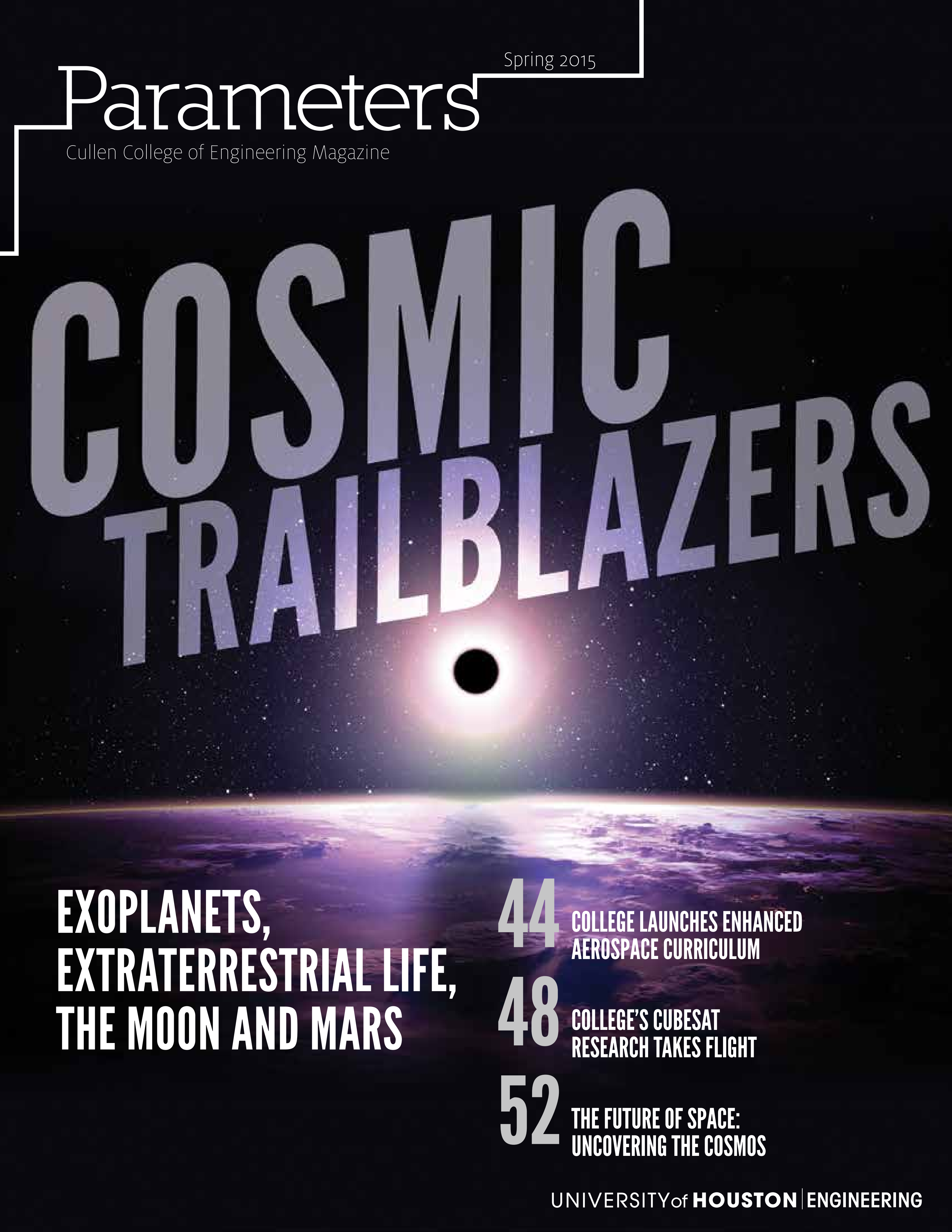
Spring 2015

Parameters

Cullen College of Engineering Magazine



COSMIC TRAILBLAZERS

EXOPLANETS, EXTRATERRESTRIAL LIFE, THE MOON AND MARS

UNIVERSITY of HOUSTON | ENGINEERING

IN THE MEDIA

The National Center for Airborne Laser Mapping (NCALM) at the UH Cullen College of Engineering is receiving international media attention for uncovering evidence of an ancient civilization deep within the Honduran rainforests. NCALM researchers first discovered evidence of the lost city — once believed to be the legendary White City, or Ciudad Blanca — in 2012, when they completed the first light detection and ranging (LiDAR) survey of the country's Mosquitia region. A group of scientists and a documentary crew recently explored the region on foot, confirming that LiDAR had uncovered not the mythical city they originally thought, but rather two main cities and several smaller settlements of an ancient civilization that has yet to be named. Juan Carlos Fernandez Diaz, senior researcher with NCALM, was part of this expedition to confirm the discovery of the ancient civilization in Honduras. Read more about this story on page 16.

Media outlets covering the NCALM team include:

NATIONAL GEOGRAPHIC CNN The New York Times

NBC NEWS abc npr HOUSTON CHRONICLE

TIME theguardian Daily Mail

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

Director of the Division of Undergraduate Programs & Student Success
Fritz Claydon

Parameters

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

Communications Director
Audrey Grayson

Senior Writer
Elena Watts

Writer/Editor
Melanie Ziems

Creative Director/Graphic Designer
Rachel Ward

Photographer/Videographer
Carlos Landa

Contributing Writers/Editors
John Lienhard 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: 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
uhengineering
UHCullenCollege
University of Houston Cullen College of Engineering

UNIVERSITY of HOUSTON
CULLEN COLLEGE of ENGINEERING

DEAN'S LETTER

The University of Houston Cullen College of Engineering reflects the DNA of the city of Houston. For those of us lucky enough to live in Space City, reaching for the stars is in our blood. Only in a city like Houston – a region rich with entrepreneurial know-how, risk-takers and dreamers – could the country's sole human space flight facility, the NASA Johnson Space Center, exist.

This is why researchers at the Cullen College are working to push space research and space exploration beyond its earthly limits. The Cullen College is a key driver of Houston's economy, pioneering research and facilitating the transfer of technology for the space and aerospace industries in the state of Texas. Students and faculty members work side-by-side with researchers at NASA and leaders in private industry to solve some of the most pressing challenges of space exploration.

With the recent appointment of former NASA astronaut Bonnie J. Dunbar as the director of the aerospace engineering graduate program, the Cullen College's aerospace curriculum has entered into a period of unprecedented growth and revival. In this issue of *Parameters*, we take a closer look at the revitalized aerospace engineering curriculum and research at the Cullen College, as well as the professors and students who continue to reach for the stars.

Warm regards,

Joseph W. Tedesco

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

"WHAT HAS SPACE EXPLORATION DONE FOR ME?"

Believe it or not, this is a question asked by many Americans as they debate the amount of federal funding to devote to NASA research and space exploration each year.

In fact, space exploration has contributed to thousands of technologies used on a daily basis on Earth. NASA has generated more than 6,000 patents, which have inspired thousands of devices and technologies. NASA was born in 1958 with the Space Act, which established the organization's mission to develop spacecraft and to conduct research that benefits humanity.

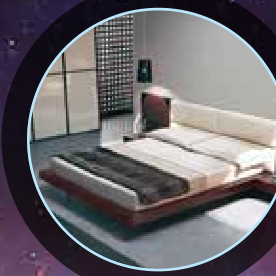
In honor of NASA and its successful ongoing mission, the Cullen College highlights some of NASA's ground-breaking, life-altering discoveries and technological spinoffs.

LONG DISTANCE COMMUNICATIONS

GLOBAL POSITIONING SATELLITES (GPS)

ARTIFICIAL LIMBS

VENTRICULAR ASSIST DEVICES (HEART PUMPS)



MEMORY FOAM MATTRESSES

INFRARED EAR THERMOMETERS

SMOKE DETECTORS

WATER FILTERS

FREEZE DRYING

LEDS (LIGHT-EMITTING DIODES)

VIDEO IMAGE STABILIZATION AND REGISTRATION TECHNOLOGIES

COCHLEAR IMPLANTS

ANTI-ICING SYSTEMS

CHEMICAL DETECTION

FIREFIGHTING EQUIPMENT

HARNESSING SOLAR ENERGY

ENRICHED BABY FOOD

POWDERED LUBRICANTS

STRUCTURAL ANALYSIS SOFTWARE

ANTI-CORROSION COATING

Find all of these NASA inventions and much more at spinoff.nasa.gov!

ENGINEERING HOUSTON, ENGINEERING THE WORLD.

Over the next 10 years, the UH Cullen College of Engineering will vastly extend its reach and impact in the Houston area and beyond. The Cullen College will double its student enrollment, build new state-of-the-art research and classroom facilities and increase its research expenditures to $50 million. By 2025, the UH Cullen College of Engineering will be a key driver of Houston's economy, pioneering research with a resounding impact in the state of Texas and graduating thousands of the most talented engineers into Houston's STEM pipeline each year.

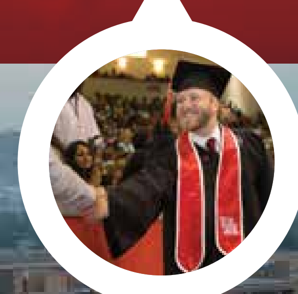
2016: Construction of the state-of-the-art Multidisciplinary Research and Engineering Building (MREB) at the University of Houston will culminate in its grand opening.

2017: The UH Cullen College of Engineering will promote a **$612 MILLION** increase in annual economic activity in the city of Houston.

2018: The UH Cullen College of Engineering will extend its reach to the UH Sugar Land and UH Katy campuses.

2019: Industry leaders in the Houston region and around the world will sponsor more than **$9 MILLION** worth of research at the UH Cullen College of Engineering.

2020: The UH Cullen College of Engineering will welcome 11 new National Academy of Engineering (NAE) faculty members, bringing the total number of NAE faculty members to 22.



2021: The UH Cullen College of Engineering will accommodate both traditional and non-traditional students with main and satellite campuses, online courses and industry-led certification courses.

2022: Nearly **1,700** female engineering students and **2,000** Hispanic engineering students will pursue bachelor's degrees at UH Cullen College of Engineering.

2023: Approximately **4,000** world-class engineers will graduate from UH Cullen College of Engineering. Of these alumni, 80 percent will be employed in Texas within one year of graduation.

2024: The UH Cullen College of Engineering will reach **$50 MILLION** in research expenditures.

2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025

THE UH CULLEN COLLEGE OF ENGINEERING WILL BE RECOGNIZED BY U.S. NEWS & WORLD REPORT AS A TOP 50 ENGINEERING PROGRAM.

IN THE MEDIA SPOTLIGHT

PLANT-DERIVED COMPOUND ‘MAY EFFECTIVELY TREAT LUPUS WITH FEWER SIDE EFFECTS’

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

Health News Digest · Houston Chronicle · Deer Park Broadcaster · Medical News Today

HIGH-TECH HOPE: INVENTIONS BRING THE GIFT OF MOVEMENT

FEATURING Jose Luis “Pepe” Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen Distinguished Professor of electrical and computer engineering

USA Today · The Telegraph · Houston Chronicle · Phys.org · my Fox Houston · The Baltimore Sun

OTHER RECENT MEDIA COVERAGE: PRINT

THE ANTARCTIC SUN

Scanning the horizon
Featuring The National Center for Airborne Laser Mapping (NCALM)
(Published January 30, 2015)

ASU NEWS

ASU workshop explores potential of robotics used to rehabilitate
Featuring Jose Luis “Pepe” Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen Distinguished Professor of electrical and computer engineering
(Published February 10, 2015)

BLOOMBERG

BP Dives Deeper Offshore into Mars-Like World
Featuring Matthew Franchek, director of the subsea engineering program and professor of mechanical engineering
(Published September 17, 2014)

ENERGY VOICE

BP Macondo being pumped into US Subsea Systems Institute
Featuring University of Houston Subsea Systems Institute
(Published February 4, 2015)

FILTRATIONANDSEPARATION.COM (WWW.FILTSEP.COM)

Nanofiltration could solve US water crisis
Featuring Shankar Chellam, professor of civil and environmental engineering
(Published October 29, 2014)

HOUSTON BUSINESS JOURNAL

Houston University breaks ground on $51 million research facility
Featuring the Multidisciplinary Research and Engineering Building (MREB)
(Published October 7, 2014)

UH company aims to purify water, help end global water crisis
Featuring Debora Rodrigues, assistant professor of civil and environmental engineering
(Published April 4, 2014)

HOUSTON CHRONICLE

UH scientist, choreographer study the dance of the brainwaves
Featuring Jose Luis “Pepe” Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen Distinguished Professor of electrical and computer engineering
(Published March 20, 2015)

Electrical engineers experience energizing work
Featuring Yolanda Brooks Brown, manager of cooperative education and internship programs at the Engineering Career Center
(Published March 20, 2015)

Education will open doors to engineering, energy future
Featuring Vita Como, director of the Engineering Career Center
(Published February 16, 2015)

WISE luncheon celebrates three honorees
Featuring Bonnie Dunbar, M.D. Anderson Professor of mechanical engineering, director of the UH STEM Center and the aerospace engineering graduate program
(Published January 23, 2015)

Energy, industries utilize chemical engineers’ expertise
Featuring Vita Como, director of the Engineering Career Center
(Published December 12, 2014)

Shale industry staying busy with activity
Featuring Vita Como, director of the Engineering Career Center
(Published November 21, 2014)

UH students compete to design HISD school
Featuring petroleum engineering program
(Published November 19, 2014)

UH at ‘tipping point’ as dramatic improvements come with rising costs
Featuring Matt Franchek, director of the subsea engineering program and professor of mechanical engineering; Ramanan Krishnamoorti, professor of chemical and biomolecular engineering and chief energy officer of the University of Houston; Venkat Selvamanickam, M.D. Anderson Chair Professor of mechanical engineering
(Published November 16, 2014)

UH breaks ground on multimillion-dollar research center
Featuring the Multidisciplinary Research and Engineering Building (MREB)
(Published October 6, 2014)

Professor teams up with local artist to study aesthetic experiences in the brain
Featuring Jose Luis “Pepe” Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen Distinguished Professor of electrical and computer engineering
(Published April 13, 2014)

OFFSHORE TECHNOLOGY

University of Houston to lead national offshore research center in Texas, US
Featuring University of Houston Subsea Systems Institute
(Published January 22, 2015)

OILONLINE.COM

UH Engineering Fair breaks attendance record
Featuring The Cullen College of Engineering Career Center
(Published September 29, 2014)

PHYS.ORG

UH professor helps South-Asian countries manage water resources
Featuring Hyongki Lee, assistant professor of civil and environmental engineering
(Published March 6, 2015)

University of Houston selected to lead offshore energy research center
Featuring University of Houston Subsea Systems Institute
(Published January 20, 2015)

RIGZONE

UH takes subsea program to new heights
Featuring Matthew Franchek, director of the subsea engineering program and professor of mechanical engineering
(Published September 2, 2014)

UNIVERSITY HERALD

University of Houston to offer graduate certificate in upstream energy safety
Featuring Ramanan Krishnamoorti, professor of chemical and biomolecular engineering and chief energy officer of the University of Houston
(Published December 4, 2014)

UH SELECTED TO LEAD OFFSHORE ENERGY RESEARCH CENTER

The University of Houston will lead a national research center for subsea engineering and development of safe and sustainable offshore energy resources. The work will focus on reducing risks of offshore accidents, oil spills and other deepwater disasters in the Gulf of Mexico.

The Subsea Systems Institute is funded by the federal Resources and Ecosystems Sustainability, Tourist Opportunities and Revived Economies of the Gulf Coast States (RESTORE) Act with penalties paid by British Petroleum (BP) for the devastation caused by the 2010 Deepwater Horizon oil spill.

Outgoing Texas Gov. Rick Perry earmarked $4 million already paid to Texas by BP for the UH-led center and another center led by Texas A&M University-Corpus Christi. Total funding is pending determination of penalties levied in civil court. UH President Renu Khator called the Subsea Systems Institute a “defining moment” in the University’s growth in her annual address last fall.

