University of Houston Cullen College of Engineering

[ParamETErs]

Fall 2009

SUSTAINING THE ENVIRONMENT

PHOTO BY THOMAS SHEA

Finding ways to sustain our environment and preserve the lifespan of our natural resources will consume a large portion of our research endeavors for much of the foreseeable future. To improve the quality of our lives—and sustain this quality of living for future generations—researchers worldwide are being tasked with finding solutions to the National Academy of Engineering's Grand Challenges for Engineering in the 21st Century, three of which focus on availability of clean water, cleaner air and efficient solar energy harvesting.

At the University of Houston Cullen College of Engineering, we have been expanding our research enterprise in four core areas, including biomedical engineering, nanomaterials, energy and sustainability. Last year, college-wide annual research expenditures increased more than 50 percent thanks, in part, to funding from agencies such as the U.S. Environmental Protection Agency, the U.S. Department of Energy and the National Science Foundation in support of research programs aimed at sustaining the environment.

In this issue of *Parameters*, we feature three research efforts currently underway at the Cullen College that are focused on improving air and water quality as well as solar technology. Specifically, we outline the work of environmental engineering researchers Hanadi Rifai and Kyle Strom who are attempting to identify the source of industrial toxins found in bodies of water in the Houston area. We also feature a study focused on reducing harmful emissions from vehicle exhaust conducted by chemical engineering researchers Michael Harold, Dan Luss and Vemuri Balakotaiah. They are working to develop a piece of technology expected to reduce more than 80 percent of the smog-causing pollutants emitted from motor vehicles. And lastly, we highlight research being conducted by electrical engineering researchers Jiming Bao and Qingkai Yu who are reconstructing silicon to make solar cell technology more efficient.

Also in this issue, we spotlight the success of our graduate and undergraduate students, who are actively engaged in scholarly research, senior projects and regional competitions. Cullen College students continue to thrive in their academic and research endeavors and we are very proud!

Warm regards,

Joseph W. Tedesco

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

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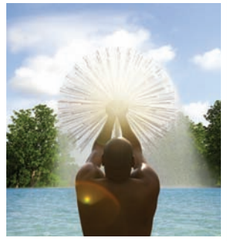


Sustaining the Environment is a global effort that relies on a variety of interdisciplinary research efforts to not only identify and solve problems existing in the current environment, but also to develop technology necessary for the future needs of the planet. UH engineering researchers are developing innovative technological solutions in an effort to sustain some of our most basic needs—air, water and energy.

FEATURES

SUSTAINING THE ENVIRONMENT

PHOTO BY THOMAS SHEA

UH Closer to Tier One Status

Earlier this year, the University of Houston celebrated the passing of two historic bills by the Texas House and Senate that create a pathway for all emerging research universities to compete and secure sustained funding for more Tier One universities in the state.

"We could not have asked for a more supportive delegation and certainly could not have found a stronger state and local agenda in favor of the University of Houston," said UH President Renu Khator. "The decade-long trek to a legislative pathway to Tier One has been achieved."

On May 31, the Texas Legislature approved the two bills—the constitutional amendment that creates the funds needed to finance Tier One research by UH and all the state's emerging research universities, and the enabling legislation that provides a pathway to compete for those funds. The constitutional amendment will be put to statewide vote in November.

SPE International
Gulf Coast Section

First Professorship Established for Petroleum Program

In support of the University of Houston's expanding petroleum engineering program, the Society of Petroleum Engineers Gulf Coast Section has committed $250,000 to establish a professorship.

The first of its kind for the program, the SPE-Gulf Coast Section College Endowed Professorship in Petroleum Engineering will support efforts to broaden course offerings, enhance community outreach and spearhead new research by a Cullen College of Engineering faculty member.

"The professorship established by the SPE-Gulf Coast Section will help expand our developing petroleum engineering program," said Joseph Tedesco, Elizabeth D. Rockwell Endowed Chair and dean. "Not only does it provide another incentive for faculty candidates who are interested in joining the program, but it supports our efforts to educate the next generation of petroleum engineers."

UH Launching New Energy Park

The UH System Board of Regents this summer approved the purchase and establishment of the University of Houston Energy Research Park.

Adjacent to the main UH campus, the 74-acre site features 15 buildings and more than 600,000 square feet of space. Research and education will be at the heart of the park—housing many of the Cullen College of Engineering's energy-related centers. These include the Texas Diesel Testing and Research Center, the Smart Materials and Structures Lab and the National Wind Energy Center.

Space will also be allocated to the college's new undergraduate program in petroleum engineering.

Chairs Named to Biomedical, Civil Departments

Metin Akay, professor and former interim chair at Arizona State University's Harrington Department of Bioengineering, has been named founding chair of the Cullen College of Engineering's newly approved department of biomedical engineering. Akay, a native of Turkey, earned his Master of Science in electrical engineering from Bogazici University in 1984 and his Ph.D. in biomedical engineering from Rutgers University in 1990. He has researched and published extensively in the areas of neural engineering, biomedical informatics and biomedical imaging.

Abdeldjelil "DJ" Belarbi, distinguished professor of civil and environmental engineering and assistant professor for distance education at the Missouri University of Science and Technology, will lead the department of civil and environmental engineering. He received his Master of Science and Ph.D. in civil and structural engineering from the University of Houston in 1986 and 1991, respectively. His analytical and experimental investigations of reinforced concrete structures as well as his research on the constitutive modeling of reinforced and prestressed concrete have been widely published.

Both are slated to begin in January 2010.

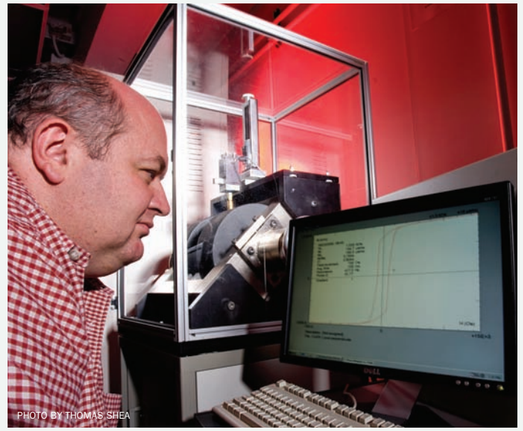


PHOTO BY THOMAS SHEA

$2 Million Grant Awarded to Boost Interest, Pursuit of STEM Fields

The National Science Foundation has awarded the University of Houston a five-year, $2 million grant to support programs for recruiting and retaining students in science, technology, engineering and math (STEM) fields.

Not only connecting students with mentors but also exposing them to real work happening in these fields, six programs will be rolled out using the funding. All are expected to help contribute to developing the highly-skilled workforce needed to fill an increasing demand for future technical jobs—some 1.25 million by 2012 according to the U.S. Bureau of Labor Statistics.

College Research Expenditures Hit New High

Research grant and contract expenditures by University of Houston Cullen College of Engineering faculty reached more than $21.8 million in fiscal year 2009, the largest ever on record.

