featured on the cover. Magnified for use, the Cullen College of Engineering logo is seen written at 10-microns—about five times smaller than the average human hair. The technique utilizes an electron beam, just a few nanometers in width, to generate the pattern of the logo on a polymethyl methacrylate (plastic-like) surface.

ORIGINAL PHOTO BY MARK LACY

$1.6M Committed to 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 scholarships, the renovation of a 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 on 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.

$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 40 years.

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.

UH Professors to Help Modernize Libya's Infrastructure

A knowledge transfer program led by local university professors is among the components of a $50 billion plan designed to help engineers from a Libyan government agency modernize infrastructure in their country. Hanadi Rifai, UH professor of civil and environmental engineering, along with Rice University's Phillip Bedient created the program's curriculum, which partners educators at UH, Rice and Texas A&M universities.

The program, promoting future urban planning in Libyan cities, is one element of the multi-billion 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.

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.

The grant, supporting engineering education and outreach, is the most recent award received by professors Stuart Long, Fritz Claydon and Kathy Zerda.

PHOTO BY THOMAS SHEA

College Programs to Benefit From BP Gift to UH

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 Cuadra (1988 BSChE), 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 $170,000 per year to the Cullen College of Engineering in support of its recruitment and retention efforts. The majority of the gift will support student 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 Mentoring and Enrichment Seminar in Engineering Training (MESET).

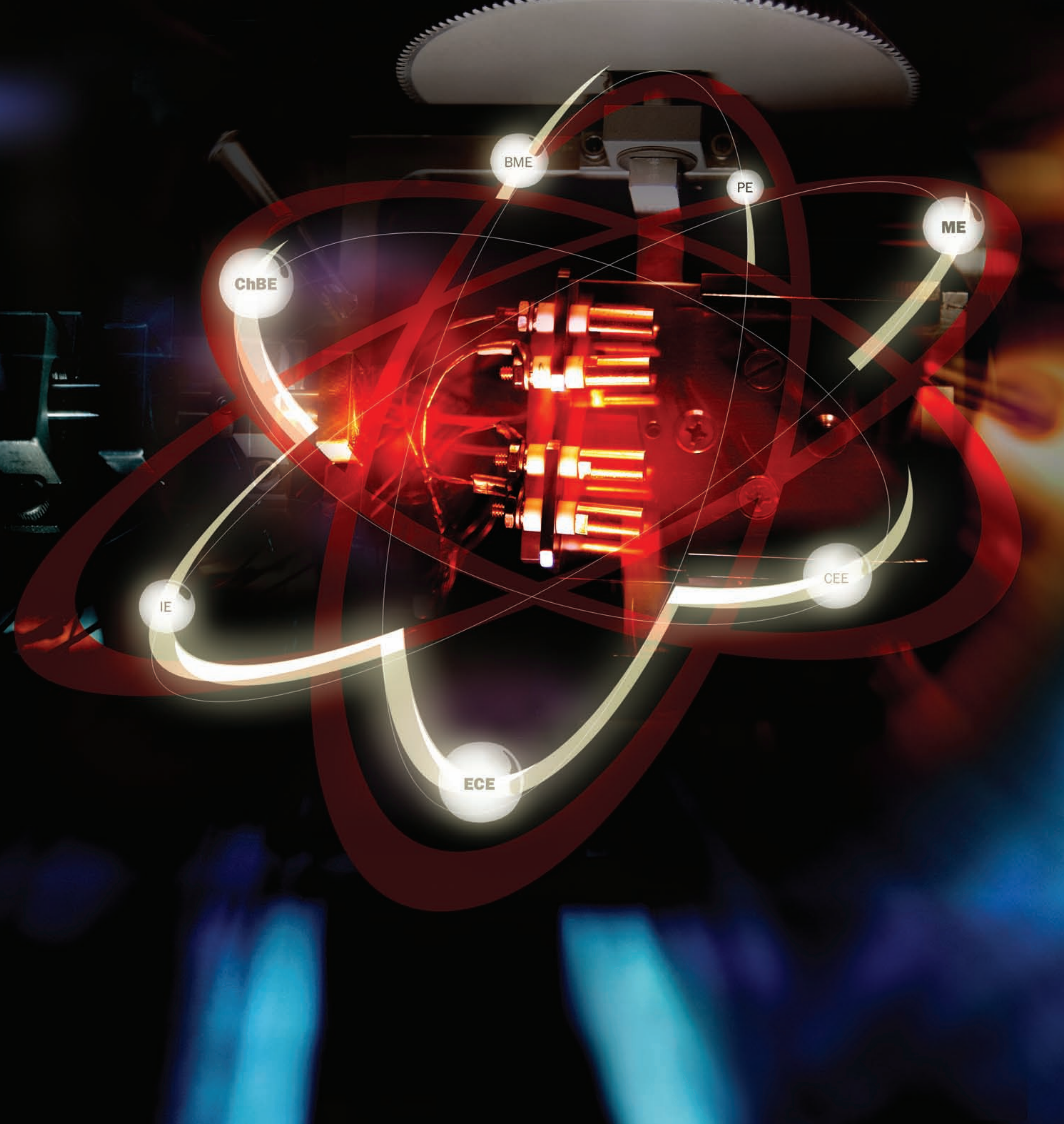
UH's College of Natural Sciences and Mathematics and the Bauer College of Business will receive the remaining balance of the $250,000 annual donation for scholarship support and graduate fellowships to attract the highest caliber students and to support research.