“We are grateful for this grant, which is the culmination of years of work to establish the University of Houston as ‘The Energy University’ and a vibrant and comprehensive partner with the energy industry,” Khator said. “We envision our Subsea Systems Institute as serving to ensure that technologies, policies, regulations and standards needed for safe and environmentally responsible operations in the energy industry are developed and shared.”

The RESTORE Act requires that the five states along the Gulf Coast affected by the Deepwater Horizon oil spill create centers to conduct research. The Houston-area Congressional delegation offered strong bipartisan support for UH as the lead institution for the center focused on offshore energy.

UH will lead the collaboration with Rice University, the NASA Johnson Space Center, Texas Southern University, Houston Community College and Lone Star College to serve as a resource for industry and government regulators.

“A center focused on prevention is the right thing to do,” said Ramanan Krishnamoorti, chief energy officer at UH. “A center in Houston is the right place to do it, and UH, Rice and NASA is the right team.”

Krishnamoorti said Houston’s thriving energy industry makes the University’s location ideal for the institute, which is also expected to explore the continued push by energy companies to move into deeper waters.

Researchers will test and validate equipment to establish neutral, third-party knowledge, standard policies and best practices. The institute will develop new materials and oversee workforce training, especially at depths and temperatures previously unexplored.

“As the home of the nation’s only subsea engineering program, the University of Houston is uniquely positioned to lead not just the United States but the world in developing educational programs to ensure future leaders are able to safely and efficiently discover and develop future sources of energy in the Gulf of Mexico and other deepwater regions,” said Paula Myrick Short, vice president for academic affairs and provost at UH.

UH ENGINEERING MAJORS RANKED 15TH IN U.S. FOR EARNING POTENTIAL

The University of Houston’s Cullen College of Engineering was ranked among the top 20 schools in the country for graduating students with the highest salary potential by PayScale.com.

The 2013-2014 PayScale Potential Salary Report features the rankings of colleges by salary potential for graduates with degrees in nine specific major groupings, including humanities, engineering, social sciences and computer sciences. The University of Houston was ranked 15th for salary potential of engineering graduates. Other top 20 schools included Columbia University (#13) and MIT (#11).

PayScale.com is an online salary, benefits and compensation information company that provides surveys to estimate compensation for professions based on education levels, academic institutions, job titles, experience, companies and location, among other factors.

According to the PayScale report, UH engineering graduates earn an average of $69,800 annually early in their careers and an average of $123,500 annually by their mid-careers.

Read the full report at www.payscale.com/college-salary-report/best-schools-by-majors/engineering.

ENGINEERING INNOVATIONS IN:

PROFESSOR WINS NSF CAREER AWARD TO TRANSFORM METHANE INTO MORE VALUABLE CHEMICALS

Methane, which is the abundant and inexpensive majority component of natural gas, would make an ideal feedstock for the fabrication of more valuable chemicals. However, engineers have not found a way to break the chemical compound's strong carbon-hydrogen bond without burning the methane. Despite decades of research, they have not realized the potential for one of the most stable molecules known in chemistry.

"Methane is essentially spherical, like a ball with no point of attack, so it requires a lot of energy to break that C-H bond," said **Lars Grabow,** assistant professor of chemical and biomolecular engineering at the UH Cullen College of Engineering. "It's a very happy molecule."

Grabow earned a prestigious National Science Foundation (NSF) CAREER Award to explore a novel chemical looping process for methane coupling to transform natural gas into more valuable commodity chemicals such as ethylene. The award totals $500,000 distributed over five years.

The foundation awards 600 grants each year to support the development of academic careers that are dedicated to the stimulation of the discovery process through inspired teaching and enthusiastic learning, according to the NSF website.

Exothermic reactions between methane's hydrogen atoms and oxygen deliver the energy necessary to break the carbon–hydrogen bond at high temperatures, but they also form carbon dioxide, and the methane burns in the process.

"You can burn it, and that's all the technology currently allows us to do with natural gas," Grabow said. "That's great if you want to use methane to generate heat to drive turbines and make electricity in a natural gas-fired power plant, but that's not our objective."

Grabow's goal is to abstract hydrogen from methane to form new carbon-carbon bonds rather than to burn it. Engineers could use the resulting hydrocarbons, which would contain commodity chemicals like ethylene and ethane, to manufacture plastics, lubricants, cosmetics and pharmaceuticals.

"It can have a huge impact on the petrochemical industry," Grabow said. "We could also make propane or polypropylene, and those are other big commodity chemicals primarily derived from petroleum right now."

Grabow plans to isolate hydrogen with carbon in one reactor and hydrogen with oxygen in another, which physically separates the carbon from the oxygen to prevent them from forming the bond that produces carbon dioxide. The key to his strategy is a hydrogen storage material, which engineers have used in numerous applications including hydrogen-powered fuel cells for electric vehicles. Such reversible hydrogen storage requires weak hydrogen binding to allow release of the gas at later times, but many discovered compounds bind hydrogen too strongly.

Grabow's idea for hydrogen abstraction from methane requires strong hydrogen binding, which could revive prior failed material discoveries. As the C-H bonds break in the first reactor, the hydrogen storage material absorbs the hydrogen like a sponge. The saturated material is moved to the regeneration reactor where the hydrogen is removed, and the material is ready to repeat the process.

"The preliminary data we gathered from literature as well as the hydrogen storage material database provided by the Department of Energy points to the fact that this concept can be realized," Grabow said. "We just need to make sure that we design the right sponge, and we have several ideas about how to do this."

Bill Epling, UH associate professor of chemical and biomolecular engineering, is lending his laboratory and experimental expertise to the project. Together, he and Grabow are in the process of designing a laboratory-scale reactor setup and training a graduate student to help test their ideas.

The overall reaction, which is two methane molecules coupled with the help of oxygen to make ethane, is called oxidative coupling of methane. Kinetics, transport phenomena and thermodynamics make the process possible. Kinetics refers to the rate of the C-H bond activation. Mass transport is required for the diffusion of hydrogen atoms through the metal's outer layer to the center where the hydride phase forms. And thermodynamics provides the driving force for metal hydride formation and methane coupling.

The project's simple methane reaction performed on different materials is conducive to individual and group projects, so Grabow intends to introduce the research to students in his undergraduate and graduate classes as well as a high school summer student. Ideally, Grabow wants his students to publish a paper from the classroom setting.

"The cool thing is that kinetics, transport and thermodynamics are the core disciplines of chemical engineering, so this project combines the course material that we teach all of our UH students in a fairly simple system," Grabow said. "It provides an interesting framework for class projects that are relevant to our local oil and gas industry, and it allows me to bring my research interests to the classroom to enrich the students' overall learning experiences."

ENERGY

RESEARCHER WINS $1.5M FEDERAL SOLAR ENERGY AWARD

Venkat Selvamanickam, professor of mechanical engineering at the UH Cullen College and director of the Applied Research Hub at the Texas Center for Superconductivity at UH, received a $1.5 million grant from the U.S. Department of Energy to create high-efficiency film solar cells for rooftops that are as economical as traditional electricity sources.

The grant is part of the department's 2011 SunShot Initiative, which has funded more than 350 projects to bring the cost of solar electricity down to about .06 cents per kilowatt-hour by the end of the decade.

Thick, rigid solar cells common to rooftops are produced on silicon wafers, but the most efficient and expensive solar cells are composed of germanium wafers topped with gallium-arsenide. The small germanium wafers are used mainly for space applications because the cost and number required for other uses make them prohibitively expensive.

Single-junction solar cells on germanium wafers produced with gallium-arsenide can operate at an efficiency of 28.5 percent, with a cost of several dollars per watt. Selvamanickam's goal is to produce a solar cell that operates at 24 percent efficiency at a cost of .20 cents per watt.

Several years ago, Selvamanickam began exploring ideas for a technique to produce thin, flexible solar cells using technology similar to the roll-to-roll manufacturing he already used to produce thin film superconducting wire.

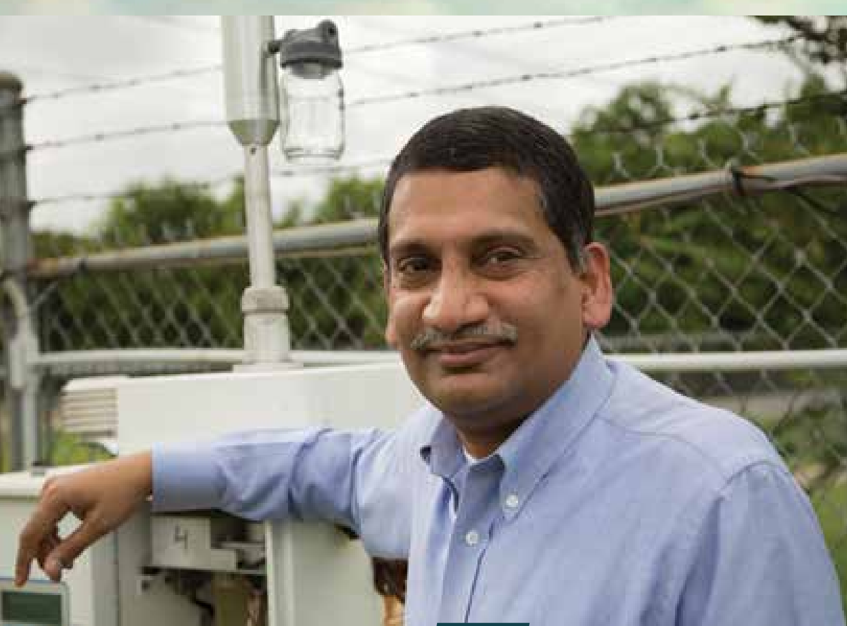
As a result, he developed a method to roll metal foil tape with germanium thin film at high speeds, coating it in a vacuum chamber with vapors of gallium and arsine. Other researchers have used roll-to-roll manufacturing technology for solar cells, but not using germanium-gallium-arsenide materials, which provide much higher efficiency, he said.

Selvamanickam conducts his work in his Energy Devices Fabrication Laboratory at the UH Energy Research Park (ERP). The University established the ERP in 2010 to conduct translational research to rapidly develop and transfer new technologies to industry. The SunShot project is a collaboration with South Dakota School of Mines and Technology.

Selvamanickam and his team presented proof-of-concept with their application to the U.S. Department of Energy, and those results were published in the journal *Applied Physics Letters* in September.

FILTRATION RESEARCH RAMPS UP

AS SOURCES FOR QUALITY WATER WORSEN



Few Houstonians wake each morning concerned that the clean water that pours from their faucets could run dry, but this is a reality that could affect future generations. In fact, the United States Bureau of Reclamation, USBR, is proactively researching more efficient, cost effective ways to desalinate brackish groundwater and surface water sources.

"You have no choice but to move to worse and worse source waters," said **Shankar Chellam,** professor of civil and environmental engineering at the UH Cullen College of Engineering. "So maybe we don't think very much about our water in Houston, but you go to other areas of Texas and Central Oklahoma, and it's already a crisis."

Chellam received $150,000 from the USBR to research ways to remove contaminants and salt from brackish surface water in Foss Reservoir in Foss, Okla., located several hours north of Houston. The City of Houston, Foss Reservoir Master Conservancy District and the University of Houston supported the project with in-kind contributions.

Growing population pressures and symptoms of drought, which include overutilization of groundwater, increased concentrations of existing pollutants and addition of new pollutants, have taken their tolls on water supplies around the world. Consequently, the relatively clean surface water and groundwater supplies available 50 years ago are essentially nonexistent today, Chellam said.

"So the qualities of the water supplies are decreasing as we are forced to expand production," Chellam said. "Old technologies are incapable of dealing with these issues."

The extended drought has caused high evaporative losses in Foss Reservoir, and the remaining water has higher-than-usual salt content without the diluting effects of rain. The water district has relied on electrodialysis reversal, an expensive desalination method, in the face of the drought, which is expected to continue for several more years. It is a scenario that has become more common among water districts in arid areas across the country.

The most common method for salt filtration in the U.S. is reverse osmosis, which is also the gold standard for removing high levels of salt from seawater and ocean water. However, the salt content is so high in ocean water that the energy required for desalination is prohibitively expensive for public water utilities in all but a few areas of the world where limited freshwater supplies make it necessary, Chellam said.

"We want to implement less expensive processes so the induction into an actual technology can happen faster," Chellam said. "We don't always want to use the most expensive method even though we know it does a very good job."

Chellam's earlier work with nanofiltration membranes focused on improved methods for eliminating contaminants such as bacteria, viruses, organic matter and inorganic chemicals from surface waters that serve as municipal water supplies. This project aims also to remove salt from the mix.

Nanofiltration membranes, which are less expensive than reverse osmosis membranes, could potentially fill a niche for waters that fall somewhere on the salt spectrum between relatively unsalted lakes, such as Lake Conroe, and briny oceans.

Polymer nanofiltration membranes have irregular-shaped, nano-sized pores that filter salt and contaminates by size exclusion and charge repulsion. The filters mimic most natural systems with negative charges that repel negatively charged contaminants.

The challenge is to understand the mechanisms by which contaminants pass through filters to determine ways to improve their removal, to optimize flow of water without irreversibly clogging the filters and to determine ways to regenerate the filters when they clog. Chellam plans to evaluate electrocoagulation and electroflotation, novel pretreatment methods, to prevent clogging.

"Nanofilters are useless if they clog rapidly," Chellam said. "They need to last five or 10 years, or they become unreasonably expensive."

Water conservation is another benefit of nanofiltration. Desalination with reverse osmosis membranes typically recovers 75 to 80 percent of the feed water, which means 20 to 25 percent of the water is lost, said Kevin McCalla, special counsel for the Texas Commission on Environmental Quality's Office of Water, in an email.

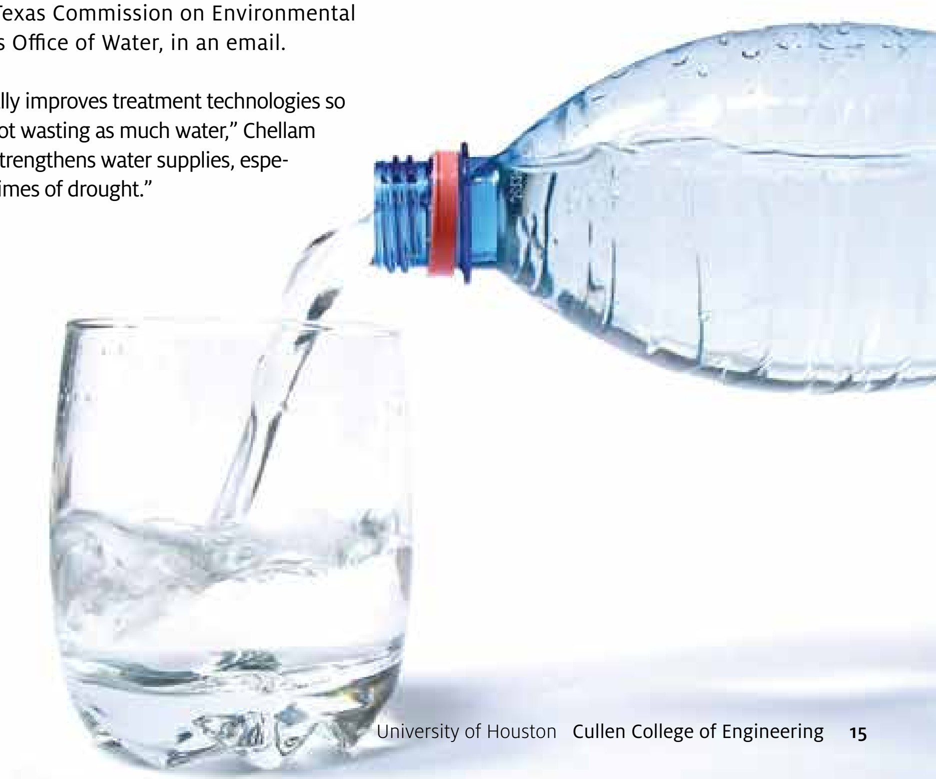
"It basically improves treatment technologies so they're not wasting as much water," Chellam said. "It strengthens water supplies, especially in times of drought."

