Fall 2014

Parameters

Cullen College of Engineering Magazine

HOUSTON'S HIDDEN HEROES

The Brains Behind the Bayou City

30 KEEPING HURRICANES AT BAY

42 HELPING HOUSTON BREATHE EASIER

46 THE SMARTEST GRID ON THE BLOCK

UNIVERSITY of HOUSTON | ENGINEERING

COMING IN 2016

Multidisciplinary Research & Engineering Building (MREB)

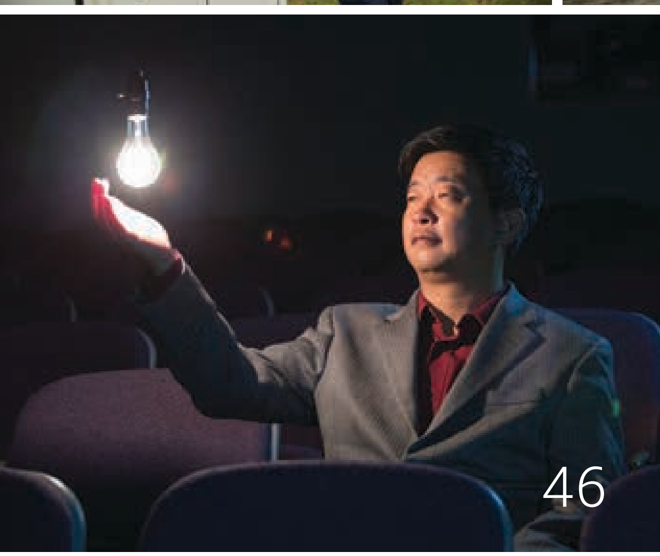
The UH Cullen College of Engineering has met its fundraising goal of $10 million for the MREB – and the timing couldn't be better. The Cullen College will be doubling its size over the next 10 years, welcoming more than 4,000 new students and 50 new faculty members by 2025. The MREB will provide the critical infrastructure needed to increase student enrollment, associated faculty and research funding.

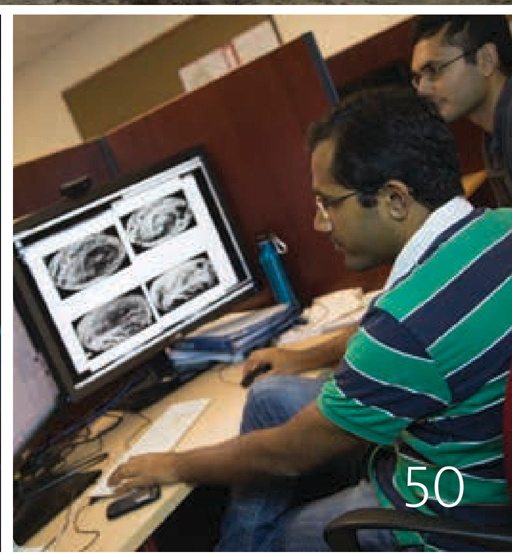
The MREB is expected to help generate approximately $36 million in research funding annually for the Cullen College of Engineering and to promote an approximate $612 million increase in annual economic activity in Houston alone. It will also allow UH to add more than 250 talented graduate students and hire new National Academy of Engineering faculty.

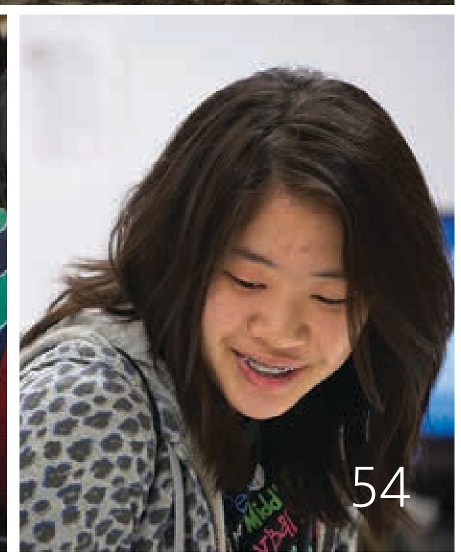
Construction will begin in November 2014, with completion scheduled for the summer of 2016.

Parameters Fall 2014 I www.egr.uh.edu

UNIVERSITY of HOUSTON | ENGINEERING







Cullen College of Engineering

Dean
Joseph W. Tedesco

Associate Dean for Research & Facilities
Hanadi Rifai

Associate Dean for Graduate Programs & Computing Facilities
Suresh K. Khator

Associate Dean for Undergraduate Programs
David P. Shattuck

Parameters

Parameters is published biannually by the University of Houston Cullen College of Engineering, Office of Communications.

Communications Director
Audrey Grayson

Managing Editor
Melanie Ziems

Creative Director/Graphic Designer
Rachel Ward

Photography
Carlos Landa

Contributing Writers/Editors
John Lienhard, Toby Weber, Elena Watts, Jeannie Kever, Lisa Merkl

Contact us:
Office of Communications
Cullen College of Engineering
University of Houston
E301 Engineering Bldg. 2
Houston, Texas 77204-4009

Phone 713.743.4217
Fax 713.743.8240
E-mail parameters@egr.uh.edu
Website www.egr.uh.edu

Academic Departments

Biomedical Engineering
Chair: Metin Akay
Web: http://www.bme.uh.edu
832-842-8813

Chemical & Biomolecular Engineering
Chair: Mike Harold
Web: http://www.chee.uh.edu
713-743-4300

Civil & Environmental Engineering
Chair: Roberto Ballarini
Web: http://www.cive.uh.edu
713-743-4250

Electrical & Computer Engineering
Chair: Badrinath "Badri" Roysam
Web: http://www.ee.uh.edu
713-743-4400

Industrial Engineering
Chair: Gino Lim
Web: http://www.ie.uh.edu
713-743-4180

Mechanical Engineering
Chair: Pradeep Sharma
Web: http://www.me.uh.edu
713-743-4500

Office of Advancement
Mail: University of Houston
Cullen College of Engineering
E421 Engineering Bldg 2
Houston, TX 77204-4007

Web: http://www.egr.uh.edu/giving/office-advancement

cullen college news

@uhengineering

UNIVERSITY of HOUSTON
CULLEN COLLEGE of ENGINEERING

Dean's Letter

The city of Houston is the heartbeat of the United States.

As the energy, medicine and space capital of the world, what happens here in Houston has reverberations that can be felt across the globe. This is why I believe that the future of our city depends on engineers and engineering.

Engineers and other STEM professionals are driving forces behind Houston's position as an economic powerhouse. In fact, our city created more jobs last year than any other major U.S. city thanks to our booming energy and engineering industries.

The work we do here profoundly and directly benefits the lives of Houstonians each and every day. As a college, we have an obligation to ensure the city of Houston remains a global economic leader for many, many years to come.

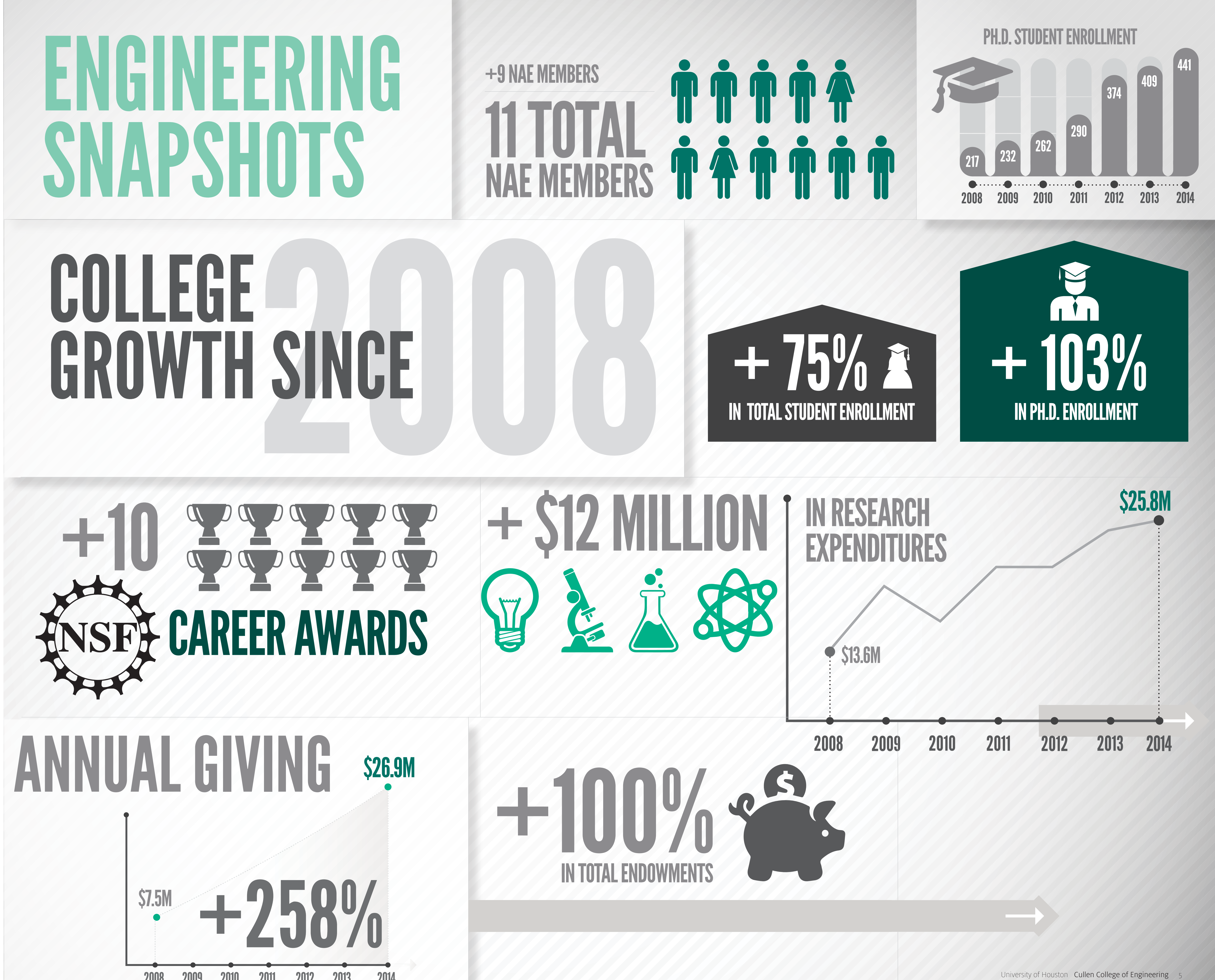
This issue of Parameters is dedicated to the UH Cullen College of Engineering professors and students who devote their lives to ensuring that Houston remains the world's engineering and innovation hub. These researchers protect our city and our coastline from future hurricanes, develop new methods and technologies to identify harmful air and water pollutants, and boost medical research taking place within the Texas Medical Center, among other contributions too numerous to name.

For engineers, there is truly no better place to be than the city of Houston. Together, we tackle the grand challenges of engineering embodied in our bustling city – from sustainability to infrastructure and medicine. Our engineers have an intrinsic desire to address issues at home in Houston first.

Warm regards,

Joseph W. Tedesco

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



COLLEGE GROWTH (THROUGH 2025)

X2 DOUBLE STUDENT ENROLLMENT BY 2025

+50% INCREASE IN FACULTY BY 2020

DOUBLE NAE MEMBERS BY 2020

INCREASE INDUSTRY SPONSORED RESEARCH (FROM 10% TO 30% OF TOTAL SPONSORED RESEARCH)

TOP 50

BECOME A TOP 50 ENGINEERING PROGRAM (AS RANKED BY U.S. NEWS & WORLD REPORT)

IMPACT IN HOUSTON

80% of all Cullen College undergrads are employed in Texas within one year of graduation

18,045 total alumni of the Cullen College of Engineering

3,500+ UH alumni are presidents, CEOs or heads of their own companies

63% of all UH alumni live and work in Houston

UH students spend over 1 million hours volunteering and interning in Houston each year

14% of all Houstonians with bachelor's degrees earned them from UH

BRAGGING POINTS

We've got everything you would expect from a top engineering college – outstanding faculty, cutting-edge research and state-of-the-art facilities. But just how good are we?

Named one of Princeton Review's "best value colleges" (2012, 2013)

Listed as one of the world's top universities for grads who become CEOs (Source: The Times Higher Education of London, 2014)

Ranked #4 in the nation for "top colleges where students get the best bang for their buck" (Source: PolicyMic, 2013)

Ranked among the top 75 in the nation and #1 in Houston for engineering research and development expenditures by the National Science Foundation (2011)

CULLEN COLLEGE WELCOMES NAE MEMBER, CHRISTINE EHLIG-ECONOMIDES

Christine Ehlig-Economides has joined the UH Cullen College of Engineering as the William C. Miller Endowed Chair Professor of petroleum engineering.

She is the 11th National Academy of Engineering (NAE) member to join the Cullen College faculty, and the ninth NAE member to join the college since 2008.

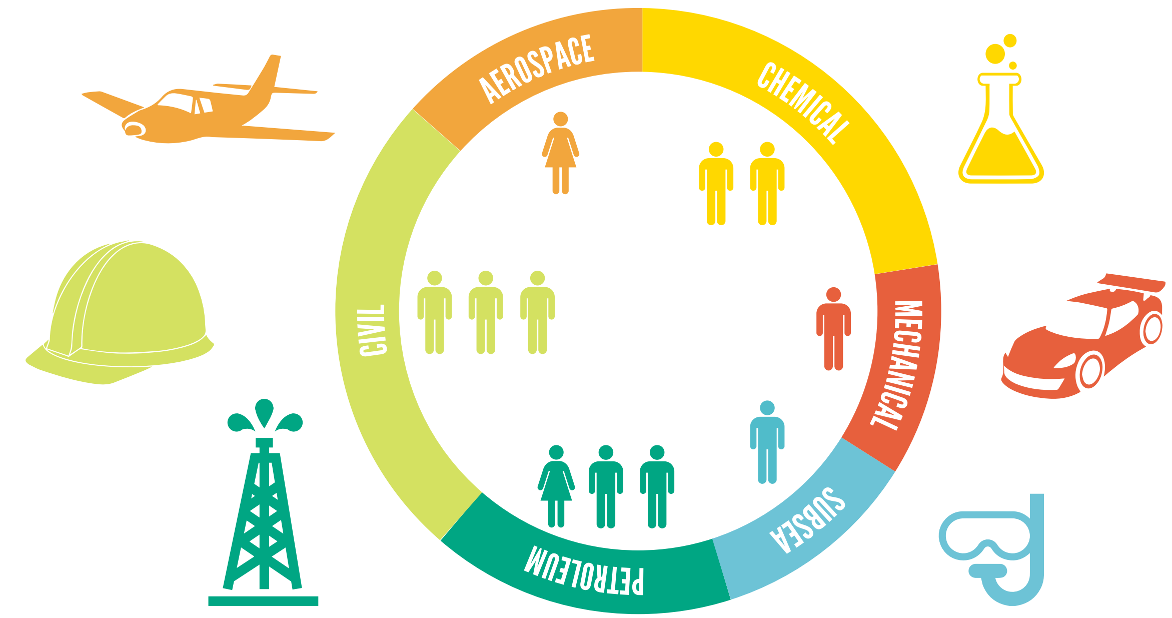
Ehlig-Economides is a world-renowned expert in reservoir engineering, pressure transient analysis, integrated reservoir characterization, complex well design and production enhancement. She came to the UH Cullen College of Engineering from Texas A&M University, where she held the Albert B. Stevens endowed chair in petroleum engineering.

Ehlig-Economides was the first American woman to earn a Ph.D. in petroleum engineering, a degree she obtained in 1979 from Stanford University. She earned her master's degree in chemical engineering from the University of Kansas and her bachelor's degree in math-science from Rice University. She spent 20 years traveling around the world as an employee for Schlumberger and has published more than 115 papers, lectured or consulted in 50 countries and authored two patents.

NATIONAL ACADEMY OF ENGINEERING SHOWCASE

With 11 total NAE members serving as faculty within the Cullen College, these world-class educators have expertise in a variety of different engineering disciplines and fields. Learn more about the Cullen College's NAE faculty members and their areas of expertise on the following page.

11 TOTAL NAE MEMBERS



AEROSPACE ENGINEERING

Bonnie J. Dunbar
M.D. Anderson Professor of Mechanical and Biomedical Engineering, Director of the Aerospace Engineering Graduate Program, Director of the UH STEM Center

Dunbar is a former NASA astronaut who logged more than 50 days in space and flew in five space missions. Her current focus is on educating and raising enthusiasm for STEM among people of all ages to address the critical shortage of trained STEM workers in the U.S.

MECHANICAL ENGINEERING

John Lienhard
Professor Emeritus of Mechanical Engineering and History

Lienhard is somewhat of an institution in the Houston region. As the author and voice of "The Engines of Our Ingenuity" on Houston Public Media, he has delighted radio audiences by spreading high-level engineering and science concepts in an entertaining and accessible format. He has won two Crystal Microphone awards for his radio program.

SUBSEA ENGINEERING

Benton Baugh
Distinguished Adjunct Professor of Mechanical Engineering

Baugh, an alumnus of the Cullen College's mechanical engineering department, has more than 50 years of experience in oilfield and subsea systems. He was recently named a charter fellow of the National Academy of Inventors for his design and development of oilfield and offshore drilling equipment.

CIVIL ENGINEERING

James M. Symons
Cullen Distinguished Professor Emeritus of Civil and Environmental Engineering

Symons spent 20 years working in the federal government to prevent carcinogens from creeping into drinking water. He joined UH in 1982 and has since made major research discoveries which have significantly advanced the understanding and practice of improving drinking water safety.

Anestis Veletsos
Adjunct Professor of Civil and Environmental Engineering

Veletsos is a two-time winner of the Norman Medal, the highest award given by the American Society of Civil Engineers for papers published in its journals. His research led to major advances in structural dynamics and earthquake engineering across the world.

Kaspar Willam
Hugh Roy and Lillie Cranz Cullen Distinguished Professor of Civil and Environmental Engineering

Willam is a recognized national and international authority on structural mechanics and materials in civil engineering. His research contributions include constitutive modeling and computational failure analysis of concrete and quasi-brittle materials and structures.

CHEMICAL ENGINEERING

Charles Cutler
Distinguished Adjunct Professor of Chemical and Biomolecular Engineering

An alumnus of the Cullen College's chemical engineering department, Cutler went on to invent and commercialize a new-generation digital process control technology.

Dan Luss
Cullen Distinguished Professor of Chemical and Biomolecular Engineering

Luss lead the Cullen College's department of chemical and biomolecular engineering through a period of unprecedented growth and success from 1975-1995. He is also widely recognized for his research on important industrial problems in chemical reactor engineering.

PETROLEUM ENGINEERING

J. J. Azar
Distinguished Adjunct Professor of Petroleum Engineering

Azar is a world-renowned petroleum engineering expert, lecturer and researcher who formerly served as director of Drilling Research Projects at the University of Tulsa, a cooperative program supported by major oil and gas companies worldwide.

John Lee
Hugh Roy and Lillie Cranz Cullen Distinguished University Chair of Petroleum Engineering

Lee has authored four best-selling engineering textbooks and was the lead engineer on the SEC's revised rules for reporting petroleum reserves.

IN THE MEDIA

RADIO

88.7 KUHF-FM
Bauer Business Focus: Badri Roysam and Electric Power Research
Featuring Badri Roysam, Chair of the Electrical and Computer Engineering Department
(Aired April 4, 2014)

CenterPoint, Direct Energy, Join UH in Electric Power Research Venture
Featuring UH Cullen College of Engineering
(Aired March 27, 2014)

TV

ABC 13 Eyewitness News
GRADE Camp Sets Girls Up For Bright Future
Featuring Stuart Long, Professor of Electrical and Computer Engineering
(Aired June 26, 2014)

University of Houston Receives $3.3M to Promote Women in STEM Fields
Featuring UH Cullen College of Engineering
(Aired August 20, 2014)

The EnergyMakers Show
Episode 147, Dr. Christine Ehlig-Economides
Featuring Christine Ehlig-Economides, William C. Miller Endowed Chair Professor of Petroleum Engineering
(Aired August 14, 2014)

Episode 146, Dr. Tom Holley
Featuring Tom Holley, Professor and Director of Petroleum Engineering Program
(Aired August 7, 2014)

Episode 136, Dr. Michael Harold
Featuring Michael Harold, M.D. Anderson Professor and Chair of the Chemical and Biomolecular Engineering Department
(Aired May 29, 2014)

PRINT

Bio News Texas
UH Lab Awarded Grant to Research Specific Drugs for Lupus Nephritis
Featuring Chandra Mohan, Hugh Roy and Lillie Cranz Cullen Endowed Professor of Biomedical Engineering
(Published May 6, 2014)

Bloomberg Businessweek
Old Math Casts Doubt on Accuracy of Oil Reserve Estimates
Featuring John Lee, Professor and Hugh Roy and Lillie Cranz Cullen Distinguished University Chair of Petroleum Engineering
(Published April 3, 2014)

Business Recorder
U.S. Oil Reserves Jump on Shale but Gas Tumbles in 2012: EIA
Featuring John Lee, Professor and Hugh Roy and Lillie Cranz Cullen Distinguished University Chair of Petroleum Engineering
(Published April 11, 2014)

E&P Magazine
Training Tomorrow's Subsea Engineers
Featuring Phaneendra Kondapi, KBR Adjunct Professor of Mechanical Engineering
(Published August 1, 2014)

Houston Chronicle
Finding New Energy Offers Never-Ending Challenges
Featuring David Shattuck, Associate Professor of Electrical and Computer Engineering and Associate Dean of Undergraduate Programs
(Published July 11, 2014)

Industry Raids Academia for Oil Engineering Talent
Featuring Tom Holley, Professor and Director of Petroleum Engineering Program
(Published July 4, 2014)

Houston Matters
Offshore Technology Conference
Featuring Tom Holley, Professor and Director of Petroleum Engineering Program
(Published May 5, 2014)

Houston Medical Journal
University of Houston Biomedical Engineer Works to Make Blood Transfusions Safer
Featuring Sergey Shevkoplyas, Associate Professor of Biomedical Engineering
(Published July 23, 2014)

Medical Xpress
Biomedical Engineer Looks at New Applications for Novel Lupus Drug
Featuring Chandra Mohan, Hugh Roy and Lillie Cranz Cullen Endowed Professor of Biomedical Engineering
(Published July 24, 2014)

News-Medical
New Textbook on Tissue Engineering and Artificial Organ Development
Featuring Ravi Birla, Associate Professor of Biomedical Engineering
(Published July 26, 2014)

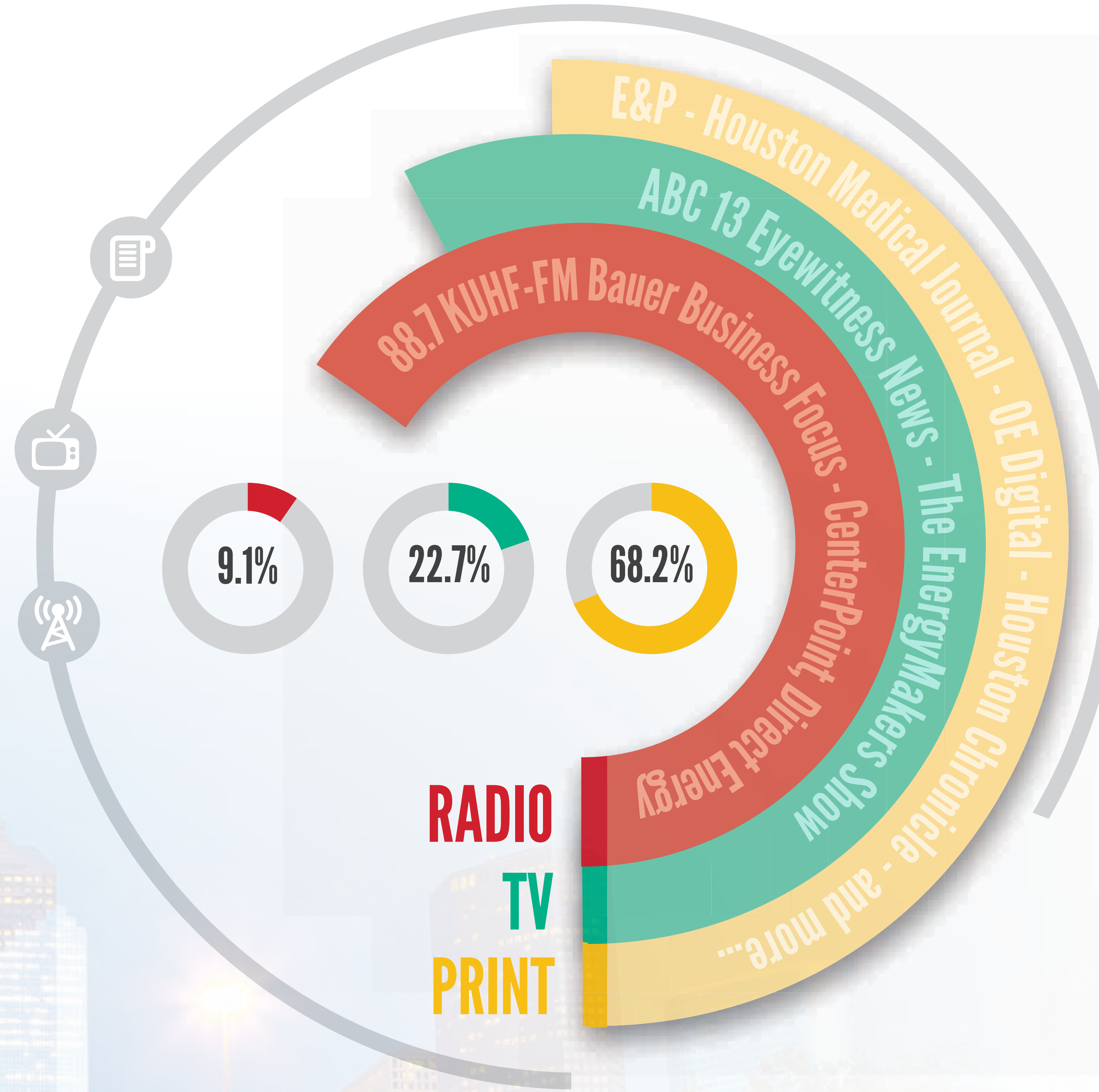
New Version of Drug Successfully Treats Lupus in Mice
Featuring Chandra Mohan, Hugh Roy and Lillie Cranz Cullen Endowed Professor of Biomedical Engineering
(Published July 24, 2014)

UH Biomedical Engineer Receives ALR Grant to Study Case of Lupus Nephritis
Featuring Chandra Mohan, Hugh Roy and Lillie Cranz Cullen Endowed Professor of Biomedical Engineering
(Published May 6, 2014)

OE Digital
ERP Aims to Fuel Houston's Energy Industry
Featuring Tom Holley, Professor and Director of Petroleum Engineering Program, and Venkat Selvamanickam, M.D. Anderson Chair Professor of Mechanical Engineering
(Published July 15, 2014)

Orlando Sentinel
U.S. Proved Crude Reserves Reach 36-Year High on Shale Oil
Featuring John Lee, Professor and Hugh Roy and Lillie Cranz Cullen Distinguished University Chair of Petroleum Engineering
(Published April 11, 2014)

The Pearland Journal
Are You Ready for Hurricane Season to Enter High Gear?
Featuring Cumaraswamy "Vipu" Vipulanandan, Professor of Civil and Environmental Engineering and Director of the Texas Hurricane Center for Innovative Technology (THC-IT)
(Published July 21, 2014)



COLLEGE NEWS

Cullen College Spearheads $3.3M Grant to Promote Women in STEM Fields

The University of Houston was awarded a $3.29 million grant over five years by the National Science Foundation's (NSF) ADVANCE program to increase the number and success of women faculty in the science, technology, engineering and mathematics (STEM) fields.

The focus of the ADVANCE program is to "increase the representation and advancement of women in academic science and engineering careers, thereby contributing to the development of a more diverse science and engineering workforce." This award will allow the university to establish a "Center for ADVANCING Faculty Success" to oversee the goal of increasing female STEM faculty recruitment, especially among women of color, as well as enhancing UH's infrastructure to make gender equity and diversity campus-wide priorities.

The Cullen College of Engineering spearheaded the grant proposal with support from the College of Technology, the College of Liberal Arts and Social Sciences, the College of Education and the College of Natural Sciences and Mathematics. Renu Khator, chancellor and president of the University of Houston, is the principal investigator on the grant.