Interdisciplinary Research:

[materials]

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.

FEATURES BY ERIN D. MCKENZIE. PHOTOS BY THOMAS SHEA.
PHOTO ILLUSTRATIONS BY HARRIET YIM.



nanopantography

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 downsizing dilemma.

Demetre Economou
John and Rebecca Moores Professor of Chemical and Biomolecular Engineering

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 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 four-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 beamlet to a spot on the wafer surface.

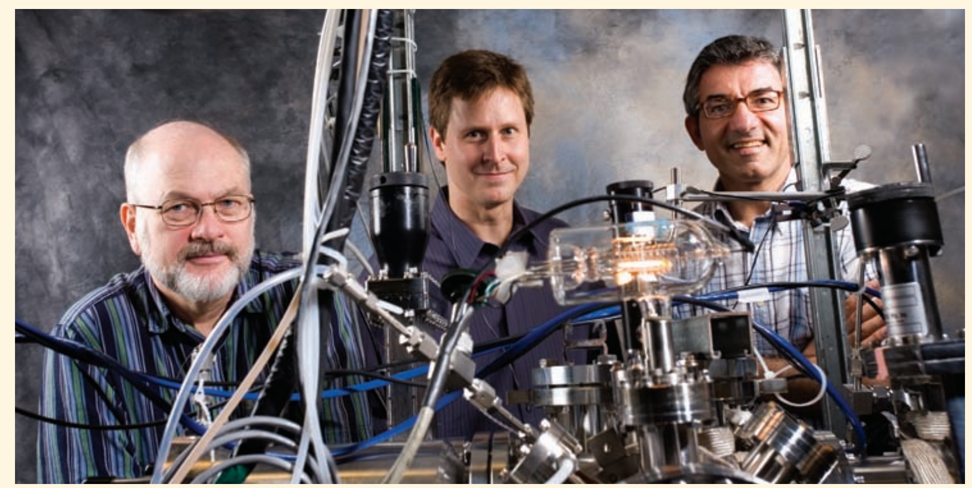
When the wafer is tilted, the focal spot is translated along the wafer surface allowing nanopatterns to be written in millions of places simultaneously.

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.

Researchers Vincent Donnelly, Paul Ruchhoeft and Demetre Economou showcase their nanopantography instrument in the Plasma Processing Laboratory.



Dmitri Litvinov
Professor of Electrical and Computer Engineering

nanomagnetic storage

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

A professor in the department of electrical and computer engineering, Litvinov is using building blocks so miniscule 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 unstable 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."

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 Willson, a professor at The University of Texas at Austin; and Dieter Weller, executive director of magnetic media development at Seagate Technology. Funded by a $1.1 million grant from the National Science Foundation's 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 crystallite, rather than practices currently writing 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 that 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 magnetism, Litvinov said, originates 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."