In Texas, 13 water treatment plants desalinate surface water, and three more, including one in Galveston County, are approved for construction, McCalla said. All the facilities use reverse osmosis membranes with the exception of one, which uses electrodialysis reversal.

The total combined maximum amount of water desalinated at the 13 plants ranges from 15 to 22 million gallons per day, which means three to six million gallons are lost each day in Texas from these plants, based on 2010 data.

In the next couple of years, Chellam, his graduate student, Mutiara Ayu Sari, and his collaborators from Austin's USBR office, Collins Balcombe and Anna Hoag, expect to lay the theoretical and experimental framework for meaningful implementation of this technology.

"Every environmental engineer is working to protect the environment we all interact with, whether it's clean air, clean soil or clean water, and they're all important for our quality of life," Chellam said. "Safe, clean drinking water is an important environmental issue that affects every single human."



RESEARCHERS HELP UNCOVER FURTHER EVIDENCE OF ANCIENT CULTURE IN HONDURAN JUNGLE

A scientist with the National Center for Airborne Laser Mapping (NCALM) at the University of Houston was part of the first expedition to a remote area of the Honduran rain forest, returning with more supporting evidence of an ancient civilization that has yet to be named.

Juan Carlos Fernandez Diaz said the group explored a small portion of the region the UH team mapped in 2012, when researchers completed the first light detection and ranging (LiDAR) survey of that country's Mosquitia region.

In addition to Fernandez, the group included American and Honduran archaeologists, an anthropologist, a documentary film crew, Honduran military forces and a British security crew. A reporter and photographer from National Geographic also accompanied the crew, which traveled to Honduras last month to gather additional evidence of the civilization.

Originally, the 2012 LiDAR mapping triggered talk that researchers had found the legendary White City, or Ciudad Blanca. But Fernandez said they identified evidence of two main cities and several smaller settlements, indicating not the mythological city but instead extensive traces of an ancient civilization that scientists have been aware of for decades but still have not been able to fully identify or name.

UH serves as the operational center for the National Center for Airborne Laser Mapping (NCALM), a collaboration between UH and the University of California at Berkeley funded by the National Science Foundation. LiDAR is used in a variety of applications – archaeology, charting land erosion, mapping the sea floor and identifying levees in danger of failing, among others.

It works by shooting thousands of laser bursts per second at the ground – the newest technology sends 900,000 bursts per second – using the information gathered as the light returns to the source create detailed topographical maps.

Ramesh Shrestha, NCALM director and Hugh Roy and Lillie Cranz Cullen Distinguished Professor of civil and environmental engineering at UH, said the 2012 expedition returned with evidence of several distinct sites.

"Nobody knew what it was," he said. "How do we know what is down there? They haven't even named the civilization, but now they know it exists."

Researchers documented the artifacts discovered last month but left them in place. Fernandez said the Honduran military has agreed to secure the area – the exact location hasn't been named, to prevent looting.

It took more than two years for researchers to return after the initial discovery, in part, because there was no way to reach the area. Shrestha noted that there were no roads to the area, located in the midst of an impenetrable jungle.

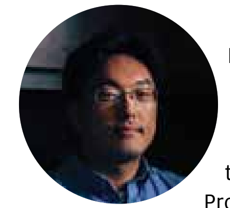
While the 2012 mapping was done with airborne LiDAR, Fernandez took a smaller, portable LiDAR unit on this trip to document the artifacts and more finely detail the 2012 findings. But he said he and the other team members left with more questions than answers.

"We don't know who they were, or how they lived, what foods they produced and consumed, or how they died," he said of the original inhabitants.

When the area was inhabited is still a matter of debate. Preliminary estimates from external researchers suggest the area was inhabited sometime between 500 A.D. and 1500 A.D. Fernandez said that is just one subject among many for future researchers to pursue.

"This is one of the nice things about being on the cutting edge of science and technology," he said. "More questions than answers."

PROFESSOR HELPS SOUTH ASIAN COUNTRIES MANAGE WATER RESOURCES WITH NASA GRANT



Hyongki Lee, assistant professor in the Cullen College's department of civil and environmental engineering, won a grant through NASA's Applied Sciences Program to help South Asian nations independently manage their water resources using software that interprets data collected from NASA satellites. The award to UH totals $220,000 distributed over four years.

Lee is an expert in utilizing data collected from remote imaging and sensing technologies, such as satellites, to create robust maps and data sets of regions of the world that are difficult to access by foot. Last year, Lee won NASA's New (Early Career) Investigator Award in Earth Science to use data collected from remote sensing technologies to better understand the hydrology and hydrodynamics of the waters in the Congo River Basin as well as the basin's connections with climate change, deforestation and carbon emissions from Congo waters.

With his latest NASA grant, Lee will travel to several South Asian countries to train government officials to use a novel software toolbox to better predict and prepare for floods and monsoons. Lee and his collaborators at the University of Washington and Ohio State University developed the software, which translates satellite altimetry data into easy-to-interpret maps and text descriptions of river water levels throughout South Asia.

The software toolkit, Lee said, is incredibly user-friendly, and the process of training government officials to use the toolkit is simple, inexpensive and relatively quick. Together, Lee and his team will visit Bangladesh, Pakistan, Bhutan and Nepal – all countries that depend on transboundary, or shared, river basins for their annual water supplies.

Many South Asian nations – including Pakistan, Thailand, Bangladesh, Myanmar, Laos, Vietnam, India, Cambodia, the Philippines and Malaysia – depend entirely on the monsoon season's heavy rains and flooding for their water supplies. In some of these places, up to 80 percent of the total annual rainfall comes during the monsoon season, which usually begins in mid-May and ends in late October or early November.

But floods and monsoons in these countries often originate in river basins that are located outside of their nations' boundaries.

"These countries often don't have enough time to prepare for flooding – for example, only about three days of lead time in the case of Bangladesh – because of a lack of communication between the nations," Lee said. "This is devastating for them."

The annual monsoon rains combined with increased glacial melt have made flooding more severe as well as more difficult to predict in these regions, Lee said. Last year, news reports cited that millions of people across South Asia were stranded in their flooded homes and hundreds of people died from waterborne diseases, electrocution, building collapses and drowning.

Lee and his collaborators developed their software toolkit for interpreting satellite data a few years ago. Since then, Lee has focused on creating a very simple and accessible graphic user interface, or GUI, for their software toolkit.

"The GUI is what takes all of the complicated data in the back end of the software – all of the calculations and algorithms – and translates it on the front end into a very user-friendly interface where the data appears as either a graphic map or a text output," Lee said.

Last year, Lee and his collaborators took their software toolbox to Bangladesh to train officials at the Bangladesh Flood Forecasting Warning Center to use the software to predict floods. With the new software, officials at the center were able to accurately predict floods up to eight days before they occurred.

"This was a huge success," Lee said. "We were able to increase their time to prepare by five days."

Lee and his collaborators traveled to Pakistan last March to provide officials with their software and training.

"Part of the purpose of this visit is to talk with decision-makers there about their specific needs," Lee said. "Then, we will take their feedback back to our labs and incorporate it into a modified version of the software toolkit, which will allow us to provide them with a product that is tailored specifically to their needs."

The ultimate goal is for these countries to use this software without the help of the researchers so that they can independently manage their own water supplies and better predict major floods and monsoons, Lee said.

This research falls under NASA's Applied Sciences Program, which encourages more researchers to use satellite altimetry data to solve real-world problems.

"There has been a lot of great basic research making use of satellite data, but NASA also wants to encourage researchers and academics to find novel ways of using satellite data for operational usage that has a real impact here on Earth," Lee said. "That's my specialty: using satellite data to solve real problems we are facing today."

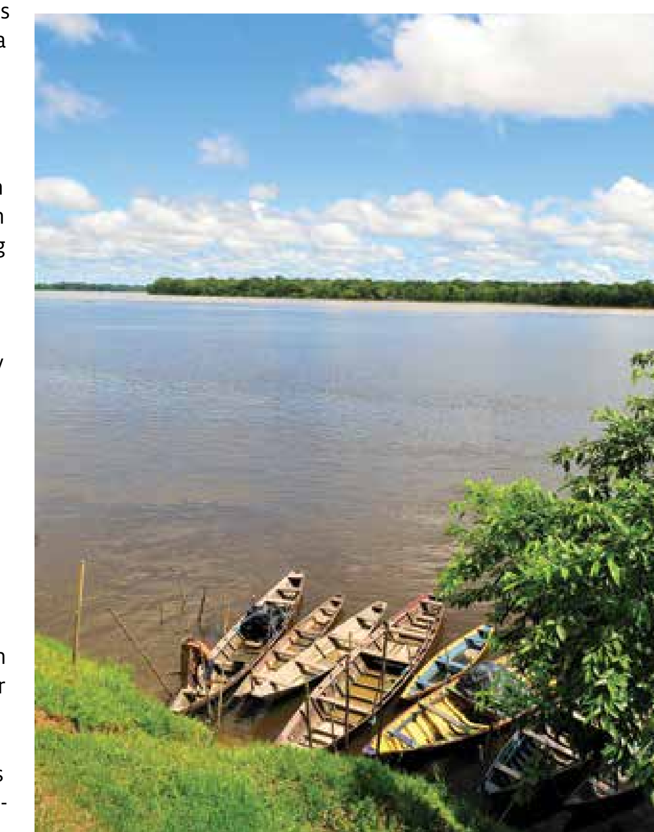


Photo by Neil Palmer/CIAT for Center for International Forestry Research (CIFOR).

ART AND SCIENCE COME TOGETHER ON THE DANCE FLOOR

Becky Valls is racing an unseen enemy – trench coat and bare feet adding to the sense of urgency. Music by Ravi Shankar drives an almost unbearable tension as she runs, swoops and dives through a small space on the Jose Quintero Theatre stage, lights flickering in keeping with the shifting brainwaves projected as a backdrop.

Art, meet science.

University of Houston neuroscientist and engineer **Jose Luis Contreras-Vidal** is working with Valls, UH associate professor of dance, to produce what Contreras-Vidal calls "a brain-computer interface in service of the arts," part of an ongoing project to study how creativity affects the brain.

Contreras-Vidal discussed the work, "Your Brain on Art: Understanding the Brain in Creative Action and Context," on Feb. 25 at the Blaffer Art Museum on the UH campus.

He also led a demonstration on campus with Valls, who performed her composition, "Red Square." She wore a skullcap embedded with electrodes that tracked her brainwaves and allowed her to control the stage lights in the Quintero Theatre.

The talk and dance were part of the Blaffer Art Museum Innovation Series, a slate of public programs developed by the museum in conjunction with the exhibition "Janet Biggs: Echo of the Unknown," which deals with memory loss and the role of memory in forming identity.

Blaffer deputy director James Rosengren first began co-organizing cross-disciplinary lectures in 2011 to deepen the museum's ties with other University departments and the community. This lineup of programs, the first keyed to a Blaffer exhibition, involves more than a dozen UH departments and Houston institutions.

Valls first met Contreras-Vidal when Karen Bradley, head of the dance program at the University of Maryland, came to Houston to work with him on a project several years ago. Valls' own research involves how movement affects learning in children, making the project a natural fit.

Valls and other dancers have performed the signature composition, which is an emotionally charged eight-minute solo, across the United States. She chose the dance for the research project because of its emotional content and because of her intense familiarity with the work, which should help her interpret the EEG results for Contreras-Vidal and his research team, she said.

Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen Distinguished Professor of electrical and computer engineering, develops algorithms that read electrical activity in the brain, and much of his recent research centers around people with disabilities. He helps them to use bionic hands and to regain movement by "walking" in exoskeletons powered by their own thoughts.

The intersection of art, science and engineering can provide important information about non-motor aspects of life, he said.

This work is related to a project Contreras-Vidal began last year with conceptual artist Dario Robleto at the Menil Collection. The exhibition allows museum visitors to wear skullcaps that record their brain activity while they observe Robleto's artwork (read more about this research on page 22). That research will soon continue as a permanent installation in Blaffer.

The emerging discipline of neuroaesthetics combines neuroscience and the study of art, creative movement and perception. The findings are different for each person, much like DNA, Contreras-Vidal said.

The results, however, could hold implications for all of society.

"(The goal is) to understand personality, creativity, perception, to understand decision-making and preference," he said. "We know a lot about what it takes to move a finger or a leg, but we know very little about why it's so hard to move or communicate when someone is depressed, or why two people may instantly connect and both move their hands at the same time, or mimic each other."

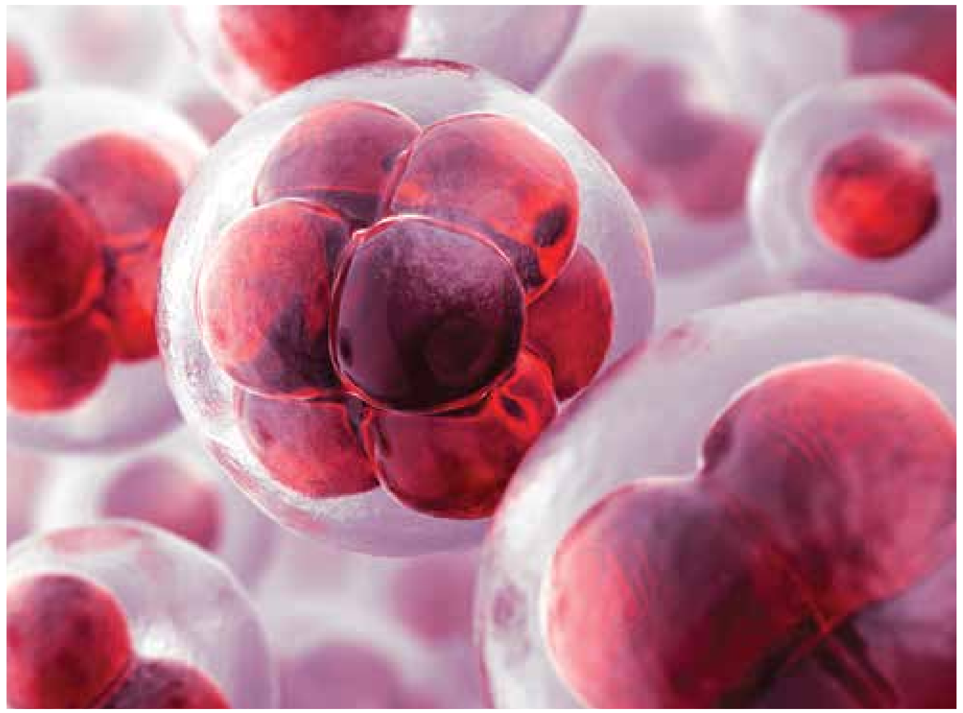
Additional members of the project include associate professor of theater Jonathan Middents, College of Architecture lecturers Michael Gonzales and Meg Jackson, UH alumni Francisco Arevalo and Javier Fadul and graduate students Jesus Cruz, Zach Hernandez and Andrew Paek.

Watch a video of Valls dancing while her brainwaves are recorded by EEG at https://www.youtube.com/watch?v=I79reIx5XGM.

Becks Valls and Jose Luis Contreras-Vidal demonstrate how creativity affects the brain at the Blaffer Art Museum on the UH campus.

PROFESSOR AND POST-DOC PUBLISH PAPER ON NOVEL LEUKEMIA TREATMENT

Almost 19,000 new cases of acute myeloid leukemia and 10,500 deaths from the blood and bone marrow cancer could strike Americans this year, according to the American Cancer Society. Chemotherapy, when used as primary treatment, is successful in about 65 percent of patients with the cancer, and remission rates vary depending on patients' individual characteristics, according to the organization.



A few years ago, a second-line immunotherapy treatment approved by the Food and Drug Administration was withdrawn from the market after a decade of use because of safety concerns. Now, a team of chemical and biomolecular engineers at the University of Houston is exploring a different approach to immunotherapy treatment for acute myeloid leukemia.