Co-investigators include Joseph W. Tedesco, Elizabeth D. Rockwell Professor and Dean of the Cullen College of Engineering; Bonnie Dunbar, M.D. Anderson Professor of mechanical and biomedical engineering, director of the UH STEM Center and the aerospace engineering program; Dan Wells, interim dean of the College of Natural Sciences and Mathematics; and Holly Hutchins, associate professor of human development and consumer sciences in the College of Technology.

"The future of the engineering profession in the U.S. depends on recruiting more women and underrepresented minorities," Tedesco said. "In order to be successful, we need women and underrepresented minority role models in leadership positions throughout our STEM colleges. This grant will help UH to achieve that goal, and I'm extremely proud that the Cullen College of Engineering has taken a leadership role in this process."

The UH grant proposal included several goals in addition to attracting more women STEM faculty at senior, mid-career and junior levels. The center also hopes to increase the support and representation of women STEM faculty in administrative leadership positions at the department, college and university levels.

To achieve these goals, UH will establish mentorship programs between senior female STEM faculty members and their mid-career and junior counterparts. The ADVANCE Center will also launch diversity training and workshops for STEM chairs, deans and faculty members. Other programs to be implemented include leadership training for administrators, work-life integration activities for female employees and a "STEM in the Americas" speaker series.

Paula Myrick Short, senior vice chancellor for academic affairs for the UH system and provost of UH, will serve as the center's director. Lisa Robertson, executive director of external relations and strategic partnerships at the Cullen College, will serve as interim managing director.

In addition to creating an environment favorable to women STEM professionals, the proposal also establishes an ADVANCE Regional Network (ARN), linking Prairie View A&M University, Rice University, Texas A&M University and the University of Texas – Pan American with UH.

ARN will be the first-ever regional, multi-institutional ADVANCE network. Each of the ARN partners brings to the network a broad set of ADVANCE expertise that will be shared through mentoring programs, workshops, special events and webinars. ARN will provide a platform from which ADVANCE centers can reach out to other institutions to engage in dialogues about women faculty's experiences and help catalyze activities at those institutions to improve the success of women STEM faculty.

The period of performance for the NSF grant will run from Sept. 1, 2014 through Aug. 31, 2019.

To learn more about the UH ADVANCE Center, please visit: www.uh.edu/advance.

Biomedical Engineering Department Hosts 'BME Day: New Frontiers in Healthcare'

The UH Cullen College of Engineering's Department of Biomedical Engineering hosted the first-ever "BME Day: New Frontiers in Healthcare" last April at the UH Hilton. The event was co-sponsored by BioHouston and included talks from the world's leading experts, researchers and movers and shakers from the biomedical engineering field.

The department of biomedical engineering is a new addition to the Cullen College, and department chair Metin Akay said BME Day will help to "promote and strengthen the biomedical and healthcare engineering research and educational programs at UH and in Texas."

Speakers at the event included Andrew Laine, Columbia University professor and IEEE-EMBS president elect; Theresa Good, director of the National Science Foundation's biotechnology, biochemical and biomass engineering program; Shuming Nie, biomedical engineering professor at Emory University and the Georgia Institute of Technology; Ferdinando Mussa-Ivaldi, biomedical engineering professor at Northwestern University; and May Wang, biomedical engineering professor at the Georgia Institute of Technology. Topics covered ranged from advances in healthcare technologies to the development of long-term and cost-effective healthcare solutions, delivery and management.

Industrial Engineering Offers New Joint IE/M.B.A. Program

The UH Cullen College of Engineering and the C.T. Bauer College of Business have teamed up to create an interdisciplinary degree in industrial engineering (IE) and business administration, called the IE/M.B.A. program. The program was offered to students for the first time this fall.

According to Gino Lim, Hari and Anjali Agrawal Faculty Fellow and chair of the industrial engineering department at the Cullen College, the curriculum for a degree in industrial engineering and an M.B.A. complement one another in a way that sets students up for future success in their careers. Industrial engineers often work in fields such as energy, healthcare, finance, transportation, logistics, manufacturing and information technology. In these fields, industrial engineers address topics such as data analytics, optimization, statistical analysis, simulation, systems engineering, quality control, project management, reliability and safety – all of which require skills that can be further sharpened with a business education.

"An industrial engineering degree gives you analytical background, and an M.B.A. gives you an entrepreneurial background," Lim said. "It's really the perfect combination, and I'm ecstatic to be able to offer the best of both worlds to our students."

CITIES

International Team Using Shape Memory Alloys to Rehab Concrete Structures

A team of researchers from the UH Cullen College of Engineering and Qatar University has won a $779,000 grant to develop a new way to rehabilitate deteriorating reinforced concrete structures.

The three-year grant, from the Qatar National Research Fund, goes to a team led on the UH end by civil and environmental engineering assistant professor **Mina Dawood**. His UH collaborators are professor Abdeldjelil Belarbi and assistant professor Bora Gencturk, both from the same department. They are teaming up with Mohammed Al-Ansari, a civil engineering professor at Qatar University in Doha, Qatar.

There's nothing new about attempts to extend the life of old concrete structures. It's often far cheaper to extend the life of an existing bridge or building by several years (or decades) through rehabilitation than to replace it completely.

One well-established technique in this field is the use of fiber-reinforced polymers (FRPs), which are essentially super-strong fabrics that can be wrapped around columns. This, said Dawood, is an example of passive confinement. FRPs wrapped around a column confine the structure and limit outward expansion. The repair materials are engaged when – and only when – the column deforms or experiences damage.

But Dawood and his colleagues are proposing an active confinement system that confines the column at all times. At the heart of this research are shape memory alloys (SMAs), which are materials that can take on specific shapes when exposed to specific conditions. This research uses commercially available SMAs that are long pre-stretched wires or rods that contract to their original lengths when heated.

While their initial efforts will focus on the type of deterioration caused by Qatar's harsh environment, the research team plans to develop a fundamental model of the behavior of SMA-reinforced concrete. Such a model would allow this reinforcement technique to be translated to different structural members with varying degrees of deterioration.

Researchers Win $700K Grant to Develop Pipeline Safety System

Damage to natural gas pipelines is both dangerous and expensive to repair. Much of it is also entirely avoidable.

Excavators cause about 30 percent of pipeline damage incidents. In most of these events, the teams working the excavators began digging before they consulted a 24/7 national hotline that provides locations for natural gas pipelines.

In response, two researchers with the UH Cullen College of Engineering are developing a low-cost GPS-based system that can provide real-time alerts for pipeline owners and excavator operators when digging takes place near the pipelines. The research is supported by a $700,000 grant from the U.S. Department of Transportation and the Gas Technology Institute.

Assistant professor **Craig Glennie** and professor **Hanadi Rifai**, both with the civil and environmental engineering department, are leading the project.

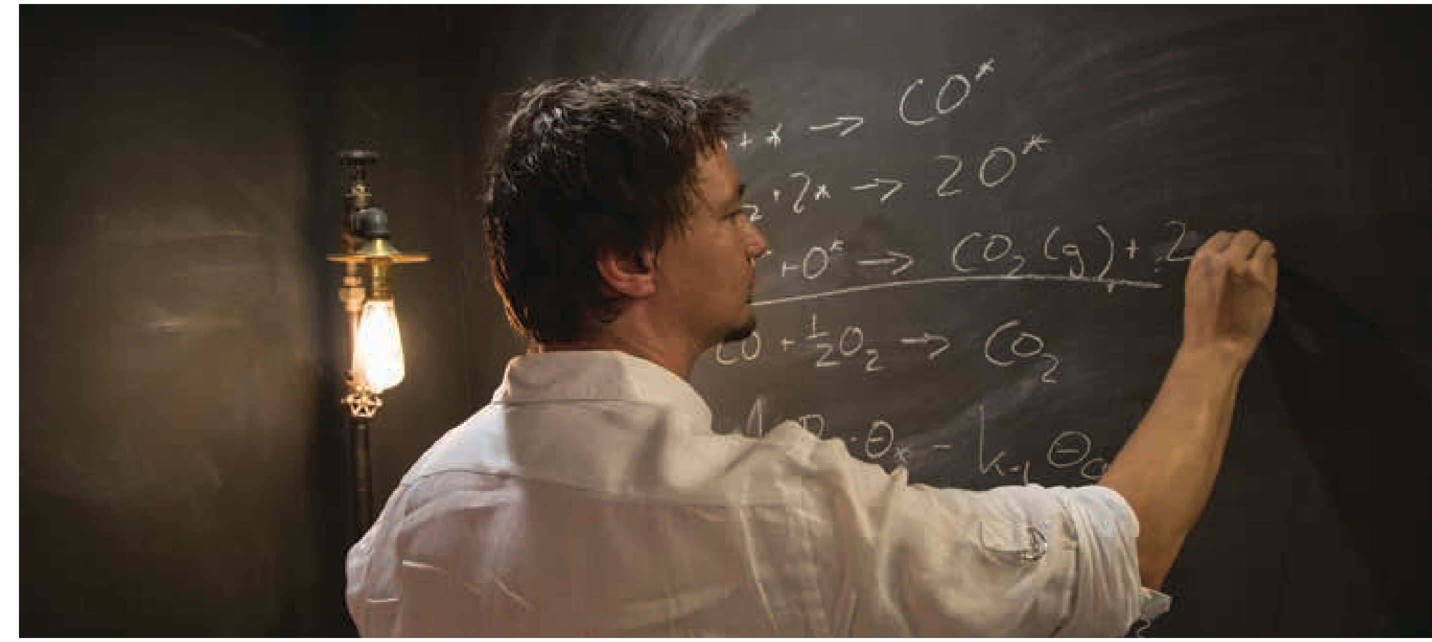
The system employs two GPS units, one in the cab of the excavator and one at the end of the digging arm. The units will not only reveal where exactly the excavator is, but by comparing the readings from each one, the researchers will be able to tell whether the arm is actually below ground level, indicating that it is digging.

That information will be sent over a cellular network to a central server loaded with a geographic information system, or GIS, that will provide an accurate map of pipeline locations and their buffer zones. The GPS data and the GIS are then matched up to look for potential problems.

"The software will look at the signals coming from the excavator in real time, determine if it's within any pipeline boundaries and actively digging, and if it is, will alert the owner of the pipeline and the person operating the excavator," Glennie said.

While there are other systems that warn operators about pipelines, they cost tens of thousands of dollars. Glennie and Rifai are aiming for a system that costs between $500 and $750.

ENERGY



Lars Grabow, assistant professor of chemical and biomolecular engineering

Professor Wins DOE Early Career Award to Upgrade Bio-Oil to Fuel

Lars Grabow, an assistant professor of chemical and biomolecular engineering at the UH Cullen College of Engineering, has won a U.S. Department of Energy (DOE) Early Career Award to explore new ways of upgrading bio-oil to fuel. The award is designed to support the nation's most exceptional researchers during the early years of their careers.

Bio-oil, which is oil made from wood and other plant materials, is an intermediate product in the conversion of biomass to biofuel and chemicals. Currently, bio-oil isn't suitable as a transportation fuel or for chemical use because the oxygen content is too high – as much as 40 percent by weight. This makes it unstable and incompatible with petroleum-based fuels.

The DOE's goal is to replace about 30 percent of all fossil-derived fuels with biofuels by 2025, with biochemicals replacing about 25 percent of all petroleum-derived chemicals by 2025.

Bio-oil is created in a process called flash pyrolysis, which involves rapidly heating biomass – wood, such as dead trees and branches, switchgrass or other plant waste – until it forms a vapor, which then condenses to a liquid. But the oil's high oxygen content results in a low heating value, making it unsuitable to combine with conventional fuels.

Researchers know how to remove the oxygen, Grabow said, but it's not cost-effective. That's the next step in his research, which he will continue with the funding from the Early Career Award.

One key will be to attempt to adapt existing technologies, including those used in refineries to remove sulfur from petroleum products. Most of his work is done with supercomputers, simulating reactions to predict what materials might work as good catalysts and, ultimately, creating a database of possible solutions. When his lab comes up with a promising solution, collaborators at the University of Oklahoma and the Massachusetts Institute of Technology will test it, Grabow said.

Although the DOE has been forced to scale back some of its ambitious goals for biofuels over the past few years, Grabow said he's confident that ultimately the concept will be successful.

"It's not going to be tomorrow," he said. "It's maybe not going to be in 10 years. At some point, even abundant natural gas is going to run out. The only truly sustainable energy source is the sun."

The sun is the true source of biofuels, too, he said, providing food for plant life.

In addition to Grabow's work on upgrading bio-oil, his lab works with converting methane into value-added chemicals and with treating emissions from natural gas and diesel engines.

The DOE announced 35 Early Career Awards earlier this month, 17 to scientists working in the DOE's national laboratories and 18 to researchers in the nation's universities. Grabow's work was selected for funding by the Office of Basic Energy Sciences.

ENERGY

Professor Develops Plant-Based Materials for Wind Turbines

Megan Robertson, assistant professor of chemical and biomolecular engineering at the UH Cullen College of Engineering, has won a $100,000, two-year Norman Hackerman Advanced Research Program (NHARP) grant from the Texas Higher Education Coordinating Board to develop fruit and vegetable-based materials for wind turbines. The purpose of the NHARP grant is to encourage and provide support for basic research in biomedicine, energy and the environment.

Robertson will be working with a class of polymers (which are long, chain-like molecules made up of repeating units) called epoxy resins, a type of adhesive material you can buy in any hardware store. Epoxy resins are commonly used for a wide variety of applications, from coating floors and countertops to structural composites – and, more recently, for wind turbine blades.

Traditional epoxy resins are partially derived from a compound called bisphenol A, or BPA. Traditional BPA-based epoxy resins have desirable traits such as high strength and stiffness, but they also have some deficiencies, such as brittleness. After being exposed to stresses for long periods of time – such as the wind shear against wind turbine blades that are constantly in motion – the material will become fatigued and eventually fail.

"One goal of this project is to make materials that are more ductile and tough compared to current materials, and another major goal is to make materials that are sustainable and environmentally friendly," Robertson said.

Robertson specializes in studying plant-based products for plastics and rubbers. This research won her the National Science Foundation's CAREER Award last January, one of the most prestigious grants given to young investigators.

Applying her plant-based polymer expertise to the field of wind energy made wonderful sense, said Robertson, especially since UH is home to the National Wind Energy Center, which received a $2.3 million grant from the U.S. Department of Energy in 2010. "The state of Texas is also investing in wind as an energy source, so it seems very relevant to be working on materials for that alternative energy source here in Houston," said Robertson.

For epoxy resins, Robertson's group is looking into replacing BPA with phenolic acids, which are compounds found in fruits and vegetables. Because BPA and phenolic acids have similar molecular structures, Robertson hopes the "green" epoxy resins her team develops will have similar properties to the BPA-based resins.

Robertson's group is also investigating the incorporation of vegetable oils into epoxy resins, which will make the materials biodegradable, providing additional end-of-life options such as disposal in a compost facility. Currently, no epoxy resins can be recycled, but Robertson believes this shouldn't be the case. "We want to look at the full lifecycle of a material – not only what the source of the material is, but what happens to the material after the end of its lifecycle," Robertson explained.

DOI Award Funds New Technologies for Detecting Subsea Oil Spills

The U.S. Department of the Interior's (DOI) Bureau of Safety and Environmental Enforcement has awarded electrical and computer engineering assistant professor **Wei-Chuan Shih** with nearly $900,000 over two years to investigate new sensing techniques for detecting oil spills and hydrocarbon leaks in subsea oil and gas operations.

One of the challenges faced by the offshore petroleum sector is monitoring for oil leaks at unmanned production platforms. This is typically done by visual inspection carried out on a helicopter – an imperfect solution at best. Helicopters are expensive to operate and cannot fly during the night or under inclement weather, while visual inspections can miss leaks.

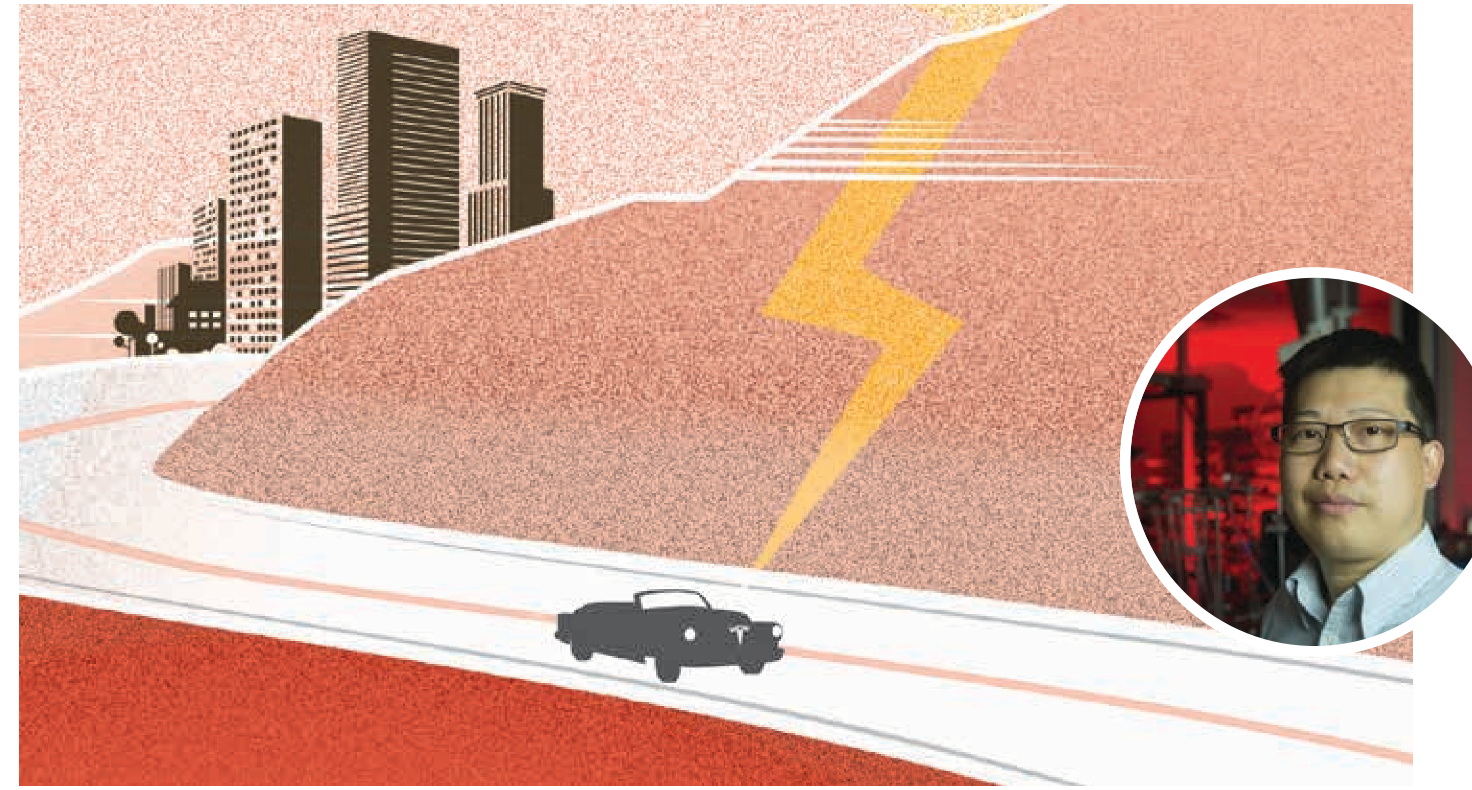
In the case of subsea oil and gas operations, which take place hundreds to thousands of feet under water, leaks often go undetected until the oil reaches the ocean's surface. The technology Shih develops will detect very small quantities of contaminants such as oil and hydrocarbons at the ocean floor.

His idea involves an optical fiber integrated with a gold plasmonic nanostructure consisting of light-excited electrons. Plasmonics enables very strong light-matter interactions near the surface of these gold nanostructures, which Shih said would allow certain "hot spots" along the fiber to interact with particles in the environment.

Based on how excited the electrons in the fiber become – that is to say, how much they oscillate in response to certain interactions – Shih and his team will develop fingerprints of various subsea contaminants. "By measuring the returned or transmitted light, one can potentially identify the local chemical and molecular environment," he said.

Shih's collaborators on the project include Ramanan Krishnamoorti, professor of chemical and biomolecular engineering as well as the university's chief energy officer, and Zhu Han, associate professor of electrical and computer engineering.

In addition to detecting potentially harmful chemicals in subsea environments, Shih said the sensors he's developing will allow his team to study little-understood hydrocarbon-water interactions such as emulsion, wherein water and oil blend together through the constant motion of ocean waves. Emulsion makes the already tedious process of cleaning up an oil spill all the more complicated, and Shih said he hopes the data his team collects will provide insight into more effective remediation efforts after a spill occurs.



Yan Yao, assistant professor of electrical and computer engineering

NSF Award Boosts Sodium-Ion Battery Research in Texas

Last June, Texas Gov. Rick Perry drove an electric car made by Tesla Motors in front of the Texas State Capitol Building in Austin – a symbolic gesture meant to signify his intention of convincing Tesla executives to build their more than $4 billion battery factory here in the Lone Star State.

"The timing of all of this couldn't be better for battery research," said **Yan Yao**, assistant professor of electrical and computer engineering at the UH Cullen College of Engineering. Yao recently won a three-year award from the National Science Foundation (NSF) totaling more than $340,000 to develop sodium-ion batteries.

This research is particularly important to the state of Texas, which is the only state in the U.S. with an independent electricity grid. Because of this, the state has the benefit of making modifications to its grid without seeking federal approval to do so. "Now the state is looking into adding an energy storage function to the existing grid," Yao explained. "This is the motivation for my research group."

Yao's main research expertise is developing suitable alternatives to traditional lithium-ion batteries, which are used to power much of the modern world. Lithium ions are commonly used in batteries because they are light and have a high energy density, which allows them to hold large amounts of energy in a small space, said Yao.

Lithium, though, is an expensive metal. When building batteries to power a cell phone, for example, the cost of lithium ions may seem somewhat reasonable, but as we move toward building batteries that can power an electric car or store energy from an electricity grid, the need for far cheaper materials becomes increasingly urgent.

That's why Yao first proposed to study the underlying kinetics and mechanisms of sodium-ion batteries, an earth abundant material that's much cheaper than lithium ion. However, Yao explained that sodium-ion batteries are extremely difficult to make. Because the size of sodium ions is much larger than lithium ions, they charge and discharge energy much slower than their lithium counterparts.

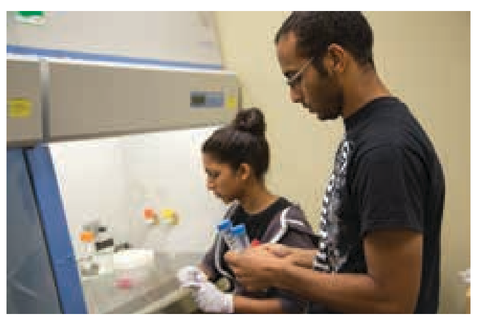
Yao said he hopes that by understanding the fundamental limitations of sodium ion intercalation kinetics in existing host materials used for batteries, his team will be able to develop better sodium-ion batteries which can store and discharge energy as efficiently as lithium-ion batteries.

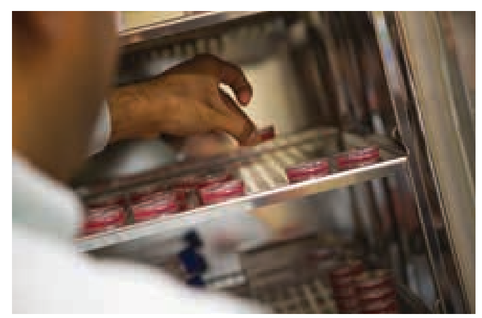
This research falls under the NSF's "SusChem" (or sustainable chemistry) initiative, which addresses the interrelated challenges of sustainable supply, engineering, production, and use of chemicals and materials. Yao said much of the research within his lab is devoted to finding low-cost, earth-abundant and sustainable energy storage solutions.

The media attention surrounding Tesla's Gigafactory helped to put the spotlight on the importance of battery research, Yao said. Since many of the non-lithium-ion batteries his lab is developing would work well for electric vehicles and even for power grid energy storage, he added that "it's a very exciting time for my lab group."

HEALTH

Biomedical Engineering Professor Publishes First Comprehensive Textbook on Tissue Engineering





Top: Ravi Birla, associate professor of biomedical engineering
Bottom: Birla conducts research in his lab with graduate students

***Ravi Birla**, associate professor of biomedical engineering, has published the first-ever definitive textbook on tissue engineering.*

"Introduction to Tissue Engineering: Applications and Challenges" offers a comprehensive guide for students entering the field of artificial organ development. Biomedical engineering founding chair and professor Metin Akay served as a series editor on the book.

According to Birla, there are some published books on the subject of growing artificial organs and tissues, but many of these are either out of date or serve as a collection of articles written by different researchers rather than as an instructional guide that students or individuals entering the field can follow. "These books are written by different authors, and you really can't use them for teaching," Birla explained. "It's highly inconsistent in terms of who is saying what, and they're designed to be read by professionals who are already very familiar with the field of growing and engineering artificial organs."

Birla's book, however, was written with undergraduate and early graduate students in mind, providing an accessible and easy-to-follow overview of how to synthesize artificial organs in a laboratory. To simplify this highly complex field of research into a guide that's accessible to entry-level engineers, Birla broke down his tissue engineering process into eight steps, each with its own designated chapter.

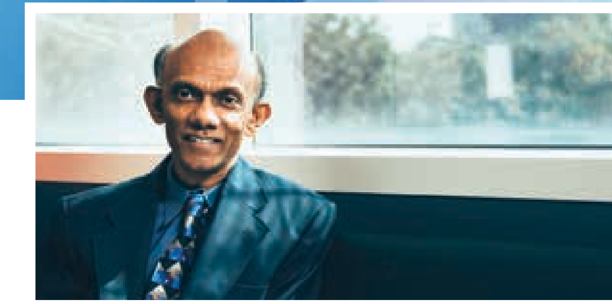
In addition, Birla's textbook proposes a new, standard definition of tissue engineering.

"If you look at what's happening, [the definition of] tissue engineering is so convoluted," Birla said. "One of the exercises we went through was to go through some of the prominent definitions, like the National Science Foundation's and the National Institutes of Health's definitions, as well as the definitions from some of the early researchers in the area, and based on that we came up with the commonalities of the definition and what the field involves. From that, I proposed a standard definition of tissue engineering." Birla said he hopes the definition provided in his textbook will become the new standard.

In addition to bringing some consistency and uniformity to tissue engineering curriculums at universities across the country and around the world, Birla said he hopes his textbook will encourage more young STEM-enthusiasts to enter into this exciting new field.

"I want not only to make this field more accessible to a larger number of people, but I want to help get younger people excited about tissue engineering and about STEM in general," Birla said. "My hope is that this textbook will introduce some young people to the field in a way that excites them so we have many more talented engineers entering into this field and conducting new research."

Plant Extract Offers Hope as Lupus Treatment



Chandra Mohan, Hugh Roy and Lillie Cranz Cullen Endowed Professor of biomedical engineering

Chandra Mohan, Hugh Roy and Lillie Cranz Cullen Endowed Professor of biomedical engineering at the Cullen College, has published findings that raise hope for a new class of drugs to treat lupus that may not include the long list of adverse risks and side effects often associated with current treatments for this disease.

The promising findings were recently published in Arthritis & Rheumatology, the monthly journal of the American College of Rheumatology.

Lupus, or systemic lupus erythematosus, is a progressive, degenerative disease in which the immune system turns against itself, attacking a person's healthy tissue, cells and organs. Symptoms range from debilitating pain and fatigue to organ failure and a host of other impairments. An estimated 1.5 million Americans, and at least 5 million people worldwide, have a form of lupus.

Mohan and his team are working toward finding new treatments for lupus and, ultimately, a cure. This latest work could lead to new, more natural therapeutics for lupus that are derived from plant-based chemicals.

With only one drug specifically approved for the treatment of lupus in the past 50 years, lupus patients are commonly treated with steroids, a class of immunosuppressive drugs that delay the development and progression of the disease by suppressing the immune system. By suppressing the immune system in its entirety, however, this mode of treatment carries with it an increased risk of infections and other harmful side effects.

In this latest research, Mohan and his colleagues present new findings that detail the use of a synthetic, plant-derived compound – abbreviated CDDO – that was shown to effectively suppress the multiple steps of lupus development in murine models, including the onset of kidney disease.