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 the doors to several other interconnected, grant-funded projects related to magnetics and nanomagnetics totaling more than $2 million.

- A $200,000 grant from the National Science Foundation, awarded earlier this year, will help to establish a nanoengineering minor at the college.
- The Texas Advanced Research Program awarded a two-year, $149,981 grant in May to help develop a method for fabricating tightly packed nano-sized features with sharp corners resulting in more powerful, reliable computing devices.
- A three-year, $365,561 grant received from the National Science Foundation in 2007 could replace conventional semiconductor circuitry 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 production.
- A two-year, $226,630 grant from NSF in 2005 allowed graduate students to pursue research at UH while interning throughout the summer at the U.S. Naval Research Laboratory and Naval Air Warfare Center Weapons Division.
- A three-year, $891,000 grant awarded in 2005 by the National Institutes of Health and the National Institute of Biomedical Engineering and Bioengineering 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 new technology that could provide a foolproof cancer diagnosis using miniscule quantities of tissue obtained through non-invasive means.
- The Information Storage Consortium awarded Litvinov, Wolfe and Ruchhoeft a three-year, $110,000 grant in 2005 to develop a bit-patterned magnetic medium recording method, allowing improved recording performance of magnetic bits.

piezoelectrics

Research by University of Houston engineering professors could turn wasted ambient energy into watts of power if they are successful in their bid to engineer a new, more powerful piezoelectric material.

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."

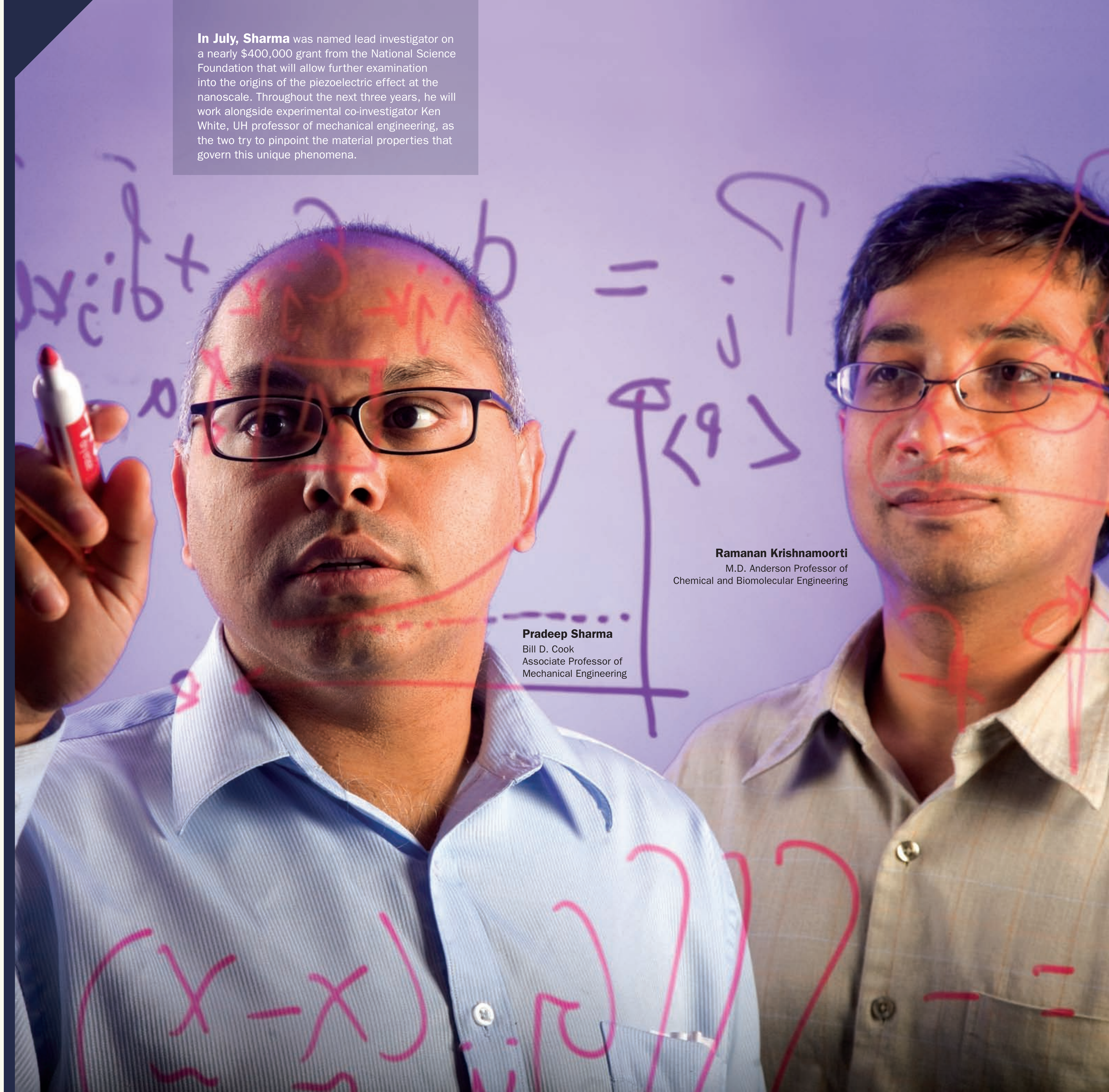
The lead investigator on the $1.22 million grant from the National Science Foundation's Nanoscale Interdisciplinary Research Team Program, Sharma is working with Ramanan Krishnamoorti, M.D. Anderson Professor of Chemical and Biomolecular Engineering at UH, Professor Boris Yakobson of Rice University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