Up some 50 percent from the previous fiscal year's total, primarily the federal government—the National Institutes of Health, the National Science Foundation and the U.S. Department of Energy—supported the research. A significant milestone for the college, the jump in annual research expenditures is among the initiatives outlined in an 18-page strategic plan critical in helping boost the college's status by securing a spot as a nationally ranked, top 50 program.

"Our strategic plan outlines an aggressive push for the college to become competitive on the national level," said Joseph Tedesco, Elizabeth D. Rockwell Endowed Chair and dean. "Research expenditures are at the core of this push and I'm excited to see the college moving in the right direction."

The increase represents a three-year rise in expenditures at the college—going from a consistent $11.5 million from 2005 to 2007, to $14.4 million in 2008 and now $21,889,978.

The additional funding in fiscal year 2009, Associate Dean for Administration and Research Fritz Claydon said, was not only important for the college, but also one of the key factors in making discoveries that lead to a strong future economy. Expenditures throughout the year helped drive scientific innovations in areas of national and regional need—nanomaterials, energy and sustainability—all of which are emphasized in the strategic plan.

SUSTAINING *the* ENVIRONMENT

Features by Erin D. McKenzie || Photos by Thomas Shea || Photo Illustrations by Harriet Yim

For decades, reports have painted a grim picture of the state of our environment.

Greenhouse gases, toxic waste, global warming and acid rain all have been boldly displayed in news headlines, on posters and in television ad campaigns.

It has been for good reason. Our modern lives are disrupting the delicate balance of the ecosystems that make up Earth. In fact, the way we live is causing our crops to die, animals to become extinct, air quality to deteriorate and bodies of water to harbor harmful cancer-causing pollutants.

While it seems dire, we have not completely turned a blind eye to our problems. Progress has been made. The U.S. Environmental Protection Agency, for example, indicates it would take 20 of today's new cars to release the same number of emissions as a 1960s model. Not to mention, since 1970 Americans have reduced toxic releases by 50 million tons.

Both can be directly linked to a recent push to perfect existing and invent new, "greener" technology.

It is a trend University of Houston Cullen College of Engineering researchers believe in. For years, they have driven efforts to find innovative ways to sustain the planet that surrounds us.

Using millions in grant funding from environmentally conscious organizations and federal agencies, they are collecting samples in the field and testing theories in labs across campus.

What they are discovering are more efficient technologies and less wasteful practices that could help preserve a similar quality of life for future generations.

PROTECTING OUR WATER

The U.S. Environmental Protection Agency estimates trash, sewage spills and other hazards keep nearly five million acres of lakes and more than 300,000 miles of rivers and streams from meeting state water quality standards.

This same pollution closes hundreds of beaches each year. And in Houston, it has led to advisories warning residents to limit, or completely avoid, consumption of fish and crabs in several bodies of water.

One University of Houston Cullen College of Engineering researcher is on the front lines of efforts to take back these waters, and protect their future use, by uncovering some of their dirty secrets.

What she has discovered in the Houston Ship Channel—just one of these advisory laden water bodies—are tiny toxins called persistent organic pollutants.

"These persistent organic pollutants are typically put here by industry, sometimes accidentally, and they don't break down in the environment. They get into the food chain," said Hanadi Rifai, professor of civil and environmental engineering. "They accumulate in the fatty tissue of fish and when you eat them you get exposed and can suffer reproductive problems, cancer and liver damage."

So far she has identified dioxins, one class of these pollutants, in the ship channel. Using information from various samples taken from the water body, she traced a significant source back to an abandoned industrial waste facility and to paper mills that once dotted the channel some three decades ago. The EPA, who is concentrating efforts on how to clean up the larger problem at the long abandoned facility, is now using her results.

But Rifai is already hot on the trail of another family of these chemicals, lurking in channel waters. They are what she calls PCBs, or polychlorinated biphenyls, commonly used as lubricants and coolants in electrical transformers before the EPA banned them in the 1970s.

With support from a three-year, $1.8 million grant from the Texas Commission on Environmental Quality, Rifai and Kyle Strom, assistant professor of civil and environmental engineering, are testing PCB concentrations and seeking evidence on how they came to be in the channel.

Using high-volume sampling, the researchers pump large quantities of the water through fiber filters to collect suspended solids—particles that the pollutants attach themselves to. The water is then passed through a resin, extracting PCBs that may be present.

Hanadi Rifai Professor
Department of Civil & Environmental Engineering

Kyle Strom Assistant Professor
Department of Civil & Environmental Engineering

"The high-volume samples are necessary because we are looking for such small concentrations that a standard water quality sample would not detect it," Rifai said, noting the chemical is on the picogram scale, and not visible without the aid of a microscope.

After results are gathered, simple mathematical calculations allow the researchers to determine the concentration of PCBs in the water. Sediment and tissue samples from fish also help trace the source of the toxin.

Two years into their PCB study, these samples are revealing surprising results.

"We are seeing an interesting behavioral phenomenon," she said, noting PCBs are often found to linger for years in the environment, mainly in layers of sediment, after being deposited by industry. "We are seeing more PCBs that are dissolved in the water as opposed to being trapped on the particles. Unlike the dioxin study, this evidence points us to the possibility of current PCB sources. We have had so much growth and industrial activity since the 1990s, this might mean there is some new material coming in. We are taking another sampling now; we will have to see what we find."

CLEANING UP EMISSIONS

Smog has become synonymous with major metropolitan areas across the globe. This hazy, polluted air is not just unsightly—it's damaging.

It seeps through the protective layer in crop leaves affecting their ability to thrive. Smog damages paint, metal and rubber and can pose a variety of serious health risks.

The U.S. Environmental Protection Agency is pegging one piece of modern technology partially responsible—cars. Their emissions account for a third of the human-generated greenhouse gases that contribute to smog.

Even the newer, eco-friendly cars with lean-burn and diesel engines praised for higher fuel efficiency and their ability to emit fewer carbon monoxide and unburned hydrocarbons don't pass the test.

Why? Their exhaust systems are equipped with a component unable to filter out one toxin—nitrogen oxide or NOx, the respiratory irritant in smog.

A study led by researchers at the University of Houston Cullen College of Engineering is centered on cleaning up the air by replacing this component with a piece of technology expected to get rid of more than 80 percent of the NOx that's now being released from these engines' exhaust.

"We are doing research that looks at the development of an advanced catalytic converter for lean-burn or diesel vehicles to help remove NOx from their exhaust," said Michael Harold, professor of chemical and biomolecular engineering and lead investigator on the study. "This will help meet new EPA emission standards that require a dramatic decrease in the discharge of particulate matter and NOx from diesel vehicles by 2010."

Michael Harold Professor
Department of Chemical & Biomolecular Engineering

Dan Luss Professor
Department of Chemical & Biomolecular Engineering

Vemuri Balakotaiah Professor
Department of Chemical & Biomolecular Engineering

Harold is partnering with Dan Luss and Vemuri Balakotaiah, both professors of chemical and biomolecular engineering, as well as researchers at the University of Kentucky, Oak Ridge National Laboratory, Ford Motor Company and BASF to virtually eliminate exhaust pollutants.