One of the most common organs to be attacked by lupus is the kidney, manifesting in lupus nephritis. While this condition doesn't affect all lupus sufferers, an estimated 40 percent of lupus patients develop it. Lupus nephritis, which causes inflammation of the kidneys and impairs the organ's ability to effectively rid the body of waste products and other toxins, is the leading cause of lupus-related deaths and results in tens of thousands of hospitalizations per year.

"The development of lupus is a two-step reaction. First, the immune system develops antibodies that attack the body's own DNA, then that activated immune system attacks the kidneys," Mohan said. "We found that CDDO may block both of these steps."

Mohan said there is much left to be discovered about CDDO, including how it works in suppressing the progression of lupus. The next step for this research is to confirm whether the CDDO compound suppresses the immune system across the board, or whether it simply suppresses the activation of the specific signaling pathways that lead to the development of lupus. In order to find this out, Mohan's group will test it in the lab to see if they can mount the proper immune response. If not, Mohan says the compound likely could be suppressing the entire immune system, which is the current problem with using steroids to treat lupus. Even if the compound is shown to be generally immunosuppressive, however, it still may be a better treatment option than steroids for some patients.

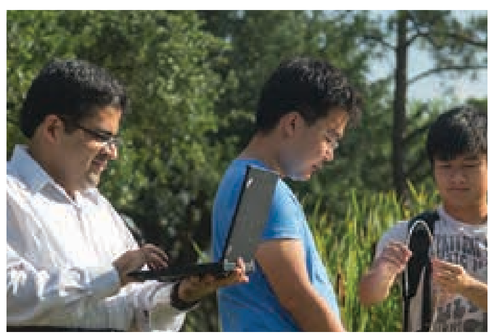
"The most exciting part of this research is that CDDO is originally plant-derived, so it's relatively natural and carries less chance of side effects," Mohan said. "That's a very important point, because many of the current therapeutic agents being used for lupus have significant side effects. As far as we have tested in these experiments, we found that the CDDO compound had no known side effects. Additionally, compared to many other test compounds we've previously tried for treating lupus, this one appears to be much more effective."

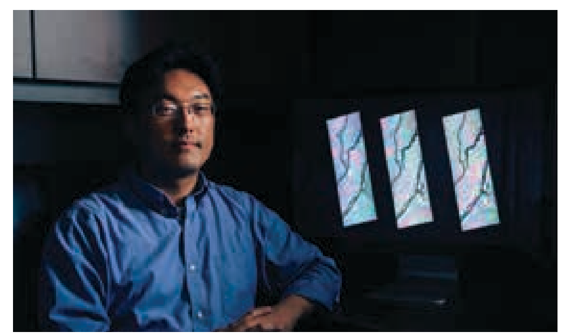
While it will take time to validate this before the compound can move from testing in the lab to clinical trials in humans, Mohan is encouraged by the prospect of treating lupus patients with more natural compounds that have fewer side effects.

IMAGING

Two Imaging Analysis Experts Win NASA New Investigator Awards in Earth Science

Two professors at the UH Cullen College of Engineering won New Investigator Awards in Earth Science from NASA. Only 21 proposals were selected from more than 130 submitted. The New Investigator Program was established by NASA in 1996 to support outstanding scientific research and career development of scientists and engineers at the early stages of their professional careers.





Left: Saurabh Prasad, assistant professor of electrical and computer engineering, conducts research with students
Right: Hyongki Lee, assistant professor of electrical and computer engineering

Professor Develops Novel Image Analysis Techniques to Study Gulf Coast Wetlands

Saurabh Prasad, assistant professor of electrical and computer engineering, won NASA's New Investigator Award to develop novel approaches for advancing state-of-the-art geospatial image analysis. The algorithms he develops to extract information from these images will be used to study the ecology of the Gulf Coast wetlands.

The algorithms Prasad is currently developing can take enormous data sets from geospatial sensors and turn them into maps that accurately characterize the ground cover. Prasad said that his mapping algorithms could be utilized to quantify metrics such as vegetation health, water quality, changes in vegetation cover, and sediment deposits over time, among other indicators of ecosystem health.

Currently, our ability to understand the complex ecosystem of the Gulf Coast wetlands relies on teams of scientists who must travel by boat, from point to point, to gather data on the local plants, animals and hydrology (the movement and quality of water) in the wetlands. This information, as difficult and tedious as it is to collect, is vital to our understanding of climate change and its overall impact on the environment.

Thanks to Prasad's efforts, scientists can one day use satellite and aerial imaging data in conjunction with field measurements for a much more robust understanding of coastal wetlands at various levels of detail – from very high resolution ground-based hyperspectral imagery that quantifies local processes, to wide-scale aerial and satellite imagery that can inform scientists on holistic trends related to ecosystem health.

Satellite Imaging Expert Studies Climate Change in Congo River Basin

Hyongki Lee, assistant professor of civil and environmental engineering, won NASA's New Investigator Award to study the hydrology and hydrodynamics of the waters in the Congo River Basin, and their connections to climate change, deforestation and carbon emissions.

With a surface area of approximately 3.7 million square kilometers, the Congo River Basin is the second largest river basin in the world, surpassed only by the Amazon. Compared to the Amazon, though, the Congo Basin is a mystery. Its remote location combined with political instability in the region have prevented researchers from gathering even the most basic information about the basin: How much water exists in its wetlands? Is most of this water from direct precipitation, river flooding or upland runoff? How does deforestation impact downstream discharge? Is the Congo Basin a carbon sink? All of these are unknowns.

But there's still plenty of data being collected on the Congo River Basin. Satellites orbiting the Earth are constantly imaging the region, but these bird's eye views of the wetlands provide only the crudest details of a vast and highly complex ecosystem.

Luckily, Lee is an expert at taking the various forms of satellite remote sensing data and combining them to answer complex earth science questions. In this particular project, Lee will integrate satellite radar images, satellite radar altimetry data and multi-spectral satellite images to create two-dimensional, high-resolution maps of water balances in the Congo wetlands.

The maps of the region will help to answer the most pressing questions about water flow, sources, and patterns and contributions to global methane emissions. The project should give researchers a better understanding of everything from regional climate change to greenhouse gas emissions, Lee said.

Craig Glennie, assistant professor of civil and environmental engineering

NCALM Researcher Awarded $200K To Develop Open-Source LiDAR Software

Craig Glennie, assistant professor of civil and environmental engineering and researcher at the National Center for Airborne Laser Mapping (NCALM), was awarded a two-year grant for more than $200,000 by the National Science Foundation to develop an open-source software suite tailored specifically to the users of LiDAR (light detection and ranging) data. The hope, Glennie said, is that this new software will allow for a much greater range of data analysis than is possible through current LiDAR software.

LiDAR technology allows unprecedented data collection in areas of the world that are extremely difficult to enter on foot, such as the interiors of rainforests. NCALM researchers are using the data generated by LiDAR to create detailed maps of previously uncharted areas, such as the Tahoe National Forest and the Honduran Rainforest.

The basics of LiDAR are simple: an airplane flies over the area to be mapped with a system that shoots thousands of laser pulses per second at the ground. The speed at which those pulses hit the ground and bounce back to their source can be used to calculate the exact distance between the plane and the ground.

However, the process of turning this data into a map is complicated. Users of LiDAR who want to analyze the data they've collected must rely on the limited software that comes directly from the manufacturer of LiDAR equipment.

In fact, NCALM researchers had to develop their own algorithms and add-ons for the standard software suite provided by the LiDAR equipment manufacturer to generate their highly detailed maps, one of which uncovered the legendary lost city of Ciudad Blanca in Honduras.

"The best case scenario would be if we released this software to the open source and a community of developers began actively participating and improving upon the software, uploading their own changes and algorithms to it as well, so it becomes kind of its own living, breathing organism," Glennie said.

MATERIALS

Professor Publishes First Definitive Evidence on Zeolite Growth in Science Magazine

Zeolites play an important role in day-to-day life. These crystalline materials are used as adsorbents and catalysts in a variety of chemical processes with applications for thousands of commercial and consumer products ranging from gasoline production to additives for laundry detergent. But despite their importance, zeolite growth is not well understood, and methods to synthesize zeolites have been largely ad hoc.

That is until now. **Jeff Rimer**, the Ernest J. and Barbara M. Henley Assistant Professor of chemical and biomolecular engineering with the UH Cullen College of Engineering, has published an article in Science Magazine that outlines an in situ method for visualizing the growth of zeolites through the use of instrumentation that permits measurements to be performed in realistic synthesis conditions.

Typically, researchers have relied on a powerful imaging tool called Atomic Force Microscopy (AFM), an ex situ technique to visualize the topography of zeolites after they have grown, from which inferences can be made regarding the mechanism of growth. However, AFM is traditionally used at or near room temperature, and zeolites typically grow at temperatures ranging from 80 to 100 degrees Celsius. Moreover, researchers could only image zeolites for very short periods of time using AFM because of lateral drift, or the tendency for the area being imaged to gradually shift out of the frame.

To bypass these obstacles, Rimer teamed up with a company called Asylum Research to design a liquid cell, which allows AFM to image zeolite surface growth at much higher temperatures. They also worked together to create a new software suite that accounts for lateral drift while using AFM to continuously image the surface of zeolite crystals. By shifting the view so the same surface area is imaged, researchers are able to scan zeolite surfaces for up to 48 hours.

Together, these two advancements in AFM technology from Rimer's group will allow researchers to study zeolite growth in situ and to elucidate the pathways of crystallization for the first time.

In fact, Rimer was able to conclusively answer what he calls a "25-year-old-question" about how zeolites form by using these new tools.

Researchers have been scratching their heads for more than two decades over the role of tiny silica nanoparticles which are present during the entire process of zeolite growth. Until now, researchers have wondered exactly what role, if any, these silica particles play in the growth of zeolites. Rimer's group tracked the deposition of silica particles on the surface of the crystal, revealing a highly dynamic process in which silica particles attach to the surface and rearrange themselves into the underlying crystal.

However, Rimer said that there is still much to be revealed about these particles. "We don't quite understand their structure or how they evolve over time," he said. But one thing is for sure: using the novel AFM instrumentation from Rimer's group, researchers will now be able to study zeolite growth and the role silica nanoparticle precursors play in this process with a level of detail never before possible.

Discovering New Materials for 3-D Printing With NSF Grant

The latest developments in 3-D printing technology are opening doors to advances in research fields like medicine, computing and electronics. But while these advances are promising, the feedstocks used in 3-D printing are mostly limited to simple polymers, which are great for constructing trinkets and demo devices but not as useful for creating complex circuit boards or flexible, bendable wiring.

Jacinta Conrad, assistant professor of chemical and biomolecular engineering at the Cullen College, is doing her part to change that and more. Conrad received a three-year, $299,479 grant from the National Science Foundation (NSF) to study the role of attractions in modifying the confined flow of colloids. Simply put, she and her research team are hoping to discover how to design better materials for applications like 3-D printing. "The goal here is to try to extend printing feedstocks beyond simple polymers toward functional materials," Conrad said.

Adding micro- or nano-sized colloidal particles to feedstocks is one simple way to obtain this additional functionality. However, a big issue she and her team are facing is one of traffic jams. For example, if they are looking to print a conductive end product, such as a wire, they will add conductive particles to the ink. But these particles can jam up the narrow flow channels and clog the printhead.

To address this issue, Conrad's lab creates models of printing feedstocks by mixing large particles and small polymers. They then research how to tune the interactions between the particles so the suspension can flow more readily through microscale channels. Conrad said they control the attractive interactions between the large particles by changing the size and concentration of the polymers.

While Conrad will spearhead the project, the preliminary research was conducted by chemical engineering Ph.D. student Rahul Pandey.

"Particles in flow typically want to consolidate, but consolidation is bad and causes jams, and also won't allow you to have a connected network of particles," Conrad said. "Rahul showed that by slightly tuning the interparticle attractions, you can mitigate some of the mechanisms that lead to consolidation."

Conrad's NSF grant funds outreach efforts as well. She and her research team partner with several college- and university-level initiatives, including G.R.A.D.E. Camp, STEP Forward Camp, Mars Rover and the NSF-sponsored Research Experience for Teachers (RET) to introduce students to materials engineering.

Professor and Ph.D. Student Confirm Structure of Bilayer Graphene in Nanotechnology

When a material known as graphene was first produced inside of a lab in 2004, the science and technology community buzzed with predictions that it would become the "next big thing" for the semiconductor industry. Graphene is essentially a one-atom-thick sheet of carbon that conducts heat and electricity with incredible efficiency, making it a very appealing material for the semiconductor and electronic device manufacturing industries.

Graphene can also be treated as a two-dimensional building block to create new structures. A bilayer graphene is created when one layer of graphene is stacked on another layer of graphene. Although the basic properties of single layer graphene are well understood, the properties of bilayer graphene remain a mystery for the scientific community.

Now, **Jiming Bao**, electrical and computer engineering assistant professor at the UH Cullen College of Engineering, has confirmed the band structure of twisted bilayer graphene. He published his findings in the journal Nanotechnology. His paper, "Four-fold Raman enhancement of 2-D band in twisted bilayer graphene: evidence for a doubly degenerate Dirac band and quantum interference," was selected to be highlighted on the journal's website, www.nanotechweb.org.

Perhaps one of the most puzzling properties of twisted bilayer graphene is that it is essentially a two-dimensional metallic material, making it interact with light and other materials in unusual and unexpected ways. Electromagnetic wave simulations have shown that graphene has the ability to act as an optical waveguide for surface plasmon, essentially serving as a pathway along which these electromagnetic waves can travel. Bao's group is currently exploring these peculiar plasmonic properties of graphene with the support of a National Science Foundation CAREER Award.

Working with bilayer graphene synthesized by electrical and computer engineering professor Steven Pei, Bao's group investigated the material using Raman spectroscopy. Typically, Raman intensity would be expected to double in bilayer graphene when compared to single layer graphene, but Bao's team observed a four-fold increase in Raman intensity with bilayer graphene.

Bao conducted much of his work alongside electrical and computer engineering Ph.D. student Yanan Wang, who noted that Raman enhancement was seen in previously published papers, but the phenomenon was never used to determine the underlying band structure of graphene itself.

"This is a classical example or interpretation of quantum mechanics," Bao said. "We can use this phenomenon to further explore the very interesting product of graphene and further characterize bilayer graphene." Bao added that with graphene's enormous appeal to the semiconductor industry, understanding the material and its properties has never been more crucial.

ME Chairman and Student Publish Paper on World's Thinnest Piezoelectric Material in Nature Communications

Doctoral student Matthew Zelisko (left) and Pradeep Sharma, chair of the mechanical engineering department

There are a handful of naturally occurring materials, known as piezoelectric materials, which generate electricity when bent, stretched or influenced by another mechanical force, and vice versa. Voltages applied across the materials cause them to deform accordingly.

Pradeep Sharma, M.D. Anderson Chair Professor and mechanical engineering department chairman at the UH Cullen College of Engineering, and **Matthew Zelisko**, his doctoral student, have identified one of the thinnest possible piezoelectric materials on the planet – graphene nitride. The material measures just one atomic layer, which is one thousand times thinner than a single strand of human hair. Sharma, Zelisko and their collaborators published their findings in the journal Nature Communications.

Interestingly, graphene nitride wasn't supposed to have any piezoelectric properties. "Matthew did the calculations and simulations to show that it should be piezoelectric, which was unexpected," Sharma said. Sharma and Zelisko's experimental collaborators at Rice University, led by engineering professor Pulickel Ajayan, fabricated the graphene nitride sheet devices. Another group of collaborators, led by Professor Jiangyu Li at the University of Washington in Seattle, tested the material using a state-of-the-art apparatus and proved it was piezoelectric.

The reason for graphene nitride's unexpected piezoelectricity was predicted by Sharma in some of his earlier theoretical work on the topic. "Some of Pradeep's prior work identified that pure graphene with triangular holes can effectively become piezoelectric," Zelisko said.

Sharma and Zelisko proved through this latest research that any semiconducting material can be made piezoelectric by cutting triangular holes pointing in the same direction on the material. The reason for the triangular shape, Zelisko said, is that the holes cannot have mirror symmetry to become piezoelectric. "We did scientific theoretical work that told us this would work, but this was the first time we proved our prediction," Sharma said.

STEM EDUCATION & OUTREACH

STEP Forward Camp Fosters Lasting Friendships While Teaching Engineering Basics

In 2006, just months after stepping into her new role as director of the Program for Mastery in Engineering Studies (PROMES), Kathy Zerda led her first STEP Forward Camp at the UH Cullen College of Engineering. Over the course of the week-long camp, she watched her high school campers form friendships through team building exercises and field trips, and she found herself bonding with them as well. After the camp ended, she remained in touch with some campers, a few of whom became UH cougars, and lost touch with others.

Eight years later, as Zerda prepared for another summer of STEP Forward Camp, she learned that the father of one of her 2006 campers had passed away. Zerda attended his father's wake and realized when she arrived that she was not the only member of the UH community supporting the former STEP Forward camper. In the lobby, he was surrounded by the very same group of friends whom he met at the summer camp in 2006. A group of strangers who she watched meet for the first time eight years prior had formed a bond that stood the test of time.

STEP Forward Camp is a residential engineering introduction program for rising 12th-graders sponsored by PROMES and supported by ExxonMobil, Shell, Williams, Hewlett-Packard, BP and Chevron as well as the National Science Foundation and the Texas Workforce Commission. Admission is highly competitive, and the camp is limited to a small number of talented high schoolers who spend the week immersed in introductory engineering courses. Campers stay on campus in the dorms and interact with current Cullen College students acting as mentors and counselors. The camp has taken many different forms since its inception in 1979, including different names and lengths, but the central mission, to inspire a new generation of engineers to strive for greatness, has remained the same.

The intense camp schedule has participants up at about 6 a.m. every day and busy with activities until 11 p.m. In addition to activities on campus, the group also visits companies like ExxonMobil and Hewlett-Packard to get an up-close and personal view of engineering professionals in action.

The hard work pays off, too. Campers are at an advantage when they begin their college careers because they work from the same books as Cullen College freshmen in PROMES. They leave with a realistic view of college life and benefit from the team building lessons. As Zerda witnessed firsthand, the lasting bonds formed at STEP Forward Camp expand far beyond the boundaries of the UH campus.

$1.5M Grant Helps UH Re-Think 'Gateway' Math, Science Classes

The University of Houston has received a $1.5 million grant from the Howard Hughes Medical Institute to help solve a national shortage in the number of Americans with college degrees in science, technology, engineering and mathematics (STEM).

The goal is to find new ways to encourage freshmen and first-year transfer students who enroll in classes such as chemistry, biology, physics and math to stay the course, despite difficulties many might encounter.

The university will redesign these introductory courses and expand mentoring programs, said Bonnie J. Dunbar, principal investigator on the grant and director of the UH STEM Center.

UH was among 37 research universities to receive the grants, which total $60 million over five years.

"We are not changing the standards and content," said Dunbar, who is also director of the Cullen College of Engineering's aerospace engineering program and a former NASA astronaut. "We are changing the way we present the material, to more proactively engage the students in learning through hands-on projects, and to provide academic assistance when students arrive not fully prepared from high school or community college."

In addition to changing classroom instruction, the university proposed that Houston Public Media produce short documentaries about successful alumni for use in classrooms. Also outlined was the development of social support communities for students through undergraduate technical societies.

Co-investigators on the project include Dan Wells, interim dean of the College of Natural Sciences and Mathematics; James Briggs, interim chairman of the department of biology and biochemistry; Jacqueline Hawkins, associate professor of education; David Hoffman, chairman of the department of chemistry, and Jeffrey Morgan, associate provost for education innovation and technology.

G.R.A.D.E. Camp Introduces Engineering to a New Generation of Girls

It's no secret that women are underrepresented in the science, technology, engineering and mathematics (STEM) fields. A 2011 report by the U.S. Department of Commerce showed only one in seven engineers are female. While STEM opportunities across the country increase annually, women have not seen employment growth in STEM careers since 2000.

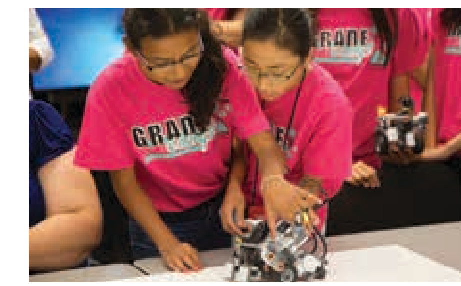
It's a monumental problem facing the U.S., but the UH Cullen College of Engineering is attacking it head-on with STEM outreach initiatives. One of these is G.R.A.D.E. Camp, or Girls Reaching and Demonstrating Excellence. G.R.A.D.E. Camp is held every summer at the college for area girls entering the eighth through 12th grades in the fall. Campers are introduced to basic engineering concepts like robotics and electronics through hands-on experiments and team-building exercises. The culmination of their experience is building a robot that follows a track through a maze, which they demonstrate for friends and family on the last day of camp.

"I want to be a role model for these girls," said Tori Speer-Manson, G.R.A.D.E. Camp mentor and electrical engineering student. "It is important for them to get involved with STEM at this age, because the world is evolving to [need] these areas of expertise. As a woman in engineering, I see that the ratio of women to men is nowhere close to being equal."

Speer-Manson has worked with the camp as a mentor under the direction of electrical and computer engineering professor Frank "Fritz" Claydon for three years. In her experience, the magic of G.R.A.D.E. Camp lies in its ability to reach even the most uninterested camper.

"On the first morning of camp, most of the girls are excited and eager to learn about engineering, but there are always a select few who aren't showing very much enthusiasm because their parents signed them up without them knowing or they just don't think they are interested in engineering," she said. "It is always great to see their attitudes toward engineering change throughout the week because they are actually having fun while learning."

In addition to hands-on experience with engineering experimentation, campers also attend lectures that introduce them to the basics of the industry and the different engineering disciplines. They also meet women who work in the industry throughout the week. By incorporating fun, team-centered activities into highly educational experiences, the camp reaches girls on a level that excites them about engineering, and more importantly, their own futures.



Subsea Engineering Program Bridges Gap Between Elementary School and College With 'Passport to UH'

School may have been out of for the summer, but that didn't stop a group of young scientists from getting their hands dirty at the UH Cullen College of Engineering. A class of 40 fourth-graders from Memorial Elementary School toured the engineering complex, as well as other UH landmarks, courtesy of the Cullen College's subsea engineering program. They enjoyed lunch at the Cougar baseball field.

The event, dubbed "Passport to UH," is part of a new outreach partnership between Memorial Elementary and the Cullen College of Engineering led by Matthew Franchek, founding director of the subsea engineering program and professor of mechanical engineering. As part of the growing relationship between the schools, UH students also spent time with Memorial Elementary students last spring semester for an egg drop competition. Students were challenged to build homemade encasements to protect raw eggs dropped from a second-story balcony.

According to Franchek, the subsea engineering program and its students intend to expand their efforts to reach elementary school students throughout the Houston area.

Researcher Wins NASA Award to Develop Flexible Batteries for Spacesuits

***Haleh Ardebili**, assistant professor of mechanical engineering at the UH Cullen College of Engineering, has won a one-year, $10,000 New Investigator Award from the NASA Texas Space Center Grant Consortium to develop flexible, stretchable batteries for spacesuits.*

With this grant, Ardebili said she will be building on current research to develop an altogether new application for stretchable batteries. "Our research is very compatible with space applications, and especially spacesuits," she said.

In 2012, Ardebili won the highly competitive National Science Foundation CAREER Award to explore the fundamental scientific underpinnings of flexible and stretchable lithium-ion batteries. When sewn into fabric, the batteries could be used to power equipment worn by soldiers in the field or as medical patches placed on the skin to monitor or diagnose patients. Worn around the wrist, the batteries could provide backup power for devices such as smartphones.

Traditional lithium-ion batteries use organic liquid electrolytes, which perform well at the expense of several favorable properties, such as stability and non-flammability. Constant risk of leakage of the unsafe liquid is another drawback. As a result, lithium-ion batteries must be protected by a hard case, such as traditional battery packs used to power toys and other electronics. The same is currently true for spacesuits, which feature hard, bulky battery packs that add significant weight and volume.

Ardebili is developing a battery that uses electrolyte gel or solid polymer rather than liquid. "The solid or gel generally gives us a safer component," she said. "It also gives us flexibility and the ability to make thin films, so from those aspects we have more advantages with these materials."

Additionally, since there is no longer any danger of having an unsafe liquid leak out, the batteries don't have the same restrictions on packaging as traditional lithium-ion batteries. That is to say, spacesuits may suddenly become a lot lighter and more flexible thanks to Ardebili's research. "If we could remove that hard, heavy battery case on current spacesuits and make the batteries into a thin, flexible film that could be embedded in a pocket or even within the lining of the spacesuit, well, that would be great," she said.

Professor Draws Inspiration for Camouflage System From Marine Life

A Cullen College professor has developed a technology that allows a material to automatically read its environment and adapt to mimic its surroundings. The technology is described in a paper published last August in the Proceedings of the National Academy of Sciences.

Cunjiang Yu, assistant professor of mechanical engineering and lead author of the paper, said the optoelectronic camouflage system was inspired by the skins of cephalopods, a class of marine animals including octopuses, squid and cuttlefish, which can change coloration quickly, both for camouflage and as a form of warning.

Other researchers on the project include John A. Rogers of the University of Illinois at Urbana-Champaign and Yonggang Huang of Northwestern University.

Earlier camouflage systems didn't automatically adapt, he said. "Our device sees color and matches it. It reads the environment using thermochromatic material."

The prototype developed by the researchers works in black and white, with shades of gray, but Yu said it could be designed to work in the full color spectrum. Similarly, he said while the prototype is less than one-inch square, it can be easily scaled up for manufacturing.

The flexible skin of the device is comprised of ultrathin layers, combining semiconductor actuators, switching components and light sensors with inorganic reflectors and organic color-changing materials in such a way to allow autonomous matching to background coloration.

The researchers describe their work as including pixelated devices that have analogs to each of the key elements included in the skin of cephalopods, with two exceptions, the iridophores and central ocular organs.

While the most valuable applications would be for defense or industry, Yu said consumer applications such as toys and wearable electronics also could offer a market for such a technology.

Another possibility? Luxury carmakers now try to give a car's occupants the sensation that the car has disappeared by deploying cameras to shoot videos on the passenger side of the car and using LED mats to display the view. Yu said this technology could be incorporated for a similar purpose.

Making Device Fabrication Easier, Thanks to NSF Grant

Ernest J. and Barbara M. Henley Assistant Professor **Gila Stein** won a $279,411, three-year grant from the National Science Foundation to build models that can explain the complex physical and chemical reactions that take place in lithography systems used for device fabrication.

The semiconductor industry relies on the lithography process to produce nearly all electronic device components. Yet, little is understood about the underlying physics and chemistry that cause the complex chemical reactions required for semiconductor patterning.

Stein wants to change this by researching materials called chemically amplified resists, which are systems wherein a polymer is blended with a catalyst to produce a chemical reaction that forms the patterns for semiconductor devices. Her collaborator is Manolis Doxastakis, a materials scientist and simulations expert at Argonne National Laboratory.

"These are the materials that are used to pattern semiconductor devices, like the chips in your computer. As computers become faster and faster, it's because you're shrinking the size of all the little devices that go into those integrated circuits, like the microprocessors and memory chips," Stein said. "So, if you want to be able to pattern things that are very, very small, you need to have really good control over the reactions that create those patterns."

The bulk of Stein's research will involve performing very simple experiments with chemically amplified resists, interpreting the results of those experiments and building models to predict how those same materials will perform under much more complex circumstances like those at the industrial scale. Having such a model in place would be a homerun for the semiconductor industry because the time needed to evaluate materials and optimize their processing would be vastly reduced.

UH Seed Funding Boosts Research on Water Splitting Nanoparticles

Last year, a researcher from the UH Cullen College of Engineering made an amazing discovery. Jiming Bao, assistant professor of electrical and computer engineering, found that cobalt monoxide nanoparticles can be used to split water into hydrogen and oxygen when exposed to sunlight.

Although these findings have enormous implications for industries ranging from energy to electronics, one huge problem remains: researchers fundamentally do not understand why cobalt monoxide nanoparticles work so effectively as photocatalysts.

But now, thanks to seed funding provided through the University of Houston's GEAR program, or Grants to Enhance and Advance Research, one Cullen College professor is joining Bao's team – and together they may be able to find the answer to this looming question. **Lars Grabow**, assistant professor of chemical and biomolecular engineering, was awarded $30,000 for one year through the GEAR program to help determine the fundamental science underpinning this mysterious phenomenon.