In July, Sharma was named lead investigator on a nearly $400,000 grant from the National Science Foundation that will allow further examination into the origins of the piezoelectric effect at the nanoscale. Throughout the next three years, he will work alongside experimental co-investigator Ken White, UH professor of mechanical engineering, as the two try to pinpoint the material properties that govern this unique phenomena.

Ramanan Krishnamoorti
M.D. Anderson Professor of
Chemical and Biomolecular Engineering

Pradeep Sharma
Bill D. Cook
Associate Professor of
Mechanical Engineering

PHOTO BY THOMAS SHEA

Venkat Selvamanickam

Title:
M.D. Anderson Distinguished Professor of Mechanical Engineering

Education:
Ph.D. materials engineering, University of Houston, 1993

Career Overview:
Selvamanickam joined UH after a 14-year career with SuperPower, Inc., a subsidiary of Philips and one of the leading developers of high-temperature superconductors. In his role as vice president and chief technical officer at the company, he was responsible for the creation and management of SuperPower's technology roadmap, IP portfolio, and cooperative research agreements with national laboratories and universities. He also secured funding for and oversaw research and development operations.

Research Focus:
Development of novel synthesis techniques to achieve superior performance in advanced and complex materials

Research Interests:
Epitaxial thin film growth by physical vapor deposition and chemical vapor deposition, solidification and crystal growth, oxide materials, superconductors, photovoltaics, thermoelectrics, batteries, supercapacitors, roll-to-roll thin film coatings, bulk ceramic processing

Applications:
Energy transmission and generation, transportation, medical, high-energy physics

Current Research Projects:
High-performance, high-temperature superconducting wires, high-efficiency thin film photovoltaics, high-efficiency thermoelectrics for power generation using waste heat

Funding:
U.S. Department of Energy, SuperPower, Inc.

Laboratory:
Physical and Chemical Vapor Thin Film Deposition Lab, University of Houston

CHEMICAL AND BIOMOLECULAR ENGINEERING

Vincent Donnelly was named John and Rebecca Moores 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 Fluor Daniel Faculty Excellence Award from the UH Cullen College of Engineering.

Michael Harold received the Richard A. Glenn Award for best paper in the fuel chemistry 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' Poster Paper Award from the American Institute of Chemical Engineers.

Jim Richardson received the 2007 Best Applied Paper Award from the South Texas Section of the American Institute of Chemical Engineers.

CIVIL AND ENVIRONMENTAL ENGINEERING

Shankar Chellam received the W.T. Kittinger Teaching Excellence Award from the UH Cullen College of Engineering.

Yi-Lung Mo received a Best Paper Award from the Institute of Electrical and Electronics Engineers.