The roughly $3.2 million grant from the U.S. Department of Energy is one of four, totaling more than $6 million, awarded by the DOE and the EPA to Harold and other UH researchers to explore exhaust cleaning techniques.

Lean-burn and diesel engines, for which the group is developing this specific exhaust technology, lead environmentally friendly efforts due to their ability to increase fuel efficiency and reduce most harmful exhaust emissions. This is possible because they use more air and less fuel during combustion—the chemical process that generates energy from the reaction between the fuel and air mixture. It is the same process that causes oxygen and nitrogen in the air to react together, forming the NOx.

"The oxygen that is not consumed during combustion makes it more difficult to eliminate the exhaust NOx," Harold said. Simply put, he said, the catalytic converter technology—the part of the exhaust system responsible for reducing toxins from emissions on gasoline-powered vehicles—is not effective at removing it.

Researchers are targeting this shortfall by coupling a Selective Catalytic Reduction (SCR) system and Lean NOx Trap that takes on the reduction of this toxin in two phases. As NOx travels through the exhaust system, the trap stores NOx and later converts it to ammonia. The ammonia is stored by the SCR catalyst and used to convert remaining NOx that slips past the trap to nitrogen gas, a naturally occurring substance in the air we breath.

Using the funding, the group will also look at a non-ammonia based mechanism with Ford as well as ways to use fewer precious metals when converting NOx, in the hopes of further improving efficiency and reducing the overall cost of aftertreatment systems.

CAPTURING FUEL FROM THE SKY

Qingkai Yu Research Assistant Professor
Department of Electrical & Computer Engineering

Jiming Bao Assistant Professor
Department of Electrical & Computer Engineering

A growing world population is increasing energy consumption and diminishing fossil fuel reserves that heat our homes, power our cars and run our power plants.

These fossil fuels are producing greenhouse gases that heat the Earth's surface. While necessary to some extent, concentrations of these gases in our atmosphere are rising over time.

The U.S. Environmental Protection Agency reports they have already increased surface temperature a degree within the last century and could continue to do so—threatening the depletion of polar ice caps, raising sea levels and influencing rainfall patterns.

Now, more than ever, there is a need for renewable energy sources to build a sustainable future.

Two researchers from the University of Houston Cullen College of Engineering think the answer may be in solar technology.

Jiming Bao and Qingkai Yu believe restructuring silicon—key in producing the electrical current that solar cells generate when struck by sunlight—may allow them to catch more of the energy-rich rays present silicon-equipped solar cells cannot.

"This is a new type of silicon; it has a different electronic structure," said Bao, assistant professor of electrical and computer engineering and lead investigator on the three-year, $348,645 National Science Foundation grant. "This type of silicon will have a lower band gap, and will be able to convert infrared light into electricity where right now you can only convert visible light. It should make the solar cell more efficient."

Right now, solar power is an energy source that's virtually untapped. It accounts for barely a percent of the world's energy needs. However, it has a lot of potential as an environmentally friendly energy source.

On a bright day, every 10 square feet of the Earth's surface is exposed to nearly 1,000 watts, or one kilowatt, of energy from the sun. Just 40 minutes worth is enough to power the planet for a year.

Bao and Yu, research assistant professor of electrical and computer engineering, will attempt to tap into this free, limitless energy source.

Working at the nanoscale, the two plan to create silicon with a new, hexagonal structure. Already widely used in electronics and solar cells, present silicon uses a diamond or cubic structure.

Through the use of a method called chemical vapor deposition, Yu will grow silicon nanowires. The technique heats silicon compounds, breaking down their molecular structure and depositing silicon on the surface of a metal catalyst. This, in turn, promotes the growth of the new silicon nanowires—just a few millionths of a centimeter thick.

"We need to figure out our own recipe for this—really, what catalyst and gases to use to make this happen," Bao said of the first phase of the research.

Once successful, Bao will study the material's basic properties in order to further refine its hexagonal structure, later testing the effectiveness of this new structure by creating a device using these nanowires.

"A new type of silicon could expand a lot of applications of silicon," said Yu. "For example, a solar cell based on silicon may have higher efficiency to convert solar energy to electric energy. If this project goes smoothly, we will have an impact on the microelectronic and clean energy industry."

Pradeep Sharma

Bill D. Cook Associate Professor of Mechanical Engineering

Education:
Ph.D., mechanical engineering, University of Maryland at College Park

Career Overview:
Before joining UH in 2004, Sharma was a research scientist for General Electric R&D where he worked simultaneously in GE's nanotechnology and photonics programs. He also pursued basic research in theoretical and computational materials science.

His work with UH and GE has earned him several honors including the Young Investigators Award from the U.S. Office of Naval Research, the Thomas J.R. Hughes Young Investigator Award from the American Society of Mechanical Engineers, the Texas Space Grants Consortium New Investigators Program Award and the University of Houston Excellence in Research Award. He also serves as an associate editor for both the *Journal of Computational and Theoretical Nanoscience* and the *Journal of Applied Mechanics*.

Research Interests:
Theoretical and computational materials science, basic mechanics and physics of solids, multiscale modeling, nanoscale piezoelectricity, quantum dots, self-assembly, size-effects in coupled physical phenomena

Applications:
Energy storage and harvesting, nano-sensors, design of materials, optoelectronic devices

Current Research Projects:
Nanoscale piezoelectricity and generalized electromechanical couplings, the coupling of strain to quantum mechanical behavior of quantum dots and applications for sensing and lasers, the self-assembly of nanostructures, the energy storage of nanocapacitors and Li-ion batteries, the quantum definition of stress, surface energy, stress and elasticity, and the homogenization of rough surfaces

PHOTO BY THOMAS SHEA

CHEMICAL AND BIOMOLECULAR ENGINEERING

Demetre Economou was named the 31st recipient of the Esther Farfel Award, the highest faculty honor given by UH.

Michael Harold received the Abraham E. Dukler Distinguished Engineering Faculty Award from the UH Engineering Alumni Association.

Valery Khabashesku's research on the functionalization of single-walled carbon nanotubes was publicized by the Institute of Physics' journal *Nanotechnology* and is highlighted at nanotechweb.org/cws/article/lab/39533.

Ramanan Krishnamoorti was selected to participate in the National Academy of Engineering's 15th Annual U.S. Frontiers of Engineering Symposium.

Peter Strasser received a Junior Faculty Research Award from the college.

Richard Willson received the 2009 Fluor Daniel Faculty Excellence Award from the college.

CIVIL AND ENVIRONMENTAL ENGINEERING

K.H. Wang received a Teaching Excellence Award from UH.

ELECTRICAL AND COMPUTER ENGINEERING

Stanko Brankovic received a Junior Faculty Research Award from the college.

Ovidiu Crisan received the W.T. Kittenger Teaching Excellence Award from the college.