Gabrielle Romain, post-doctoral research fellow in the UH Cullen College of Engineering, recently published a paper in the journal, *Blood*, which is a publication of the American Society of Hematology. Her research, conducted with principal investigator, Navin Varadarajan, assistant professor of chemical and biomolecular engineering at the Cullen College, is a preliminary study of an innovative immunotherapy that targets acute myeloid leukemia tumor cells with engineered monoclonal antibodies to improve the quality and quantity of killing by natural killer immune cells.

"The disease does not have enough treatment options, so there is a need for alternative therapies," Romain said. "So with a new mutation inserted in an existing antibody, we hope to revive interest in this strategy to treat leukemia."

The UH chemical engineering team is collaborating with the teams of Badri Roysam, chair of the Cullen College's electrical engineering department, George Georgiou, professor of chemical and biomedical engineering at the University of Texas at Austin, and Dean Lee, professor of biomedical engineering in the pediatrics division of UT M.D. Anderson Cancer Center. In addition to standard bulk testing, the University of Houston is contributing its single-cell assay to the project.

"It's a good collaboration merging the expertise of engineers and clinicians, and the result is that we can focus on immunotherapeutic treatment for leukemia," Romain said.

Prior to this study, Romain and her colleagues developed the single-cell assay, Timelapse Imaging Microscopy in Nanowell Grids, or TIMING, which is a soft, biocompatible polymer grid that creates 20,000 nanowells when placed atop a glass slide. Each nanowell, which is about the size of a speck of dust, captures approximately one to three cells, and the objective is to capture and observe the interaction between an immune cell and one or more tumor cells.

"With TIMING, we are not only imaging but also measuring characteristics of the immune cells," Romain said.

The researchers can quantify singular dynamics of natural killer cell-mediated killing of tumor cells with the single-cell assay. This innovative technology complements bulk testing, which is limited to observation of end results, such as total amounts of targeted tumor cells killed when engineered antibodies are mixed with tumor and immune cells.

The previous antibody, which the FDA eventually removed from the market, was bound to a toxin that targeted the acute myeloid leukemia cells. Romain and the other researchers used a slightly different strategy. They targeted the same antigen, but their antibody was engineered to improve recruitment and efficiency of immune cells rather than to deliver toxins to tumor cells.

Surfaces of different types of tumor cells express unique molecular patterns, and researchers work to identify the tumor-associated antigens so they can engineer particular antibodies to target them. In this study, the mutation involved interchanging three amino acids in the constant region of the antibody, which conferred an affinity for natural killer immune cells. Romain coated the CD33 tumor cells with the engineered antibodies during an incubation process before she loaded them with the immune cells onto the biocompatible grid of nanowells. The coating facilitated recognition of the tumor cells by natural killer immune cells.

"We observed under the microscope that the interactions between the immune and tumor cells were better with the help of engineered antibodies," Romain said. "The natural killer immune cells killed faster and increased their serial killing ability."

The addition of the engineered antibodies as intermediates allowed immune cells to triple the overall amplitude and to double the speed of their targeted killing in preliminary studies. The next step is to translate those results in animal models.

"Antibody immunotherapy is now an established treatment modality," Romain said. "And these engineered antibodies can reinvigorate interest in antibody immunotherapy for acute myeloid leukemia."

BABY SEE, BABY DO?

UH RESEARCH TARGETS YOUNGEST SUBJECTS

In research aimed at determining how babies and toddlers begin to understand the actions of others, a University of Houston research team is studying brain activity triggered by playtime interactions.

The study involves children from ages six months to 24 months old.

The interactions between the children and researchers are literally child's play. But information about brain activity recorded as the child reaches for a toy or imitates the researcher – pushing a button on a toy, for example, or playing with a toy car – may provide clues as to how children learn meanings of actions performed by others and how they learn to imitate those actions.

Jose Luis Contreras-Vidal, professor of electrical and computer engineering at the UH Cullen College of Engineering and director of the University's Non-Invasive Brain Machine Interface Systems Laboratory, said the work is designed to teach researchers more about how typically developing children learn and react to those around them. That knowledge could lead to development of better diagnoses and treatments for children with autism and other developmental disorders, he said.

"The more we know about typically developing children, the better we will be able to develop interventions or early diagnoses, when the brain is still able to be retrained," he said.

The work is part of a multi-institution project funded by a $6 million grant from the National Institutes of Health, with related projects underway at the University of Chicago, the University of Maryland and the University of Parma, Italy.

In this study, approved by the University's Committee for the Protection of Human Subjects, children wear caps – similar to swimming caps – covered with sensors that read brain activity. Additional sensors are attached to their forearms, torsos and heads to record body movements. The children, accompanied by parents or guardians, are tested in a small room, decorated to resemble a childhood nursery, located in Contreras-Vidal's main lab at the UH Cullen College of Engineering.

Contreras-Vidal or a member of his research team tries to engage each child by choosing a toy from a nearby basket and encouraging the child to imitate the movement of reaching for a toy.

"It can be a challenge, because you cannot really talk with them," he said. "My experience is, if they are happy, they can do many things for you. Maybe they cannot do what you are doing, but they try to do so."

The test takes between 10 and 20 minutes to complete and ends prematurely if a child does not want to cooperate, Contreras-Vidal said. The total time commitment is about an hour.

To learn more about this research, please visit www.egr.uh.edu/news/201410/baby-see-baby-do-uh-research-targets-youngest-subjects.

PROFESSOR TEAMS UP WITH LOCAL ARTIST TO STUDY AESTHETIC EXPERIENCES IN THE BRAIN

It's rare to find science and art so inextricably tied together. It's rarer still to find yourself playing the role of scientist, artist and art observer all at the same time.

But patrons of the Menil Collection had the once-in-a-lifetime opportunity to do just that at Houston conceptual artist Dario Robleto's exhibition, "The Boundary of Life is Quietly Crossed."

Visitors to Robleto's exhibit between November 2014 and January 2015 were greeted by a team of researchers from the University of Houston's Cullen College of Engineering led by **Jose "Pepe" Luis Contreras-Vidal**, Hugh Roy and Lillie Cranz Cullen Distinguished Professor of electrical and computer engineering. The research team gave museumgoers the option of wearing EEG skullcaps to record their brain activity while they observed Robleto's artwork.

Pepe's research team consisted of Jesus Cruz, Sho Nakagome and Justin Brantley, all electrical and computer engineering doctoral students working within Pepe's Non-Invasive Brain Machine Interface Systems Laboratory at UH.

Pepe's team is currently using these EEG results to map the neural networks activated by aesthetic experiences – that is to say, what our brainwaves look like as we observe and experience works of art in a public setting. This is where the line between science and art becomes blurred.

"In this case, Dario is inviting visitors to become a part of his artwork, just as we are inviting Dario and those coming to see his work to be a part of our research," Pepe said.

Conducting this research will bring Pepe and his team a step closer to achieving one of their ultimate goals: to reverse-engineer a human brain by mapping individual experiences, thoughts and emotions.

Pepe, a world-renowned expert on brain-machine interface systems, hopes to use this research to create seamless, thought-controlled robotic exoskeletons that people with disabilities can use not only to regain movement functions such as walking, but also to communicate their emotions through movement.

This research project also represents a first-of-its-kind in terms of setting and scope, Pepe added. Although previous studies have looked at the human brain's response to art and aesthetics, such research was conducted in laboratory settings wherein research subjects were asked to perform specific tasks or consider certain pieces of art while their brain activity was measured.

"As far as I know, this is the first time this research has been attempted at an art exhibit inside of a museum," Pepe said.

Furthermore, previous studies looking at aesthetic experiences in the brain only sampled handfuls of subjects. Pepe's team studied 435 freely behaving subjects in a public setting, which makes it by far the largest study of its kind.

"Dario Robleto: The Boundary of Life is Quietly Crossed" is a culmination of three years of work, first inspired by the Voyager Golden Records, gold-plated copper phonograph records launched aboard NASA's *Voyager 1* spacecraft in 1977. The records, which are intended for extraterrestrial life or future humans, contain "arguably the most important EEG ever recorded," Robleto said.

The first-ever recorded brainwaves launched into space belong to Ann Druyan, executive producer and writer for the Emmy-nominated series, "Cosmos: A Spacetime Odyssey." Her EEG was taken as she reflected on her love for her new fiancé, famed cosmologist and author Carl Sagan.

Sagan was chosen by NASA to lead a committee tasked with creating a time capsule of human life to stow aboard the Voyager spacecraft – the first probes with missions beyond the Earth's solar system.

Much like Robleto and Pepe's collaboration, the inspiration behind the Golden Records was some parts art and some parts science, Robleto said.

For Robleto, the art behind the Golden Records is the symbolic gesture of sharing a small piece of humankind's existence on Earth with the dark and unknown expanses of universes beyond. The science is in the small sliver of hope that perhaps one day, light years away in the stretches of interstellar space, extraterrestrial life might encounter the Voyager space probes and uncover these artifacts of human love in the form of Druyan's EEG recordings.

In addition to Druyan's brain activity, the Golden Records contain EKG recordings of her heartbeat as she thought about Sagan,

UH Engineering students prepare Contreras-Vidal's EEG skullcap.

Jose Luis "Pepe" Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen University Professor, observes art while wearing EEG cap

to whom she secretly became engaged only a few days earlier. Although impossible to decipher with technologies at that time, Druyan and Sagan hoped that a future technology could decode human love within these recordings.

"Ann and Carl assumed it would be millions of years in the future, and some alien technology that would have the capabilities of deciphering emotional content within these brainwaves," Robleto said. "I wanted to update the story, which is why I sought out Pepe."

Robleto began researching experts in the field of mapping neural networks and deciphering brainwave activity within EEG recordings. As a Houston native, he quickly stumbled upon Pepe's research, which was happening just a few miles from him at the University of Houston. Robleto felt as though he had come full circle with his exhibition when his search for answers led him to Pepe.

"I knew if there was anyone who could answer this question that Ann and Carl first asked more than 30 years ago – if it was possible to listen to an electronic recording of an EEG and decipher that it represented human love – it was Pepe," Robleto said."Pepe is the present tense of the history that I'm laying out here, and he represents where the technology and the future are headed."

For the Menil Collection's curator, Michelle White, this kind of active engagement with the sciences and the scientific community is precisely what sets Robleto apart from other artists and makes his work so profound.

"What's so unique about Dario is that he's not only reflecting on science, but he's acting as a researcher, too," White said. "He's producing knowledge alongside what Pepe and his team are doing, and that's really quite special."

Robleto developed the exhibition through a two-year joint research residency with the UH Cynthia Woods Mitchell Center for the Arts, which co-presented the work with the Menil Collection.

Watch the video on Pepe and Dario's collaboration at www.egr.uh.edu/video-menil-collaboration.

NSF AWARD BOOSTS COMMERCIALIZATION OF SMARTPHONE-BASED RAPID DIAGNOSTIC TESTS

A professor and doctoral student in the chemical and biomolecular engineering department at the UH Cullen College of Engineering won the National Science Foundation's (NSF) Innovation Corps (I-Corps) award. The UH I-Corps team will use the $50,000 award to develop highly sensitive rapid medical diagnostic tests that use "glow-in-the-dark" nanoparticles to signal the presence of a disease target.

The NSF I-Corps program aims to prepare scientists and engineers to extend their focus beyond the laboratory and bring select, NSF-funded projects to the commercial market. Balakrishnan Raja, a chemical engineering Ph.D. student, is serving as the Entrepreneurial Lead on the I-Corps grant. **Richard Willson,** Huffington-Woestemeyer Professor of chemical and biomolecular engineering, is the grant's principal investigator. Raja and Willson have recruited Tim McGrath, who has over 20 years of experience as an executive in the biotech industry and has served as president or CEO of three life sciences companies, as the I-Corps business mentor.

Willson, an expert on improving medical diagnostic tools and technologies, has had several NSF-funded research projects that many of his graduate students participate in. Raja has been conducting research alongside Willson throughout his career as a Ph.D. student. During this time, Willson's lab group developed the core of the technology that won them the I-Corps award.

Their idea involves the use of nanophosphors, or light-emitting nanoparticles, to replace the traditional colored nanoparticles found in most rapid diagnostic tests, such as over-the-counter pregnancy tests or rapid HIV tests.

"One of the issues with colored nanoparticles is you have to look by eye, and sometimes the results can be very faint," Raja said. "This format of rapid diagnostic test is used for a variety of diseases right now, but it has several limitations."

Among the limitations of current diagnostic tests, Raja said, is their inability to detect low levels of diagnostic targets for several diseases. The tests are also not very sensitive, and they can't provide quantitative information such as stage of disease.

Using phosphorescent nanoparticles and a light-based readout will allow for much more sensitive, quantitative and reliable test results. Moreover, Raja said an inexpensive smartphone attachment, designed like a phone case, could be manufactured, allowing the test results to be read with the phone's built-in camera and flash.

"A user would have to add the sample, such as a fingerprick quantity of blood, to a disposable test cartridge containing our nanoparticles, and then insert it into the smartphone attachment after 15 minutes. The flash from the camera will excite the luminescent particles, and the camera will capture the light emitted by them," Raja said.

The researchers will also develop a smartphone app to analyze the picture captured by the camera and provide an immediate, quantitative readout of the results.

While Willson and Raja are currently exploring many different disease targets for their rapid diagnostic test, one of their initial interests is developing a rapid test for chlamydia, the most commonly reported sexually transmitted disease in the U.S., according to the Centers for Disease Control and Prevention. If left untreated, chlamydia can lead to cervical cancer, infertility and many other complications.

Raja and Willson are also exploring rapid tests for dengue fever, flu and strep throat. Their vision, Raja said, is to one day sell a variety of these rapid diagnostic tests over-the-counter at very affordable prices.

The group's idea will be put to the test during the intensive 6-month I-Corps program, which requires them to attend entrepreneurship workshops, engage with future customers and competitors, and ultimately develop a fully-functioning prototype of their proposed diagnostic system.

And the timing of the rigorous entrepreneurial I-Corps training couldn't have been better for Raja and a small group of Willson's Ph.D. students; long before the opportunity to apply for the NSF I-Corps program arose, Raja said that he and two other students working in Willson's lab were planning to commercialize their glowing diagnostic tests. "The I-Corps award will be a huge boost to these efforts," he said.

Andrew Paterson (a co-inventor of the nanophosphor technology) and Gavin Garvey, both Ph.D. students at UH, along with Gabe Hodges, a physician specializing in internal medicine and pediatrics, have been working with Raja for over six months on their startup company, Luminostics, which is dedicated to bringing these rapid diagnostic tests into hospitals and clinics as quickly as possible. Willson will continue to serve as an advisor to Luminostics even after Raja's academic career comes to a close.

"Dr. Willson has been very supportive of us in doing this. It's not typical of Ph.D. advisors to let their students just pursue these commercial interests," Raja said. "I truly appreciate that. It's really cool."

FIGHTING ANTIBIOTIC-RESISTANT BACTERIA WITH NIH GRANT

"This is a race of humans developing antibiotics against nature's evolving bacteria ..."

A professor in the UH Cullen College of Engineering and his collaborator in the College of Pharmacy remain players in the relentless cat-and-mouse game played between bacteria and antibiotics with a $519,000 grant from the National Institutes of Health.

Chemical and biomolecular engineering professor **Mike Nikolaou** and pharmacy professor Vincent Tam earned their initial $400,000 grant from the National Science Foundation (NSF) a few years ago. Their work to combat drug-resistant bacteria has produced a patented equation that universally assesses the effects of combinations of antibiotics on bacteria found in preliminary lab data. By the end of 2015, the researchers anticipate the development of the first working prototype of a methodology and associated software to improve the process of determining effective antibiotic cocktails for patients in clinical settings and to expedite the development and approval of new antibiotics.

"So this is a race of humans developing antibiotics against nature's evolving bacteria, and it's very difficult to win that race because bacteria evolve fairly rapidly," Nikolaou said.

The process of antibiotic development and approval is painstaking. From the moment a company discovers a molecule that kills bacteria to the time it determines a safe and effective dosing regimen for patients, the process can easily last a decade, Nikolaou said. Nikolaou and Tam's work can more efficiently analyze data to find dosing regimens at particular concentrations that are both effective against bacteria and safe for patients.