Jerry Rogers was named a distinguished member of the American Society of Civil Engineers.

Keh-Han Wang received the Best of Session Paper Award at the Texas Section Fall Meeting of the American Society of Civil Engineers.

ELECTRICAL AND COMPUTER ENGINEERING

Joe Charlson was named a life member of the Institute of Electrical and Electronics Engineers.

Ji Chen was named a fellow of the Oak Ridge Institute for Science and Education. He also was named distinguished lecturer by the Electromagnetic Compatibility Society, a division of the Institute of Electrical and Electronics Engineers.

Frank "Fritz" Claydon was named associate dean for administration and research at the college.

John Glover received the 2007 Individual Outstanding Achievement Award from the Institute of Electronics and Electrical Engineers for his support of the UH IEEE Student Chapter.

Stuart Long received the Career Teaching Award from the UH Cullen College of Engineering.

David Shattuck was named associate dean for undergraduate studies at the college.

INDUSTRIAL ENGINEERING

Suresh Khator was named associate dean for graduate programs and computer facilities at the college.

Gino Lim was named a Hari and Anjali Agrawal Faculty Fellow in the department.

MECHANICAL ENGINEERING

Karolos Grigoriadis was awarded a three-year visiting professorship at Loughborough University in Leicestershire, UK. He will work on a project focused on optimizing sensing elements for control and fault tolerance of complex systems.

Fazle Hussain was named Scholar of the Year at the First Non-Resident Bangladeshi Conference.

Kirill Larin received the Herbert Allen Award from the American Society of Mechanical Engineers as well as the Outstanding Young Scientist Award from the Houston Society for Engineering Medicine and Biology.

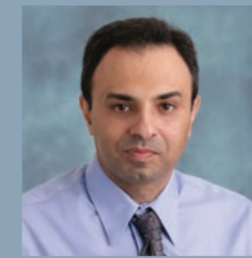
Ralph Metcalfe was appointed chair of the National Institutes of Health Cardiovascular Study Section.

Gangbing Song received the 2007 Outstanding Technical Contribution Award from the American Society of Civil Engineers' Aerospace Division.

Kenneth White received a Fulbright Senior Scholar Award from the Council for International Exchange of Scholars.

New Faculty

Ashraf Ayoub



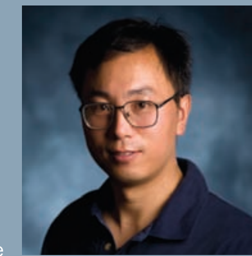
Title: Associate professor of civil and environmental engineering

Previously: Assistant professor, University of Missouri-Rolla

Education: Ph.D. structural engineering, University of California-Berkeley

Research: Constitutive modeling, non-linear finite element analysis of reinforced and pre-stressed concrete and composite structures

Jiming Bao



Title: Assistant professor of electrical and computer engineering

Previously: Research associate, Harvard University

Education: Ph.D. applied physics, University of Michigan

Research: Semiconductor nanowire optoelectronics, silicon photonics, metallic nanostructures for plasmonics

Zhu Han

Title: Assistant professor of electrical and computer engineering

Previously: Assistant professor, Boise State University

Education: Ph.D. electrical engineering, University of Maryland

Research: Collaborative transmission networks, cognitive radios, compressed sensing, sensor network design, security, bio signal processing, MIMO wireless communications

Suresh Khator

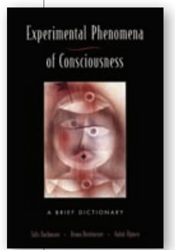
Title: Professor of industrial engineering, and associate dean for graduate programs and computer facilities

Previously: Director of engineering computing and professor, University of South Florida

Education: Ph.D. industrial engineering, Purdue University

Research: Modeling of energy, healthcare and manufacturing systems, facilities design, production and control, project management