Zhu Han received a best paper award at the IEEE International Conference on Communications for his paper titled "Crystalized Rates Region of the Interference Channel via Correlated Equilibrium with Interference as Noise," which he co-authored with collaborators at Stanford University.

Dmitri Litvinov received the 2008 IEEE Region 5 Individual Member Achievement Award.

Stuart Long received the inaugural UH Teaching Excellence Career Award.

Leang Shieh received a Career Teaching Award from the college.

MECHANICAL ENGINEERING

Karolos Grigoriadis received the Senior Faculty Research Award from the college.

Keith Hollingsworth was named a fellow of the American Society of Mechanical Engineers and received the UH Faculty Award for Mentoring Undergraduate Research.

Larry Witte received a Career Teaching Award from the college.

David Zimmerman was named a fellow of the American Society of Mechanical Engineers.

New Faculty

Mina Dawood

Title: Assistant professor of civil and environmental engineering

Previously: Postdoctoral research associate, North Carolina State University

Education: Ph.D., civil engineering, North Carolina State University

Research: Repair and rehabilitation of steel structures, composite materials and fiber reinforced polymer structures, new and innovative structural materials and systems

Ali Ekici

Title: Assistant professor of industrial engineering

Previously: Instructor, Georgia Institute of Technology

Education: Ph.D., industrial and systems engineering, Georgia Institute of Technology

Research: Humanitarian logistics, network design/expansion, dynamic routing, decision making, industry applications of scheduling/packing

O. Erhun Kundakcioglu

Title: Assistant professor of industrial engineering

Previously: Instructor, University of Florida

Education: Ph.D., industrial and systems engineering, University of Florida

Research: Infrastructure, logistics, transportation and stochastic processes, computer and information science and engineering

Jeffrey Rimer

Title: Assistant professor of chemical and biomolecular engineering

Previously: Postdoctoral fellow, New York University

Education: Ph.D., chemical engineering, University of Delaware

Research: Microporous materials synthesis and characterization for catalytic and biomedical applications, pathological biomineralization of kidney stones and vascular calcification, crystal engineering, nanomaterials self-assembly, X-ray and neutron scattering, atomic force microscopy

Wei-Chuan Shih

Title: Assistant professor of electrical and computer engineering

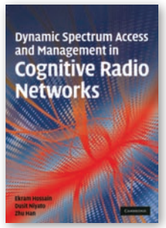
Previously: Postdoctoral research scientist, Schlumberger-Doll Research

Education: Ph.D., biomedical spectroscopy/mechanical engineering, Massachusetts Institute of Technology

Research: Development of novel optical techniques and nano/microtechnologies for applications in biomedicine, energy, automation and the environment

In Print

Cognitive Radio Networks



Zhu Han, assistant professor of electrical and computer engineering, explores emerging techniques and methods for designing next generation wireless networks in his book *Dynamic Spectrum Access and Management in Cognitive Radio Networks*, published by Cambridge University Press in 2009. Co-authored by professors Ekram Hossain from the University of Manitoba in Winnipeg, Canada and Dusit Niyato from Nanyant Technological University in Singapore, the book outlines the fundamentals of cognitive radio-based wireless communication and networking, spectrum sharing models and dynamic spectrum access.

Insight

The Economist

Neuroscience research being conducted by Bhavin Sheth, assistant professor of electrical and computer engineering, was featured in the April 18, 2009 issue of *The Economist*, a weekly newsmagazine focused on international affairs. The article spotlights his work with London researcher Joydeep Bhattacharya and Austrian researcher Simone Sandkuhler on insight, which is characterized as the clear and often sudden understanding of a complex situation or problem. The study by the researchers suggests insight occurs much earlier than once thought—as much as eight seconds before individuals are consciously aware they have solved a problem.

Grant Backs New Take on Atomic Layer Etching Technique

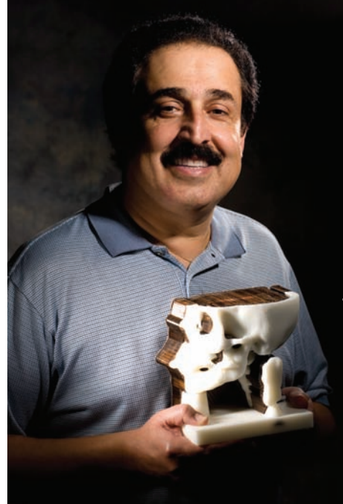
Getting things smaller is not the only means of advancing nanoscience. Furthering the field requires boosting the etching speed of one of the leading techniques used in the fabrication of nanocircuits.

And two University of Houston researchers believe their method may be the answer—surpassing current rates of atomic layer etching by as much as 30 times.

"We are developing the principles and techniques for a practical method of etching surfaces away, one atomic monolayer at a time, by pulsing the electronics of an etching device," said Demetre Economou (pictured) of his work with Vincent Donnelly, both professors in the department of chemical and biomolecular engineering. "Conventional atomic layer etching is very slow because it pulses the introduction of etching gases with long reactant absorption and purging steps. The central idea is to pulse the plasma and ion bombardment rather than the reactive gases."

The duo is using $545,000 in grant funding from U.S. Department of Energy and the National Science Foundation to support their new research endeavor.

PHOTO BY THOMAS SHEA



Professor Puts Prototyping Techniques to New, Biomedical Use

An effort is underway at the UH Cullen College of Engineering to use technologies with origins in the automobile industry to develop new tools that will help doctors and technicians better plan radiation therapy for patients with head and neck cancer.

Ali Kamrani, associate professor of industrial engineering and former auto industry researcher, is teaming up with Lei Dong, associate professor and deputy research director of radiation physics at The University of Texas M.D. Anderson Cancer Center, to develop predictive models of tumors that hopefully will increase the accuracy of radiation therapy.

"We aim to better understand tumor deformations using geometric and statistical models—rather than repetitive CT scans," said Kamrani. "In this case, patients will undergo a minimum number of CT scans, and the radiation plans will be developed using the predictive models."

Reducing the number of costly, tedious CT scans with his rapid prototyping method—also known as solid free form fabrication—is a primary objective for Kamrani, because it will reduce the patient's risk to unwanted radiation.

PHOTO BY THOMAS SHEA

Engineering Researcher to Improve on

TxDOT Road Maintenance Device

PHOTO BY THOMAS SHEA

Drivers may think the only thing standing between them and a collision in rush hour traffic is their brakes, but really the friction generated as their tires move over a road's surface has a lot to do with stopping ability.

It is what the Texas Department of Transportation (TxDOT) calls skid resistance. In short, if the surface texture of a road is too smooth it can not only negatively affect stopping time, but also increase chances of hydroplaning on rainy days.

During the course of the last decade, Richard Liu, professor of electrical and computer engineering, has been working with TxDOT to refine a vehicle-mounted laser he created to improve driver safety by revolutionizing the way wear is tested on some 80,000 centerline miles of highway across Texas.