Different antibiotics kill the multitudes of bacterial varieties in many ways, but the common thread is that all antibiotics remove elements vital to the survival and proliferation of bacterial cells. Through trial and error, physicians determine the least toxic antibiotic concentrations that are still potent enough to cure serious clinical infections, such as cancer in patients with weakened immune systems. At microbiology labs in hospitals, they add progressively more potent antibiotic concentrations to bacteria-infected blood in test tubes. After a certain period of time, usually 24 hours, they examine the results. Blood that remains cloudy is still infected with bacteria, while blood that appears clear is free of the microorganisms. The lowest antibiotic concentration that clears the blood is given to patients.

The problem is that bacteria are increasingly resistant, so physicians test concentrations of antibiotics that are so high that they become toxic for patients, and they still do not kill the bacteria.

Bacteria develop mechanisms of resistance that counter the actions of the antibiotics. For example, the bacteria might develop efflux pumps that push antibiotics out of cells, or they might secrete substances that neutralize the antibiotics. In such cases, other substances are used to augment the same antibiotics to battle the countermeasures of bacteria.

"Single antibiotics are becoming less and less effective against bacteria, so very frequently you have to use combinations of antibiotics," Nikolaou said. "In recent years, we've been using more combinations of antibiotics so that we can have a combined effect that can make the antibiotics more potent and perhaps kill bacteria that would otherwise be resistant."

Numerous possibilities for interactions between antibiotics exist. An example of an interaction might involve one antibiotic opening pores in bacterial cell walls so another antibiotic might easily enter to do the killing, Nikolaou said.

Physicians are presented with the challenge of considering overwhelming varieties of antibiotic combinations, or cocktails, and their dosing regimens for patients. Time restrictions necessitate that they eyeball results and make best guesses about treatments based on their expertise and intuition.

"Unfortunately, no one has the time," Nikolaou said. "Doctors' and patients' time is extremely precious."

Nikolaou and Tam are working to optimize the process by reducing the amount of time and guesswork needed to assess the most effective drug combinations for killing bacteria.

"Our approach is empirical, so it relies on experimental data rather than detailed prior knowledge," Nikolaou said. "So you don't need to know the type of bacteria, the type of killing mechanism or the mechanism of resistance."

Nikolaou and his team of students composed their basic mathematical model based on Tam's observations of the effects of antibiotics and combinations of antibiotics on bacteria populations in blood over time. Through better use of collected data, their equations predict the course of bacteria populations in realistic situations reasonably well.

"The equations do not define logic, they augment logic and intuition more accurately," Nikolaou said.

The researchers plan to use existing image analysis technology to automatically record the effects of various antibiotic cocktails on bacteria in blood samples. A photometer modified for their purposes can feed the data to computer software, which the team is in the process of developing, that runs the patented mathematical model.

"The user will simply have to push the button, and the software will do the calculations that tell the doctor what antibiotic or combination of antibiotics to use at what concentration," Nikolaou said.

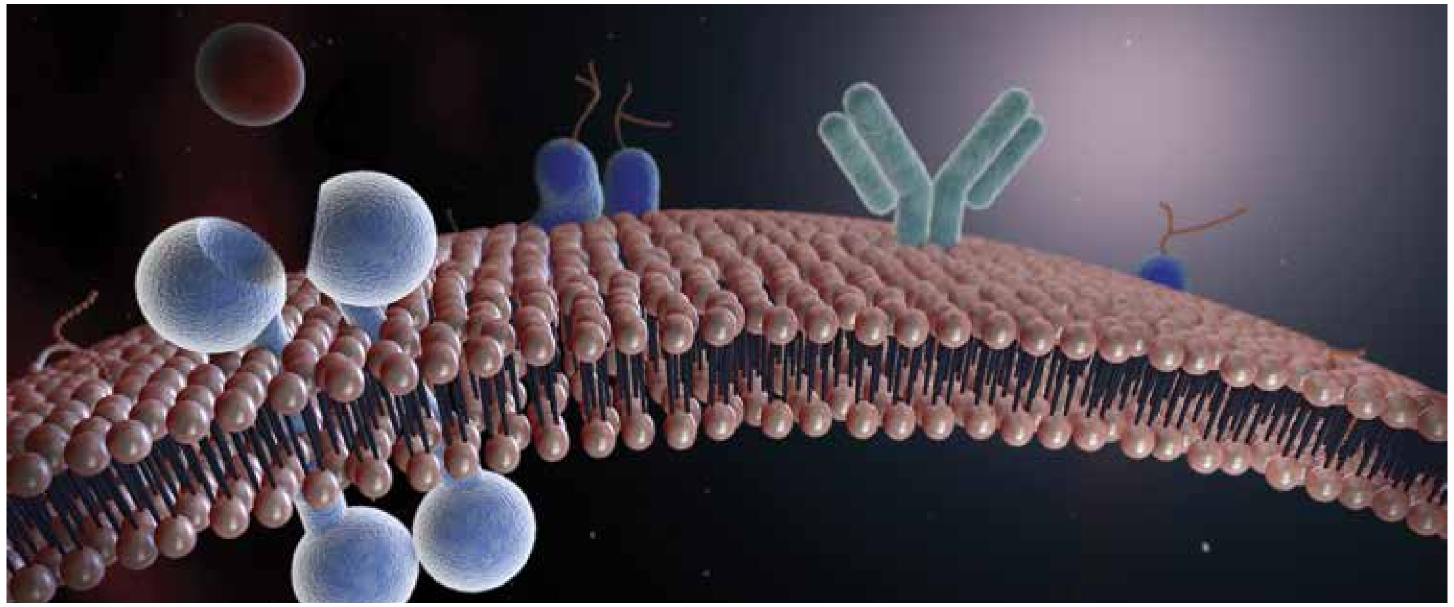
Automation provides opportunities to collect additional data that is more accurate at more frequent intervals. The photometer can record data every hour, for example, rather than once at the end of a 24-hour time period. Instead of plotting two points on a graph, the software can plot 24 or more points and create an entire curve that helps to more accurately extrapolate outcomes beyond 24 hours. Furthermore, photo analysis can provide more precise information such as the extent of the blood's cloudiness or clearness and the rate of decline of bacteria populations.

The software can also account for differences between patients and test tubes. Concentrations of antibiotics degrade over time in patients while they remain fixed in test tubes. In the field of antibiotics development, test tube research is often followed by tests conducted with elaborate systems that attempt to mimic the ways antibiotics work in the human body.

"So you're gaining efficiency ... plus you don't have to do a bunch of tests afterwards," Nikolaou said.

From left: Vincent Tam, professor of pharmacy, and Mike Nikolau, professor of chemical and biomolecular engineering. Photo by John Shapley.

PROFESSOR EXAMINES UNDERLYING MECHANICS OF NUCLEUS MEMBRANES IN BIOLOGICAL CELLS



Ashutosh Agrawal, assistant professor of mechanical engineering, likes to tell his students at the Cullen College that many lessons on mechanics and structures can be gleaned from nature. “There is so much diversity and beauty in nature, and biological cells are a wonderful example of this,” he said.

Agrawal was recently awarded $382,000 over three-years from the National Science Foundation (NSF) to study the underlying mechanics of the outer membranes of the nucleus that encapsulate the DNA of the cell.

“The same physical laws that govern the mechanics and design of skyscrapers and bridges also govern the structure and the physical response of biological cells,” Agrawal said. Nature is full of structures where functionality and beauty have been balanced in a remarkable way. The interface of a nucleus in a cell, called a nuclear envelope, is an excellent example. One can think of it as a structure made up of thousands of tiny donut-shaped pores fused together. Inside of these pores are proteins that act as gatekeepers to the vital genetic information stored inside of the nucleus. It is one of the most fascinating structures inside of biological cells, but very little is understood about the nuclear envelope.

“If we can understand the structure and the adaptation of the nuclear envelope, we can gain insight into the organization of the genetic material inside of the nucleus,” Agrawal said. The nuclear envelope can regulate gene expression by allowing proteins to access the DNA inside of the nucleus through the envelope’s pores. By examining the proteins that regulate the structure of the nuclear envelope, researchers will have a much better understanding of many diseases that are linked to mutations in these proteins. Ultimately, this work would lead to more targeted treatments or even cures for diseases linked to the cell nucleus, he added.

Researchers have yet to understand how pores in these membranes are formed to allow the passage of proteins into the nucleus. “Cells create new pores throughout their lifecycle,” Agrawal said. “This involves continuous remodeling of the nuclear membranes at the site of pore formation without disturbing the envelope away from the site. Understanding the mechanics of membrane remodeling is very relevant because if there’s a defect of any kind, the process of creating new pores will stop.”

To answer these questions, Agrawal and his team will develop models to look at the structure of the nuclear envelope and what it would take to fuse the two membranes within it together. “The models we develop will be able to predict how much energy is needed to bend the membranes, the energetics of pore formation from the two bilayers, and which proteins are up to the task of assisting in the formation of pores,” he said.

Once Agrawal’s team completes these models, they will share them with collaborators at the University of Florida led by Tanmay Lele, professor of chemical and biomedical engineering. Lele’s experiments will involve making changes to the cell environment and then quantifying how those changes affect the cell structure and function. For instance, proteins will be systematically removed from the nuclear envelope and the subsequent changes in envelope structure and pore formation will be recorded.

Agrawal said this research could eventually lead to improved drug delivery using biomimetic drugs. “A multilayered structure already exists within cells, so if we can understand them, we can design sophisticated multifunctional drug delivery platforms,” he said.

RESEARCH AIMS FOR BETTER UNDERSTANDING OF MICROVASCULAR DISEASES

New technologies being developed by a University of Houston researcher to produce three-dimensional models of tissue and whole organ microstructures offer the promise of better diagnoses and treatments for a variety of diseases.

David Mayerich, assistant professor of electrical and computer engineering, received a $984,505 grant from the National Institutes of Health/National Library of Medicine to focus on large-scale reconstruction of microvascular networks.

A wide range of diseases are closely tied to microvascular structure, including several cancers and neurodegenerative diseases.

Mayerich joined the UH Cullen College of Engineering this fall after completing a Beckman Fellowship at the University of Illinois. He specializes in high-performance computing and biomedical imaging and is creating open-source visualization methods, designed to make the information available to biologists for analysis and use in their own research.

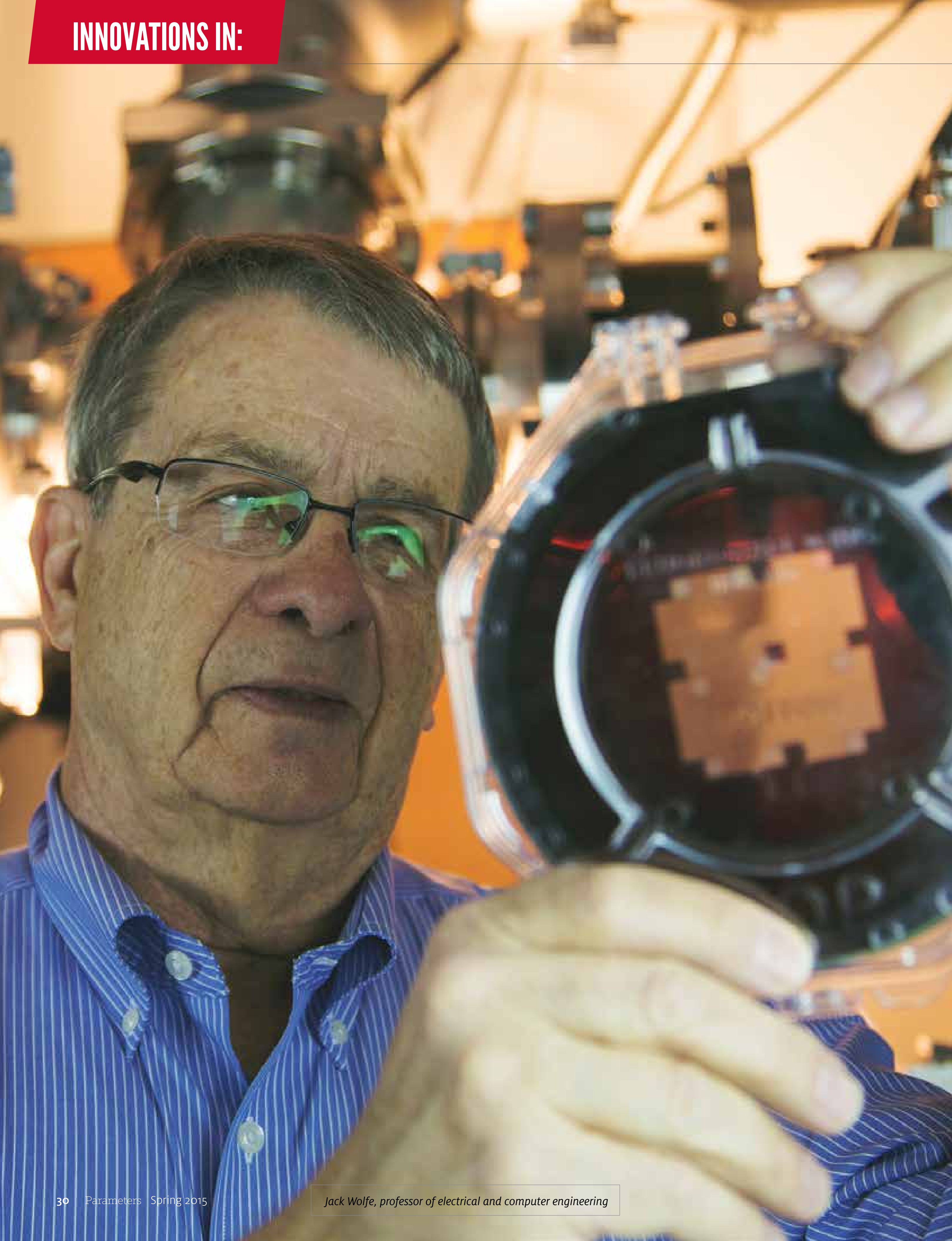
His lab focuses on developing new technologies for three-dimensional imaging of whole organs at subcellular resolution. This work is important for biomedical research and ultimately could be valuable at the clinical level, he said.

The work Mayerich proposed under the NIH grant is complementary to work proposed in a $2 million grant that the University received from the Cancer Prevention & Research Institute of Texas to recruit Mayerich to Houston. The CPRIT project involves high-throughput instrumentation and analysis for whole tumor phenotyping.

Both projects were designed to work together, he said. Visualizing large images of tissue microstructure – the subject of the NIH grant – is challenging because biological samples are often densely packed, and high-resolution imaging typically allows only samples of less than half a millimeter to be scanned.

Mayerich has developed much faster methods, allowing data to be collected from whole organs. With the grant, he will use these imaging techniques to convert that data into three-dimensional models, offering researchers and clinicians additional tools.

“The models, we hope would be something researchers and clinicians could use to diagnose and treat diseases,” he said.



Jack Wolfe, professor of electrical and computer engineering

NOVEL NEURAL PROBE HELPS TO UNLOCK MYSTERIES OF THE BRAIN

In 2013, President Obama announced the launch of the BRAIN (Brain Research through Advancing Innovative Neurotechnologies) Initiative, an ambitious "grand challenge" aimed at vastly increasing our understanding of the human brain. The goal of the initiative, Obama said, is "to unlock the mysteries of the brain, to improve our treatment of conditions like Alzheimer's and autism and to deepen our understanding of how we think, learn and remember."

The BRAIN Initiative will provide more than $3.5 billion over 12 years to accelerate the development and application of new technologies that will allow researchers to understand how individual brain cells and complex neural circuits interact at the speed of thought.

"There's a big gap between what we want to do in brain research and the technologies available to take us there," said Francis S. Collins, director of the National Institutes of Health (NIH), which sponsors a major part of the Initiative. "The initial awards are focused on developing the tools and technologies needed to make the next leap in understanding the brain."

One of those initial NIH awards went to **Jack Wolfe** and **Wei-Chuan Shih,** both professors in the UH Cullen College of Engineering's department of electrical and computer engineering. Their collaborator on the project is Gopathy Purushothaman at the Vanderbilt School of Medicine. Together, they aim to develop a novel brain probe for use in optogenetic studies of the brain. Their award totals $428,406 over two years.