The bulk of Grabow's work will involve running computer simulations to try to predict how band structure changes as a function of particle size. "We will study particles of different sizes, calculate their electronic structure, extract the band edge positions, and then we want to find the trends: How does the band structure change with particle size? What is the radius at which particle dimensions actually start to matter? Then we can start to predict what is happening with the band structure of other semiconductors as their size shrinks," Grabow said.

Previously, researchers have relied only on a semiconductor's bulk properties to predict whether it will work for a given electronic application, with most research efforts focusing on band gap engineering to create suitable semiconducting materials. Once Grabow finishes his particle-size simulations, though, he hopes that researchers will then have a much larger list of materials that can work as semiconductors at the nanoscale.

Francisco Robles Hernández, assistant professor in the UH College of Technology and a collaborator on this research, will synthesize other types of semiconductors as nanoparticles and test Grabow's predictions. Grabow believes this fundamental research into the odd and unexpected behaviors of tiny particles can be exploited to the benefit of the entire semiconductor industry. Since semiconductors are used in virtually all modern electronics, these findings could have enormous implications.

HOUSTON'S HIDDEN HEROES

The Brains Behind the Bayou City

"It was time for the University of Houston to take the lead on ensuring our city is prepared for the next hurricane or natural disaster," Vipu said.

KEEPING HURRICANES AT BAY

For those of us living in the Gulf Coast region, Hurricane Ike was a resilience test for our communities.

To date, Hurricane Ike is the third costliest Atlantic hurricane of all time in the U.S., causing over $29 billion in total damages. Hurricane Ike is to blame for at least 195 deaths, but 202 people are still missing. Somewhere around 100,000 homes in Texas were flooded. Five days after Ike made landfall on Sept. 13, 2008, Galveston Mayor Lyda Ann Thomas compared the status of the island to that of a "Third World country."

In downtown Houston, office furniture floated down the flooded streets. In the following weeks, some communities experienced wastewater drainage problems, while others went without clean running water. Power outages affected more than 3 million people, which represented about 70 percent of the Houston and Galveston region. Even as far inland as Conroe, 85 miles north of Galveston Island, residents were without power for over two weeks.

The telling and retelling of these facts is more than just score keeping of the personal and economic loss caused by Hurricane Ike; it's vital to the region's preparation for future storms, hurricanes and other natural disasters. In the past 109 years, the Texas Gulf Coast – where one-third of all Texans reside – has been hit with 42 hurricanes, meaning we can reasonably expect about one hurricane every two to three years. The city of Galveston is especially vulnerable, having had 13 hurricanes in the past 110 years – the highest number of hurricanes to hit any city in Texas.

That's why, while so many residents struggled to piece together their homes and their lives in the days after Ike hit, **Cumaraswamy Vipulanandan** ("Vipu"), director of the Texas Hurricane Center for Innovative Technology (THC-IT), sat in his office in the University of Houston Cullen College of Engineering and prepared a survey document for the Gulf Coast residents affected by Ike.

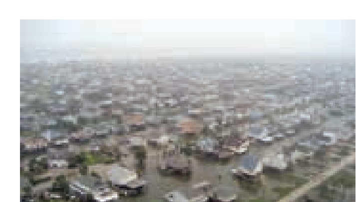
Vipu, a professor of civil and environmental engineering at the Cullen College, said the purpose of his survey was to assess how prepared Gulf Coast residents were for "giant Ike." The survey included questions about residents' locations, the type of structures they lived in (house, apartment or mobile home), the materials their homes were made of (brick, wood or concrete), their insurance statuses, and the degrees of damage to their homes, among many more questions.

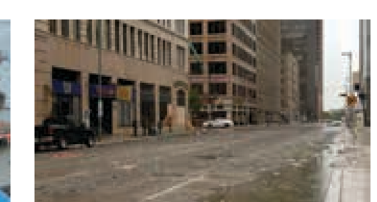
Two weeks later, Vipu delivered his three-page survey to thousands of Houstonians and coastal residents. More than 550 Texans responded to the survey, providing Vipu with invaluable insight into how prepared our communities were for Ike and how they can better prepare for the next big Gulf Coast hurricane. "We were the only guys in town doing a hands-on survey after Ike. This survey is the only one like it for the Gulf Coast region," he said. "We wanted to get information that would be useful for the future, and we did. We learned a lot."

But the learning couldn't stop with the survey, Vipu said. "It was time for the University of Houston to take the lead on ensuring our city is prepared for the next hurricane or natural disaster." So, in 2009, less than a year after Ike, Vipu formed the Texas Hurricane Center for Innovative Technology at UH along with eight other Cullen College colleagues.

The center boasts a wide range of expertise in materials science and engineering, assessment technologies, design and construction of bridges, structures and pipelines, water and wastewater treatment, flooding issues, performance of damaged foundations, and retrofitting and repairing technologies that relate to urban infrastructure. Cullen College faculty members involved in the center include Shankar Chellam, Yuhua Chen, Craig Glennie, Ramanan Krishnamoorti, Gino Lim, Yi-Lung Mo, Ramesh Shresthra, Keh-Han Wang, Hyongki Lee and Joseph W. Tedesco, dean of the Cullen College.

Vipu and the engineering dream team who make up the Texas Hurricane Center have shed new light on lessons learned from Hurricane Ike. Together, they continue to develop new technologies and smart materials for protection from future hurricanes, to predict the risk of annual hurricanes in Texas and the Gulf of Mexico, and to educate residents of the Gulf Coast region on how to ensure a rapid return to normal life after the next hurricane or natural disaster.





Impact of 2008's Huricane Ike
Left and Middle: Image Credit - US Air Force
Right: Image Credit - US Navy

LESSONS (RE)LEARNED

According to Vipu, one of the greatest lessons learned from Hurricane Ike was the need to keep relearning lessons about Gulf Coast natural disaster preparedness alongside community members and public officials.

"After all, we are Houston's University. We have a responsibility to connect with our community and share the lessons we learned and relearned about how we can prepare for the next major hurricane and other natural and man-made disasters, such as oil spills," he said.

The same year the Texas Hurricane Center was officially formed at UH, Vipu and his colleagues assembled the Gulf Coast region's top researchers, industry leaders and government officials for the first-ever Texas Hurricane Conference. "The community was very receptive," said Vipu. The day-long conference held on the UH campus featured 20 speakers and attracted roughly 100 attendees.

State Rep. Bill Callegari, a civil engineer who helped to pass legislation to create the Texas Hurricane Center shortly after Hurricane Ike, said he has attended the Texas Hurricane Conference every year since its inception. "Dr. Vipu has done a really good job with these conferences. He brings together really great speakers who are very involved in our communities – our mayors and county judges and emergency management folks... to exchange ideas on what can be done to better prepare for hurricanes and storms," Callegari said.

The Texas Hurricane Conference has been held at UH every year since 2009 and continues to grow both in terms of attendance as well as range of research and topics covered. Issues addressed at each year's conference include flood-related challenges, Port of Houston concerns and issues, coastal county preparedness and protection, and emergency management planning and collaboration in the Texas Medical Center. Power grid considerations, addressing forecast uncertainty in hurricane response plans, loss mitigation, evacuation, transportation issues, rapid recovery and new technologies are also discussed.

The sixth annual Texas Hurricane Conference was held on Aug. 1 and featured talks from leading researchers, county judges, industry professionals, and state and local emergency management representatives. "Almost anyone who is affected by Gulf Coast hurricanes is represented in one way or another at the conference," Vipu said.

The conference kicked off with a talk by Baytown Mayor Stephen DonCarlos, who outlined some of the obstacles the city faced both during and after Hurricane Ike. The city of Baytown, located on the upper portion of Galveston Bay, sustained major flood damage from the storm surge. "There was enough debris to fill the Astrodome 40 feet high," DonCarlos said. In addition, the city faced a critical shortage of clean water and fuel in the days after the hurricane. The nation's largest refinery, an ExxonMobil facility in Baytown, was one of 15 Gulf Coast refineries forced to cease operations in the aftermath of Hurricane Ike.

Nim Kidd, chief of the Texas Division of Emergency Management who gave a presentation on disaster-related challenges in the state of Texas at this year's conference, said one of the greatest strengths of the Texas Hurricane Center is its ability to bring together the state's leaders in government, academia and private industry to share ideas and new technologies that can help Texas remain at the forefront of hurricane and natural disaster preparedness.

"So many [technologies] change over the years, so bringing people together on an annual basis to have that refresher...that really keeps us on the forefront of our game in being prepared to respond to hurricanes and other natural disasters," Kidd said. "When I looked at the crowd in there today and saw state representatives and legislators – the folks that do have the ability to make and impact change when it comes to budget and law – it's important to have them in there... knowing that they understand the technologies that are being employed now."

Vipu moderated a panel on coastal protection at this year's conference, with presentations on various options under consideration, including the Ike Dike, a coastal barrier designed to protect the region from storm surge. Presenters included William Merrell and Leonard Waterworth from Texas A&M University at Galveston and Thomas Richardson from Jackson State University in Mississippi. Vipu discussed a proposal he developed in 2009 to use a shutter system to protect vulnerable coastal structures.

SMART PROTECTION WITH SMART MATERIALS

"Think of the window in your car," Vipu said. "When the weather is nice, you keep it down and feel the nice weather. When the weather is bad, you roll the window up to keep out the rain. That's the idea behind this research."

Although it's a bit more complicated than that.

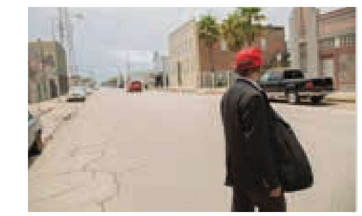
The idea behind Vipu's shutter system starts with a material that has a very special quality known as piezoelectricity. There are a handful of these engineered materials, known as piezoelectric materials, which generate electricity if you bend, stretch or apply another mechanical force to them, and vice versa – if you apply a voltage across them, they'll deform accordingly. These materials are currently the subject of intense research for their potential applications in energy harvesting, artificial muscles and sensors, among others. Piezoelectric materials are also used in everyday devices such as loudspeakers, which rely on piezoelectric characteristics to convert electrical signals to mechanical vibrations that create sound waves to produce the desired acoustic signal.

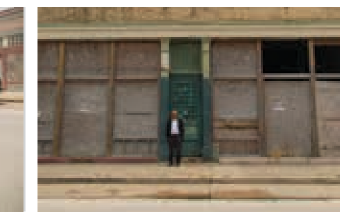
Using these materials, Vipu and his collaborators propose that piezoelectric shutters be built and buried in the ground outside of homes, businesses and other vital facilities near the coast or in areas vulnerable to flash flooding. When a hurricane hits the Gulf Coast, the idea is to bring up the piezoelectric shutters to keep out the floodwaters. When more moderate weather conditions return, the shutters can descend back into the earth – and here's one of the best parts: "If the shutters are under the ground along the coastline, the movement of the ocean's waves against the shutters can be harnessed to generate electricity inside of the facilities the shutters are protecting," Vipu said.

Vipu is also investigating the use of another smart material, known as a piezoresistive material, to create sensors that can help researchers and emergency responders identify infrastructures most vulnerable to damage from hurricane winds and waters.

Much like a piezoelectric material, a piezoresistive material also responds to pressure or stress – except instead of creating a charge or voltage, the resistiveness of the material changes. By turning these materials into sensors and placing them on bridges or on vulnerable parts of vital buildings and structures, researchers can measure the tiny changes in the material's resistance to forces and assess the speed of hurricane winds at specific locations. With this information, Vipu said researchers can determine when buildings and infrastructures are in danger of structural damage or even collapse due to hurricane winds.

Moreover, knowing exact wind speeds in specific parts of the Gulf Coast region can enable local officials to infer important information on relative flood water levels and to predict the amount of damage to specific communities, Vipu added.





Left Page: Top Image Credit - Alexander Steffler
Above: Vipu shows us around Galveston as he explains the necessity for proper storm preparedness and examines the remaining damage from 2008's Hurricane Ike

A RAPID RETURN TO NORMAL LIFE

One of the overarching goals of the Texas Hurricane Center and the Texas Hurricane Conference is to ensure a rapid return to normal life after a natural disaster such as Hurricane Ike. Although the Gulf Coast region hasn't been hit with a major storm since Ike made landfall in 2008, Vipu said that regional planners, policymakers and residents can't afford to be complacent. "The predictions are for this to be a low-key year, but things can change rapidly," he said. "The community has to be prepared. That's why having the Texas Hurricane Center here in Houston is so important."

The sixth annual Texas Hurricane Conference was co-sponsored by the Cullen College of Engineering's departments of civil and environmental engineering and industrial engineering. In a greater effort to coordinate efforts across other Gulf Coast states, speakers at the conference hailed from Mississippi, Florida and Louisiana. Texas-based speakers included David Popoff, director of Galveston County Emergency Management; Jack Steele, executive director of the Houston Galveston Area Council; Fort Bend Country Judge Robert Herbert; Randy Proyor, director of operations for CenterPoint Energy; Angela Smith, emergency management planner for Texas Children's Hospital; and Micelle Havelka, homeland security coordinator at the Texas Commission on Environmental Quality, among many others.

DRIVING HOUSTON TO CLEANER ENGINES, EMISSIONS AND FUELS

If you live in the sprawling Houston region, the odds are you're spending a lot of time inside of a vehicle.

A 2013 commuter survey conducted by the nonprofit organization Central Houston Inc. found that Houstonians travel a median distance of 20 to 29 miles to work each day. Survey respondents reported a median morning commute duration of 30 and 39 minutes and a median evening commute of about 40 to 49 minutes. This means Houston-area residents spend nearly 10 percent of their waking hours driving to and from work each day in private vehicles or on public buses.

All of these engines on the road release smog-causing emissions, as do the heavy-duty engines required for ships, tractors, generators, construction equipment, and many industrial and petrochemical processes. But together, these engines are essential elements of Houston's vibrant economy. In fact, Houston is among the major cities in the U.S. with the fastest growing economies and populations.

So how do we continue driving the region toward greater industrial and economic growth while also reducing harmful engine emissions?

This question becomes more pressing as the U.S. Environmental Protection Agency continues to tighten regulations on both smog-causing emissions (such as nitrogen oxides, or NOx) and greenhouse gas emissions (such as nitrous oxide, carbon dioxide and methane) released by vehicle and equipment engines.

"This is one of the questions we're working on around the clock," said **Henry Ng**, director of the Texas Center for Clean Engines, Emissions & Fuels (TxCEF) at the University of Houston Cullen College of Engineering.

For over a decade, Ng and a group of Cullen College faculty members who make up TxCEF have dedicated their efforts to help Houstonians breathe a little easier. Just as the name of the center implies, TxCEF conducts research to advance the discovery and adoption of new engines, fuels and emission reduction technologies that can help Houston cut down on air pollution without sacrificing its position as a booming economic epicenter.

"Our center is in a very good position to provide this kind of data, and the city of Houston needs a dedicated research center to provide them information on how to further reduce emissions and make Houston's air even cleaner," Ng said. "The city of Houston needs to set the example for other large cities on how to do this, and that's why we're here, to help the city do that."

Top: Henry Ng, director of the Texas Center for Clean Engines, Emissions & Fuels (TxCEF)
Middle: TxCEF researcher
Bottom (from left): Bill Epling, associate professor of chemical and biomolecular engineering and president of the Greater Houston Natural Gas Vehicle Alliance; TxCEF researchers test the fuel efficiency of a Harris County Metro bus

PARTNERING WITH THE CITY OF HOUSTON

TxCEF was established at UH's Energy Research Park in 2002 through an almost $4 million grant from the city of Houston. Known then as the Texas Diesel Testing & Research Center, TxCEF began as an independent testing site for emission reduction technologies that could potentially be used in the city's fleet of diesel-powered vehicles.

In 2009, the city of Houston and TxCEF made national news when a fleet of diesel-powered HISD school buses was retrofitted with state-of-the-art emission reduction systems. Then, in 2011, the center made headlines once again when it tested the fuel efficiency of diesel-electric hybrid buses owned by the Metropolitan Transit Authority of Harris County (Metro).

Since 2002, TxCEF has received almost $10 million in funding from local, state and federal government agencies, including the Texas Commission on Environmental Quality (TCEQ), the EPA and the U.S. Department of Energy (DOE). As a result, the center has expanded into a comprehensive research, development and testing center focused on more than just diesel engines.

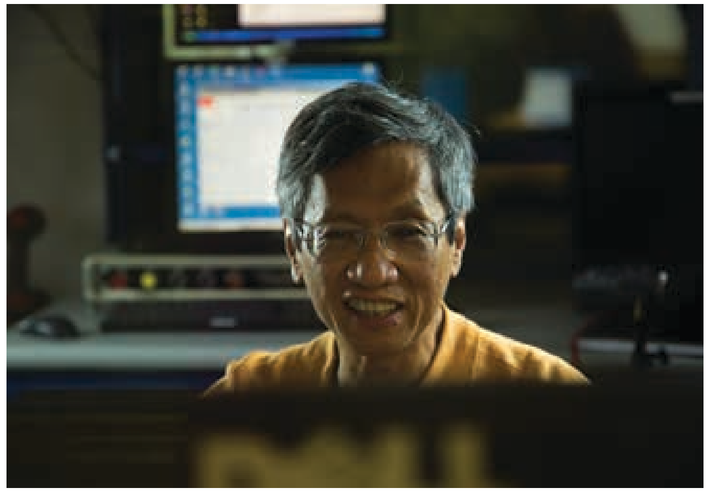
"The industry has largely solved the problem with diesel engine NOx and particulate emissions with selective catalytic reduction and diesel particulate filters, so we have less and less need to do that kind of testing [at TxCEF]," said Mike Harold, founder of TxCEF and chairman of the chemical and biomolecular engineering department at the Cullen College.

"It's a moving target," Harold said, adding that with all of the change in the engine and transportation industries, there lies great opportunity for TxCEF and its researchers. Correspondingly, TxCEF has expanded its research scope to include new catalytic converters for natural gas engines, renewable fuels, fuel additives and, of course, even cleaner emissions for mid-sized and heavy-duty vehicles.

The Cullen College's department of chemical and biomolecular engineering is uniquely equipped to take on this research. With the world's leading experts in areas ranging from catalysis to reaction engineering, one of the center's greatest strengths is predicting what the future holds for engines, fuels and emissions.

"In other words, we're not just relying on technology to come to us and then testing its efficiency or capabilities. We're actually inventing new approaches and techniques and understandings," Harold said. "The rest of the time, we're predicting what's going to happen next."

What's next for TxCEF, both Harold and Ng agreed, will come in the form of more natural gas engines, fuel additives and the continued drive for increased fuel efficiency.



THE NATURAL GAS CATCH-22

Natural gas engines currently account for only about 2 to 3 percent of all motor vehicle engines on the roads, Ng said. But with the discovery of shale gas across the vast Texas landscape, more companies are beginning to eye natural gas engines as viable alternatives to mid-sized and heavy-duty diesel engines because of their lower costs and reduced amounts of some emissions.

"But there's been a bit of a catch-22 with natural gas engines," Harold explained. Until a few years ago, there were only three public natural gas fueling stations in and around the city of Houston, which made it difficult for natural gas vehicles to gain momentum among engine makers and consumers alike.

Today, Houston has eight total public natural gas fueling stations, and several companies have announced plans to build more in the region. Adoption of the natural gas engines by area companies becomes more viable with increased access to natural gas fueling stations.

Still, one major obstacle remains that natural gas engines must overcome to take a bigger chunk of the engine market share. In a phenomenon known as "slippage," natural gas engines emit methane into the air.

"That's what we're working on in our labs right now, making catalytic converters that eliminate methane slip from natural gas engines," said **Bill Epling**, a TxCEF researcher and associate professor of chemical and biomolecular engineering at the Cullen College.

Epling got a head start on the research with funding from the National Science Foundation (NSF) and the DOE. Last year, Epling and a team of researchers from the Cullen College and Oak Ridge National Laboratory received a three-year, $1.2 million grant jointly awarded by the two agencies to develop new selective catalytic converters to further reduce emissions from diesel engines without compromising any of the engine's efficiency. Epling said part of the project includes oxidation of hydrocarbons emitted from diesel engines, and the advanced catalytic converters they develop might be fine-tuned for natural gas engines.

Epling's UH collaborators, all members of the same department, include Vemuri Balakotaiah, professor and Hugh Roy and Lillie Cranz Cullen Distinguished University Chair; Lars Grabow, assistant professor; Mike Harold, M.D. Anderson Professor; and Dan Luss, Cullen Professor of Engineering. Their Oak Ridge collaborator is Jim Parks, emissions and catalysis research group leader.

Epling and his team are developing catalytic converters that account for, and even take advantage of, the changes in temperature throughout the converter, as well as the changes in the properties of the exhaust gas.

"I call this 'tailor designing the catalyst'," Epling said, adding that his team will not focus on creating entirely new catalyst materials. Instead, they'll be altering the ratios of existing catalysts like platinum and palladium – more platinum at one end, more palladium at another, for instance. Modifying the amounts of these expensive materials throughout the converter actually reduces the amount of catalysts required for the reactions to take place, which means reduced costs for the manufacturer and the consumer alike.

"We started doing this for diesel engines about 10 years ago, and it works beautifully for those engines," Epling said. Although the lessons learned from developing selective catalytic converters for diesel engines could easily be transferred over to natural gas engines, "methane is still the toughest nut to crack," he explained. Because methane requires much higher temperatures to combust than other hydrocarbon emissions, Epling and the TxCEF team are currently looking at ways to make these catalysts work at much lower temperatures.

"We all know the new EPA regulations on methane are coming – the catalyst manufacturers, the vehicle manufacturers, not to mention all of the researchers here [at the Cullen College], so I have no doubt [the methane slippage in] current natural gas engines will be adequately addressed by the time the new rules are in place," Epling said.

"That made us extremely proud," said Ng. "Because of our work, companies will start selling these big engines with dual fuel capability."

NEW RULES, BETTER FUELS

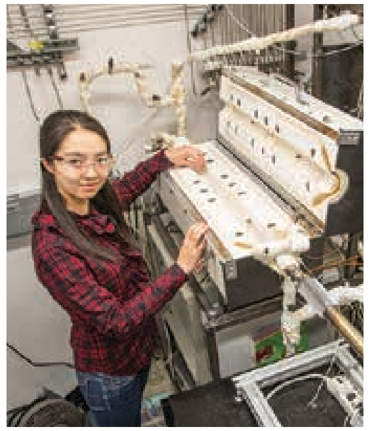
Another major area of focus for TxCEF is developing and testing fuel additives and dual fuel systems, both of which have proven to be very effective at reducing harmful NOx, CO_2 and greenhouse gas engine emissions in tests conducted at the center, Ng said.

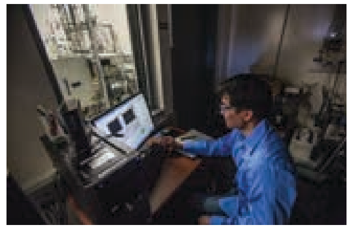
Currently, TxCEF researchers are spending much of their time evaluating new fuel additives that promise increased fuel efficiency with reduced engine emissions. These additives are particularly appealing to oil and gas companies that rely on heavy-duty engines for many retrieval and refining operations.

"We are one of the only centers in this region with the capability to perform the same certification testing that's done at EPA labs for engines and additives," Ng said. "So far, we've found that many of these additives can significantly improve engine performance while reducing emissions, so we're thrilled to be helping the city of Houston and the companies here to be the first ones to adopt these cleaner fuels and technologies."

In addition, the center recently received funding from alternative fuel maker Hythane Company to test a new dual diesel and natural gas fuel system. This dual fuel system could be added to conventional diesel engines used in hydraulic fracturing, Ng said. Testing at TxCEF confirmed that it successfully reduced harmful emissions well below current EPA requirements.

"That made us extremely proud," said Ng. "Because of our work, companies will start selling these big engines with dual fuel capability." By enabling natural gas to partially power these heavy-duty diesel engines, companies could save money on fuel while drastically reducing harmful emissions. "So we're very excited and pleased we played a major role in making this successful. We do this kind of thing a lot, but we would like to do even more of it," he said.





PREDICTING THE FUTURE FOR ENGINES, EMISSIONS AND FUELS

According to Epling, who also serves as the president of the Greater Houston Natural Gas Vehicle (NGV) Alliance, Houston's roads can expect to see more natural gas-powered vehicles, many of them public buses and commercial vehicles, in the coming years. Passenger cars are appearing more in showrooms, he said.

"For city trucks and fleets that are short-haulers – like a UPS truck with a daily route – converting to natural gas engines would save a huge amount of money on fuel," Epling said. "It's catching on more and more in the Houston region, and we're seeing more natural gas fueling stations pop up, but many are privately-owned by these companies so their fleets can refuel overnight."

And with natural gas currently sitting at about half the price of diesel fuel, he added, the cost of replacing a diesel engine with a natural gas engine generally pays for itself in six months to two years, depending on mileage. After that, companies save money on fuel – not to mention savings to the atmosphere in the reduction of harmful emissions.

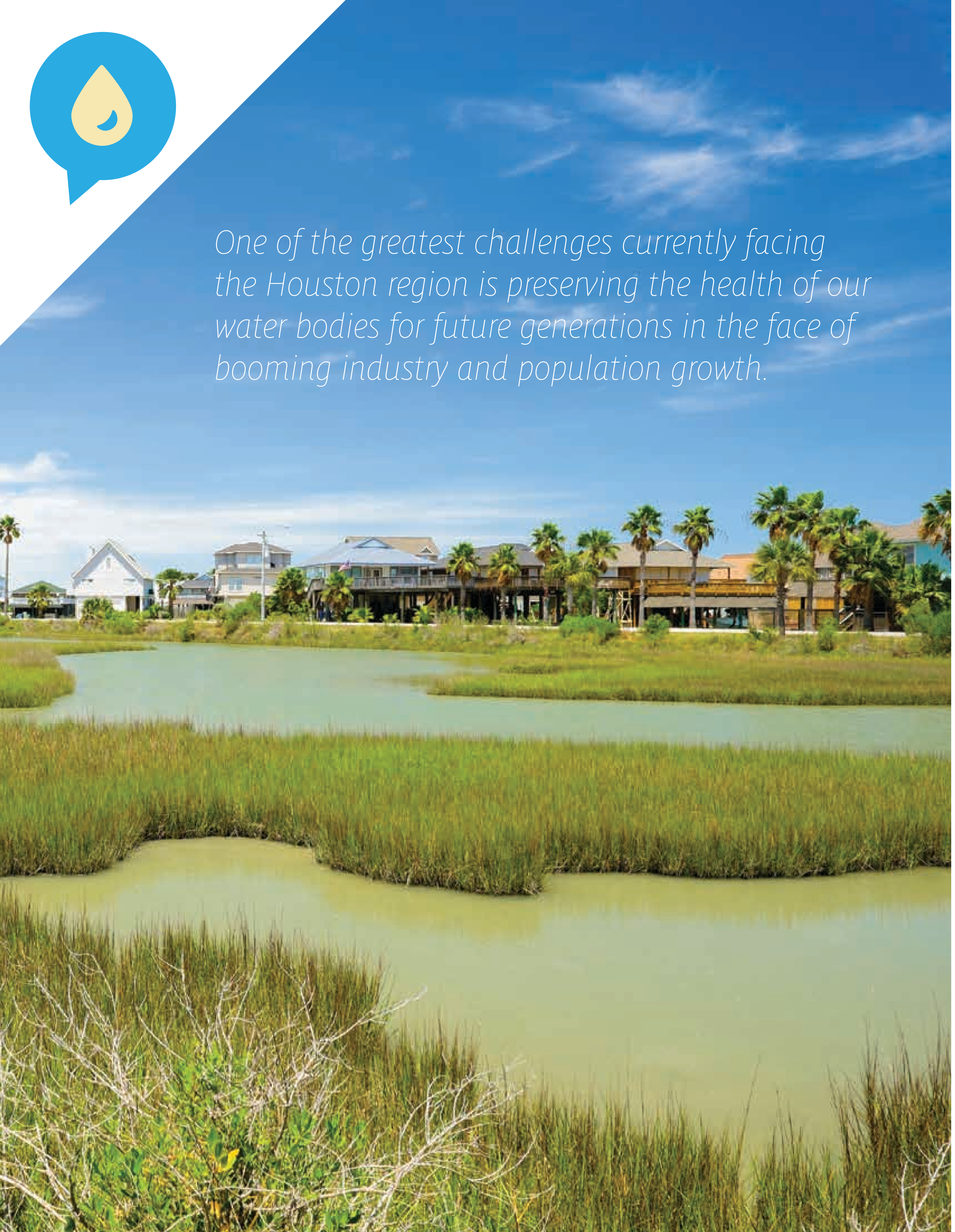
Today, approximately 40 percent of all new bus orders are for natural gas-powered engines, according to the Greater Houston Natural Gas Vehicle Alliance.