In Print



Visual Perception

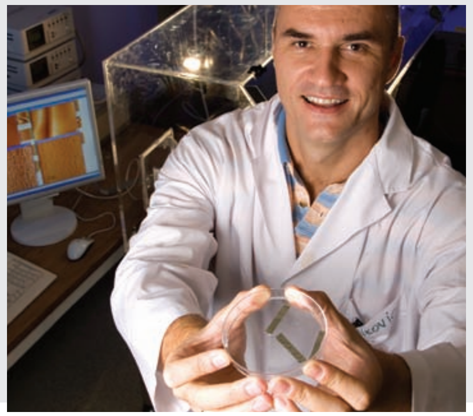
Haluk Ogmen, chair and professor of electrical and computer engineering, and Bruno Breitmeyer, UH professor of psychology, have published their third book in two years on visual perception and consciousness. The book specifically focuses on how the brain processes various visual stimuli at conscious 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

Shankar 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 biofilm. Featured on the cover of the February 2008 issue of *Biotechnology & Bioengineering*, Chellam's findings may lead to more advanced methods of treating membrane filters.

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 nanodevices could have wide ranging impact on everything from medical diagnostics to national defense.



Brankovic received the $500,000 grant from the National Science Foundation earlier this year. The funding is supported through NSF's GOALI program, which provides grant opportunities for academic and industry partnerships. Brankovic, along with co-investigators Dmitri Litvinov, UH professor of electrical and computer engineering, Arizona State University Professor Ray Carpenter and Nils Gokemeijer at Seagate Research, is using the funding to support an electrochemical nanofabrication method that would allow the development of devices smaller than 10 nanometers. The result—a magnetic field sensor at least a hundred times more sensitive than anything currently available.

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—one dedicated to the heart's pulmonary loop and the other to the systemic loop.

Throughout the next four years, professors Matthew Franchek and Ralph Metcalfe will work alongside lead investigator, Dr. O.H. "Bud" Frazier, chief of the Center for Cardiac Support and director of Surgical 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.

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 its 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.

PHOTOS BY THOMAS SHEA

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 these 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 better predict the best location for drilling 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 proppants, 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.

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.

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 set a tradition and new heritage," said Wade Barnes, UH team captain who graduated in May with a bachelor's degree in civil engineering.

The competition incorporated five sprint and long distance canoe races held on 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 20-foot, 215-pound canoe. High rankings in each of these four categories launched the group to the top spot.

Named Arevanche, which is Portuguese for revenge, the canoe was designed from a male mold of wooden ribs and Styrofoam. A concrete mixture much lighter than typical driveway cement—58 pounds per cubic foot compared to the average 150—was applied by hand to the mold until it measured ½ inch thick. The buoyant blend incorporated materials such as silica fume and man-made glass bubbles.

The sleek design of the boat and the team's paddling skills are credited with the regional win, an accomplishment not attained by a UH team for nearly 14 years prior to the 2007 regional victory. Their recent win sent the team to the national competition for the second time in June, where they improved six spots from their ranking last year.

CONCRETE CANOE BY THE NUMBERS

Weight: 215 pounds
Height: 13 inches
Width: (Largest portion) 28 inches
Length: 20 feet
Concrete: ½ inch thick
Construction Hours: 300+
Average Water Speed for 200-meter with 180 degree turn: 6 mph

PHOTOS BY THOMAS SHEA

CHEM-E CAR

PHOTO BY THOMAS SHEA

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 Fleischer (1975 MSChE, 1978 PhD ChE), adjunct professor of chemical and biomolecular engineering and Chem-E Car faculty adviser. "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.

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 Electronics Engineers Region 5 Technical Professional Student Conference. The student robotics competition, held annually, challenges students to engineer autonomic robots capable of picking up three canisters of varied weights and delivering them to the appropriate colored box.

Student Accolades

CHEMICAL AND BIOMOLECULAR ENGINEERING

Graduate student **Mai Ha** received first place in the student poster competition at the 2008 Polyolenfins National Meeting.

ELECTRICAL AND COMPUTER ENGINEERING

Undergraduate **Joshua Kovitz**, captured first place in the Institute of Electrical and Electronics Engineers Region 5 Web Design Contest.

Graduate student **Vikram Shete** was awarded a travel grant from Global Wireless Technology to attend the Institute of Electrical and Electronics Engineers Antennas and Propagation Symposium in San Diego, Calif.

Graduate student **Mithun Singla** won first place in the American Institute of Aeronautics and Astronautics' Adaptive Structure Shootout last March.