Optogenetics, named the "method of the year" by the journal *Nature Methods* in 2010, is a transformative technology wherein a tiny volume of suspended virus particles is injected into a region of the brain associated with a specific behavior (for example, walking in a counterclockwise circle). The virus transfers a gene to the specific neurons responsible for the behavior, which causes the neurons to become sensitive to and excited by light.

Shining a light on the sensitized neurons will cause them to emit electrical pulses that, in turn, cause the animal to walk in a counterclockwise circle.

Because the neurons respond to light extremely quickly, neuroscientists are able to track the link between brain activity and behavior at the speed of thought. The technique can be equally applied in the sensory systems, in learning, and even in creative thought. Optogenetics is also useful in understanding how the brain is disrupted by neurological and psychiatric disease.

The ultimate hope, said Wolfe, is that light stimulation of the brain's neurons will one day be added to the current treatment options for brain disorders.

But the neural probes that are currently available for optogenetics studies have some drawbacks. For starters, they can't probe very deep inside of the brain – only a few millimeters, in fact. This poses a problem when it comes to studying the brain, as many of the its neural networks are located as deep as 50 millimeters. Secondly, current probes are much larger in diameter than the probe being developed by Wolfe and Shih, which means they cause more damage when inserted into the brain.

By comparison, the probes being developed at the Cullen College are less than 60 microns in diameter, while commercially available probes measure between 125 to 500 microns in diameter. Wolfe and Shih's probe is so fine, in fact, that it is smaller than a single strand of human hair. Their goal is to make the probe even smaller – about a third of the size of a human hair, or about 30 microns in diameter – by the end of this project.

At the core of Wolfe's novel probe is a single strand of optical fiber. Using lithography, the researchers print sets of electrodes directly onto the fiber. These electrodes record and transmit information on brain activity resulting from light stimulation.

Even more impressive, they are able to print more than one set of electrodes on a single fiber at varying distances from one another. This will allow researchers to monitor neurons in different layers of the brain simultaneously with a single probe, a research technique that has not been previously available for deep brain probes. "We will be able to create accurate, three-dimensional maps of the brain's neural circuits for the first time ever," Wolfe said.

Unlike many probe prototypes in use today, the probe being developed by Wolfe's team is compatible with high-throughput manufacturing at very low cost. That is to say, the new probe could be cheaply and reliably manufactured, making it an optimal option for use in research centers and clinics around the world.

"The emphasis is on being able to make them very quickly and reliably," Wolfe said. "A wide variety of tests will be performed to make sure they are reliable in all the ways they need to be."

This finer, stiffer and longer probe would be particularly helpful to researchers such as Purushothaman, whose primary research interest is mapping the neural networks involved in the brain's vision system. Current probes can only reach a few millimeters into the brain, but critical structures, such as the thalamus, a switching center for visual signals, are located several centimeters inside of a primate's brain.

"As you can imagine, this is a very exciting development for myself and many other researchers who have been waiting for a probe that is long enough to reach deep into the brain," Purushothaman said.

The brain's circuitry, even in a small piece of brain tissue, is incredibly complicated. "There are thousands of neurons that are very specifically connected, so it's like having a highly complex integrated circuit in a very compact space that is in three dimensions," Purushothaman said.

"This probe gives me the ability to understand how those neurons are connected and how they work together in the circuit," he added. "That is a major benefit to my research, and that's precisely the goal of the BRAIN Initiative – to decipher, in as much detail as possible, the brain circuitry."

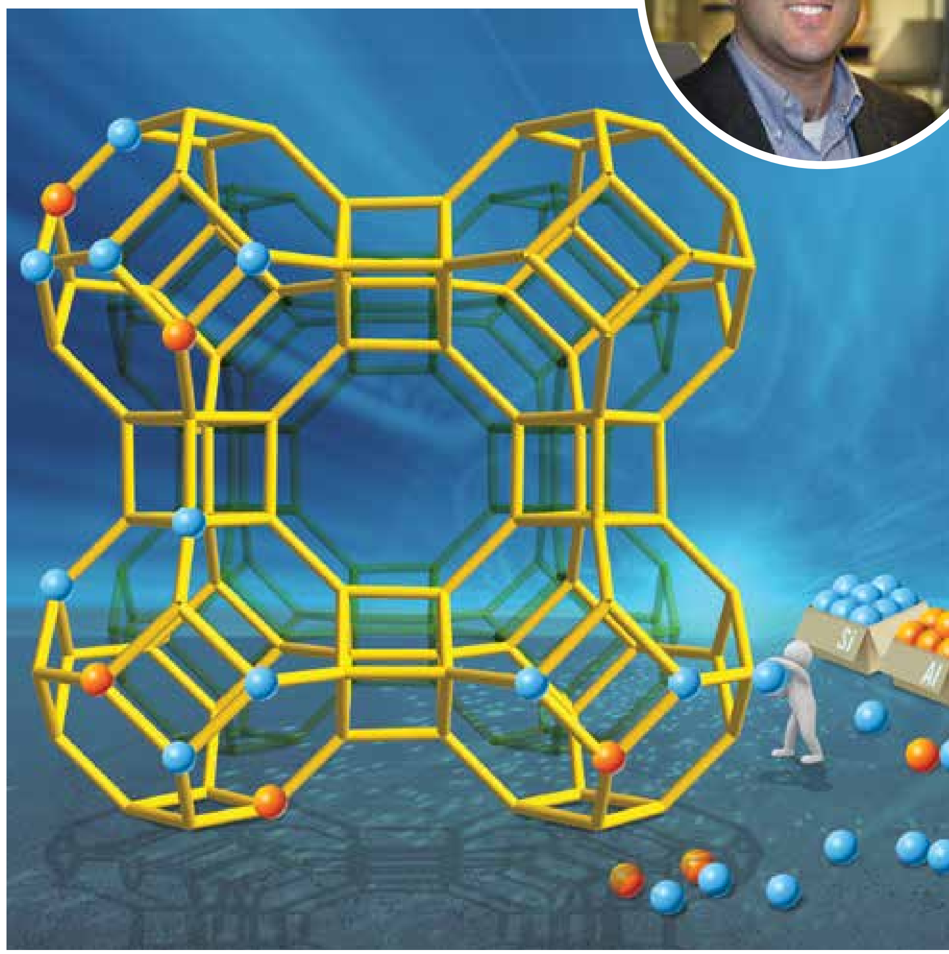
Although this study is still in its early phases, the three researchers agreed that there is a very high chance their probe will be tested in human clinical trials. "Once we get this project done we will have a working product, which can then move into the clinical arena," Purushothaman said.

Wei-Chuan Shih, professor of electrical and computer engineering

JOURNAL FEATURES IMPROVED METHOD FOR ZEOLITE SYNTHESIS ON COVER

A professor at the UH Cullen College of Engineering has discovered an improved method for synthesizing a zeolite structure that is more hydrothermally stable than its counterpart currently used in industrial processes.

Jeff Rimer, Ernest J. and Barbara M. Henley Assistant Professor of chemical and biomolecular engineering, published his findings in the journal, *Chemical Communications*. His article and corresponding artwork were featured as the cover story for the journal's January issue. Rimer conducted the research alongside his postdoc, Marlon Conato, and his graduate student, Matthew Oleksiak.



Zeolites are crystalline materials that are used as adsorbents and catalysts in a variety of chemical processes, spanning applications from gasoline production to additives for laundry detergent – not to mention thousands of other commercial and consumer products.

But despite the importance of these materials in many chemical and industrial processes, the ways in which these crystals are synthesized are not well understood. Rimer's primary research focus is finding better ways to rationally design zeolites in order to improve the materials' performance and reduce the costs and trial-and-error associated with their synthesis.

The typical synthesis of certain zeolite structures yields crystals made up of silicon and aluminum atoms in a one-to-one ratio. Such zeolites are particularly good adsorbents – for example, these crystals could be used to remove greenhouse gases, such as CO_2, from the atmosphere.

The zeolite structure being studied in Rimer's group, known as zeolite A (LTA type), performs very poorly as a catalyst due to its high aluminum content. In order to use this zeolite as a catalyst, researchers must improve its hydrothermal stability by increasing the silicon content in the crystal.

One way of doing this is by adding organic structure-directing agents to the growth solutions used to prepare the zeolites. However, these additives are generally expensive and the process of synthesizing zeolite structures by this route is economically infeasible, Rimer said.

Rimer's team, then, is investigating new methods of growing these zeolite structures without the use of these organic additives.

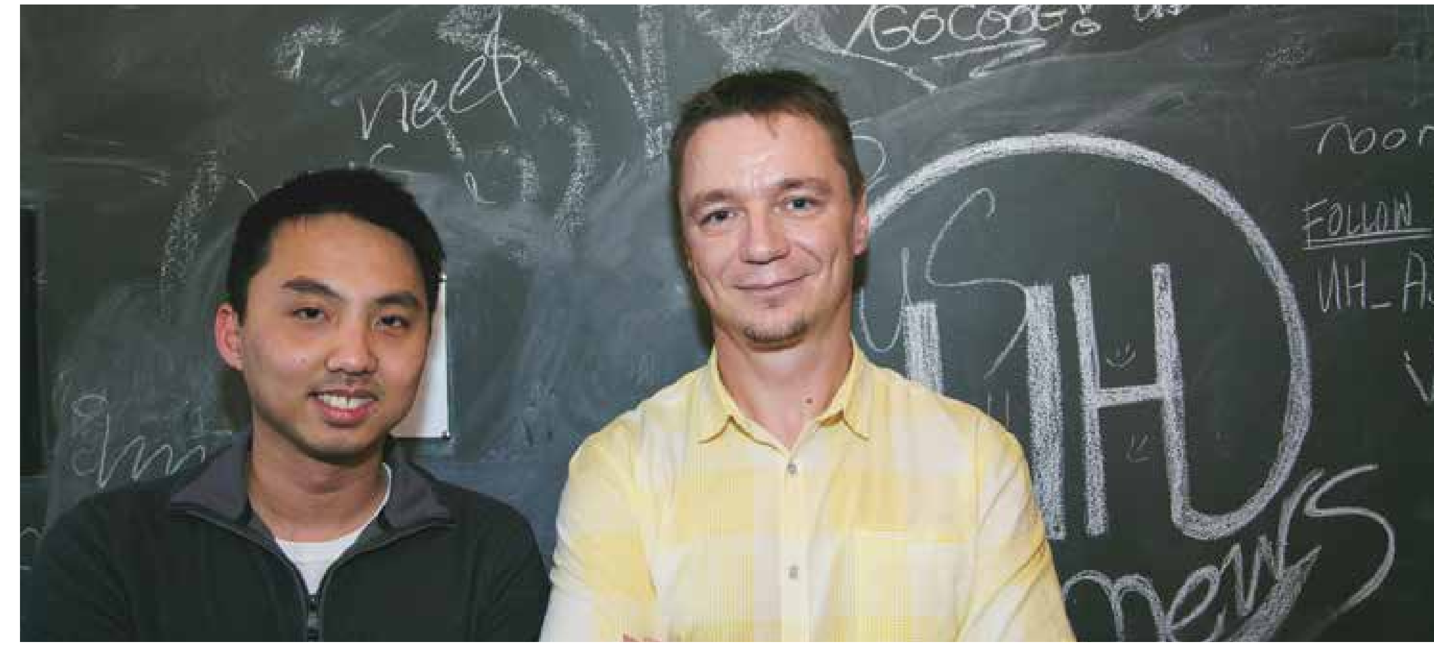
So far, Rimer's group has established a basic platform for conducting organic-free synthesis of many types of zeolite structures. These findings were published in the *Journal of the American Chemical Society* last year. While developing these models, Rimer said that his team noticed one particular "sweet spot" in their diagram where a zeolite structure with very commercially-appealing characteristics was formed.

This zeolite structure, named HOU-2, exhibits nearly twice as many silicon atoms as its more aluminous analogue zeolite A, making it a potentially far more effective catalyst. Moreover, Rimer's team found that this zeolite structure was very stable when synthesized under certain conditions and yielded twice as many crystals as zeolite A.

Rimer's group collaborated with Radha Motkuri, a researcher at the Pacific Northwest National Laboratory, to further investigate the gas absorption qualities of HOU-2. So far, the researchers have found that the zeolite works effectively at selectively separating CO_2 from other gases. Researchers at the Pacific Northwest National Laboratory are particularly interested in the zeolite's performance as an adsorbent for CO_2 sequestration.

"We have improved the stability of these materials in a way that's economically viable to industry and we're using standard conditions that are very similar to what industry uses when they manufacture zeolites," Rimer said. "This is something that could be integrated into current commercial processes very rapidly."

PROFESSOR AND STUDENT REVEAL SECRETS BEHIND GOLD'S UNEXPECTED OXIDATION



From left: Ph.D. student Hieu Doan and chemical and biomolecular engineering professor Lars Grabow

Perhaps one of the most desirable qualities of gold – especially to those wearing it as jewelry – is its ability to hold onto its bright, shining glow. Gold can resist rusting and tarnishing when exposed to air or water because it's inert, meaning it's one of the least reactive of all metals.

But gold has some unexpected properties, too. For instance, gold nanoparticles can be used as a catalyst to oxidize carbon monoxide (CO) into carbon dioxide (CO_2) – a puzzling quality for a metal that isn't supposed to be reactive.

For the past 25 years, researchers have observed the catalytic behaviors of gold and proposed many explanations as to why an inert metal would help to speed up a chemical reaction. Until now, no single model has completely explained what takes place during a reaction wherein gold is used to help transform CO into CO_2.

A professor and Ph.D. student at the UH Cullen College of Engineering have created the first-ever model to fully explain what happens during the catalytic oxidation of carbon monoxide. **Lars Grabow,** assistant professor of chemical and biomolecular engineering with the Cullen College, conducted this research alongside his Ph.D. student, Hieu Doan. The collaborators on this project were Bert Chandler, Johnny Saavedra and Christopher Pursell at Trinity University in San Antonio. Their findings were published last year in the journal *Science*.

The catalytic oxidation that transforms CO into CO_2 has always relied on one basic, elementary notion: carbon monoxide reacts with oxygen to form CO_2. However, Saavedra, Pursell and Chandler observed through their research that something else might be playing a hidden role in this reaction.

"So at that point, Hieu stepped in and said he wanted to explain why this happened and started doing some basic calculations," Grabow explained. "It all started with that – just some basic calculations – then it led to this paper."

Using the best available experimental and theoretical methods in combination, the team was able to provide direct evidence of the role each element plays in this particular chemical reaction, and pinpointed exactly how gold is able to act as a catalyst within the reaction.

"The answer is water," Grabow said. Although water is not one of the reactants in this chemical reaction, Grabow's team was able to prove that it serves as a co-catalyst for the reaction.

The presence of tiny amounts of water is what essentially drives the reaction on the surface of the gold catalysts. A thin layer of water settles on the surface of the catalyst, and protons (positively charged hydrogen atoms) from inside the water layer can detach from the water molecules and attach themselves to oxygen molecules. Those protonated oxygen molecules are then absorbed onto the surface of the gold catalyst, allowing the reaction to proceed very quickly. When the reaction is complete, the protons return once again to the water layer on the surface of the catalyst.

"We imagine that the layer of water is like a sea of protons and they just swim in that water layer like fish and they jump out to facilitate the reaction then they jump back into the water layer," Grabow said.

Although people have been experimenting with CO oxidation using gold catalysts for nearly 30 years and many researchers have reported that water can change the reaction kinetics quite drastically, Grabow noted that until now no research has ever reported the exact mechanism that his group identified in their *Science* article.

PROFESSOR WINS NSF CAREER AWARD TO STUDY NOVEL MATERIALS FOR BRIDGE COLUMNS

Bora Gencturk, assistant professor of civil and environmental engineering at the UH Cullen College of Engineering, earned a National Science Foundation (NSF) CAREER Award to explore novel materials to increase the resiliency of reinforced concrete bridge columns. The award totals $500,000 over five years.