Much of the story, Ng said, is yet to unfold. While natural gas will certainly play more of a leading role in engines and fuels in coming years, "there's still a lot of work that needs to be done to keep making these engines and fuels cleaner," Ng said. "But luckily, our [TxCEF] center is here for that."

Still, one thing is certain for the future of engines and fuels: natural gas has completely altered the energy landscape in Texas and beyond. "Natural gas is changing the U.S.," Epling said. "It's changing the way we think about driving in terms of vehicles. It's changing the way we're thinking about making chemicals, and it's completely changed everything we think about in terms of the energy that we consume."

The Greater Houston Natural Gas Vehicle Alliance is a nonprofit group composed of university and private sector experts dedicated to educating policymakers and the general public on the benefits of adopting natural gas engines.

Left Page: Henry Ng
This Page: Researchers and students working at TxCEF



One of the greatest challenges currently facing the Houston region is preserving the health of our water bodies for future generations in the face of booming industry and population growth.

GUARDIANS OF THE GALVESTON BAY:

ENSURING THE HEALTH OF HOUSTON'S WATERS

The Galveston Bay is one of the most valuable natural resources in the state of Texas.

Freshwater flows in from the Trinity and San Jacinto Rivers and mixes with the Gulf of Mexico's salty incoming tides to form this stunning 600-square-mile estuary made up of deltas, mudflats, wetlands, sandbars and marshes. Teeming with rich vegetation and marine life, the clean and navigable waters of the Galveston Bay estuary first attracted early settlers to the region nearly 7,000 years ago.

Since then, the waters have allowed civilization to bloom along its banks, even spurring on an oil boom in the early 1900s that firmly established the region as an industrial epicenter. Today, the Galveston Bay is home to one of the world's busiest commercial seaports. More than six million people rely on the water system for food, transportation, shipping, recreation, oil and gas production, and industrial and urban development. Each year, the waters support a $3 billion recreational and commercial fishing industry and a $7.5 billion tourism industry.

The economic and environmental health of the Texas Gulf Coast region depends on this water system, which has allowed Houston to become one of the fastest growing economies and populations in the U.S. One of the greatest challenges currently facing the region is preserving the health of the water bodies for future generations in the face of booming industry and population growth.

To address this challenge, state and local officials must find new ways to limit the potentially harmful environmental impacts of increased urbanization, especially as it relates to the Galveston Bay estuary. But first, the Galveston Bay's biggest polluters must be identified so that policymakers can make decisions on how best to limit these pollution sources.

Government officials and policymakers, however, cannot perform this task alone. That's why, for the past 20 years, the U.S. Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ) have depended on one woman at the University of Houston Cullen College of Engineering to arm them with the information they need to ensure the health of these waters.

Hanadi Rifai, professor of civil and environmental engineering and director of the environmental engineering graduate program at the Cullen College, began her research into the waters of the Galveston Bay system in the early 1990s with funding from the EPA's National Estuary Program, which identified valuable estuaries around the U.S. and provided funding to researchers across the nation to explore pollution amounts and sources for the estuaries.

The program initially awarded Rifai funding to explore nonpoint sources of pollution, which is water pollution that is caused by rainfall-runoff. Rifai's findings from this work led to her involvement in the development of the very first "State of the Bay" report, which identified the greatest environmental challenges facing the Galveston Bay estuaries.

This was only the beginning of what would become a longstanding relationship between Rifai and TCEQ. Since then, Rifai has received millions of dollars in funding from the EPA and TCEQ to uncover the dirty secrets in Houston's water and to help inform state and federal policymakers on ways to keep the natural water bodies safe for human and animal use.

Above: Hanadi Rifai (left), professor of civil and environmental engineering, collects water samples with students

FIRST, THE FISH GOT SICK

Reports in the early 1990s, which advised Gulf Coast residents not to consume certain kinds of fish and crabs caught in the Houston Ship Channel and the bay's upper reaches, spawned much of Rifai's research. The warnings were based on high levels of industrial pollutants found in the fatty tissues of the marine animals.

With $3.2 million in funding from TCEQ, Rifai sprang into action and began examining water samples from the Houston Ship Channel, the San Jacinto River and nearly every natural body of water in the Houston metro area. Her team collected data from more than 50 sampling sites across the region and used the results to create sophisticated mathematical models to estimate the amount and sources of pollution in the bodies of water. The team compared the pollution levels of the various water bodies to the safety standards for swimming and fishing activities set by the EPA's Total Maximum Daily Load Program.

The challenges of collecting samples from the field, gathering and quantifying the data, and incorporating the results in a larger model differ from area to area, Rifai said. For instance, modeling a watershed in an urban area like Houston requires tracking industrial pollutants, while modeling a rural watershed must account for agricultural pollutants like pesticides as well as the impact of any livestock.

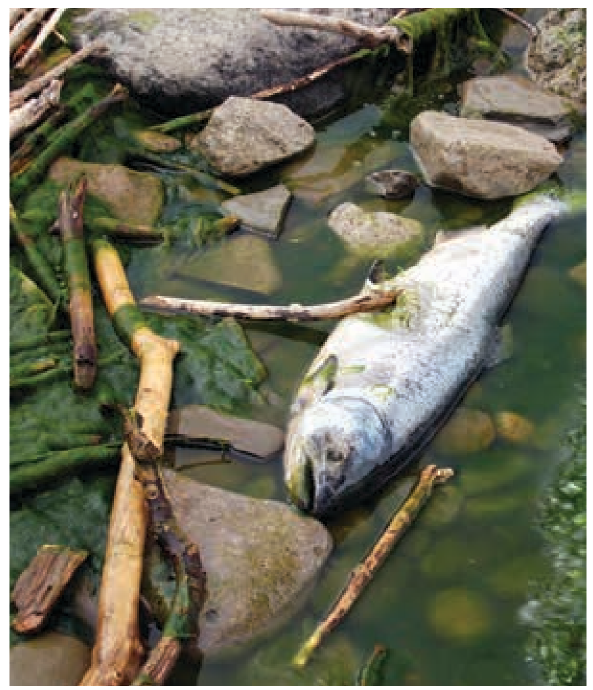
Rifai's expertise is tracing tiny toxins called persistent organic pollutants within samples of water, and her research group is the only one tracking these pollutants in Houston's water bodies. Two particular pollutants, dioxin and polychlorinated biphenyls, or PCBs, were found in very high levels in the ship channel's waters, she said.

Rifai was able to trace the source of the dioxins to an abandoned industrial waste facility on the San Jacinto River as well as several paper mills that once dotted the shores of the ship channel more than 30 years ago. "This is what we call legacy pollution," she said. "Meaning, it is pollution that's been there for quite some time from past industrial activities."

The EPA used Rifai's research to decide how to clean up the long-abandoned, pollution-causing facilities. One of the pollution sources identified along the San Jacinto River was added to the EPA's Superfund, a federal program that cleans up the nation's uncontrolled hazardous waste sites.

Unfortunately, even after these major pollution sources were identified, health advisories to avoid eating seafood from the ship channel resurfaced in 2008. However, the warnings weren't limited to the channel and the bay's upper reaches, where most of Houston's industrial activity takes place – they also included certain fish that were caught in the open waters of Galveston Bay.

The seafood advisories led to Rifai's next round of TCEQ funding in 2009 in the amount of $1.8 million to identify the specific sources of PCB pollution in the Galveston Bay estuary. Rifai's research would help federal and state officials determine whether or not the seafood advisories for Galveston Bay should remain in place.



TRACKING TOXINS IN THE GALVESTON BAY

PCBs were commonly used as lubricants and coolants in electrical transformers before the compound was banned by the EPA in the 1970s. So, naturally, Rifai expected to find that the PCBs in the Houston Ship Channel were a legacy pollutant. The results so far have shown this may not be the case in some parts of the system.

Using high-volume sampling, the researchers pumped large quantities of water through fiber filters to collect suspended particles to which pollutants attached themselves. The water was then passed through a resin that extracts PCBs. Rifai and her research team also collected tissue samples from fish and crabs as well as sediment samples to help trace the sources of the toxins. The samples were analyzed and mathematical models allowed Rifai and her team to determine the concentration of PCBs in the water – with surprising results.

Typically, PCBs linger in the environment for years after becoming trapped in layers of sediment beneath the water. "What we saw, though, was more PCBs that were dissolved in the water as opposed to being trapped in the particles. Unlike the dioxin study, this evidence points us to the possibility of current PCB sources," Rifai said.

With an additional $500,000 from TCEQ in 2011, Rifai expanded her work into the larger, open areas of Galveston Bay to investigate the sources of the recent PCB pollution. Although the research is still underway, Rifai has a hunch that Hurricane Ike might deserve some of the blame.

Although PCBs were banned for use in manufacturing in the U.S. more than 40 years ago, the chemicals could still be found in old electrical equipment and insulation inside of transformers. In 2008, many old PCB-containing transformers were destroyed by Hurricane Ike, which could explain how the toxins are polluting Houston's water again.

Rifai said it could take another 30 to 40 years to restore the Galveston Bay because the toxins are bioaccumulative, which means they build up in human and animal tissue and can be passed to their offspring. However, her estimation is accurate only when the PCB sources are controlled and the affected sediment, which can trap PCBs and dioxins for decades, is remediated.

"The rest of the story is yet to come," she explained. "A lot more research needs to be done for us to figure out exactly how to deal with this complex problem."

Despite the decades necessary to restore the waters, the bay is still quite healthy and only continued effort and attention can keep it that way, Rifai said. "I think the key message here is that the Galveston Bay System is still a pretty healthy estuary and is well worth maintaining and sustaining," she said. "People in the Houston region really value the Galveston Bay System, and it's an important resource. Hopefully it will be there for the future."

During the summer of 2008, Saharan dust contributed as much as 20 micrograms of fine particulate matter to our air – a whopping 66 percent of the total fine particles in the air at the time.

HELPING HOUSTON BREATHE EASIER

Air quality in Houston is a real problem.

The American Lung Association's 2014 "State of the Air" report listed the metropolitan area encompassing Houston and The Woodlands as the sixth most polluted city by ozone level, an increase from last year's seventh place position. The Houston region was also ranked 30th in the U.S. for worst particle pollution.

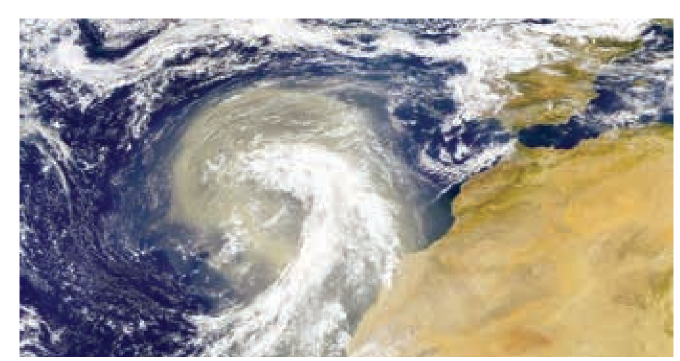
Harmful particulate matter in our air is made up of a mixture of organic, inorganic and metal material that's given off by natural sources, such as sea spray, windblown dust and grassfires, and manmade sources, such as vehicles and industrial operations. Studies have linked particle pollution to an increased risk for asthma, cardiovascular disease, lung cancer and even premature death.

Although the Houston region has shown improvement in reducing particle pollution over the last four years, the American Lung Association still gives Harris County an "F" for annual particle pollution. Moreover, the U.S. Environmental Protection Agency (EPA) recently lowered the acceptable amount of particle pollution in U.S. cities from 15 micrograms/m^3 to 12 micrograms/m^3 to better protect public health.

With these more stringent air quality regulations now in place, Houston researchers and policymakers must find new ways to identify and limit various contributors to particle pollution in the region. To address this issue, though, researchers must first quantify how much each pollution source is contributing to the fine particles in our air, said **Shankar Chellam**, professor of civil and environmental engineering at the UH Cullen College of Engineering. And for over a decade, that's precisely what Chellam has done.

Chellam uses a technique he calls fingerprinting to identify specific pollutants in an air sample, then quantifies exactly how much certain types of pollution (including exhaust from motor vehicles and smog from oil refineries) contribute to the harmful particles in our air.

While conducting this research, Chellam made another discovery that was both surprising and serendipitous. He found that dust from the Sahara Desert in North Africa was a significant contributor to Houston's air quality woes. By identifying this pollution source and finding out exactly how much other types of pollution contribute to particulate matter in the air that we breathe, Chellam said he hopes local and state officials will be better informed on how to shape public policy pertaining to air quality.



TRACING METALS, CHASING ANSWERS

Chellam's method for fingerprinting focuses on identifying metal particles found in air samples. "Finding trace amounts of metals in air samples is our main expertise, and the overall approach is to find signatures of certain pollutants and give them a fingerprint so we can easily detect them inside of air samples containing thousands of other particles and pollutants," Chellam said. However, knowing when and where to collect air samples as well as what types of metals to test for is not so simple, he said. "I guess you could say it's some parts art, some parts science."

To create fingerprints for most sources, Chellam's team looked for specific combinations of metals in specific quantities within air samples that were collected at carefully chosen locations and times.

In the case of particulate matter released by petroleum refineries, for example, Chellam focused on rare earth metals found in cracking catalysts used during the refining process. Similarly, in the case of vehicle pollution, Chellam's team looked at the catalytic converters used in all gasoline-powered motor vehicles. These catalysts contain trace amounts of precious metals – specifically, platinum, palladium and rhodium – which served as excellent fingerprints since very few sources emit these materials into the air.

Chellam's team measures metals in units as small as picograms. "You can imagine that in order to do that you need very sophisticated techniques and careful measurements in the lab," he said. "So that's what we do. That's our main expertise."

A standardized method for measuring fine particulate matter and trace amounts of metals in air samples did not exist before Chellam began his research. By developing advanced techniques for fingerprinting and measuring particle pollution in samples of air, Chellam has helped to arm government officials and policymakers around the world with the information they need to make important decisions about pollution identification and regulation.

In fact, researchers from the Institute for Heath and Consumer Protection, a branch of the European Commission's Joint Research Centre, cited Chellam's work in a 2006 report on pollution source apportionment provided to the European Union.

Above: Dust from the Sahara Desert moving across the Atlantic Ocean (Image Credit - SeaWiFS Project, NASA/Goddard Space Flight Center, and ORBIMAGE)
Top Right: Students collecting air samples

PETROLEUM REFINERIES, VEHICLE EXHAUST AND… SAHARAN DUST?

From Top: Shankar Chellam, professor of civil and environmental engineering; Ayse Bozlaker, post-doc researcher at the Cullen College

Right Page: Steve Paciotti, engineer at the Texas Commission on Environmental Quality

Chellam's work identifying and measuring Houston's most troublesome pollutants officially began more than 10 years ago, when he received funding from the Texas Air Research Center (TARC). He has since received grants from the EPA and the Texas Commission on Environmental Quality (TCEQ) as well as assistance from engineers at Houston's Bureau of Air Quality Control and Harris County Precinct 2 to investigate the impacts of petroleum refining and motor vehicles on air pollution in the Houston area.

Working with urban air quality expert Matthew Fraser from Arizona State University, Cullen College Ph.D. students and a NASA scientist, Chellam and his team encountered some surprising facts about how much emissions from refinery activities impact overall air quality.

The first surprising finding was that emissions from refineries fluctuated a great deal from day to day and even hour to hour, rather than remaining more or less constant as Chellam had initially expected.

Another surprise was that industrial pollutants emitted near the Houston Ship Channel were found in many Houston suburbs, with some particles traveling as far as 30 miles to Kingwood.

A few years after this research began, Chellam received another grant from TARC to quantify the pollution fingerprint of gasoline-driven vehicles. According to Chellam, this was a far more challenging task than identifying the particulate pollution caused by petroleum refineries since vehicles release their unique marker metals at much lower concentrations, making it very difficult to detect and extract the pollutants.

Luckily, the Houston area is home to the Washburn Tunnel, the state's only operational underwater vehicle tunnel and therefore an ideal location for collecting air samples to test for vehicle pollution, Chellam said. Because the tunnel is closed to large, diesel-powered vehicles, Chellam was able to get a virtually undiluted sample of the emissions from standard, gasoline-powered vehicles.

Inside the tunnel, Chellam's team found that about half of the fine particulate matter in the air came from gasoline-powered vehicle emissions and approximately one-quarter was caused by road dust. The team also discovered that road dust kicked up by moving cars accounted for half of the larger particulate matter in the air, while tailpipe emissions accounted for about 14 percent.

However, most vehicles operate in the open air where their exhaust mixes with pollution from other sources, which makes it difficult to measure their combined real-world impact. For this reason, the team is currently setting up samplers near surface roads to collect fine particles in order to estimate mobile source contributions to airborne particles. One such sampling site is located just steps away from the Houston Independent School District's R.P. Harris Elementary School near the intersection of Interstate 10 and Federal Road. This sampling site is particularly important because the air quality directly impacts local children's health, Chellam said.

Parallel to this research on motor vehicle emissions, Chellam and his collaborators continued their work quantifying particle pollution from oil refineries – that is, until Chellam encountered what he called "the most curious coincidence" while collecting data outside of industrial plants along the Houston Ship Channel.

Specifically, Chellam began noticing spikes in the levels of particulate matter in the air around the ship channel that his team could not attribute to emissions events from the surrounding refineries. "There were five days in July and August [of 2008] in particular where we saw a big spike," he said. That's when he recalled seeing satellite images of Saharan dust clouds moving across the Atlantic Ocean and settling over portions of the U.S., including Houston.

With additional funding from TCEQ and TARC, Chellam set out to fingerprint the Saharan dust in order to find out just how much it contributed to the Houston region's air pollution. Chellam's research took on new urgency when the EPA strengthened air quality standards for the total amount of fine particle pollution in December of 2012.

"That's when we began to ask ourselves: how much does the Saharan dust in our air add to our particulate pollution?" Chellam said. They found that some days during the summer of 2008, Saharan dust contributed as much as 20 micrograms of fine particulate matter to our air – a whopping 66 percent of the total fine particles in the air at the time. Chellam and his team published these findings in the journal Environmental Science & Technology last year.

The next question is how to reduce particulate matter concentrations in our air if we are subject to pollution events that are out of our control, such as Saharan dust plumes that tend to settle over the region each summer, Chellam said.

"So if the Saharan dust is increasing our particulate pollution levels, then how should we decide our public policy? In other words, should we restrict emissions from local sources more aggressively, or should we tell the EPA that we met their health-based standards based on the pollution sources that are within our control? I don't know which argument to choose, and each of these arguments has economic constraints associated with it. Luckily, I'm not the guy who has to make that call," Chellam added.

Much of this policymaking burden will fall onto TCEQ, which has already provided evidence to the EPA to show that Houston's air contained higher than normal soot levels for seven days between 2010 and 2012 due to African dust and smoke from wildfires in Mexico. If not for these naturally occurring sources of particulate pollution, the Houston region would have met EPA air quality standards on those particular days.

Chellam and his collaborators, including Joseph Prospero, professor emeritus of marine and atmospheric chemistry at the University of Miami, and Ayse Bozlaker, a post-doctoral researcher at the Cullen College, are currently looking at additional air samples from 2008 and new samples from 2014 to confirm their previous findings and to further quantify the impact that Saharan dust has on Houston's air.

Steve Paciotti, a TCEQ engineer who has assisted Chellam and his team with collecting air samples for the past seven years, said this research will allow TCEQ to make informed decisions in terms of public policy on air quality for the region and the state. "Our agency always looks forward to new data so that… good decisions can be made about policies in our state."

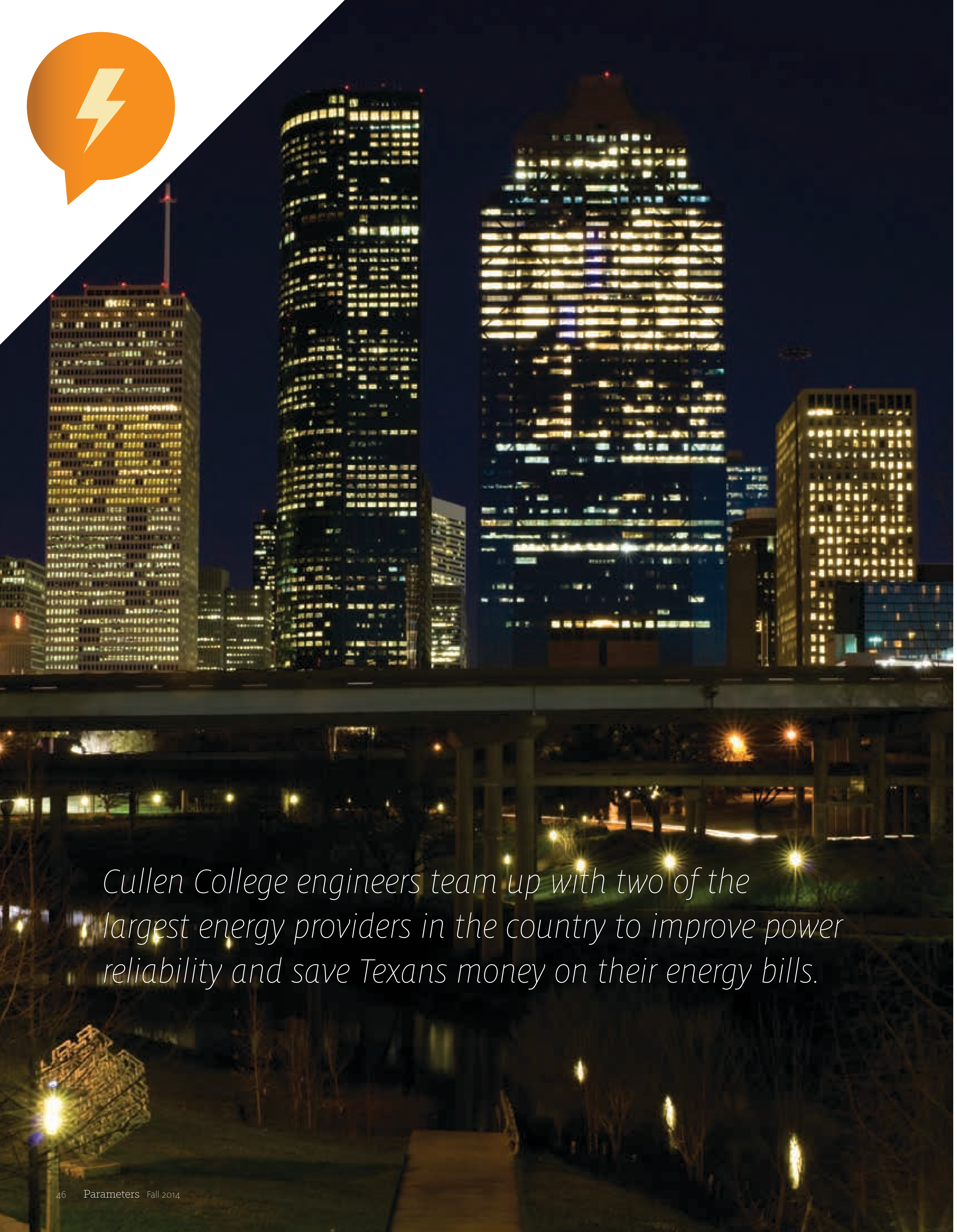
IF ALL PARTICLES ARE NOT CREATED EQUAL

While Chellam agreed that his research will help to guide TCEQ's decision-making, he added that this work doesn't answer many of the big questions that remain about the health effects of air pollution.

"For example, are all of these particles created equal or does toxicity depend on composition? Or in other words, will certain types of particles cause some diseases and other particles cause different diseases?" Chellam asked. "Do all of these particles increase your risk for disease equally, or are some more toxic than others? I'm just doing the fingerprinting of these pollution sources, I'm not doing toxicology on them, so I can't answer these questions."

Chellam and his team laid the groundwork for determining the toxicology of fine particles in our air by identifying and quantifying the different sources of particle pollution. The next step is for Chellam to work with epidemiologists and toxicologists to study the impacts these particles have on human health.

"You can't do that kind of [toxicology] research without first doing the fingerprints for each pollution source to quantify the amounts," Chellam said. "It certainly is a huge next question."



THE SMARTEST GRID ON THE BLOCK

Since 2008, CenterPoint Energy has installed more than 2.3 million smart meters at homes and businesses across the Houston and Galveston areas. From a customer's standpoint, the transition from the antiquated analog meters to the new smart meters was easy to miss because it seemed nearly seamless. For some, the enormous installation effort went entirely unnoticed. But for ***Zhu Han****, associate professor of electrical and computer engineering at the University of Houston Cullen College of Engineering, the new technology meant opportunity.*

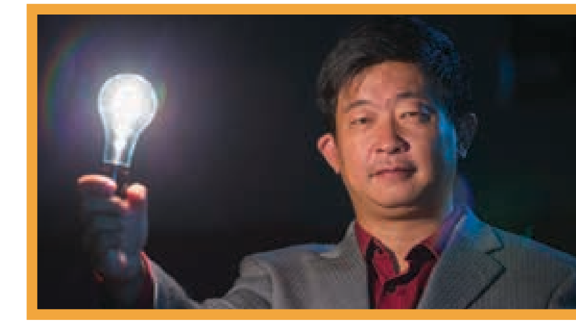
Millions of smart meters installed across Houston wirelessly transmit information collected on customers' electricity usage to CenterPoint's central data center every 15 minutes. This data could be analyzed and put to use for many practical applications including predicting power demand, helping to manage power generation, and even assisting in the design and construction of power plants, Han said. But there's one problem – and it's a really, really big one.

With more than 2 million smart meters reporting data to CenterPoint 96 times per day, these meters collectively produce an incredible amount of information – more than 220 million distinct reports every 24 hours, to be exact. Data sets of this size and complexity are known as "big data," and therein lies the big problem that faces many energy utilities companies. Sifting through these enormous data sets to find meaningful trends and insights is the next big challenge for CenterPoint and energy providers nationwide.

"Luckily, this is what we do," Han said. "We write algorithms that can pull out the important information from these very large and complex data sets so the utilities companies can put the data to practical use."

Han established the Electric Power Analytics Consortium (EPAC) at the UH Cullen College of Engineering in 2013 and welcomed CenterPoint Energy and Direct Energy, two of the region's largest energy providers, as the consortium's founding members. The mission of EPAC, Han explained, is to develop algorithms and mathematical models to make the best use of the data gathered from smart meters and other components of new smart electric power grids.

"The real focus of this research is to develop data-driven solutions that directly benefit both CenterPoint's and Direct Energy's customers in the Houston region and beyond," said Han, who serves as principal investigator and director of EPAC. For CenterPoint Energy, this means developing predictive damage assessment models to better prepare for hurricanes or major storms and to restore power more quickly after severe weather events. For Direct Energy, Han and his team will analyze customers' energy usage in order to develop innovative tools, technologies and perhaps even dynamic pricing strategies that can help customers to save money on their energy bills while encouraging energy efficiency.



A UNIQUELY BENEFICIAL COLLABORATION

The structure of the Electric Power Analytics Consortium is somewhat unique, Han said.

At most universities, businesses fund research projects through grants given to individual professors to explore a specific scientific problem. At EPAC, however, power companies pay annual membership fees. As consortium members, these companies meet regularly with Han and his research team to discuss current industry challenges and ways in which smart grid data might be leveraged to address those challenges. The membership fees the companies pay also go toward funding graduate students and postdoctoral researchers at the Cullen College to work in Han's EPAC research group.

In this unique arrangement between academia and industry, research results are shared with all of the consortium's members, meaning the research Han and his team conduct for CenterPoint also benefits Direct Energy, and vice versa. Moreover, the industry members have direct access not only to world-class researchers and cutting-edge technologies at the University of Houston campus, but also to the academic papers generated by EPAC. And by funding additional graduate student and postdoc positions in the field of smart grid data analytics, the utilities companies are increasing the number of highly-skilled and trained individuals they can hire in the future.

But the benefits don't reside only with EPAC's industry members. Cullen College students involved in Han's research gain insight into the current challenges facing industry as well as hands-on experience, which are invaluable in preparation for their careers after graduation. Additionally, the ability to access real-world data on electricity generation, transmission, distribution and usage from CenterPoint and Direct Energy (rather than data generated from computer simulations) has vastly improved the performance and accuracy of the data analysis tools that Han and his team have developed.