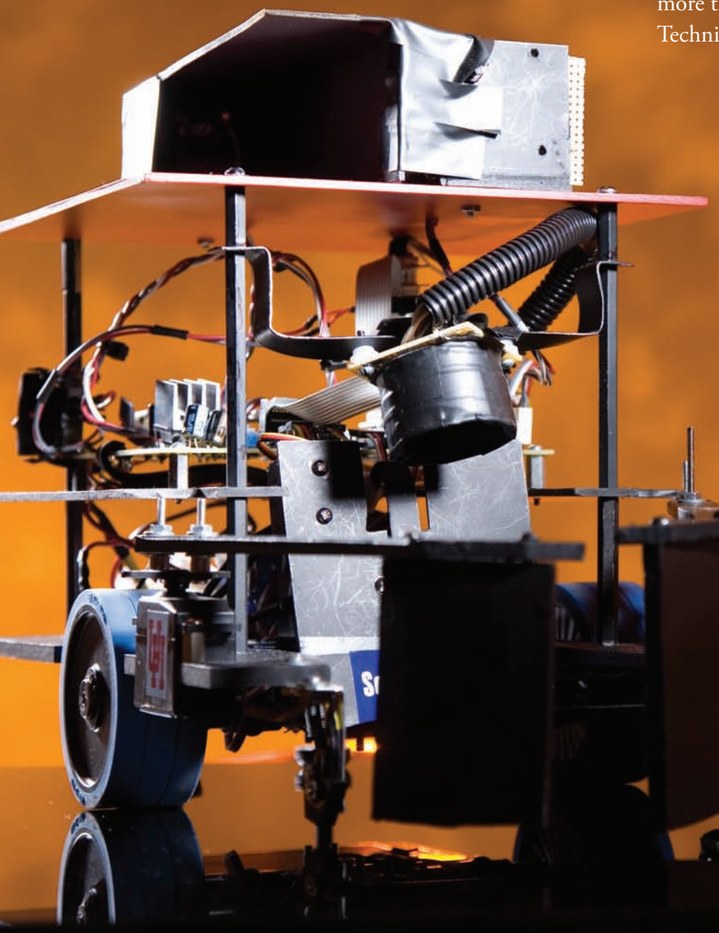
With up to $300,000 in funding from TxDOT over the next two years, Liu plans to maintain four generations of his devices already in use by TxDOT as well as develop a fifth generation model with improved power, water tightness and measurement accuracy.

Created to mount on the front of one of a few specialized vans in the TxDOT fleet, the device sits about 12 inches above the road's surface. One box, equipped with a laser, is mounted above the right wheel pass and takes eight different readings for each millimeter of distance traveled. The on-board microprocessor then sends the data to the main computer in the van, allowing TxDOT crews to review recorded assessments of the road surface.

"It's just like a ruler, but a very accurate and very fast ruler," said Liu. "The system shoots the laser that measures the distance from the vehicle to the road surface. If there is a dip, the laser travels a little farther. It delivers thousands of miles of data to TxDOT crews."

ROBOTICS TEAMS Make History at Regional Competition

One University of Houston robotics team won a lot more than a competition at the 2009 IEEE Region 5 Technical, Professional and Student Conference in April.



A successful 67-second final run by their light sensing, autonomous robot secured the group a place in UH history as the only team to take home a first place regional win at the competition. But the team led by Paul Dinh and comprised of Ibrahima Komara, Paul Moreno and Thomas Packer were not the only ones with bragging rights.

A second team—Dustin Drawhorn, Melissa Greer, Jesse Maricelli and Leif Bagge—relied on four robots to complete the competition mission, capturing third place for UH.

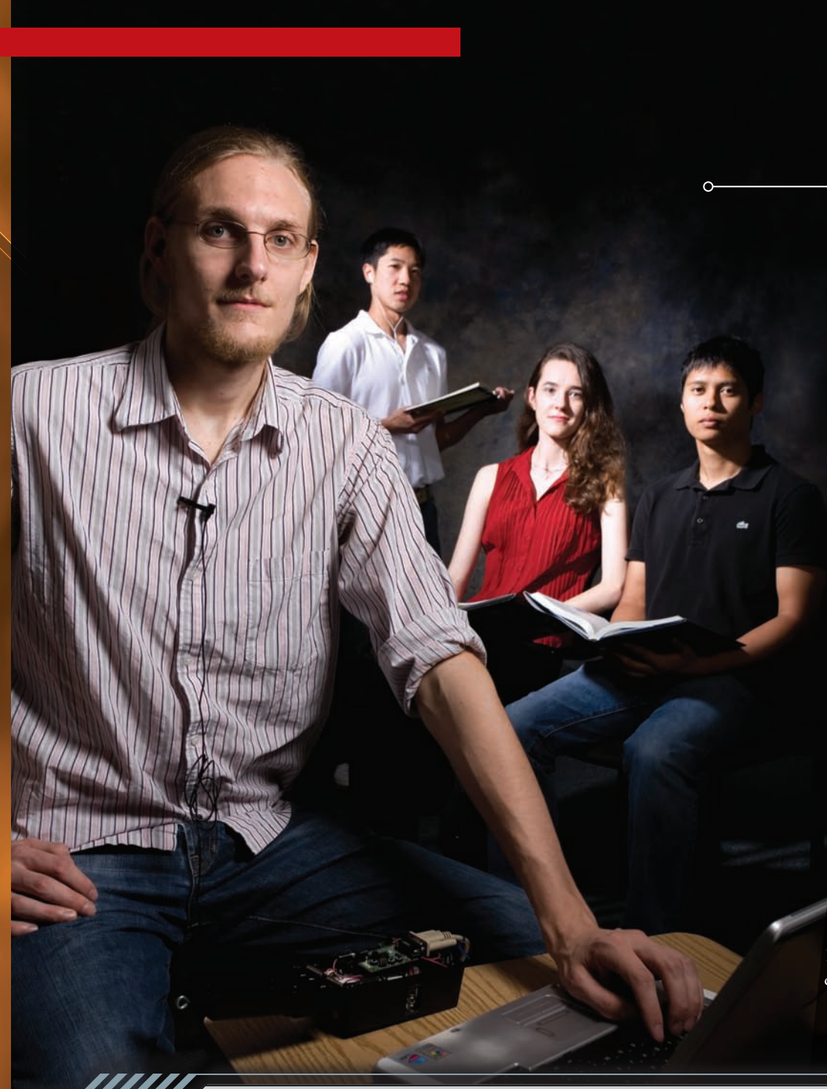
"I have been jokingly telling teams the last few years that we have gotten second and third, now it's time to get first," said John Glover, professor of electrical and computer engineering and the robotics teams' adviser. "I guess now I'll have to joke with them about getting first and second."

Under the direction of Glover, engineering students have been contenders in the annual robotics competition since 2000. Up until this year, only two other teams have ranked in the top three. And while multiple teams have competed in a year, none have been able to capture two of the top three spots.