MECHANICAL ENGINEERING

Graduate student **Peng Li**, along with **Claudio Olmi** (2004 BSComE), computer engineering graduate student, won the Distinctive Excellence Award in the WIZnet iEthernet 2007 Design Contest for their WIZnet enabled remote laboratory project.

Undergraduates **Michelle Holt** and **Mike Fernandez** captured first place at the 11th Annual Earth and Space Conference's Undergraduate Active Vibration Design Competition. **Christina Chang** and **Athar Razvi** placed third. Chang and Fernandez also earned awards for Best Undergraduate Student Paper.

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.

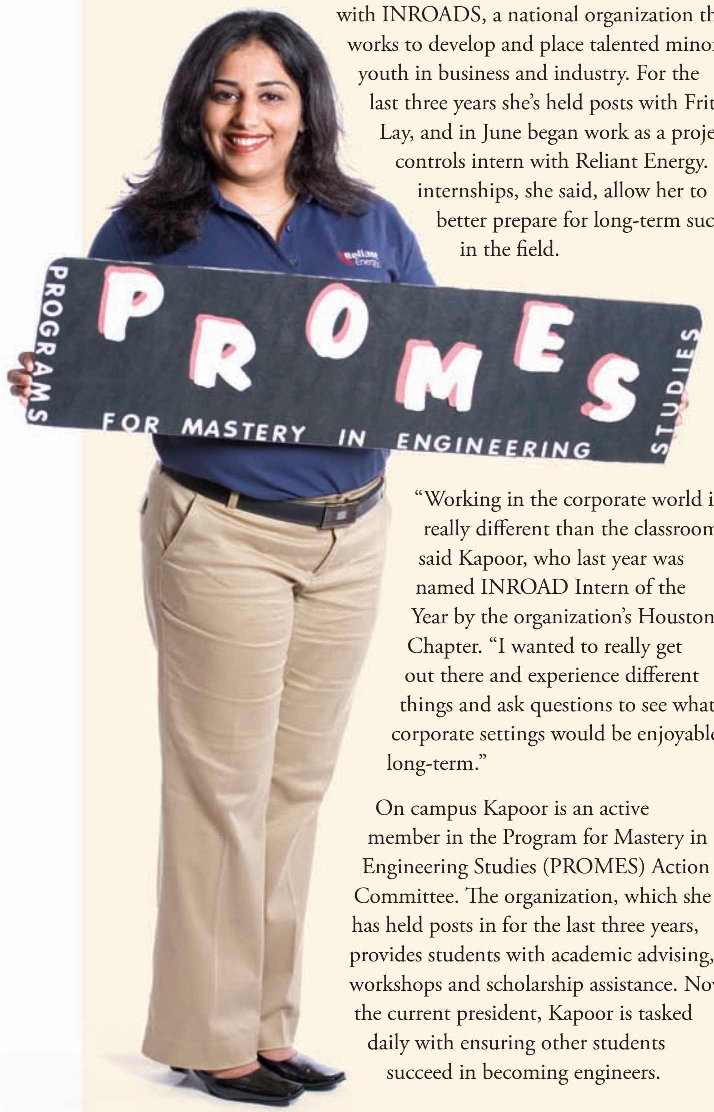
PROFILES BY ERIN D. MCKENZIE. PHOTOS BY THOMAS SHEA.

Vinita Kapoor

HOMETOWN: Houston, Texas
YEAR: Senior, May 2009
MAJOR: Industrial Engineering

Vinita Kapoor has been building on the foundation she's receiving at the UH Cullen College of Engineering since stepping on campus for her first class.

When the 22-year-old graduates 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 controls intern with Reliant Energy. The internships, she said, allow her to better prepare for long-term success in the field.



"Working in the corporate world is really different than the classroom," said Kapoor, who last year was named INROAD Intern of the Year by the organization's Houston Chapter. "I wanted to really get out there and experience different things and ask questions to see what corporate settings would be enjoyable long-term."

On campus Kapoor is an active member in the Program for Mastery in Engineering Studies (PROMES) Action Committee. The organization, which she has held posts in for the last three years, provides students with academic advising, workshops and scholarship assistance. Now the current president, Kapoor is tasked daily with ensuring other students succeed in becoming engineers.