The foundation awards 600 grants each year to support the development of academic careers that are dedicated to the stimulation of the discovery process through inspired teaching and enthusiastic learning, according to the NSF website.

Nationwide, the average age of bridges, which are generally designed for 50-year lifespans, is 42, according to data provided by the American Society of Civil Engineers. On a scale from A to F, the average grade for more than 600,000 bridges in the United States was a C-plus in 2013, and one-quarter of them were rated structurally deficient or functionally obsolete. The Federal Highway Administration estimates the cost to eliminate the backlog of bridge deficiencies at $20.5 billion annually until 2028. Currently, only $12.8 billion is spent each year.

Gencturk is working to improve durability and to lengthen lifespans of new and existing bridges. His research focuses on the combined effects of environmental aging and earthquakes on bridge infrastructure in the United States as well as the effects of using new materials for bridge construction. In the lab, Gencturk and his collaborators plan to produce representative columns with corrosion-induced damage to simulate environmental aging. Their objective is to study the load-carrying capacity of the bridges in aged conditions during regular operation and simulated seismic activity.

"The novel aspects of this study are the consideration of multiple hazards and the use of new, advanced materials to address those hazards," Gencturk said.

Deterioration is caused primarily by rusting of steel reinforcement bars inside concrete bridge columns and by reduced capacity and resistance of bridges located in seismic regions. Concrete's main flaw is that it cracks over time, and the cracks allow external environmental agents to penetrate the structures and rust the steel reinforcement.

Earthquakes, which cause large horizontal drifts, can cause significant damage to bridge columns and can render entire structures dysfunctional in their aftermath.

"We want to understand how reinforced concrete behaves and propose a new design approach to improve durability and seismic performance of the bridges," Gencturk said.

Gencturk and his team are studying conventional reinforced concrete structures to enlighten their understanding of applications for prefabricated ductile fiber-reinforced cementitious composite, DFRCC, counterparts. DFRCC provides increased crack resistance, higher tensile ductility and lower permeability. Another of Gencturk's goals is to examine designs of existing bridge columns for comparison to new design and construction approaches.

"We're not abandoning concrete and coming up with something totally new," Gencturk said. "We want to use advanced materials in an optimal sense in bridges in order to reduce repair and maintenance costs, and to extend their lifetimes."

Significant reductions in maintenance costs are expected because the materials are more resistant to environmental attacks and earthquakes. However, initial construction costs are expected to increase because DFRCC is more expensive than conventional reinforced concrete.

"Fortunately, the new bridges are expected to last at least twice as long – 100 years – which offsets initial increases in the long-term," Gencturk said.

Gencturk hopes to see his research implemented in bridge construction in the next decade. He also envisions application of the innovative design technology to marine architecture including offshore structures, piles and ports as well as parking garages and other construction exposed to environmental conditions.

ENGINEERS EARN GRANT TO EXPAND BASE PLATE CONNECTION RESEARCH IN LOW-RISE METAL BUILDINGS

Metal buildings comprise almost 50 percent of all non-residential, low-rise construction in the United States. The most common configuration is the gabled frame with sets of exterior columns supporting rafters that form house-shaped peaks, and base plates serve as the load-resisting mechanisms that withstand horizontal forces, such as high winds.

Bora Gencturk and **Mina Dawood,** assistant professors of civil and environmental engineering at UH Cullen College of Engineering, explored base plate connections in low-rise metal buildings in a preliminary study sponsored by NCI Building Systems. The results earned them a subsequent one-year $50,000 grant from the Metal Building Manufacturers Association, MBMA, with additional in-kind support to expand their research.

"The assumption was that the base acts like a hinge that freely rotates," Dawood said. "For the purposes of design, engineers had neglected stiffness in connections because they could not really quantify it."

Funded by MBMA, Gencturk and Dawood are conducting a systematic follow-up study in terms of isolating individual parameters of base plate connections to quantify their effects. The goal is to generate a realistic set of rules so that engineers can account for rotational stiffness of base connections in their designs.

"We are taking the first step in the process, which is research, so the association can take the information to code committees and develop design guidelines," Dawood said.

The initial year-long study funded by NCI Building Systems quickly and economically tested and proved the premise that base connections provide some level of rigidity. In the lab, Gencturk and Dawood used steel columns and bases to avoid replacement of concrete foundations after each test. To simulate gravity loads, they applied thousands of pounds of force to the columns, cycling them back and forth horizontally, after which they measured displacements and rotations.

With numerical analysis techniques, they quantified the stiffness for a certain subset of gabled frames using the experimental data. They determined that they could curtail costs of manufacturing metal buildings by as much as 12 percent by reducing the amount of steel in other parts of the frames for which the rigidity of base plate connections compensated. For an average building, this translated to several tons of steel, which costs approximately 50 cents per pound.

"Understanding the metal building industry is important because just looking at the funding level of the study belies the impact of the research," Dawood said. "Metal buildings are used in every sector of infrastructure including hospitals, churches, schools, shopping centers and industrial buildings."

Low-rise metal buildings are typically selected on the basis of cost, so the industry is extremely cost competitive. Even minor savings can make a significant difference.

"You can think about how much enclosed space you see in warehouses and how little steel is used in their structures," Gencturk said. "That gives you some sense of how much the manufacturers try to economize their construction by removing unnecessary weight."

NSF AWARD BOOSTS ELECTROMAGNETIC COMPATIBILITY RESEARCH AT UH

Approximately 75 percent of the three million people worldwide with implanted pacemakers need magnetic resonance imaging, or MRI, in their lifetimes, and an estimated 500,000 of them live in the United States, Canada and Mexico. However, pacemakers, which control abnormal heart rhythms, limit access to the potentially lifesaving diagnostic technology because of electromagnetic interference.

Ji Chen, professor of electrical and computer engineering at the UH Cullen College of Engineering, is overcoming limitations for patients with pacemakers and other implanted medical devices with his electromagnetic compatibility research.

In 2014, the National Science Foundation awarded Chen, his UH collaborators and Missouri University of Science and Technology with their second five-year grant totaling $225,000 through the Industry/University Cooperative Research Centers program. The initial five-year $280,000 grant was awarded in 2009 to establish the Center for Electromagnetic Compatibility Research.

"The grant gives us credibility to attract industry partners," Chen said. "We're trying to build a one-stop shop, with all companies coming to the two universities for electromagnetic compatibility research."

The center works with 25 industry partners who fund the majority of the research with annual membership dues that give their engineers access to two annual on-site meetings and weekly conference calls with university researchers. Each company pays $60,000 per year, which totals $1.5 million annually, for membership privileges.

Chen and his team work mainly on electromagnetic interference with medical industry partners including St. Jude Medical, Biotronik and Cyberonics, while Missouri University works primarily on high speed signaling systems with electronics industry partners including Apple, Samsung and Sony.

"We make sure we work closely with the industry partners," Chen said. "The conference calls are open conversations that get very technical."

Magnetic fields and radiofrequency energy used by MRI machines and other electronics interfere with the electromagnetic energy fields of pacemakers and other implantable medical devices. The devices can malfunction and burn human tissue as their temperatures increase.

"We tested one device in an MRI exam, and the temperature increased 70 degrees," Chen said. "It's like putting metal in a microwave."

Existing commercial software is incapable of modeling the entirety of the complex systems, and central processing units take months to run simulations for one solution. With David Jackson, also a UH Cullen College of Engineering professor of electrical and computer engineering, and a team of 15 students, Chen has developed computational modeling algorithms that analyze the complex interactions between human bodies, implantable medical devices and electronics on a graphic processing unit that produces numerous solutions in a matter of days.

Their research has resulted in filters that protect medical devices from harmful electromagnetic interferences, and validation of their study is underway.

"We are very happy that we are part of a group known for electromagnetics in medical research," Chen said. "We work closely with the FDA, and our results show up constantly in their presentations."

DEVICE-TO-DEVICE COMMUNICATION SHOWS PROMISE IN OPTIMIZING CELLULAR NETWORKS

Signals from smart phones are routed through base transceiver stations when they communicate, regardless of their proximity to their destinations. Signals from phones belonging to friends calling or texting in the same room must find distant base stations before they connect, just as signals from friends' phones located in opposite corners of the city must find base stations.

Zhu Han, associate professor of electrical and computer engineering in the UH Cullen College of Engineering, earned two National Science Foundation grants to develop and employ technology that allows smart phones and other devices in close proximity to communicate directly.

The foundation awarded Han with $185,000 to optimize the performance of cellular networks through device-to-device communication and $227,500 to apply the improved technology to mobile social networking. The three-year grants enable Han to employ two doctoral students, Yanru Zhang and Yunan Gu.

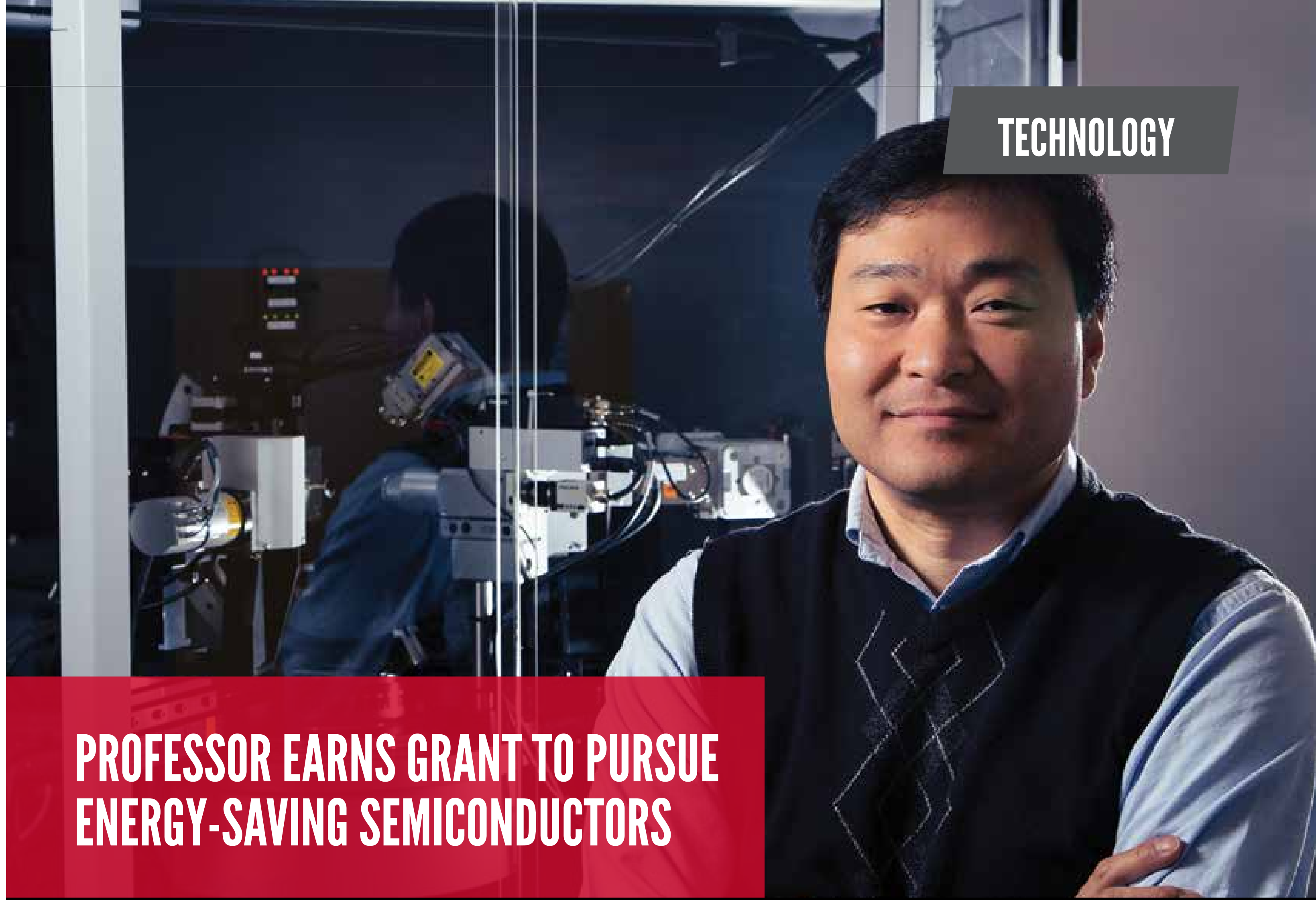
Han and his team are taking the game-theoretic approach in their development of an algorithm to allocate resources for distributed optimization of cellular networks. Device-to-device communication, which base stations can monitor rather than control, is the future, Han said.

Base stations currently control channels and the amounts of power they use, among other cellular network variables. Their capacity to handle demands of existing networks is insufficient, and future generations of networks are expected to grow significantly.

Meeting cellular network demands becomes more computationally feasible with the new technology, which can also increase efficiency, lower overhead expenses and reduce phone energy consumption, Han said. Furthermore, device-to-device communication can reduce interference, which causes slow Internet downloads and dropped or poor quality cellular phone connections. Such problems are inherent in mobile networks, regardless of their generation, so the improved technology can alleviate but not cure them, he said.

Han and his students are also using device-to-device communication to mobilize social media. Networking through smart phone applications such as Facebook and Twitter becomes mobile when devices in close proximity can share location information directly. The technology then allows the devices to avoid communication from strangers and find communication from friends. The lower-level adjacency of the technology that can enable this process is not configured yet, Han said.

"Location can be a bigger part of social networking," Han said. "We want to take advantage of that."



PROFESSOR EARNS GRANT TO PURSUE ENERGY-SAVING SEMICONDUCTORS

Silicon, despite inefficiencies, has been an effective electrical energy conversion and control material for hybrid-electric vehicles and numerous other power electronics. However, the semiconductor is reaching its physical limits in many important applications, such as next-generation electric vehicles and smart grid systems.

An engineering professor at the University of Houston is exploring the use of gallium nitride, GaN, as a more energy-efficient semiconductor alternative to silicon, Si, which is the most dominant material currently used.

Jae-Hyun Ryou, assistant professor of mechanical engineering in the Cullen College of Engineering, recently earned a three-year, $270,000 grant from Technology Engine of Science to develop a high-current, high-voltage switching and conversion device to power the next generation of electronics.

Silicon material has reached its maximum capacity in power conversions, and gallium nitride has potential to close the inefficiency gaps, Ryou said. In electric power grids, for example, silicon semiconductor switching devices that regulate voltage and currents of electricity in distribution lines cannot be closed above a particular voltage, which results in huge energy losses. Silicon devices only optimize electricity flow below certain voltage levels.

Researchers have already demonstrated proof-of-concept for the emerging gallium nitride semiconductor technology.

Ryou and his UH engineering team, which includes Seunghwan Kim, post-doctoral research fellow, and Weijie Wang and Shahab Shervin, both doctoral students, are collaborating with the University of Texas-Dallas, the Korea Institute of Industrial Technology and the Technology Engine of Science.

Together, their goal is to design and construct the switching device using gallium nitride, which is commonly used by researchers for various purposes. In fact, three researchers won the Nobel Prize in physics this year for their application of the compound to the development of blue light-emitting diodes, or LEDs.

"We hope to further expand the practical use of GaN in other applications beyond the LEDs," Ryou said.

Unique physical and chemical properties of gallium nitride provide technical benefits for demanding applications. The semiconductor material, which is more thermally and chemically stable than silicon, permits devices to operate at higher voltages, frequencies and temperatures than their silicon-counterparts. In fact, gallium nitride can carry electrical currents at three times the velocity of silicon, and the material withstands breakdown 10 times better than silicon.

To develop the new semiconductor technology, Ryou and his team must overcome technical challenges. They must minimize imperfections in the gallium nitride material through an innovative chemical vapor deposition process used to produce thin high-performance films in the semiconductor industry. Furthermore, the researchers must develop the material structure at the maximum performance suggested by theoretical studies in order to demonstrate high-performing devices.

Ryou is performing the theoretical modeling of materials and devices. Technology Engine of Science and other collaborators possess the capabilities to develop and manufacture the devices.