At the Lubbock competition, the two UH groups faced off with more than 20 other teams on a square track equipped with five flashing LED lights, one in each of the four corners with the fifth poised over the center. The robots were programmed by the students to recognize the LED lights and the different frequencies each was emitting.

At the start of each run, judges gave the teams a random sequence of corners to visit. The robots relied on the different frequencies to guide them to the corners in the correct order, grab a box and carry it to the center of the track where they determined the color of the box and placed it in its corresponding colored square. The run was not complete until all four boxes were delivered to their correct squares.

PHOTO BY THOMAS SHEA



Senior Project to Aid Research by Area Doctor

Katy Pediatric Neuropsychologist James Poysky has UH students to thank for the means to begin a study that could assist thousands of children suffering from Attention Deficit Hyperactivity Disorder (ADHD) who struggle to concentrate.

The wireless device, created by Austin Head, Hung Lam, Meaghen Krebsbach and Eric Reyes, is intended to help ADHD suffers focus in a classroom setting.

"The device does this by amplifying the teacher's voice with a lapel microphone and wirelessly transmitting it to a discreet set of ear buds worn by the student," said Head. "To help keep the student focused and on task, it also incorporated a remote that, when pressed, activates a tone that's played in the ear buds—redirecting the student to the teacher's voice."

The biomedical engineering students designed the device according to Poysky's specifications for their senior capstone design course, one of the last classes required before completing the course work necessary to earn their degrees.

Poysky, who has already begun studies with the device, intends to pursue a patent for it.

PHOTO BY THOMAS SHEA

UH Duo Captures First in Regional Circuit Competition

Engineering seniors John Hemmick and Osaid Shamsi relied on problem solving skills and classroom instruction to secure the first place title at a regional circuit design competition in April.

The two were pitted against 10 teams in the nonstop, seven-hour competition challenging them to design and build a solar-powered battery charger at the 2009 IEEE Region 5 Technical, Professional and Student Conference.

"When we got there, we saw these really exotic pieces of electronics we had never seen before," said Hemmick, a computer engineering major, of the Lubbock-based competition. "The competition was timed, and we used every second going over spec sheets and testing our design. I had no idea we were going to win, but was pleasantly surprised that night at the awards dinner."

The first team to compete for UH in seven years, Hemmick and Shamsi beat out universities that included Texas Tech University and Oklahoma State University for the honor, carrying with it a $500 cash prize.

Learning in the Lab

University of Houston Cullen College of Engineering students are enhancing their education by employing scientific methodology in real lab settings as both undergraduates and graduate students. Whether the research is seen as just a challenge or a requirement for their curriculum, students such as Ananya Roy and Gregory Bohuslav are impacting the world around them by finding answers to some of the most perplexing mysteries in science.

PROFILES BY ERIN D. MCKENZIE
PHOTOS BY THOMAS SHEA

Ananya Roy

Behind the safety glasses that frame Ananya Roy's face lays a brilliant mind.

It's a mind engrossed in the complex world of nanotechnology where researchers—Roy included—create things tens of thousands of times smaller than the diameter of a human hair.

Though Roy is still finishing the requirements for her Ph.D. in electrical engineering, the work she is doing at UH in neutral particle lithography is getting noticed by top scientists in the nanofabrication field.

"Her research is competitive with what is happening at the best universities, and she has a gift for communicating her results that few researchers possess," said Jack Wolfe, her adviser and professor of electrical and computer engineering. "Her work is important to our understanding of nanofabrication at the smallest scale and will certainly impact the global issue of pattern noise in chip manufacturing."

Like many who work in the nanofabrication field, the 25-year-old has been searching for ways to overcome a key challenge associated with making things small—statistical noise.

To do this, she is refining the method to get the transferred pattern to look as close to the real membrane as possible.

"This method is similar to stenciling—you spray paint and transfer the stencil pattern onto a surface," said Roy. "But we use a beam of energetic helium atoms as the 'paint' and our stencil is a silicon membrane with tiny holes etched through it. Whenever there are openings, the atoms are transmitted through them and the membrane pattern is transferred onto the surface being patterned."

Much like fine drops of paint around edges of a pattern, there can be roughness in these printed structures. So Roy has developed a model to reduce the noise in applications where this roughness is just a few atoms wide. Thus far, it's able to explain experimental results previously unclear, and predict solutions to extend the fundamental limits of nanofabrication.

The work earned her an Outstanding Presenter Award at the college's Department of Electrical and Computer Engineering Graduate Research Conference as well as major kudos at the Electron and Photon Beam Technology and Nanofabrication Conference, one of the top international conferences in nanofabrication.

Yet, Roy's research is not the only way she is impacting those around her. Each year, she mentors incoming graduate students, undergraduates in the Research Experience for Undergraduates program and students in two of Wolfe's classes where she is the teaching assistant.

After graduating this fall and gaining some industry experience, Roy said she hopes to combine mentoring and research to become a professor full time.

"Education has always been a very important part of my upbringing, and eventually I think I would love to teach," she said. "It is very rewarding and a great learning experience to help a student figure something out. Just like my research, it is just something I thoroughly enjoy."

Gregory Bohuslav

In the Eagleman Laboratory for Perception and Action at the Baylor College of Medicine, Gregory Bohuslav is trying to understand how the brain constructs perception.

For nearly four years, he has created and showed short clips of visual illusions to volunteers to determine how they perceive them in the hopes of getting closer to the answer.

It's been this research coupled with his studies in biomedical engineering at UH that peaked his interest in the healthcare field and solidified plans to pursue a degree in medicine when he graduates in May.

"In my mind engineering and medicine are kind of trying to accomplish the same goal," said the 22-year-old whose glowing academic record earned him membership in The Honors College at UH. "As a biomedical engineer, the goal is to be able to find out about the human body and create devices to assist doctors. As a doctor, my job would be to use those devices to fix people. Just like engineering, where there is a lot of problem solving and debugging, in medicine you are debugging a human. Since I enjoy working with people, it's a good fit."

While he finishes his degree, Bohuslav is applying what he is learning at UH to the lab.

During experiments, Bohuslav projects short, video-like clips onto a computer screen in front of participants. He uses the clips to track their eye movements, and in some cases pupil dilation—later analyzing the information to better leverage how the mind perceives and constructs reality.

Through the lab, he has worked with an area neurosurgeon conducting these experiments on epileptics; he even traveled to Norway last summer to assess fatigue in Norwegian soldiers using the clips. Eventually, Bohuslav and other researchers in the lab plan to develop a portable device for testing combat fatigue in these soldiers.

Bohuslav believes the research he is doing as an undergraduate and his UH education will help take him through his next steps in life.

"Although I work in a neuroscience lab and don't use the chemical processes, biomechanics was vital to building a device used to test human perception," he said. "In addition, the proximity to the world's largest medical center has allowed me to develop my biomedical engineering skills in a working environment."

(Top) Ananya Roy works with a Dual Chamber Reactive Ion Etching Tool she built with Professor Jack Wolfe and her mentor Barry Craver.

(Right) Gregory Bohuslav is pictured with one of several video-like clips used in his research to better understand how the mind constructs perception.