Through regular meetings between EPAC's researchers and members, with all of the different viewpoints and perspectives they bring to the table, everyone involved in the consortium is able to gain deeper insights into the future of the smart grid and the technologies that drive it.

REDUCING BLACKOUTS FROM TEXAS-SIZED STORMS

Bottom: Image Credit - NASA
Right Page: Zhu Han, associate professor of electrical and computer engineering

CenterPoint Energy, a Fortune 500 electric and natural gas utility company that serves several U.S. states, became a founding member of EPAC in 2013, joining Han and his team for the consortium's first official meeting in February of that year. Based on that conversation, Han said they came to the conclusion that the first topic his team should address is the development of algorithms to improve recovery times after severe weather events such as hurricanes.

With many of the nation's most critical energy and petrochemical facilities located in the Texas Gulf Coast region, research into improving the reliability of the power grid both during and after hurricanes or major storms is vital not only to Texas, but to the entire U.S.

CenterPoint Energy has already invested heavily in this area, installing power line sensors, remote switches and other automated equipment that locate power line outages as they occur so that repair crews know exactly where to go to restore power more quickly than ever before. These investments have already paid off. According to CenterPoint, there was an opportunity to use the smart grid technologies to automatically reroute and restore power in a matter of minutes after an outage in 2012, which affected more than 611,000 customers. Without the new smart grid technologies, CenterPoint representatives said the power outage would have lasted at least half an hour for most customers.

Han will supplement these smart grid components with the creation of a predictive damage assessment model that will tell utilities companies what the path of a storm or hurricane will be, how much damage it will cause and which parts of the Houston region will be most affected by the weather event.

When Han and his team perfect their model for predicting the path and potential damage of hurricanes and storms, they plan to move on to developing models and algorithms that can help utilities companies optimize resources after a damaging weather event. "We can provide the utilities companies with an assessment of where to put their resources before the hurricane even hits. Then, after the hurricane comes, we can tell the companies the best strategy for utilizing their resources so that they can restore power to customers as soon as possible," Han said.

Walter Bartel, director of grid performance and reliability at CenterPoint Energy, said access to Han's predictive models for assessing how best to utilize power and energy resources during and after major weather events will help to improve power grid reliability in the region.

"We believe the investments we've made in intelligent grid and analytics technologies will improve how we identify where service problems are and how quickly we restore power after a major event. Combine these technologies with the technology UH students are being exposed to today, and we're confident we'll have progressive modeling capabilities that will better prepare us for future weather events," Bartel said.

More than 2 million of CenterPoint Energy's 2.3 million consumers experienced power outages after Hurricane Ike in 2008. Power was restored to 75 percent of those customers within 10 days.

"We are always looking for ways to be better prepared for the next big event," Bartel said. "Partnering with UH will improve our ability to restore power as quickly and efficiently as possible."

In addition to the models that Han is developing for CenterPoint Energy, his team is using a $250,000, three-year grant from the National Science Foundation (NSF) to create similar models that can be applied to the entire electrical power grid across the U.S. Han said that the real-world data provided by CenterPoint on power outages from storms and hurricanes in the Houston region should help him to develop far more accurate predictive models for the nation's electricity grid.

The predictive hurricane damage and power restoration models that Han develops for the NSF will look at this problem with a wider-angle lens, which will directly benefit not only Houstonians but also energy consumers across the nation. "With CenterPoint, we are looking at how to solve a current problem based on real-world data. With this NSF funding, we now have the motivation to look at not only current challenges within the smart grid, but future challenges as well," Han explained. "This kind of research will benefit CenterPoint and Direct Energy, but also power companies, utilities providers and energy consumers across the U.S."

BIGGER DATA, SMALLER BILLS

Direct Energy, the largest energy and home services retailer in North America, became the second founding member of EPAC last spring. However, it was long before this that leadership within the company started grappling internally with the issue of how to use smart meter data to deliver power more reliably to customers while also helping them to understand their energy usage and their options for saving money on their energy bills.

"That's why we're really excited about the research project we've designed with Dr. Han to take that information from smart meters and see if there were particular insights we could gain on our customers and how they're using energy so we can communicate to them some of the choices they have on saving energy and money," said Benjamin Heard, director of business development at Direct Energy.

Direct Energy has provided Han and his team with smart meter data records from the past two years for almost 100,000 customers in the Houston region. Using the millions of reports generated on these customers, Han will deploy algorithms that can give Direct Energy more information than ever before on the types of customers they have and how the customers are using energy in their homes and businesses.

When Han identifies the varying types of energy consumers, Direct Energy can use the information to communicate with its customers about how they might reduce their energy usage and save money on their utilities bills.

Although the research is still underway, Heard said that Han has already uncovered some surprising findings and insights about Direct Energy's customers which they weren't previously aware of. "We have been surprised at some of the degrees of variance among our customers," Heard said. "We tend to think of our customers on a broader scale and we tend to group them very generally. But one of the insights that Dr. Han brought is that within the groups of customers we identified there are many different types of patterns of usage."

Heard said that the consumer data EPAC has provided to Direct Energy will be deployed commercially within its operations. This means "new products or services that we could roll out not only to our customers here in Houston, but throughout the state of Texas," he said.

One possible outcome of this research is the deployment of a dynamic pricing strategy uniquely tailored to each of Direct Energy's customers based on how they use energy in their homes, Han said. For instance, customers who work a daily 9 a.m. to 6 p.m. schedule may be able to save money on their energy bills by signing up for a dynamic pricing plan wherein power costs far more during the daytime hours than during the nighttime hours. If these dynamic pricing plans were tailored to customers based on their current energy usage trends, the customers would not have to make any major modifications to their behaviors or power usage in order to benefit from the energy cost savings.

Smart and data-driven dynamic pricing could also help save the environment. By providing energy customers with more information about how they utilize energy, Han can raise their awareness. Some customers, for instance, may be surprised to find that the power consumption in their homes is high even while they are at work during the day, leading them to turn off more lights and unplug more devices while they are gone. This, in turn, would require less energy usage, which would mean less harmful emissions from power plants.

"This would save the customer money, it would save Direct Energy money, but also by changing pricing and changing how people think about and use energy, you can reduce carbon dioxide emissions and improve the environment," Han said. "So overall, by utilizing this data, our whole environment and society will benefit."

THE SECRET SOFTWARE OF MEDICAL DISCOVERY:

BOOSTING IMAGING TECHNOLOGIES IN THE TEXAS MEDICAL CENTER AND BEYOND

Modern optical microscopes can provide doctors and researchers with crisply defined, three-dimensional images of cells and tissue. These images show everything from wide-scale changes across entire organs to crucial interactions between individual cells in breathtaking detail.

But as the old adage goes, the devil is in the details – details that, in this case, can't be deciphered so easily when viewed with the naked eye. This has been a barrier to progress in several fields. Although there are large amounts of information to be gleaned from these images, the technologies needed to extract data from them have lagged.

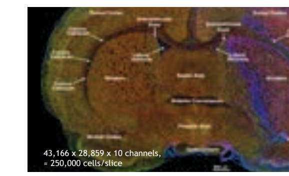
That was the inspiration behind electrical and computer engineering professor **Badri Roysam's** FARSIGHT toolkit, a software suite designed to rapidly analyze images collected from advanced microscopes. FARSIGHT quantifies the complex interactions and changes among individual cells, allowing researchers to gain unprecedented biological insights.

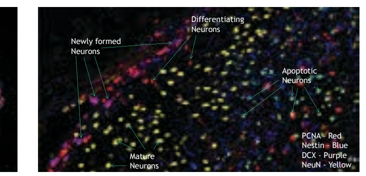
The driving force behind the FARSIGHT project is a group of talented electrical and computer engineering students at the Cullen College. Working within Roysam's laboratory, the undergraduate, graduate and doctoral students are tailoring FARSIGHT's algorithms so the software can be applied to a variety of research projects at universities and clinical centers around the world.

However, researchers and clinicians here in the city of Houston are uniquely benefitting from this powerful software. With the world's largest medical center located just a few short miles down the road from the Cullen College, researchers across Houston and the Texas Medical Center are collaborating with electrical and computer engineering students at UH to boost their research through the use of the FARSIGHT toolkit. Currently, FARSIGHT is helping to accelerate medical discoveries in fields ranging from neuroscience to cancer immunotherapy.

UNRAVELING THE BRAIN'S MYSTERIES

The brain is by far the most complicated organ, and the neuroscience field has hardly begun to unravel its many mysteries. Consequently, injuries and conditions affecting the brain are difficult to understand using current imaging modalities. This is one area in which the FARSIGHT toolkit is making progress.





ALZHEIMER'S DISEASE

Alzheimer's disease is a very important public health issue. There are currently 5 million people living with the disease, which is the sixth leading cause of death in the U.S.

Jason Eriksen, assistant professor of pharmacology at the University of Houston College of Pharmacy, has collaborated with Roysam and his students for the past three years to help accelerate his research on this complex and debilitating disease.

Much of Eriksen's research focuses on drug development by targeting brain changes that occur as a result of Alzheimer's disease with treatments to prevent or delay their onset. His group is currently looking at changes in the brain's blood vessels that are indicators of the disease. "We're interested in answering questions as to why that occurs," Eriksen said. "FARSIGHT gives us a really nice scientific advantage in doing this. It's absolutely revolutionary, in fact."

Prathmesh Kulkarni, an electrical and computer engineering Ph.D. student at the Cullen College, is working closely with Eriksen's group to develop new algorithms for FARSIGHT that identify the specific types of cells and vessels within the brain that Eriksen wants to analyze. According to Eriksen, Kulkarni has been "very helpful in getting our research to move forward so rapidly."

Without FARSIGHT, Eriksen's team would look at the blood vessels under a microscope and quantify only a few individual features of the vessels that are easy to see with the naked eye; for example, the length of a vessel or its number of branches. But with FARSIGHT, Eriksen said his group can look at not only these intrinsic features of the blood vessels (such as shape and size), but also the intricate and often subtle interactions between blood vessels and the cells they come into contact with.

"Trying to study those spatial relationships is very difficult for humans. It's not something that a person could easily do," Eriksen said. "We would have to start looking at different cells individually and then try to figure out how these cells interact with one another, but there would be a fair amount of guesswork in that."

Although his research is ongoing, Eriksen and his team are close to releasing some interesting findings that might lead to more tailored treatments and therapies for Alzheimer's patients. "Next year, we should have some spectacular things to say."

TRAUMATIC BRAIN INJURY

In the U.S., there were 2.5 million reported traumatic brain injuries (TBIs) in 2010 alone, according to the Centers for Disease Control and Prevention (CDC).

Kedar Grama, a graduate student in the department of electrical and computer engineering at the Cullen College, collaborated with researchers in the laboratory of Pramod Dash, Nina and Michael Zilkha Distinguished Chair in neurodegenerative disease research at the University of Texas Medical School at Houston and the scientific director of Mission Connect, and Dragan Maric, a staff scientist at the National Institutes of Health, to create a comprehensive map of brain cellular changes caused by TBIs.

Grama deployed machine-learning algorithms within the FARSIGHT software suite to analyze images of rat brains. This produced a much richer set of quantitative measurements to detect changes in cell structure throughout the brain, in addition to identifying the type and state of each cell.

Grama's algorithms showed that widespread brain alterations can take place after a TBI occurs – even in portions of the brain quite distant from the original injury or damage site. He pointed out that current imaging procedures often focus only on the original site of injury and can miss critical changes in other brain regions. These changes, he said, could eventually manifest in additional clinical conditions months or even years down the road.

The project was so successful that Grama entered his work into the 2013 Mission Connect Annual Scientific Symposium poster contest in the traumatic brain injury student category and took home the first-place prize.

NEUROPROSTHETICS

It may sound like science fiction, but it's science fact: researchers can implant a device inside of a patient's brain that can control prosthetic legs using the patient's own thoughts.

These devices, called neuroprosthetics, can also be used for patients with spinal cord or brain injuries, stroke victims and amputees, among others. But there's one huge problem with the device that must be solved before it's approved for patients.

After implantation, the brain's immune cells often begin attacking the device. Eventually, the device fails to receive signals from the brain and must be removed. Before FARSIGHT, researchers and clinicians were in the dark about why this happened and how it could be prevented.

Roysam is currently heading up a multi-institutional team of researchers from Rensselaer Polytechnic Institute, Seattle Children's Research Institute, the University of Michigan and MPI Research, a medical research company based in Michigan. In 2011, the group received a three-year, $4 million grant from the Defense Advanced Research Projects Agency (DARPA) to explore this problem using Roysam's FARSIGHT software.

This project is now nearing its close, and Yan Xu, a research assistant in Roysam's FARSIGHT lab who has been central to the collaboration, said the findings are insightful.

For the past three years, Xu has written machine-learning algorithms for the FARSIGHT toolkit that can specifically highlight intercellular interactions between the brain's immune cells. "In a resting state, the brain's immune cells, called microglia, look like trees with many branches, and when activated they gradually shrink their branches until the branches disappeared completely," Xu explained. "Then they come to the shape of an amoeba and they would conglomerate around the implanted device. That would block the signal from the brain to the device."

Xu and her collaborators published their findings in the Frontiers in Neuroinformatics journal last April. Moreover, the code and algorithms that Xu wrote in order to tailor FARSIGHT's toolkit for this project are now fully implemented into the FARSIGHT software. "It's a great feeling," Xu said. "Students like me really are helping to drive this technology forward."

CANCER IMMUNOTHERAPY IN THE FAST LANE

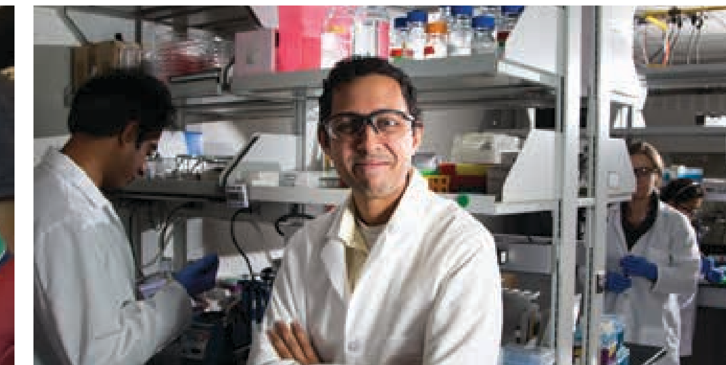
Navin Varadarajan, assistant professor of chemical and biomolecular engineering at the Cullen College, has won millions of dollars in funding from the National Institutes of Health (NIH), the National Cancer Institute (NCI) and the Cancer Prevention Research Institute of Texas (CPRIT), among others, to conduct cancer immunotherapy research.

Immunotherapy, which involves engineering the body's own immune cells to attack and kill off cancer cells, has proven to be one of the most promising cancer treatments to date. Varadarajan's research in this area has been especially promising thanks to a custom-designed nanowell array he developed. This polymer slide contains hundreds of tiny chambers that are precisely the right size to harbor a few cells. Varadarajan said this invention has allowed him to examine the interactions between immune cells and cancer cells in never before seen detail. "But without FARSIGHT, the analysis of the data arising from these assays would be challenging," Varadarajan said.

"We don't even see FARSIGHT as an external component. We think of it as an integral part of the assay itself. FARSIGHT has become part of the toolkit that comes with the assay," he added.

FARSIGHT, Varadarajan said, has allowed his research team to uncover so much knowledge about these cell-to-cell interactions that a single experiment by his team generates 1 terabyte of data from FARSIGHT.

One of Varadarajan's many funded projects focuses on examining the role that T-cells play in fighting leukemias and lymphomas. Amin Merouane and Nicolas Rey, electrical and computer engineering doctoral students, work closely with Varadarajan's team to write algorithms as unique as the research itself.



"There's nowhere else to get this software. There are no commercial packages that specifically address this problem that we're looking at," Varadarajan said. "It ties to the uniqueness of what we do. Most people in the world don't make these small containers to look at cells, so we need a very specific kind of software package to examine these cell-to-cell interactions and extract meaningful information from these images."

Varadarajan collaborates with a group of physicians and researchers at the University of Texas MD Anderson Cancer Center including Laurence Cooper, Dean Anthony Lee and Cassian Yee. Merouane said the implications of being involved in a collaborative research project with real clinical impact is not at all lost on him. "As an engineering student, I never imagined that I would be doing something which would have a real clinical impact. It feels really good to be doing something this significant," he said.

Part of the beauty of this collaboration, Varadarajan noted, is the accessibility of Roysam and his students. "Nothing beats them just being right here. We can – and we do – call them all the time when a new issue arises. We have weekly meetings with his student team. We are really, really happy that they're right here," he said.

Left Page: Jason Eriksen, assistant professor of pharmacology, points out a research image to students
Top (from left): Microscopy image; Yan Xu, student in FARSIGHT laboratory; Ravi Birla, associate professor of biomedical engineering
Bottom (from left): Prathmesh Kulkarni, student in FARSIGHT laboratory; Navin Varadarajan, assistant professor of chemical and biomolecular engineering

HOW TO MEND AN ARTIFICIAL HEART

The field of artificial tissue engineering is still a relatively new one, but a biomedical engineering researcher at the UH Cullen College of Engineering is already blazing new trails in the area by growing entire artificial hearts inside of his laboratory.

Associate professor **Ravi Birla** has received almost $1 million in funding from the NIH to conduct this research on 3-D artificial heart muscles. Birla said his laboratory relies heavily on the FARSIGHT software to take much of the guesswork out of the incredibly complicated process of profiling artificial heart tissues. "The field of tissue fabrication is so new that practically anything we can manipulate within a cell has some impact on the tissue properties, but most of these changes are unknown," he said.

Birla and his team feed a list of variables, such as the number, size and ratio of different cell types, into the FARSIGHT software, which then generates a spreadsheet highlighting the variables that have the most significant impact on a tissue's properties. Birla's group then applies this knowledge to a new set of engineered heart tissues and measures the results.

The lab results from Birla's team are then fed into FARSIGHT once again by electrical and computer engineering students so that the algorithms they've developed can learn from these outcomes in order to more accurately predict future results.

"So what FARSIGHT allows us to do is take this large, unknown, open-ended variable space and slowly narrow it down in a systematic and predictable manner," Birla said. "It allows us to determine what will happen at the end. Nothing else would allow us to do that. It's a remarkable tool."

FUELING HOUSTON'S STEM PIPELINE:

ENGINEERING OUTREACH ACROSS THE ENERGY CAPITAL

Despite high pay and a booming demand for STEM (science, technology, engineering and math) workers in the U.S., the ugly truth is that most Americans still aren't choosing STEM careers.

According to a 2012 report from the President's Council of Advisors on Science and Technology (PCAST), the U.S. is facing a shortage of 1 million STEM professionals over the next decade. In order to remain a global leader in science and technology, the U.S. must produce more than 34 percent additional STEM graduates each year.

In the city of Houston, the energy capital of the world, the lack of a highly skilled and trained STEM workforce is especially damaging to the local economy. In fact, the Brookings Institute reported last year that the city of Houston ranked fifth in STEM workforce demand out of 100 U.S. cities, though it ranked 74th in supply of STEM workers. That's precisely why the University of Houston Cullen College of Engineering has taken on a leadership role in STEM outreach efforts in the Houston region and beyond.

The Cullen College's STEM outreach efforts are varied and intended to impact every sector of the STEM pipeline, from kindergartners to college students as well as their teachers, parents and peers. These programs cater to demographics including young women, minorities, underserved communities, aspiring researchers of all ages and even teachers interested in learning more about engineering research.

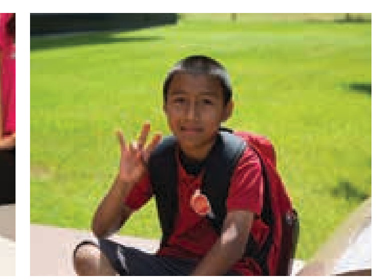
LET'S GO TO CAMP

Programs like STEP Forward Camp and G.R.A.D.E. Camp engage local students in fun but rigorous curriculums designed to introduce them to the multifaceted world of engineering.

STEP Forward Camp is a one-week engineering introduction program for rising 12th graders sponsored by PROMES and supported by ExxonMobil, Shell, Williams, Hewlett-Packard, BP and Chevron as well as the National Science Foundation and the Texas Workforce Commission. Admission is highly competitive because the camp is limited to a small group of talented high schoolers. They stay on campus in the dorms, interact with current Cullen College student mentors and counselors and spend the week immersed in introductory engineering courses. The camp has taken many different forms since its inception in 1979, including different names and durations, but the central mission has always been the same: inspire a new generation of engineers to strive for greatness.

G.R.A.D.E. Camp, which stands for Girls Reaching and Demonstrating Excellence, is held every summer at the college for area girls entering the eighth through 12th grades in the fall. Campers are introduced to basic engineering concepts like robotics and electronics through hands-on experiments and team-building exercises. The culmination of their experience is building a robot that follows a track through a maze, which they demonstrate on the last day of camp to an audience of family and friends.

According to John Matthews, Jr., PROMES program manager and STEP Forward Camp coordinator, giving high school students hands-on experience in a campus environment is pivotal in their decisions to become engineers. "Most kids do not know what engineering really is about. It's not like being a doctor or a lawyer – they see examples of [those professions] all day," Matthews said. "These are things kids need to know. They may say they want to major in mechanical engineering, but they don't know what mechanical engineers do and the different jobs they can have. This gives them a better idea."



STARTING STEM EARLY

Engineering Outreach in Houston Schools

For young children, providing a fun and accessible engineering environment is key to attracting their interest. The subsea engineering program at the Cullen College organized several outreach events during the spring 2014 semester. Organizers invited 40 fourth graders from Memorial Elementary School to tour the Cullen College as well as university hot spots like Cougar Field and the new Alumni Center. Subsea graduate students also spent several weeks at Memorial Elementary teaching students very basic engineering and physics concepts by holding an egg drop competition.

REAL RESEARCH WITH REAL IMPACTS:

STEM Training for Teachers and College Students

Teachers of future engineers are receiving resources to help incorporate STEM education in their everyday lessons. Teachers across the country can access dozens of new lesson plans and activities thanks to STEM education efforts of the Cullen College of Engineering. These plans, along with hundreds of others, can be found at www.teachengineering.org, a website run by a collection of universities along with the National Science Foundation (NSF) and a division of the National Science Digital Library.

The Cullen College-made plans were created by participants in the college's two primary STEM education programs, both funded by the NSF. Through its Research Experience for Teachers (RET) program, Houston-area high school teachers come to the college during summer breaks to get research experience they can take back to their own classrooms. The RET program is one of three University of Houston initiatives that together earned UH a spot on the 2013 President's Higher Education Community Service Honor Roll with Distinction.

The GK-12 program provides the college's graduate students with a stipend to spend time in primary and secondary school classrooms teaching engineering and science. Both efforts are designed to encourage more young people to enter the STEM fields.

Fritz Claydon, professor of electrical and computer engineering and a principle investigator on the grants supporting these efforts, said participants in each program are required to create a peer-reviewed deliverable that allows their work to be transferred to other classrooms. The feedback the Cullen College receives from the NSF on its deliverables has been outstanding, he said. "Because of the efforts we've made and the success we've had, the NSF is saying that the gold standard for deliverables is the UH model."

BUILDING THE ENGINEERING CAPITAL OF THE WORLD

For all of the STEM outreach programs currently going on at the Cullen College, there are constant new opportunities on the horizon. The college partners closely with the UH STEM Center, serving as an educational sponsor of the annual Science and Engineering Fair of Houston and collaborating on other campus-wide STEM outreach initiatives. Student organizations associated with the college also host initiatives, and the results are proving positive. Putting students on pathways to engineering at young ages not only sets them up for success, but also benefits the field, the college, the city, and ultimately, the world.

The city of Houston's economic success depends on its ability to attract and retain the best, brightest and most innovative engineers and engineering companies the world has to offer. To maintain the city's status as the energy capital of the world and to continue to create more jobs than any other city in the U.S., the University of Houston must continue to fuel Houston's STEM pipeline with highly trained, world-class engineers and STEM professionals.

The UH Cullen College of Engineering plays a central role in this mission by educating the Houston community about STEM, offering STEM training and education opportunities, and by graduating hundreds of the world's best engineers into the city of Houston each year.

FACULTY

Business Students Win Big With Yao's Technology

The University of Houston's Cullen College of Engineering and C.T. Bauer College of Business joined forces to compete in the University of Nebraska-Lincoln New Venture Competition.

The New Venture Competition, one of the oldest business plan competitions in the nation, pits student teams against each other in a battle of the business savvy. Teams present manufacturing and business plans surrounding new technologies to industry heavy-hitters and the most successful plan wins.

The UH team, named "Energetik," was composed of Jonathan Brown, Jonathan Cohen-Kurzrock, Rowbin Hickman, Noy Shemer and assistant professor of electrical and computer engineering **Yan Yao**. Together, they created an award-winning business plan based on Yao's battery research.

"Dr. Yao's successful research and development of this technology will create a battery that is safe, significantly lighter and smaller than any other batteries on the market, allowing for a competitive energy density and most importantly, a longer lifetime," Cohen-Kurzrock said. "This battery's application can range from power storage for telecommunications to submarines, but we are focusing on the solar power industry."

The team's business plan proposed outsourcing of battery manufacturing and using a third-party logistics company for warehouse and distribution operations. The team planned to sell their batteries to solar installers. Yao worked with the team for three months leading up to the competition.

"It is a great idea to have students from the business college developing business plans for technologies developed at the [Cullen] College of Engineering," Yao said. "I am extremely impressed at the quality of the undergraduate students from the Wolff Center. They are smart and fast learners. I am thrilled to be working together with them to bring this technology to market."

After their presentation at the New Venture Competition, several investors approached the team about making the conceptual business plan using Yao's technology a reality.

Plasma Etching Article Tops Journal's 'Most-Read' List for Months

A paper co-written by a UH Cullen College of Engineering professor has remained at or near the top of the Journal of Vacuum Science and Technology's most-read list since last fall.

"Plasma Etching: Yesterday, Today, and Tomorrow," was authored by professor of chemical and biomolecular engineering **Vincent Donnelly**, along with Avinoam Kornblit, a consultant and former colleague of Donnelly's at Bell Labs. The work appeared in the journal's 60th anniversary issue in September of last year.

The piece provides an overview of plasma etching, a method of using chemical reactions to selectively remove very small amounts from the surface of a material in very precise patterns. It is an essential step in the creation of integrated circuits. "Every cell phone, every computer, uses integrated circuits that were built with plasma etching," Donnelly said.

The paper is popular because a good overview of plasma etching does not exist, Donnelly said. In fact, as a teacher of plasma etching, Donnelly has felt frustrated by the lack of such a resource, though there is clearly a demand for an overview of the topic. "I've gotten a lot of feedback from people in industry in particular who've said they really appreciated the article," Donnelly said.

Professor Co-Chairs Membrane Society Conference

More than 400 people came out for the 24th annual meeting of the North American Membrane Society held on May 31-June 4 in a Houston suburb.

The meeting, which took place in the Sugar Land Marriott Town Square, was hosted by the University of Houston and Prairie View A&M University. Co-chairs were **Shankar Chellam**, professor of civil and environmental engineering at the UH Cullen College of Engineering, and Felecia Nave, associate provost and associate vice president for academic affairs at Prairie View.

Membranes are used in a variety of fields, from water purification and energy to pharmaceuticals. The program offered workshops and technical sessions keyed to specific areas, including water treatment, hydraulic fracturing, gas separation and engineered osmosis. There was also a session involving the use of nanotechnology applications, something Chellam said is of increasing interest in the field.

Both presenters and attendees represented a mix of academia, industry and government. The conference also attracted a younger audience and included a free workshop for students which offered career advice and networking opportunities.

The field traditionally has been dominated by chemical engineers – Nave is a chemical engineer – but Chellam said that it is broadening as new applications are developed for membranes. He said when he was in graduate school in the late 1980s, his adviser was one of the first environmental engineers to use membranes for water treatment.

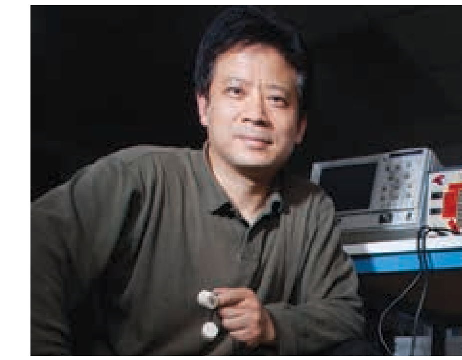
"Now, almost every environmental engineering program in the United States has someone working on membrane technology," he said.