Rhys Forgie

HOMETOWN: Ottawa in Ontario, Canada
YEAR: Junior, May 2010
MAJOR: Chemical Engineering

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 be recognized in Houston, but not for his unique birth.

The Canadian native has earned multiple spots on the Dean's List, is active in the American Institute of Chemical Engineers, The Honors College, Research Experience for Undergraduates and Engineers Without Borders. He even participates in club theatre, composes music and runs marathons—in his spare time.

"I really wanted to challenge myself and experience as much as I can while I'm here," he said of his college experience.

He's gotten a good start. In 2007, Forgie led the university's Chem-E Car Team to a second place regional win. This fall, he not only began a year-long internship with BP America, but started researching a cheaper combination of metals for fuel cell catalysts under the direction of Assistant Professor Peter Strasser.

All of this has allowed him to obtain more than 15 scholarships and grants—a real help when you consider he has four other siblings in college.

Ashleigh Williams

HOMETOWN: Houston, Texas
YEAR: M.S. Student, May 2010
MAJOR: Environmental Engineering

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 sorority, 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 ASCE'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.

In the fall, she began graduate work in water and wastewater treatment. "I hope to one day work with the Army Corps of Engineers," she said about the culmination of her studies. She noted the position might allow her to move with her active duty husband, who is currently serving a 15-month tour in Iraq.

Mohamad G. Ghosn

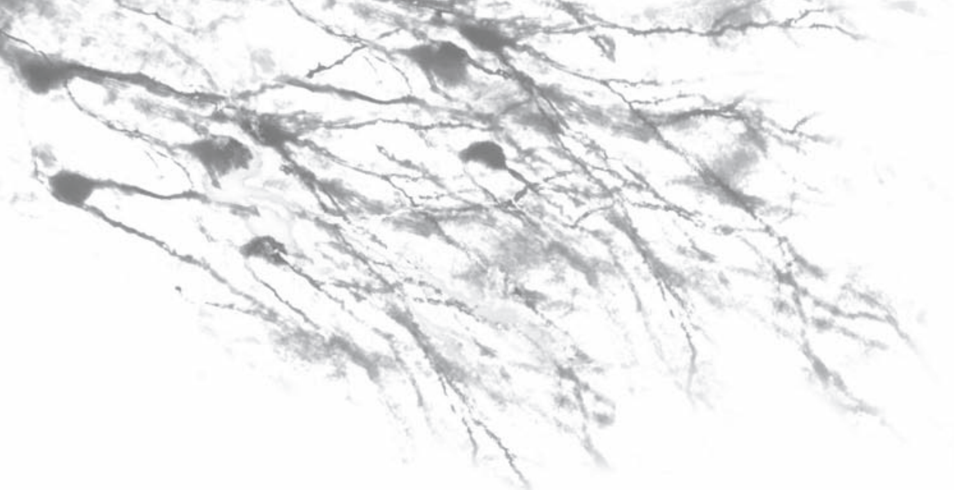
HOMETOWN: Sour, Lebanon
YEAR: Ph.D. Student, August 2009
MAJOR: Mechanical Engineering

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 10, he began tutoring neighbors, then individuals in his youth organizations. Today, he devotes time to MESET and GRADE camps held at UH for high school students every summer in addition to professionally tutoring 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.



So Much More That We Cannot See

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

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 ultrasound runs 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 trick. 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. These 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. So, until time tells, I shall have to content myself with asking my cat what she sees that I cannot—what she knows about life that I never will.

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.

PHOTO BY THOMAS SHEA

Professors in the Cullen College of Engineering have created an implantable electrode cuff and wireless telemetry system to better understand how certain neurons in locusts' brains process sensory information. The technologies, created by electrical and computer engineering professors Jack Wolfe and Richard Liu, are assisting Baylor College of Medicine researchers to analyze signals given off by tiny nerves within the locust. Their collaboration could provide the information essential to understanding how the neuron activity correlates to the insect's actual behavior, and ultimately dispel controversy over how motor actions are generated.

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.egr.uh.edu/news.

PHOTO BY THOMAS SHEA

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