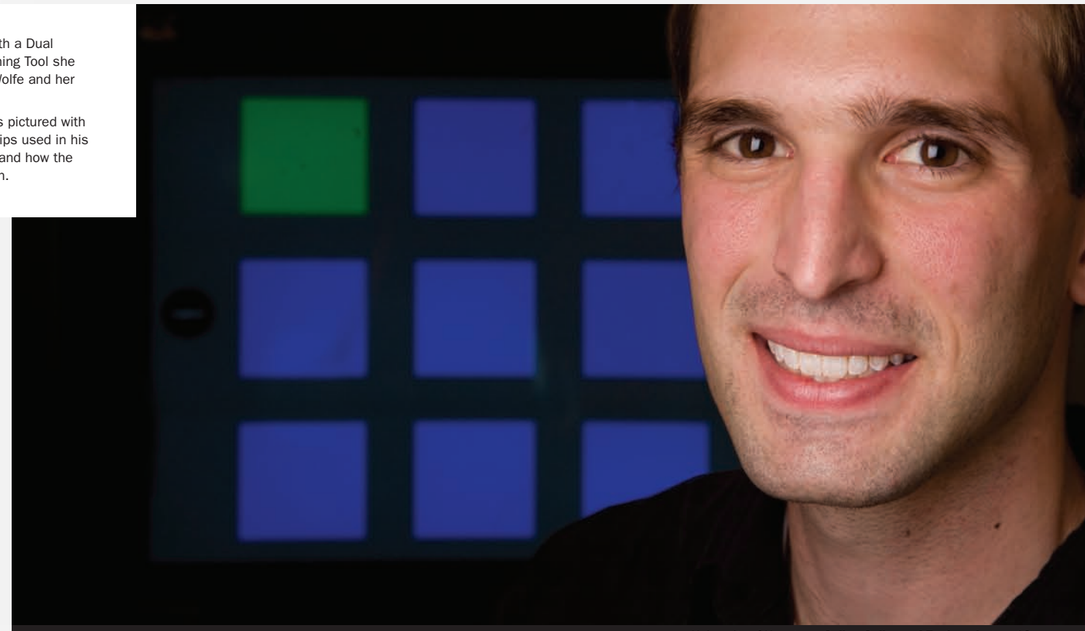


PHOTO BY THOMAS SHEA

Early Rise of Wind Power in Texas

BY JOHN LIENHARD

In 1845, the United States annexed a sovereign independent nation. That nation was Texas. We became a state. Many Americans didn't like the idea. After all, Texas was a nation of foreigners—mostly new immigrants from Northern Europe.

One of those immigrants was F.G. Witte. Just about the time we became a state, Witte imported a pair of millstones from Europe. They were four feet in diameter and a foot thick. They came by ship—then rode an oxcart to Goliad County. There, Witte set up the first windmill in Texas.

The mill stood about 20 feet high, and it ground corn for more than a decade. Witte could handle 500 pounds of grain a week, but only when the wind was right.

Twenty-five years later, in 1870, two more German immigrants bought Witte's mill and rebuilt it. Their new mill was much fancier, but it still used Witte's old grinding stones.

They built what we call a Dutch mill. It stood 35 feet high with 20-foot sails. The sails of a Dutch mill ride on a rotating turret with a long handle that reaches the ground. That way you can turn the top of the mill so it always faces into the wind. The lower part of the building is stationary.

But Texas isn't Holland. When European technology crossed the ocean, it always mutated. Holland's mills were solid masonry structures. This mill was made of wood. Big as it was, you could still break it down and move it.

The rotating turret in this mill didn't turn very smoothly. The mill also took a beating in high winds. So the new owners strengthened it. Then they moved it—maybe more than once—looking for steadier winds.

The mill ground cornmeal for many years. Finally, by the turn of the century, it sat idle—replaced by modern machines. Then, in 1935, the ladies of the Victoria Morning Study Club arranged to move it one last time. They took it into Victoria, Texas. There it's been a tourist attraction ever since.

And what an oddity it is! This is a medieval technology, suddenly come to a Stone Age land. It seems so out of place. Yet this was one of our first steps on the road to the 21st century. We telescoped that road into just 150 years.

At first you think it must be a kitchy restaurant. But this is nothing of the kind. This very real windmill is one quick step in the explosive rise of the modern West. It shows us a blink of 19th-century change in a way no textbook ever could.

__The Engines of Our Ingenuity__ is a nationally recognized 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 2,500 episodes have run. The program airs at 7:35 a.m. and 7 p.m., Monday through Friday on KUHF-FM 88.7. For more information about the program, visit www.uh.edu/engines.