The conference was supported, in part, by grants from the National Science Foundation and a number of private corporations.

AWARDS & HONORS

University Recognizes Cullen College Faculty

Each spring, the University of Houston recognizes exceptional faculty members across the university at the annual UH Faculty Excellence Awards Ceremony. This year, 12 Cullen College of Engineering faculty members were honored for their great strides in teaching and research excellence.



Left: Dmitri Litvinov, John and Rebecca Moores Professor of electrical and computer engineering
Right: Gangbing Song, professor of mechanical engineering

Two earned highest honors with their prestigious awards.

Esther Farfel Award: Dmitri Litvinov

The world owes **Dmitri Litvinov** a lot.

Litvinov is the John and Rebecca Moores Professor in the Cullen College's electrical and computer engineering department, a professor of chemical and biomolecular engineering and of chemistry, and the vice provost and dean of the UH Graduate School. He is also the director of the materials engineering program and the nanoengineering minor program, the Center for Integrated Bio and Nano Systems and the UH Nanofabrication Facility.

Litvinov's long list of titles is an indication of the many accomplishments he has made during his decade-long career with UH. For this, the university awarded Litvinov with its highest faculty honor, the Esther Farfel Award, which is given annually to a professor who excels in teaching, research and service.

Before his career in academia, Litvinov made industry strides that became ubiquitous in everyday life around the world. Litvinov worked in the research division of Seagate Technology where he championed the development of perpendicular magnetic recording, a technology used in most computer hard drives. He holds 26 U.S. patents and two pending patents.

Litvinov joined UH in 2003 to pursue his passion for education, basic research and technology development. Both his research and teaching focus on nanoscale materials and devices and their applications to information technology and medical diagnostics. He enjoys his work most when the pursuit of his personal interests benefits others.

"In everything I do, I always strive to arrive at a win-win scenario for myself, the students, my colleagues and the university," he said. "It is not much fun if I am the only beneficiary of my own work; it needs to provide tangential benefits to others, too. There is a great degree of satisfaction in this approach."

John and Rebecca Moores Professorship: Gangbing Song

Gangbing Song, a professor in the Cullen College of Engineering's department of mechanical engineering, measures his achievement by assessing his students. "My student's success is my success," he said. UH rewards its professors for their successes using a similar system. After careful consideration of Song's accomplishments, the university selected him for a 2014 John and Rebecca Moores Professorship.

The Moores Professorship is awarded annually to University of Houston faculty members who make outstanding contributions in research, teaching and service. Each Moores professor receives a stipend, and the professorship is renewable every five years. Song said the award is the unequivocal highlight of his year.

Song focuses on creating an environment of support and friendship with his students. He keeps in touch with many of them long after they leave UH. "I enjoy seeing them be successful after graduation," he said. "I hope they [would describe me] as a great mentor and a friend." He says teaching his students to perform research is particularly important to him. Song's smart materials and structures research includes adaptive control, robust control, dynamics, robotics and friction compensation. He is the founding director of the Smart Materials and Structures Laboratory.

Song calls his research "very rewarding," but maintains that the central focus of his career is teaching students. "Professors who care about their students are the great professors. That's what I try to be."

Teaching Excellence Awards

Mo Li (CEE): Teaching Excellence

Diana de la Rosa-Pohl (ECE): Teaching Excellence (Instructor/Clinical)

Jiabiao Ruan (ME): Teaching Excellence (Graduate Teaching Assistance)

Pradeep Sharma (ME): Teaching Excellence (Group Teaching)

Hanadi Rifai (CEE): Teaching Excellence (Group Teaching)

Fritz Claydon (ECE): Teaching Excellence (Group Teaching)

Stuart Long (ECE): Teaching Excellence (Group Teaching)

Eugene Chiappetta (College of Education): Teaching Excellence (Group Teaching)

Research Excellence Awards

Jeff Rimer (ChBE): Research Excellence (Assistant Professor)

Ramanan Krishnamoorti (ChBE): Research Excellence (Full Professor)

Venkat Selvamanickam (ME): Research Excellence (Full Professor)

New ECE Professor Wins $2M Recruitment Award From CPRIT

David Mayerich, assistant professor of electrical and computer engineering

Cancer imaging expert **David Mayerich** joined the UH Cullen College of Engineering's Department of Electrical and Computer Engineering this fall.

Mayerich, who spent five years as a Beckman Fellow at the University of Illinois before his arrival, will help boost the department's expertise in biomedical research, particularly in the fields of high-performance computing and biomedical imaging, said Badri Roysam, chairman of the department.

UH received a $2 million grant from the Cancer Prevention and Research Institute of Texas (CPRIT) to help recruit Mayerich, who earned his Ph.D. in computer science from Texas A&M University. The award was one of several recruitment grants awarded by CPRIT as part of the agency's mandate to spur the recruitment of cancer researchers to Texas institutions.

Mayerich has also received a National Institutes of Health (NIH) Pathway to Independence Award to fund research into imaging and modeling microvascular networks, extremely complex structures that play a particularly prominent role in kidney cancer. While he currently works with breast cancer, Mayerich said that his research is applicable to many tumors and disease types.

His two-pronged research focuses on improvement of diagnosis with new methods to image clinical tissue biopsies and development of methods to image tumors in 3-D at fine resolution and massive scale. His goals are to provide diagnosticians and researchers with insight into tissue structure and molecular composition, and ultimately, the power of high performance imaging and modeling to improve diagnosis and treatment.

"We need to provide biomedical researchers with the ability to collect and process terabyte-scale data sets on their own desktops," he said.

Roysam said Mayerich's research, including his work using quantum cascade lasers and knife-edge scanning microscopy (KESM) to map the 3-D architecture of tumors with subcellular resolution, will prove invaluable to cancer researchers in the Texas Medical Center and elsewhere in the state.

The Cullen College's electrical and computer engineering department is ranked 56th out of 126 programs in the National Research Council's Ph.D. program rankings.

Two Professors Win IEEE-APS Awards

Two faculty members from the UH Cullen College of Engineering have won prestigious awards from the IEEE (Institute of Electrical and Electronics Engineers) Antennas and Propagation Society (APS). This marks the first time that one institution has won two of these coveted IEEE-APS awards in the same year.

IEEE-APS John Kraus Antenna Award: Stuart Long

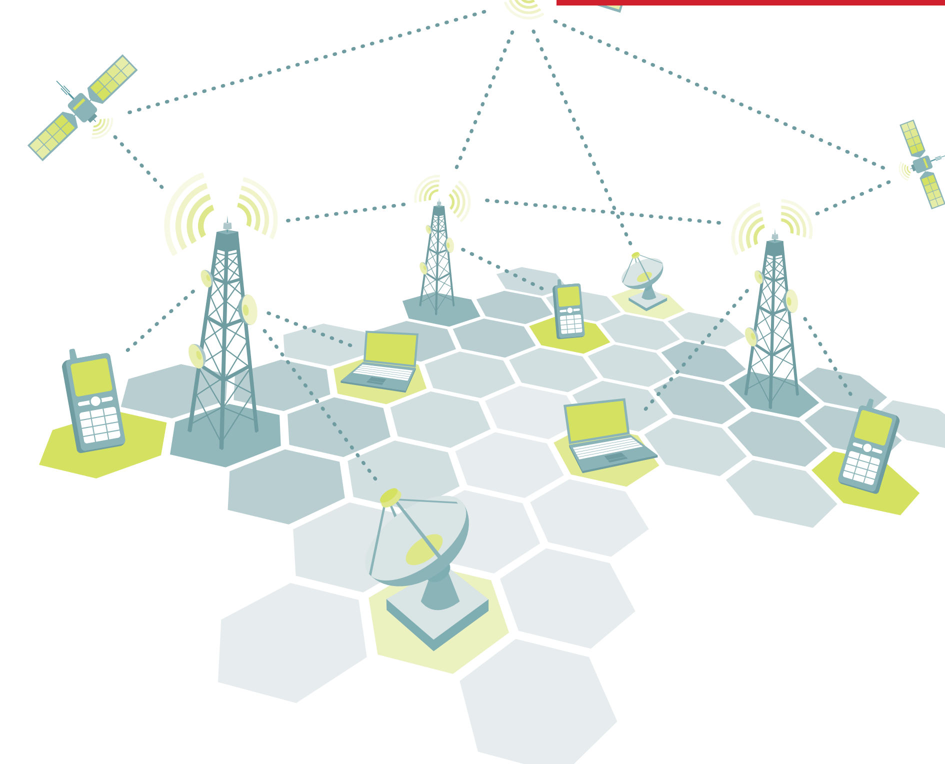
Stuart Long, professor of electrical and computer engineering, was awarded the John Kraus Antenna Award from IEEE-APS. The award is reserved for an individual or team that has made a significant advancement in antenna technology. According to the IEEE-APS website, this includes inventing a new or substantially improved antenna device, a new concept for electromagnetic transmission or an antenna design that yields a heretofore unknown capability. Long's inventive antenna design fits all three criteria.

Long's work with antennas at the University of Houston began in the 1970s, when he helped to develop a new class of antennas – known as microstrip antennas – which are currently used in most cell phones and wireless communications devices.

But the novel design which won Long the Kraus Antenna Award was for the dielectric resonator antenna. Long developed the first-ever dielectric resonator antenna in the 1980s for use in military communications systems. Unlike microstrip antennas, these antennas are efficient at very high frequencies, have a large bandwidth and are not composed of any metal or conducting materials.

The ability to use these antennas at higher frequencies in wireless communications devices will become increasingly important as cell phone providers continue adding more functions to their devices. The addition of features such as email, GPS and Internet browsing to cell phones and wireless communications devices requires more bandwidth and higher frequency transmissions. As time goes on, Long said the need for dielectric resonator antennas will continue to grow as their applications broaden. Some are already serving as nano-antennas at terahertz and optical frequencies.

AWARDS & HONORS



Long and his research group first published a paper on the novel dielectric resonator antenna designs in 1983. After more than 30 years, the paper continues to receive numerous citations annually, which establishes it as the seminal paper in the area of dielectric resonator antennas.

"I am very honored to win this award. It's really the culmination of 30 years of work and it's very rewarding," Long said. He also stressed the important roles that fellow Cullen College faculty members and students in the Cullen College's Electromagnetics Group played in his earning the Kraus Antenna Award. "All research, this included, is a product of the incredibly gifted faculty and students at our college who contributed to it and helped make it possible. I couldn't have done any of this research without their support."

Long became an IEEE Fellow in 1991. In 2010, he became a Life Fellow, which is a designation given to those with "an extraordinary record of accomplishments in any of the IEEE fields of interest." He also received the IEEE Third Millennium Medal in 2000 and the University of Houston's Esther Farfel Award in 2010.

IEEE-APS Harrington-Mittra Award in Computational Electromagnetics: Don Wilton

Don Wilton, professor of electrical and computer engineering, was awarded the inaugural Harrington-Mittra Award in Computational Electromagnetics by IEEE-APS. The award was established to honor individuals with outstanding achievements in the field of computational electromagnetics, including making fundamental contributions to the field and development of innovative methods for antennas and the analysis of interactions and scattering by electromagnetic waves.

Given the criteria, it's easy to understand the reasons Wilton became the first-ever winner of the Harrington-Mittra Award. Wilton's primary research has focused on the application of mathematical and numerical methods to solve antenna, guided wave and electromagnetic scattering problems, and he has published, lectured and consulted extensively in this area.

Widely regarded as one of the leading authorities in the field of computational electromagnetics, Wilton is perhaps best known for establishing a framework for using computer modeling to study electromagnetic scattering by irregular surfaces, such as the curved wing of an airplane.

The primary article he and his research team wrote on this subject, "Electromagnetic Scattering by Surfaces of Arbitrary Shape," was published in 1982 and has since been cited more than 3,000 times. As one of the foundational documents of computer-based computational electromagnetics, he noted, the paper receives more citations today than when it was first written. Today, Wilton said the methods outlined in this paper are used by both commercial and research organizations to model everything from computer chips to smart phone antennas to scattering from aircraft and antenna placement on ships and cars.

After publishing this groundbreaking paper, Wilton's research on computational electromagnetics continued to establish a number of important fundamentals for the field. In 1996, Wilton published a paper explaining and clarifying how best to use the method of moments, which is one of the oldest computational methods used to solve linear partial differential equations.

Wilton joined the Cullen College of Engineering as a professor of electrical engineering in 1983, a position he would hold for the duration of his tenure at UH. From 1970 to 1983, he was with the department of electrical engineering at the University of Mississippi, and from 1965 to 1968 he was with Hughes Aircraft Company, engaged in the analysis and design of phased array antennas.

Wilton is a Life Fellow of the IEEE and received the IEEE Third Millennium Medal in 2000. He has served the IEEE Antennas and Propagation Society as an associate editor of the publication Transactions on Antennas and Propagation and as a Distinguished National Lecturer. He is also a member of the Electromagnetics (EM) Research Group, and has served as a member of Commission B of the International Radio Science Union (URSI), in which he held various offices, including chair of U. S. Commission B. In 2009, he won the Cullen College's Outstanding Teaching Award. In 2012, he received the inaugural Computational Electromagnetics Award of the Applied Computational Electromagnetics Society (ACES).

Top: Stuart Long, professor of electrical and computer engineering
Bottom: Don Wilton, professor of electrical and computer engineering

AIChE Elects Chemical Engineering Chairman as Fellow

Mike Harold, chair of the chemical and biomolecular engineering department

***Mike Harold**, M.D. Anderson Professor and chairman of the chemical and biomolecular engineering department at the UH Cullen College of Engineering, was elected as a fellow of the American Institute of Chemical Engineers (AIChE).*

AIChE is the world's leading organization for chemical engineering professionals, boasting more than 45,000 members from over 100 countries. The organization is dedicated to promoting excellence in the chemical engineering profession through advancing education, career development and professional standards within the field.

"It's an honor to be elected as an AIChE fellow," Harold said. "It reflects the investment I've made as a professor in my vocation, and it's a great honor to be recognized in that capacity."

Fellowship in AIChE represents the highest grade of membership in the organization. Less than 5 percent of all AIChE members are elected as fellows of the organization. The status is reserved for AIChE members who have demonstrated service to the profession and significant professional accomplishment, in addition to providing uncompensated volunteer service to the organization.

"I've been pretty involved with AIChE through the years," Harold said, adding that he first joined AIChE as a chemical engineering undergraduate student at Pennsylvania State University in the late 1970s. Harold said he encourages all of his undergraduate students to get involved with AIChE as soon as they step foot in the door on their first day of college.

"Being a member of AIChE has professional and personal benefits. Joining these professional organizations is very important as a student. It's a great way to network with alumni and chemical engineers in industry who can offer you job opportunities – and that doesn't stop once you graduate," he said. "When you start your career, staying a member of AIChE is a great way to network with friends and colleagues in the chemical engineering field. Also, AIChE offers short courses and training that keeps you up to speed on the latest developments in safety, design and other parts of the profession."

In the late 1990s, Harold was one of several AIChE members who established the then-new Catalysis and Reaction Engineering Division of AIChE. From 2005 to 2008, Harold served as chair of the AIChE Publication Committee, a group of professionals and industry representatives responsible for overseeing AIChE's various publications.

Harold then served as a member of AIChE's Chemical Technology Operating Council in 2009. In 2011, Harold was elected as editor of the AIChE Journal.

Harold's all-around outstanding dedication as an educator, scholar, researcher and colleague won him UH's most prestigious faculty honor, the Esther Farfel Award, last year. In 2010, Harold also won the Cullen College's Outstanding Teaching Award and the Fluor-Daniel Faculty Excellence Award.

American Chemical Society Names Richard Willson as Fellow

Richard Willson, Huffington-Woestemeyer Professor of chemical and biomolecular engineering at the UH Cullen College of Engineering, was named a fellow of the American Chemical Society (ACS), the world's largest scientific society.

The ACS Fellows Program was created in 2008 to recognize ACS members for outstanding scientific achievements and contributions to the profession and the society. There are currently less than 1,000 total ACS Fellows in the U.S.

"I'm very excited and proud of this. It's a very honorable distinction," Willson said. "ACS has been my professional home and, in a lot of ways, my professional family for many years, so this is especially meaningful to me."

As a longtime member of ACS, Willson has served as the chair of the Division of Biochemical Technology at ACS as well as a member of the editorial board for Biotechnology Press, a journal co-organized by ACS. In 2001, Willson won the society's James M. Van Lanen Distinguished Service Award, which recognizes outstanding contributions to the society's Division of Biochemical Technology.

"I gave my first professional presentation at an ACS meeting," he said. "I encourage all of my students to attend ACS meetings and many of them have been involved in ACS, especially the biochemical technology division."

Richard Willson, Huffington-Woestemeyer Professor of chemical and biomolecular engineering

Willson represents the third of four generations of his family who belong to ACS. "My grandfather was a chemist, my father is a chemical engineer, I'm a chemical engineer and my son is a biochemist – and we've all been members of ACS," he said. "We're very much an ACS family, which makes this pretty special."

Willson was named a fellow of the American Institute for Medical and Biological Engineering (AIMBE) in 1999 and the American Association for the Advancement of Science (AAAS) in 2011. In 2009, he was honored with the Cullen College's Fluor Daniel Faculty Excellence Award, the highest honor given by the college.

Director of Petroleum Engineering Program Wins SPE Faculty Award

Tom Holley, professor and director of the UH Cullen College of Engineering's petroleum engineering program, won the Society of Petroleum Engineers (SPE) Gulf Coast Regional Distinguished Achievement Award for Petroleum Engineering Faculty. This prestigious award recognizes petroleum engineering faculty members for their superiority in classroom teaching, excellence in research, significant contributions to the petroleum engineering profession and effectiveness in advising and guiding students.

SPE is the primary professional organization for petroleum engineers around the world, with the Gulf Coast Section of SPE alone boasting more than 16,000 members. The mission of the SPE-GCS is to enhance technical knowledge of its members, promote professional development and networking among industry professionals, support local education initiatives and perform community service in the Greater Houston area.

The SPE-GCS has certainly lived up to its mission. The professional organization's support was instrumental in the relaunch of the Cullen College's bachelor's program in petroleum engineering. Furthermore, the SPE-GCS established an endowed professorship, the "Gulf Coast Section of the Society of Petroleum Engineers Professor," currently held by associate professor Guan Qin. The organization also provided generous funding for UH to host the SPE Gulf Coast Region Student Paper Contest for the first time last April.

"I think this award is recognition of the need for our petroleum engineering program in the Gulf Coast region, as well as validation by the SPE of their support of the UH petroleum engineering program," Holley said.

Tom Holley, director of petroleum engineering program

MEET THE CULLEN COLLEGE'S NEW FACULTY SUPERSTARS

The UH Cullen College of Engineering welcomed a dozen new faculty members this fall with expertise in a broad range of fields, including petroleum engineering, robotics, renewable and nanoscale energy, and more. Along with their top-notch research, they bring to UH a slew of awards, grants and publications. We are proud to welcome the following world-class educators and researchers to the UH Cullen College of Engineering.

Roberto Ballarini

Thomas and Laura Hsu Professor and Department Chair, Civil and Environmental Engineering

Ballarini's research focuses on the development and application of theoretical, computational and experimental techniques to characterize the response of materials and structures to mechanical, thermal and environmental loads. He is a retired professional civil engineer and has been teaching at a university level since 1985. Ballarini comes to UH from the University of Minnesota, where he served as James L. Record Professor in the department of civil engineering.

Aaron Becker

Assistant Professor, Electrical and Computer Engineering

Becker has been performing postdoctoral research at Rice University's department of computer science since 2012. His research focuses on robotics and automation, specifically control, mechatronics and motion planning. He's published 13 pieces of peer-reviewed software, 14 peer-reviewed conference publications and five journal articles.

Ryan Canolty

Assistant Professor, Electrical and Computer Engineering

Canolty's research focuses on neuroengineering. He is an expert at using a variety of electrophysiological methods to probe the brain and mind in order to uncover its many mysteries. He has extensive experience working with human patient populations in hospital settings and plans to continue researching the role of neuronal oscillations across a wide range of sensorimotor and cognitive faculties that are impacted by aging and disease.

Jinghong Chen

Associate Professor, Electrical and Computer Engineering

Chen comes to UH after an esteemed career in industry, including a stint at Bell Labs and Analog Devices, Inc. He earned his Ph.D. in electrical engineering from the University of Illinois at Urbana-Champaign in 2000 and has served as associate professor of electrical engineering at the University of Arizona in Tucson since 2013. His primary research interests are analog and mixed-signal integrated circuits, clocking and high-speed serial link circuits and systems, and RF/millimeter-wave circuits and systems for wireless and wireline communications. His research has touched on areas ranging from computing, imaging, sensors, power and energy, and biomedical and environmental engineering.

Christine Ehlig-Economides

William C. Miller Endowed Chair Professor, Petroleum Engineering

Ehlig-Economides comes to the Cullen College from Texas A&M University, where she served as Professor and Albert B. Stevens Endowed Chair of Petroleum Engineering since 2004. Ehlig-Economides' career in petroleum engineering includes technical positions at Shell and Schlumberger as well as teaching positions at universities such as Stanford and the University of Alaska. In addition to being a member of the esteemed National Academy of Engineers, she was the first American woman to earn a Ph.D. in petroleum engineering in 1979.

Xin "Felicity" Fu

Assistant Professor, Electrical and Computer Engineering

Fu comes to UH from the University of Kansas, where she was an assistant professor in the electrical engineering and computer science department since 2010. Her research interests include computer architecture, hardware reliability, energy-efficient computing, general-purpose computing on graphics processing units (GPGPUs), the impact of nanoscale technology scaling on multi/many-core processors, mobile computing and on-chip interconnection networks. Fu was one of the 2014 winners of the prestigious NSF CAREER Awards.

Hadi Ghasemi

Assistant Professor, Mechanical Engineering

Ghasemi has been performing postdoctoral research at MIT since 2011. His recent research has been on harvesting solar energy by localization of heat. He is also interested in nanoscale energy transport, solar-thermal harvesting, evaporation kinetics, interfacial energy transport, physics of wetting, physics of adsorption, surface physics and sustainable energies. He has been nominated for a 2014 World Technology Award in the energy category.

Konstantinos Kostarelos

Associate Professor, Petroleum Engineering

Kostarelos is an expert on enhanced oil recovery technologies for environmental applications, especially the use of surfactant solutions to clean up environmental contaminants which do not dissolve readily in water (such as oil). Kostarelos comes to UH from the University of Cyprus, where he served as assistant professor since 2007. Prior to that, he was an assistant professor at the Polytechnic University in Brooklyn for seven years.

Julius Marpaung

Instructional Assistant Professor, Electrical and Computer Engineering

Marpaung has experience as a teaching and research assistant, a lecturer and an assistant professor with specific interest in the fields of robotics, gaming and music. He earned his Ph.D. in computer architecture from Oklahoma State University in 2012 and has taught classes as a lecturer at the University of Texas – Pan American in electric circuits, electrical and electronics systems, digital systems and computer architecture.

David Mayerich

Assistant Professor, Electrical and Computer Engineering

Mayerich's research concentrates on high-performance computing and biomedical imaging. He focuses specifically on using high-performance computing to develop new imaging techniques, and he builds large-scale models from the resulting data. UH received a $2 million grant from the Cancer Prevention & Research Institute of Texas (CPRIT) to help recruit Mayerich, who earned his Ph.D. in computer science from Texas A&M University. The award was one of several recruitment grants awarded by CPRIT as part of the agency's mandate to spur the recruitment of cancer researchers to Texas institutions.

Jeremy Palmer

Assistant Professor, Chemical and Biomolecular Engineering

Palmer comes to UH after performing postdoctoral research at Princeton University. His research focuses on using computer simulation to understand the impact of freeze-drying – a technique commonly used to preserve biological therapeutics – on protein structure and function. He also earned valuable teaching experience as an instructor at North Carolina State University, where he received excellent reviews from his students for his Chemical Process Thermodynamics course.

Jiming Peng

Associate Professor, Industrial Engineering

Peng received his Ph.D. in operations research from Delft University of Technology in the Netherlands in 2001 and has been serving as an assistant professor of industrial engineering at the Cullen College since last year. His research focuses on several areas in optimization such as numerical methods for vibrational inequalities and complementarity problems, interior-point methods for conic optimization, optimization modeling and algorithm design with applications to biomedical image processing, data mining and financial engineering.

Diana de la Rosa-Pohl

Director, PROMES (Program for Mastery in Engineering Studies)

De la Rosa-Pohl has served as an electrical and computer engineering lecturer at the Cullen College for more than 10 years. Since 2003, she has won two awards from the college for excellence in teaching and played a central role in developing the curriculum for the Honors Engineering Program. She earned her Ed.D. in curriculum and instruction and instructional technology from UH in 2011, and she also holds two master's degrees – one in computer engineering and one in physics/optics. She was pivotal in developing the electrical and computer engineering First Year Experience Program and serves on many university-wide committees at UH.

Di Yang

Assistant Professor, Mechanical Engineering

Yang served as a research assistant and postdoctoral fellow at Johns Hopkins University since 2004. During this time, Yang gained nine years' worth of research experience in fluid mechanics and modeling of turbulent flows with applications to renewable wind energy and ocean science engineering. His primary research interests are computational and theoretical studies of turbulent flows, atmospheric boundary layer flows over ocean waves and land terrain, offshore wind farm dynamics and wind energy harvesting, upper ocean dynamics and turbulent dispersion of oil spills, and light propagation in ocean euphotic zones.

STUDENTS

Doctoral Student Works to Optimize Radiation Treatment

Ph.D. student Laleh Kardar

If you lie down and put your hand over your heart, you'll feel your chest rise and fall with each breath. It seems trivial, but the movement of lungs expanding and contracting can drastically change radiation treatment options for patients with lung cancer.

As the patient breathes, the tumor in their lung moves along with the surrounding tissue, sometimes causing radiation to miss the tumor entirely and instead blast healthy cells with its toxic rays. For many physicians, this problem can determine whether or not a patient even receives radiation therapy – but not if **Laleh Kardar** has anything to do with it.

Kardar is a Ph.D. student studying industrial engineering at the UH Cullen College of Engineering. Her advisor – industrial engineering department chair Gino Lim – suggested she help him with his research on optimizing proton therapy, an advanced form of radiation treatment. Since Kardar already had a master's degree in biomedical engineering, she said it made perfect sense for her to dive right into cutting-edge cancer treatment research alongside Lim.

Initially, Kardar studied beam angle optimization, which is the process of identifying the most effective angle to use when delivering radiation to a tumor. "It's a very large optimization problem," Kardar said. For instance, there may be 36 possible angles to deliver radiation from and physicians will be asked to choose the six angles that combine to provide the best treatment. That leaves them with 72 million combinations to choose from.

That's far too complex of a problem for even the most skilled and experienced patient care team. Sometimes clinicians must use simple trial and error. Other times, they rely on algorithms to tell them which angles to use, but these algorithms are very time consuming, even for a high-powered computer to solve.

So Kardar and Lim used industrial engineering techniques to "come up with some solution approaches that find the angle set in a reasonable amount of time," Kardar said. "Using our tool, we've developed a new model which can actually solve the problem very efficiently."

A big part of this research involves factoring in the patient's involuntary movements, which can shift the tumor location and result in an incomplete dose of radiation as well as damage to healthy tissues. For example, motions made during inhaling and exhaling by the patient can cause the location of a lung tumor to move during a treatment session.

Working with collaborators at MD Anderson, Kardar and Lim analyzed the amount of motion of more than 100 lung cancer patients and developed a tool which can help physicians predict the outcome of the treatment. "Based on the outcome, they can decide if they can treat the patient using the radiation therapy," Kardar said.

Team NEO Experiments in Zero Gravity With NASA

The Cullen College of Engineering has once again sent a team of undergraduate engineers up in NASA's zero-gravity simulation airplane, the "vomit comet."

The group consisted of Hector Alba, Andrew McClain, Zachary Hoffpauir, James Broussard, Jesus Mora and Jimmy Le, collectively known on the mission as "Team NEO" (NEO stands for Near Earth Objects). The undergraduate team was mentored by former astronaut Bonnie Dunbar, director of both the aerospace engineering graduate program at the Cullen College and the UH STEM Center.

Each year, NASA hosts a Reduced Gravity Education Flight Program, which allows undergraduate college students in STEM fields to perform assigned experiments during 25-second bouts of weightlessness on the reduced gravity aircraft. The program is intended to increase minority student interest in math and sciences fields.