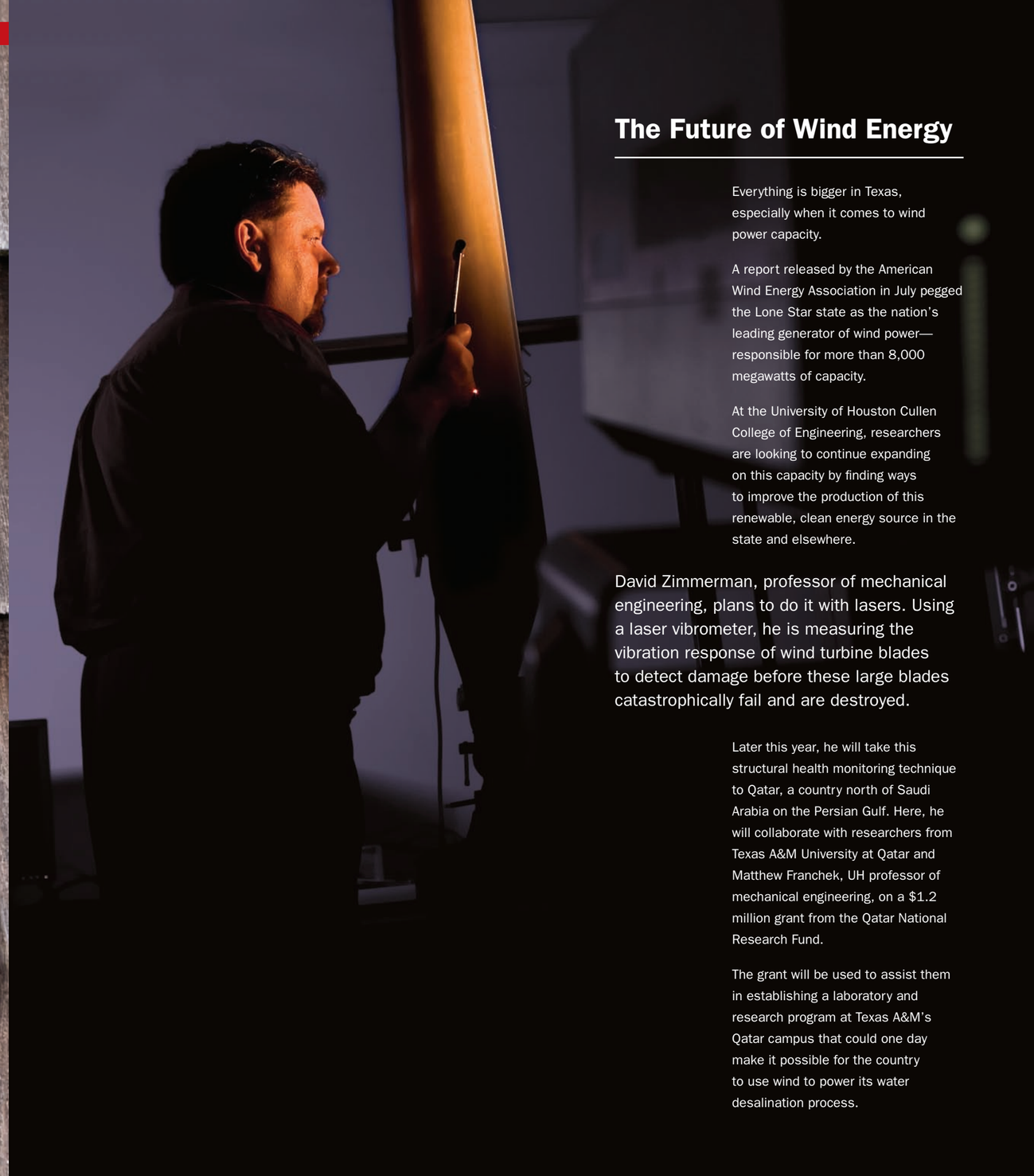


PHOTO BY THOMAS SHEA

The Future of Wind Energy

Everything is bigger in Texas, especially when it comes to wind power capacity.

A report released by the American Wind Energy Association in July pegged the Lone Star state as the nation's leading generator of wind power—responsible for more than 8,000 megawatts of capacity.

At the University of Houston Cullen College of Engineering, researchers are looking to continue expanding on this capacity by finding ways to improve the production of this renewable, clean energy source in the state and elsewhere.

David Zimmerman, professor of mechanical engineering, plans to do it with lasers. Using a laser vibrometer, he is measuring the vibration response of wind turbine blades to detect damage before these large blades catastrophically fail and are destroyed.

Later this year, he will take this structural health monitoring technique to Qatar, a country north of Saudi Arabia on the Persian Gulf. Here, he will collaborate with researchers from Texas A&M University at Qatar and Matthew Franchek, UH professor of mechanical engineering, on a $1.2 million grant from the Qatar National Research Fund.

The grant will be used to assist them in establishing a laboratory and research program at Texas A&M's Qatar campus that could one day make it possible for the country to use wind to power its water desalination process.

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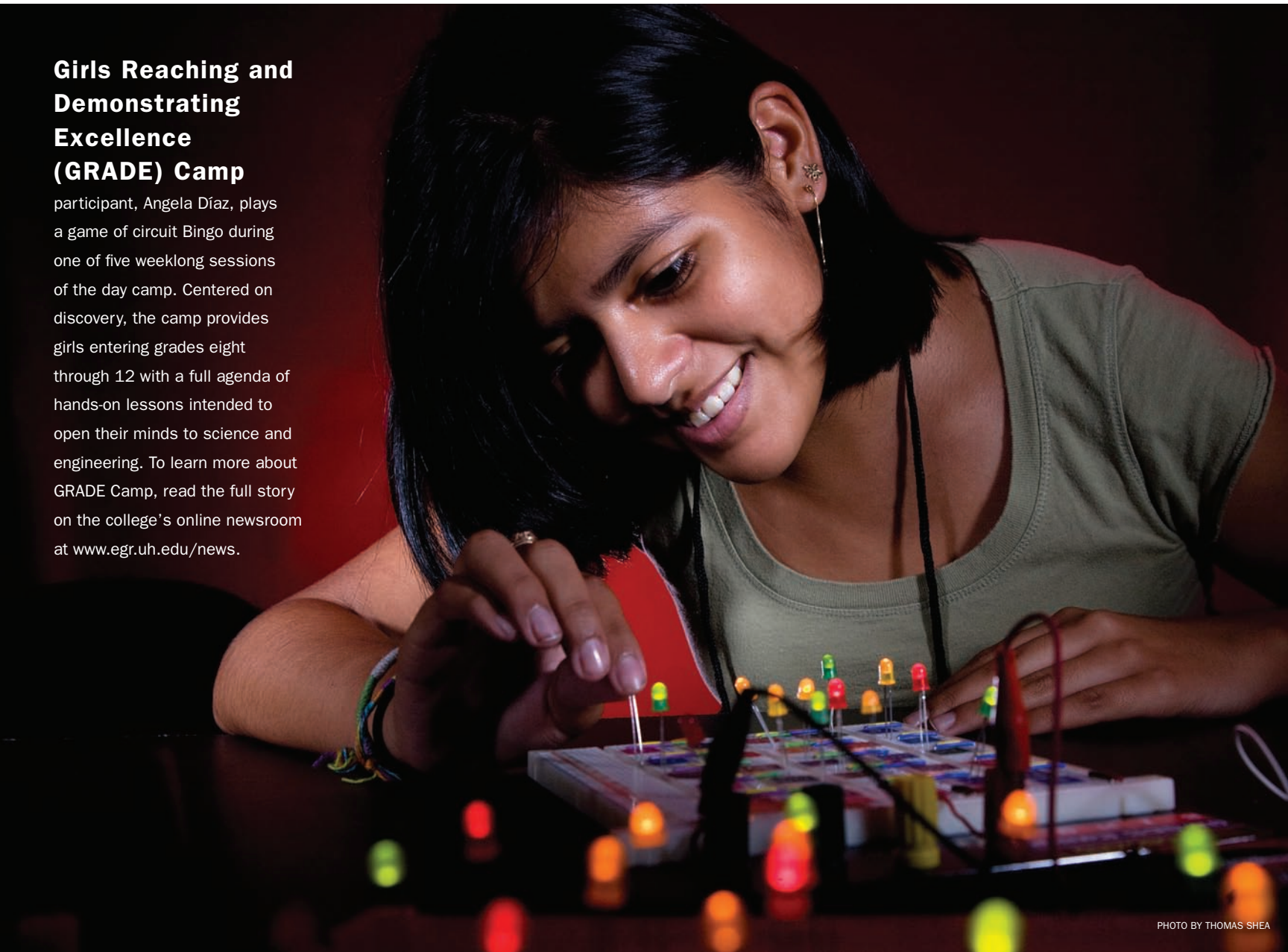

Girls Reaching and Demonstrating Excellence (GRADE) Camp

participant, Angela Díaz, plays a game of circuit Bingo during one of five weeklong sessions of the day camp. Centered on discovery, the camp provides girls entering grades eight through 12 with a full agenda of hands-on lessons intended to open their minds to science and engineering. To learn more about GRADE Camp, read the full story on the college's online newsroom at www.egr.uh.edu/news.

PHOTO BY THOMAS SHEA