Team NEO's experiment was titled "Characterization of Forces and Mechanisms Required to Separate Material Particle Sizes In Situ at Near Earth Objects (NEO)." NASA recently included NEOs in its design reference missions. For example, it extracted water from NEOs for use in fuel synthesis and life support systems. Processing, however, is problematic for the microgravity environment typical of a NEO, so Team NEO experimented with different mining methods to extract water in these environments.

Professional Society Recognizes Senior Researcher, Ph.D. Student for Shale Research

Dan Coleff, senior researcher and Ph.D. student

Dan Coleff, a senior researcher with the University of Houston's Cullen College of Engineering petroleum engineering program and a geology Ph.D. candidate, was recognized for his work to develop artificial mudrocks that match the properties of shale.

Coleff won the award for the best poster presentation at a recent meeting of the Society of Sedimentary Geology's Gulf Coast Section. His poster outlined research he is conducting with Michael Myers, a professor of petroleum engineering at the Cullen College.

While shale oil and gas have sparked an energy boom in the U.S. and beyond, actual shale rocks aren't well understood. According to Myers, the petroleum industry's knowledge of shale is decades behind its understanding of more traditional reservoir rocks. This lack of knowledge makes it more difficult and expensive for petroleum companies to safely retrieve resources from shale formations.

One of the challenges of better understanding shale is that not much actual shale rock is available for study. Most rock core samples are taken from traditional reservoirs, which don't offer much shale. Since taking a core sample is extremely expensive, few pure shale cores are available.

Coleff and Myers are working to create artificial mudrocks that match the properties of shale. In doing so, they hope to provide researchers in industry and academia with an easy and affordable shale alternative to use in their experiments.

This, Coleff said, should help researchers determine the important properties of shale more quickly. "If we can create our own shales and make the petrophysical models from these mudrocks, then we're one step ahead of the game."

Ph.D. Student Expands Research to Cover Cross-Eyed Monkeys

Mehmet Agaoglu, a Ph.D. student in the electrical and computer engineering department at the UH Cullen College of Engineering, is attracting national attention for his work researching strabismus (the disease which causes humans to go cross-eyed) in Rhesus monkeys at the College of Optometry.

Last spring, he won the members-in-training contest at the Association for Research in Vision and Ophthalmology's (ARVO) annual conference for his strabismus research and corresponding poster. His award included a travel grant to attend the ARVO conference for free.

Agaoglu began working part-time at the College of Optometry as a programmer while pursuing his engineering degree. "Their research is in a very highly technical, computationally intense area," he said. "Their work requires highly skilled engineering, because they have a lot of equipment and they need programming to make the devices talk to each other. So I went there and was able to program really quickly because I knew the concepts."

While on the job, Agaoglu said he was noticed by Vallabh Das, associate professor of optometry, and was recruited to begin conducting actual strabismus research in the primate lab. Rhesus monkeys, sometimes known as macaques, are conditioned at a young age to develop the eye condition. Das and his team then work to determine how to treat the underlying cause, which they believe to be the brain – even though popular logic currently points to eye muscles as the culprit.

"If you do corrective surgery [on a strabismus patient], they cut some of the muscles – but it only works in 40 percent of the cases," he said. "Most of the time the strabismus actually becomes worse and the patient ends up with worse vision… because [we think] the brain is adjusting its input to the muscles and pulling them back."

To test their hypothesis, Das' team records output from the different brain regions that control the eye muscles of the monkeys. "By recording these motor regions, we're trying to show that the strabismic monkeys and normal monkeys have the exact same muscle and motor command properties, so the difference must be somewhere in the brain where the command originates," Agaoglu said.

The scope of Agaoglu's strabismus research is staggering, but it's just a side gig. In pursuit of his computer engineering doctoral degree, he also studies "ballistic eye movements" under the direction of his advisor, Haluk Ogmen, professor of electrical and computer engineering. The human eye moves involuntarily at least three times per second in an effort to keep retinal images from fading or losing contrast. Agaoglu is performing computational experiments to determine how the brain accounts for these eye movements and processes the information in the scene.

SURF Provides Research Opportunity for Cullen College Undergrad

Plenty of college students use the summer months to catch up on their favorite television shows, work on their base tans and reconnect with old friends. However, the three-month break provided one Cullen College junior with the perfect opportunity to sharpen her analytical skills by diving headfirst into the world of undergraduate research.

Abby Zinecker, a junior studying mechanical engineering, participated in the Summer Undergraduate Research Fellowship (SURF), researching flexible, stretchable batteries under the mentorship of Haleh Ardebili, assistant professor of mechanical engineering. Ardebili recently received a one-year, $10,000 New Investigator Award from the NASA Texas Space Center Grant Consortium to develop flexible batteries for spacesuits.

The SURF program provides funding for UH undergraduate students to pursue full-time, 10-week research projects under the direction of UH faculty members during the summer. Course credit isn't offered for the fellowship, but students earn invaluable experience with hands-on research and analysis in real-world laboratory settings. For Zinecker, the opportunity was too good to pass up.

"I've wanted to do undergraduate research basically since I started at UH," she said. "I looked up [Dr. Ardebili's] research online and it looked really interesting – the flexible batteries – so I emailed her and asked if she was looking for any undergrad research assistants... and here I am."

Zinecker specifically looked at the performance aspect of the batteries, or how much energy the batteries can output. "It's very exciting as an undergraduate to be able to get this opportunity," she said. "I know a lot of people aren't that lucky."

While any undergraduate research project would have provided learning opportunities, Zinecker found batteries for spacesuits greatly appealing. "I've always stayed up late to watch launches on TV and whatnot, I've always liked space," she said. "I do hope to get into the space industry somehow, either at NASA or some other commercial company. I would really just like to design something that goes up into space."

ECE Senior Wins Outstanding Honors Thesis Award

Ramon Montano, an electrical engineering alumnus of the UH Cullen College of Engineering, was honored for his work on transparent antennas for cube satellites with the Outstanding Honors Thesis Award. The award, an initiative spearheaded by Joseph Tedesco, dean of the Cullen College, is in its pioneer year with Montano as its first recipient. In 2012, he began his undergraduate research with the Provost Undergraduate Research Scholarship (PURS), which introduced him to the CubeSat research being done in the Cullen College.

"Dr. [David] Jackson gave me some real simple tasks to learn the software, simulate a few different types of antennas, and come up with some rudimentary results," Montano said. When the PURS research scholarship ended, Montano continued his work with CubeSat antenna designs. He travelled to Wisconsin to present his research and attended several national symposiums held in Houston. By the time he began his senior honors thesis, he was ready to conduct some serious analysis.

Montano spent much of his senior year reading articles about different materials used for satellite antennas. "But the bulk of the time went into simulations," he said. "Some simulations are known to run from a couple of hours to a couple of days. So toward the end of the semester, I spent a couple of all-nighters running simulations because I needed better results."

Southwest Catalysis Society Symposium Awards UH Students' Posters

Three chemical and biomolecular engineering Ph.D. students swept the Spring Symposium of the Southwest Catalysis Society's poster contest on the UH campus. Matthew Oleksiak, Manjesh Kumar and Tayebeh Hamzehlouyan received top honors for their posters, "Controlling Crystal Polymorphism in Organice-Free Synthesis of Zeolites," "Tuning the Physicochemical Properties of Zeolite Catalysts Through Molecular Design" and "Experimental and Kinetic Study of SO_2 Oxidation on a Pt/γ-Al_2O_3 Catalyst," respectively.

The Southwest Catalysis Society is a branch of the North American Catalysis Society, a group focused on promoting and encouraging the growth and development of the science of catalysis. Oleksiak and Kumar both worked with chemical and biomolecular engineering professor Jeff Rimer as their advisor. Hamzehlouyan worked with faculty advisor Bill Epling, associate professor of chemical and biomolecular engineering.

Chem-E-Car Team Wins Second Place at Regionals

The University of Houston Chem-E-Car Team is well on its way to creating a tradition of supremacy in the Cullen College of Engineering. Fresh off its third-place win in last November's national Chem-E-Car competition, the team ended the 2014 regional competition in College Station with a bang. The students won second place, which means they advance to the national competition this winter.

The Chem-E-Car Competition is sponsored annually by the American Institute of Chemical Engineers. Teams construct cars powered solely by chemical reactions that can haul a certain load several meters. The load and distance remain unknown until the day of the competition. At the regional contest, cars hauled 770 milliliters of water a distance of 70 feet. The UH car's motor is powered by a battery cell and stopped by an iodine clock reaction.

Paul Abraham, a chemical engineering senior, serves as team lead. Other team members include Jose Sachango, Addam Rufael, Eliazar Nava, Robert Dimaunahan, Abraham Aboiralor, Bruce Livingston and Hayden Trask.

Now that the team has qualified for the national competition, they plan to weigh their options regarding modifications to the car. Last year's car was powered by a pressure reaction, so the switch to a battery has resulted in a dramatic decrease in power. Abraham said the team plans to experiment with biofuels as a power source in the months leading up to nationals. They also plan to downsize the reactor size for the iodine clock to reduce the stopping time spread.

While the Chem-E-Car competition is a great way for Cullen College students to flex their engineering muscles, the process also offers real-world benefits. Abraham calls it the "plant analogy."

"With a [chemical] plant, you're doing the same thing as the Chem-E-Car. You're running a chemical reaction; you have a start product and a desired end goal. On top of just making your product, you also have the additional goal of trying to make sure you do that the same every time," he said. "That's what we're doing here. We put in our battery, our chemicals, and our end product is our car stopping at a certain place. Additionally, we want to make sure the car stops at that place every single time when we do the reaction. If the car overshoots the target, I call it your plant blowing up. If the car doesn't start, your plant didn't run that day."

Student Wins Third Place in SPE Regional Paper Contest

Rahul Pandey, a Ph.D. student studying chemical and biomolecular engineering at the University of Houston Cullen College of Engineering, took home a third-place prize from the UH-hosted Society of Petroleum Engineers (SPE) Gulf Coast Regional Paper Contest.

SPE is the primary professional organization for petroleum engineers around the world, with the Gulf Coast Section of SPE alone boasting more than 16,000 members. The mission of the SPE-GCS is to enhance technical knowledge of its members, promote professional development and networking among industry professionals, support local education initiatives and perform community service in the Greater Houston area.

The UH student chapter of SPE is particularly active, especially since the relaunch of the undergraduate program in petroleum engineering in 2009. Since then, UH-SPE students have worked tirelessly to organize and host the SPE Gulf Coast Regional Paper Contest on the University of Houston campus.

Only three winners were chosen from hundreds of students for each contest including bachelor's, master's and Ph.D. divisions. "Rahul was the only UH student to win a prize, and he did an excellent job," said Tom Holley, director of the petroleum engineering program at the Cullen College of Engineering.

Rahul's paper, "Flow and dynamics of particulate fluids in complex porous media," sought to determine the phase behavior and flow properties of particle-polymer mixtures in fine geometries. His research is particularly important to the oil and gas industry because understanding the flow of drilling fluids through porous media, such as rock structures, is crucial to the success of drilling operations.

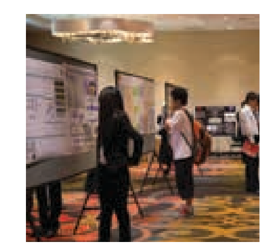
Working closely with Jacinta Conrad, assistant professor of chemical and biomolecular engineering in the Cullen College, Rahul was able to show that small changes in the size, concentration or interaction of particles can affect the properties of a fluid dramatically. "It completely changes flow properties, which then affects drilling operations," he explained.

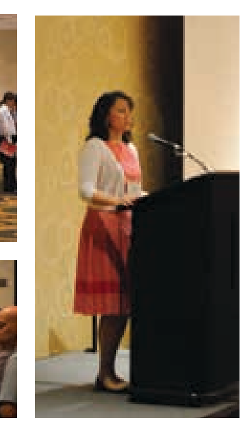
Based on this initial research, Rahul developed theories that could explain how certain interactions between particles can impact the overall flow properties of a fluid.

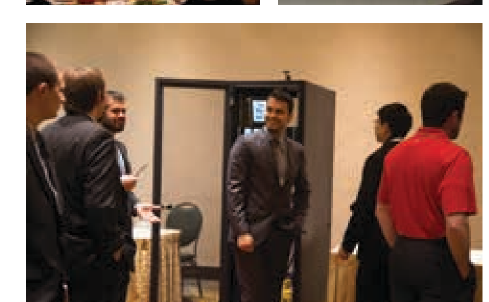
Rahul, who currently serves as an intern at Shell, said there's no better place than Houston to work as a chemical engineer. "Houston is the best place to be, and chemical engineering at UH is one of the best programs in the world," he said.

PHOTOS: 10th Annual GRC/CDC

The annual ECE Graduate Research and Senior Capstone Design Conference was held on April 25 at the UH Hilton for the 10th year in a row. The event provides a platform for undergraduate and graduate students to present their research and capstone projects to an audience and to compete for top honors among their peers.







The following Cullen College students were awarded for their outstanding presentations:

- Urvish Medh award for best overall GRC presentation: Yifei Li
- SEL award for best GRC oral presentation: Chih-Hao Liu
- ECE award for outstanding GRC poster presentation: Ji QI
- Schlumberger Capstone Design award (team): Ryan Murphy, Ramiro Lozano, Jesus Tamez Duque and Rebeca Cobian
- Agilent Capstone Design award (team): Richard Allen Hooks, Emin Elmar Mamedow, Cemil Toygan Ozyalcin and Jonathan Silva
- ECE Capstone Design award (team): Anthony Eshareturi, Gavin Guy, Karen Jordan and Andres Michel

SUPPORT & GIVING

Shell Retirees Give Endowment to PROMES Program at 40th Anniversary Party

Irv Doty (left) and Rom Cambio (middle) announced endowment for PROMES at 40th anniversary party

In the early 1980s, Ron Cambio and Irv Doty realized that their peers at Shell Oil Company were having difficulty finding minority engineers to join their teams. With Jim Braus, a company manager, they began exploring opportunities to invest in grassroots programs at local universities that supported minority participation and success in science and engineering.

The engineers found the UH Cullen College of Engineering's PROMES program (Program for Mastery in Engineering Studies), and began backing the organization financially. In 1996, they and seven other Shell engineers established the PROMES Shell Scholarship, which has funded educations for 16 students since its inception. Fearing funds for the scholarship would someday run dry, the 10 Shell retirees recently decided to establish the PROMES 40th Anniversary Endowment so their legacy of support can continue long after they have gone.

The endowment was of particular importance to the former Shell engineers because they personally witnessed the benefits of the PROMES program for the students involved in it and the companies that hired them. Together, they introduced the 40th Anniversary PROMES/Shell Engineering Retirees Scholarship Endowment in Honor of Dr. Gerhard Paskusz and Dr. Katherine S. Zerda. Cambio and Doty kicked off the endowment with a $25,000 combined initial commitment which they announced at the PROMES program's anniversary celebration in May.

"Many of the PROMES students would come to Shell as part of a co-op, and many worked in my department. It really was an effective program from the first understanding that we really weren't able to get the kind of people we wanted into engineering," Doty said. "It was a really great thing – both for the students involved in the program, who received great industry experience and professional training, and for us at the company as well, who were able to hire these well-trained engineers right in our backyard, right out of college."

PROMES' year-to-year funding relies on the generous donations of corporate sponsors and Cullen College alumni. Cambio and Doty said that though they both hope the PROMES Shell Scholarship fund continues to receive donations for many years to come, they were excited about the idea of having an endowment fund that could accrue interest until the existing scholarship fund runs out. "We very much hope that doesn't happen at all, or at least for a very long time," Doty said. "But it's nice that if it does, this endowment is here to support PROMES students."

To make a donation to the PROMES endowment, visit https://giving.uh.edu/eng/.

FMC Technologies Donates $15K to EAA Gala

The Engineering Alumni Association (EAA) hosted the Alumni Awards Gala, its largest annual fundraiser benefitting the UH Cullen College of Engineering, in June. Proceeds from the event provide operational support for the college and fund the dean's educational priorities.

Through the boundless generosity of corporate sponsors as well as Cullen College alumni and donors, the college is able to support academic and student success programs including research projects, outreach services, professional development and social support.

This year, FMC Technologies donated $15,000 to the EAA's Alumni Awards Gala. Randy Wester (pictured below), director of subsea engineering for FMC and recipient of this year's Distinguished Engineering Alumni Award, called the gift a token of appreciation for many years of successful collaboration with the University of Houston.

"The University of Houston and FMC Technologies have mutually benefited from an innovative, collaborative working relationship for many years," Wester said. Most recently, FMC and the Cullen College joined forces to create the nation's first subsea engineering degree program. "The program has grown to over 200 students in four years, demonstrating not only the value and demand of the program itself but also the positive results that UH and industry can deliver by partnering together," he said.

Russell Dunlavy, chief advancement officer for the Cullen College, said the donation from FMC means more opportunity for current students. "The success of the college is directly correlated to the support we receive from our alumni and industry partners," Dunlavy said. "Student success is not simply defined by a grade in a classroom, and the college works hard to create an environment where students have the opportunity to interact with top faculty, engage in research opportunities and participate in outreach programs to understand how engineers impact the community."

The alumni association also honored Okechukwu A. Ofili, project/design engineer at FMC Technologies, with the Distinguished Young Engineering Alumnus Award at the gala.

ALUMNI

Engineering Alumnus Brings STEM to Houston Kids

Monse Lozano, alumnus of the Cullen College

When **Monse Lozano** was a teenager growing up in the Houston Heights neighborhood, he dropped out of public high school, earned his GED and found work at a local phone company. A decade later, the UH Cullen College of Engineering alumnus and engineer at NASA's Johnson Space Center creates robotic technologies launched into space and used aboard the International Space Station.

It's an uncommon career path, but Lozano bucks tradition in more ways than one. He's also in the process of starting a nonprofit organization aimed at teaching electronics through art to Houston's youth.

Lozano's nonprofit is called Vampire Squid Labs (VSL), and he's currently in the process of getting the group certified as a 501(c)(3) with the IRS so it can obtain funding and certification necessary to offer classes later this year.

Vampire Squid Labs' goal is to introduce technology in understandable ways to younger audiences through art, which is near and dear to Lozano's heart. Student projects on the horizon include creating synthesizer circuits so the students can perform musical concerts and building small vibrating robots that can hold paintbrushes and create works of art.

The focus is on "making it fun, avoiding all the technical stuff," he said. "There is a lot of hands-on creation in the labs and with the projects."

The electronics classes had a trial run last fall when Lozano shared his curriculum with Multicultural Education and Counseling Through the Arts (MECA). The overwhelmingly positive response motivated Lozano to strike out on his own.

"If I had been exposed to this [as a child], I would have pursued engineering a lot earlier," Lozano said. "I would have graduated at the regular graduation age, 22 or 23, so I would have started my career path a lot earlier."

Lozano calls Vampire Squid Labs his "baby" despite the additional work. The high school dropout who became a NASA Johnson Space Center engineer hopes to spread interest in the field that has given him so much. "I feel lucky, and I want to share that and give others a similar opportunity," he said.

Learn more about Vampire Squid Labs at http://vampiresquidlabs.com.

Compaq CEO and Co-Founder, a Cullen College Alumnus, Speaks at MIT Enterprise Forum

Rod Canion, Compaq co-founder and CEO who graduated from the Cullen College, spoke about the future of technology at an MIT Enterprise Forum at the University of Houston in June. The event, co-hosted by the Bauer College of Business, is one of several events held annually by MIT to build connections to technology entrepreneurs and the communities in which they reside.

In his talk, Canion predicted strong growth in areas that successfully combine mobile and Internet technologies over the next five years. "And then somebody's going to stumble on the next thing and hopefully figure out how to fit it all together," he said. Canion also discussed Apple's leading position in the industry and the possibility for wearable technology syncing consumers with their doctors.

Texas Public Works Association Honors Cullen College Alumnus

Every year, the Texas Public Works Association honors a select few public works employees with the prestigious Top Public Works Leader of the Year Award. This year, Cullen College alumnus **Doug Haude** (BSCE '02) received the award for his work with the San Jacinto River Authority (SJRA).

Haude, SJRA senior project manager, oversees the implementation of the groundwater reduction plan program in Montgomery County. Several years ago, the Lone Star Groundwater Conservation District determined that area aquifers were being depleted faster than they could refill. The district mandated that large volume groundwater users in Montgomery County find an alternative source of water to reduce the pumpage rate on the aquifer over a 40-year period. Haude has led the SJRA's efforts, including the construction of a multi-million dollar treatment plant, to use treated surface water in Lake Conroe rather than ground water.

The groundwater reduction plan includes more than 50 miles of large-diameter water lines to transfer the treated Lake Conroe surface water to areas throughout Montgomery County including The Woodlands, Conroe, Oak Ridge and other municipal utility districts. The plan is intended to reduce the strain on underground aquifers by allowing large volume groundwater users to tap into an alternate water source.

For Haude, tackling public works projects in North Houston is more than a job – it's in his blood. He can trace his family lineage back to the original Spring/Klein area settlers, and he believes his Texas work ethic helped him earn the award.

"It made me proud that hard work does get recognized," he said. "I do know deep down inside that I am a hard worker and I give it all I've got. So [this award] was kind of a validation of that."

Jim Kaucher, Cheniere Energy, Inc.

ALUMNI SPOTLIGHT

It wasn't long ago that the average person had never heard of LNG, or liquefied natural gas. Today, however, it's rare to pick up a newspaper without a few LNG-related headlines. As worldwide demand for LNG continues to grow – along with America's ability to produce and export it – more LNG-related headlines can be expected in newspapers in coming years.

Simply put, LNG is natural gas that is predominantly methane sub-cooled to -260 degrees Fahrenheit where it becomes a liquid. When natural gas is converted into a liquid, the volume is reduced by 600-to-1, making it economical to transport in specially designed ships. LNG is colorless, odorless, non-corrosive and non-toxic. It is stored at cryogenic temperature and is not under pressure. Once shipped, LNG can also be safely stored in tanks for later use, at which point regasification is used to convert LNG back to its gaseous form so it can enter the natural gas pipeline system and ultimately reach consumers.

But what is the reason behind LNG's sudden popularity in the media and explosive growth as an energy source over the last several decades?

First, environmental concerns over oil spills and fuel emissions have spurred on more research into cleaner energy sources, such as natural gas. LNG is lighter than air when vaporized and there is no significant environmental impact from an accidental release. Also, the discovery of shale gas in the U.S. and improved technology to economically recover it have significantly improved the country's ability to produce and export LNG. This has raised demand for LNG liquefaction and storage facilities.

Alumni of the University of Houston Cullen College of Engineering are employed in leading positions at energy companies across Houston and around the world, and the LNG industry is no exception. Jim Kaucher, who graduated from the Cullen College in 1973 with a bachelor's degree in mechanical engineering, now serves as the vice president of technical services and procurement at Cheniere Energy Inc., a Houston-based energy company that focuses primarily on LNG.

Cheniere is among the U.S. companies leading the development of LNG import and export terminals. The company currently owns and operates the largest LNG terminal in the country, the Sabine Pass terminal, which occupies over 1,000 acres of land along the borders of Texas and Louisiana.

The Sabine Pass LNG terminal opened in 2008 to import LNG from overseas and regasify it for U.S. consumers. Situated at the mouth of the Sabine River Navigation Channel, the terminal allows for quick and easy access to both the open waters of the Gulf of Mexico and existing domestic pipelines that deliver natural gas directly to U.S. consumers.

Natural gas is certainly part of the future of energy in the U.S. and around the world, as is the University of Houston. Many alumni of the Cullen College, like Kaucher, are helping to shape the future of the energy landscape.

In response to the increased demand for LNG, Cheniere expanded its Sabine Pass LNG terminal to export the natural gas as well. Construction is underway to add liquefaction capability to the terminal. The company is also in the process of obtaining a permit to build another LNG export facility in Corpus Christi located on 1,000 acres of land near Corpus Christi Bay.

Kaucher describes Sabine Pass terminal as "a booming little city in and of itself" with thousands of construction workers bussed in every day to continue building and expanding. The first-ever LNG shipment exported from the Sabine Pass LNG terminal is expected to leave in late 2015.

With the U.S. taking the lead as the world's biggest producer of natural gas, the Sabine Pass LNG terminal can likely continue significant activity for many years to come. "We hope that all the activity we're seeing now at the Sabine Pass LNG terminal is just the beginning," Kaucher said.

Natural gas is certainly part of the future of energy in the U.S. and around the world, as is the University of Houston. Many alumni of the Cullen College, like Kaucher, are helping to shape the future of the energy landscape.

ALUMNI EVENTS

PHOTOS:
2014 EAA Gala

The Engineering Alumni Association (EAA) held its annual Alumni Awards Gala on June 12 at the Houston Petroleum Club. The event is held every year in honor of several Cullen College alumni and faculty for their achievements in the engineering industry. In addition, proceeds from the event are used by the EAA to help further the goals of the Cullen College and its students.

PHOTOS:
Academy of Distinguished Civil & Environmental Engineers Induction Ceremony

On May 1, the UH Cullen College of Engineering's Department of Civil and Environmental Engineering inducted two new members into their prestigious Academy of Distinguished Civil and Environmental Engineers. The induction ceremony and dinner took place at the Hess Club in Houston. Joe Zimmerman, vice president of Klotz & Associates, and David Collins, senior civil engineer at FCM Engineering, were the latest inductees into the academy.

PHOTOS:
Annual IE Awards & Honors Banquet

The UH Cullen College of Engineering's Department of Industrial Engineering hosted its annual awards and honors banquet on May 2 to honor its outstanding alumni, donors, faculty, staff and students. The formal affair was held at Brady's Landing restaurant. The event featured a heartfelt tribute to George Hall, a well-known and beloved alumnus of the department who earned his master's degree in industrial engineering from the Cullen College at the tender age of 86. To this day, Hall serves as an inspiration to many Cullen College students and as a testament to the fact that it is never too late to follow your dreams. Awards for scholarship donors and recipients were also presented at the banquet, along with outstanding faculty, staff and student awards.

PHOTOS:
40 Years of PROMES BBQ

The PROMES 40th Anniversary Mixer was held in front of Engineering Building 1 on May 31. Hundreds of current PROMES students and PROMES alumni gathered to celebrate the history, longevity and success of the program, which serves as a community for undergraduate engineering students and offers academic support and skills development. Partygoers also enjoyed a dunk tank, inflatable slide and a photo booth complete with wacky props and costumes.

John Lienhard

ENGINES OF OUR INGENUITY:
Taken from Episode 2587

You know Guy Noir's tagline, "A dark night in a city that knows how to keep its secrets." Well, what city doesn't have its secrets? Some years ago I did a program on Stanley Greenberg's book, "Invisible New York," about the secret recesses of that city.

Houston, Texas, is somewhat smaller and a lot younger, but none of us lives here very long without making all kinds of secret places uniquely ours. Many of mine are on the University of Houston campus: our Meditation Garden, the mysterious statue in the middle of our University Center (it harbors symbolism that only we old-timers know). The forested banks of the Bayou running through the campus, so rich in water birds. Of course, any other part of the city harbors secrets of its own.

And few of us ever think about the greatest secret of any city: its subterranean mirror image. Just below the surface lie telephone conduits and electric power ducts. Further down are gas lines, low-pressure domestic water, high-pressure water for fire fighting. Deeper yet we find sewage lines, storm drains and building foundations.

Systems of tunnels often serve the utilities. In many large cities, below all else run subway tunnels, linked to the surface only by long ventilation shafts. The shining city above ground is inevitably served by that second invisible city below – the one we hardly know is there.

We have a splendid secret subterranean place here in Houston: our system of downtown underground tunnels. Seven miles of tunnels link some 95 city blocks and hold every kind of shop and service. How can such a thing be secret? Well, how many of you, my Houston listeners, have actually walked and used that system? It really does remain a secret to more people than not.

So, your assignment today is: go out and find the unexpected. Here in Houston that might be the old Gable Street Power Station or the 1940 Air Terminal Museum. Both are architectural relics, too little known and too seldom visited. Or maybe you'll simply find your own family of barn swallows below a bayou bridge.

Our secret place might be no more than a special shop or restaurant. No matter, a city becomes ours when we feel we own its special places. When you or I own our city, we become its custodian. And that's the point at which all those secret places truly serve the common good.

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 and a member of the National Academy of Engineering. The program first aired in 1988, and since then more than 2,800 episodes have been broadcast. For more information about the program, visit www.uh.edu/engines.

UNIVERSITY of HOUSTON | ENGINEERING

UH Cullen College of Engineering
Office of Communications
E301 Engineering Bldg. 2
Houston, TX 77204-4009