"We want to have a prototype device that can be applied to any power conversion applications at the end of the three-year grant," Ryou said.

UNIVERSITY OF HOUSTON HOSTS SCIENCE ENGINEERING FAIR OF HOUSTON

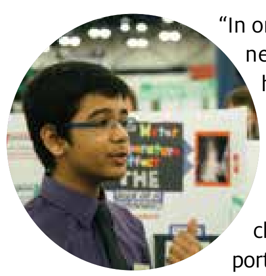
The 56th Annual Science Engineering Fair of Houston (SEFH), presented by Chevron Corporation, was held on Feb. 27 - 28, 2015 at the University of Houston Main Campus Alumni Center. The winning students and Teacher of the Year were celebrated at an awards ceremony held on March 1 at the University of Houston's Cullen Performance Hall.

SEFH serves as one of the largest regional science and engineering fairs for all public, private, chartered and home-schooled junior and senior high school students in Houston as well as the 22 surrounding counties throughout southeast Texas. More than 1,000 middle and high school students from 125 schools competed at the 56th annual SEFH.

"It's an incredibly exciting event," said SEFH director Bonnie J. Dunbar, a professor of mechanical engineering at the UH Cullen College of Engineering. Dunbar is a former NASA astronaut and currently serves as director of the University of Houston STEM Center and the Cullen College's aerospace engineering program.

Inspiring young people across the country to pursue STEM (science, technology, engineering and mathematics) careers is one of Dunbar's primary passions. Science fairs, she said, are extremely important events for engaging students into STEM careers.

"The nation is facing a shortage of qualified scientists and engineers, a situation described in the 2012 report by President Obama's Council of Advisors on Science and Technology. The challenge to the nation is to graduate 1 million new scientists and engineers by 2020," Dunbar said.



"In order to graduate more scientists and engineers, we need more and better-prepared math and science high school students for our colleges of engineering, math and science," she said. "That translates into biology, chemistry and physics and four years of math by high school graduation. At the completion of a college education in engineering, math, biology, chemistry and physics are a wealth of careers with opportunities to creatively solve some of the most pressing challenges of our time."

A 2013 Brookings Report identified a clear need in Houston. It reported that Houston ranked 5th in STEM career demand out of 100 U.S. cities, but 72nd in supplying STEM workers. About two-thirds of the local STEM workforce with at least a bachelor's degree comes from outside of Texas; almost one-fourth were born outside of the United States.

Local industries and research institutes are very interested in the success of SEFH. In addition to presenting sponsor Chevron Corporation, contributing sponsors include the University of Houston, Air Liquide, Exxon Mobil, Phillips 66, Shell and the Houston Geological Society.

For more information on the Science Engineering Fair of Houston, please visit www.sefhouston.org.

STEM EDUCATION & OUTREACH

PI TAU SIGMA HOSTS 'ENGINEERING 101'

In a growing effort to build relationships between the Cullen College of Engineering and local schools, Pi Tau Sigma hosted a group of 50 grade school students from Gregg Elementary for their first annual "Engineering 101" day.

Students heard from Diana de la Rosa-Pohl, PROMES director, about different engineering disciplines. They then broke off into small groups to spend some time gaining hands-on experience with engineering concepts. The students built towers out of raw spaghetti and marshmallows, and built anti-shock devices for a spaceship landing out of rubber bands, straws, marshmallows and other small materials.

"Overall, the students were very engaged, and they asked a lot of questions about engineering and college life," said Gabriela Bernardes, Pi Tau Sigma vice president. After the activities, students had the chance to observe a student panel discuss their experiences at the University of Houston.

View photos from Engineering 101 and other Cullen College events at www.egr.uh.edu/news/photo-gallery.

SWE LAUNCHES LOCAL HIGH SCHOOL STUDENTS INTO ENGINEERING

The Society of Women Engineers (SWE) hosted a group of over 200 local high school students for their annual "Launch into Engineering" event on Feb. 20. The goal of the event, which is in its third year, is to introduce young people to the different disciplines within engineering in a fun, accessible and engaging way.

"We give them a chance to break through some of the stereotypes [surrounding STEM fields] and expose them to different types of things engineers do so they can see something that sparks their interest and hopefully encourages them to join an engineering field," said Michelle Wood, SWE Logistics Coordinator.

Students participated in hands-on activities to learn about the engineering disciplines, like creating a coating to maintain the structure of a Skittle when immersed in Sprite. Former NASA astronaut Bonnie Dunbar, who serves as the director of the UH STEM Center and the Cullen College's aerospace engineering program, also spoke to the group.

Watch the video from Launch into Engineering at www.egr.uh.edu/swe-launch-video.

View the photos from Launch into Engineering at https://www.egr.uh.edu/news/photo-gallery.

COSMIC TRAILBLAZERS

EXOPLANETS, EXTRATERRESTRIAL LIFE, THE MOON AND MARS

by Elena Watts

Discoveries of Earth-like exoplanets and development of a giant telescope powerful enough to penetrate their atmospheres as well as prospects for space tourism and Mars missions have renewed mainstream interest in space exploration around the world. During this exciting time in space history, the Cullen College's aerospace engineering program has also gained momentum with the addition of former NASA astronaut Bonnie J. Dunbar to the faculty in 2013. Dunbar belongs to an elite group of about 60 women who have flown in space, and she now adds professor and director of the aerospace engineering and space architecture programs to her list of accomplishments. She brings invaluable enthusiasm and experience from five space missions to Cullen College engineering classrooms as she works to grow numbers of students enrolled in the graduate programs, to broaden the scope of the UH Small Satellite Laboratory and to revive and expand space research opportunities with funding from NASA and aerospace companies.

COOGS IN SPACE

Professors and students at the UH Cullen College of Engineering are engaged in research that impacts almost every aspect of space exploration, from the launch and reentry of spacecraft to the design of safe human habitats for extreme environments. The glossary that follows provides a glimpse of the space-related research projects and NASA collaborations that Cullen College professors and students are tackling head-on.

Diagram composed of images courtesy of NASA

SATELLITES: REMOTE IMAGING AND SENSING

Credit: NASA

More than 2,200 satellites currently orbit the Earth, according to the Goddard Space Flight Center. Some of the satellites are used for communications, such as beaming television and cell phone signals around the world or delivering GPS data to smartphones. Other satellites collect vast amounts of data about the Earth, the solar system and even faraway galaxies by photographing planets, stars, natural satellites, weather systems, black holes and dark matter, among other objects of interest. These images help scientists and engineers predict weather, understand climate change and learn more about the universe.

Hyongki Lee (CEE): Lee is an expert in utilizing data collected from remote imaging and sensing technologies, such as NASA satellites, to create robust maps and data sets of regions of the world that are difficult to access on foot. Lee was recently awarded $220,000 from NASA's Applied Sciences Program to help South Asian nations independently manage their water resources using software that interprets data collected from NASA satellites. Lee also received NASA's $335,000 New (Early Career) Investigator Award in Earth Science to use data collected from satellites to better understand the hydrology of the Congo River Basin and its connection with climate change, deforestation and carbon emissions from Congo waters.

Link: http://www.egr.uh.edu/news/201406/civil-environmental-engineering-researcher-wins-nasas-new-investigator-award

Saurabh Prasad (ECE): Prasad is an expert on signal processing and image analysis. Last year, Prasad won NASA's New (Early Career) Investigator Award in Earth Science to develop algorithms allowing scientists to employ satellite and aerial imaging data in conjunction with field measurements for a much more robust understanding of the Gulf Coast wetlands. Levels of detail range from extremely high resolution, ground-based hyper-spectral imagery that quantifies local processes to wide-scale aerial and satellite imagery that informs scientists about holistic trends related to ecosystem health.

Link: http://www.egr.uh.edu/news/201407/electrical-computer-engineering-researcher-wins-nasas-new-investigator-award

CUBESATS

Small satellites, or CubeSats, are generally classified as small, cube-shaped satellites that weigh less than three kilograms. Compared to standard-sized satellites that typically require hundreds of millions of dollars to develop and launch, CubeSats cost about $5,000 to develop and less than $100,000 to launch. The affordability of small satellites makes them ideal teaching tools for academic institutions, which are able to provide university students with unprecedented access to space for education and scientific research.

David Jackson (ECE) and Ji Chen (ECE): Jackson and Chen launched the Small Satellite Research Laboratory at the UH Cullen College of Engineering in 2013. Since then, the lab has received $200,000 in funding from NASA. The students involved in ongoing research inside the lab have won numerous national and international awards.

Link: http://www.egr.uh.edu/news/201308/ece-small-satellite-research-lab-receives-nasa-funding

Steve Provence (ECE): Provence is a full-time NASA engineer, a Cullen College alumnus and an adjunct professor in the electrical and computer engineering department at the UH Cullen College of Engineering. For more than 13 years, Provence has designed and developed CubeSats for NASA. He has also works closely with students in the Small Satellite Laboratory at UH, serving as the NASA liaison for student-led research projects. Recently, he mentored a group of UH engineering undergraduates who won national awards for their novel CubeSat antenna design. He currently mentors a group of UH engineering undergraduates who are working closely with NASA, Texas A&M and UT-Austin to develop an image capture technology for CubeSats.

Link: https://www.egr.uh.edu/news/201305/nasa-sponsored-student-team-develops-innovative-small-satellite-antenna-designs

NASA TECHNOLOGIES FOR HUMANS

Many technologies developed by NASA for space missions also have enormous commercial and societal benefits on Earth. NASA-developed technologies are found in nearly every sector of the economy, including health and medicine, transportation, public safety, consumer goods, energy and environment, information technology and industrial productivity.

Jose Luis "Pepe" Contreras-Vidal (ECE): Contreras-Vidal is a world-renowned expert on brain-machine interfaces, or BMIs, that turn a person's thoughts into commands that control a robotic exoskeleton. He uses a non-invasive skullcap that scans brain activity to move the exoskeleton. Contreras-Vidal is currently working with engineers from NASA/Oceaneering Space Systems to combine his BMI technology with NASA's X1 exoskeleton for use as a rehabilitation device on Earth. The BMI and exoskeleton could allow patients with brain injuries, paralysis or other mobility issues to regain their ability to walk using only the power of their thoughts. The researchers hope that patients can rewire their brains to control their limbs by walking with assistance of exoskeletons.

Link: http://www.egr.uh.edu/news/201309/photos-video-rehabiltation-robots

SPACESUITS

Spacesuits are more than just clothing made for astronauts – they are a mini-spacecraft. They protect astronauts from the dangers of space by providing oxygen, water, temperature stability and jet-thrusting capability. The engineering that goes into spacesuit design is challenging because researchers must find novel ways of decreasing the weight and size of the suits while adding more functionality.

Haleh Ardebili (ME): Thanks to Ardebili, spacesuits may not need the hard, heavy and bulky battery packs they currently require for power. Ardebili won a one-year, $10,000 New Investigator Award from the NASA Texas Space Center Grant Consortium to develop flexible, stretchable batteries for spacesuits.

Link: http://www.egr.uh.edu/news/201405/mechanical-engineering-professor-wins-new-investigator-award-nasa-texas-space-center

COMMERCIAL SPACEPORTS

Most Houstonians have likely heard about the proposed spaceport at Ellington Airport. However, they might not have heard that University of Houston space architects have researched and proposed the conception and design of Houston's first spaceport.

Sam Ximenes and Nejc Trost: Ximenes and Trost, alumni of the UH space architecture program, worked together to propose a design for Houston's first-ever commercial spaceport at Ellington Field. The Houston Airport System (HAS) proposed a spaceport in 2011 and awarded Ximenes' company, XArc Exploration Architecture Corporation, a study contract in 2013. Ximenes recruited Trost, a fellow UH space architecture alumnus, to help research the economic and business viability of constructing the proposed spaceport and to help create 3-D renderings of the proposed spaceport.

Link: https://www.egr.uh.edu/news/201310/uh-space-architects-help-design-houston's-proposed-spaceport

JET PROPULSION

Ralph Metcalfe (ME & BME): Metcalfe has contributed to the reality of past and future space missions with his early professional work in jet propulsion and turbulent flow for NASA. He plans to revive some of his earlier space research in collaboration with Bonnie Dunbar, director of the Cullen College's aerospace engineering graduate program. In the meantime, Metcalfe continues to mentor UH engineering students to prepare them for careers at NASA and commerical space companies, among other organizations.

Link: https://www.egr.uh.edu/news/201306/aerodynamic-aerospace-engineering-grad-student-researches-nasa

THE MOON

Ralph Metcalfe (ME & BME): Metcalfe eagerly anticipates return missions to the Moon for many reasons, including geological studies to inform theories about formation of the Moon's large lava beds, called maria. As an undergraduate student at the University of Washington in 1968, Metcalfe and his professor, Nils Barricelli, theorized that collisions with moonlets orbiting the Earth billions of years ago caused the lava beds on the lunar surface. Analysis of computer simulations of Earth satellite orbits provided a consistent explanation for the predominance of maria near the lunar equator on the side of the moon facing the Earth. They published their study in 1969, and a summary appeared the next year in the first edition of *The Moon*, a journal founded by Harold C. Urey, winner of the 1934 Nobel Prize in chemistry.

Link: https://www.egr.uh.edu/news/201503/professor-theorizes-about-formation-lava-beds-moon

HUMAN FACTORS

In the late 1980s, NASA developed its first set of design standards for human factors. The document, called NASA-STD-3000, specified ways to support human health, safety and productivity during space flight, though the scope was later determined too narrow. NASA has developed a new set of human factors standards in more general terms with more emphasis on crew health and medical support. However, new technologies and systems are continuously emerging, so researchers must constantly reevaluate and tailor human factors standards to unique situations and missions. As a result, NASA often taps into UH engineering talent to help ensure that astronauts are as safe and comfortable as possible during their missions.

Lawrence Schulze (IE): Schulze has enjoyed a long career collaborating on NASA projects related to human factors engineering. He played a role in engineering some of the technologies and systems found in NASA spacecraft and on the International Space Station (ISS), including an early version of the touch screen technology currently used in every smartphone on the market. Schulze also helped develop the displays, control panels and temperature control systems for spacecraft and the ISS. He even assisted in the development of a water reclamation system, which recycles urine into purified drinking water. Schulze's expertise in ergonomics and human factors engineering is considered one of the cornerstones of the aerospace engineering program at the Cullen College.

Kirill Larin (BME): Decompression sickness, also known as the bends, occurs in people who move too quickly from an environment with high air pressure to one with lower air pressure – a regular activity for astronauts in space. This can cause nitrogen dissolved in the blood to form gas bubbles, which can lead to maladies ranging from joint pain and seizures to strokes and comas. In extreme cases, decompression sickness can even cause death. Larin developed a non-invasive tool that diagnoses decompression sickness before its effects are felt, which allows time for medical action to reduce the consequences of the condition. Larin has received funding from the U.S. Navy's Office of Naval Research to develop the diagnostic tool, which benefits everyone from highly-trained naval divers to astronauts.

Link: https://www.egr.uh.edu/news/201309/imaging-expert-researching-submarine-escapes-heart-development

MATERIALS

Credit: NASA

Space is an extreme environment, and materials used to build spacecraft, spacesuits and other technologies and tools deployed in space must withstand multiple extreme conditions. Weathering high and low temperatures, living in microgravity and braving space dust travelling faster than speeding bullets require engineers with expertise on smart materials and structures. Luckily, NASA doesn't have to look far. Many experts work at the UH Cullen College of Engineering, just up the road from the NASA Johnson Space Center.

Gangbing Song (ME): As the director of the Cullen College's Smart Materials and Structures Laboratory, Song is an expert in all major smart material categories. These smart materials include shape-memory alloys, piezoelectric ceramics, magnetostrictive materials, and electrorheological and magnetorheological fluids. What these materials do is nothing short of remarkable: they change shape, rigidity, position, natural frequency and other mechanical characteristics, almost like magic, in response to slight changes in temperature or electromagnetic fields. These materials are crucial for space applications because they can withstand and adapt to extreme environments.

Link: https://www.egr.uh.edu/news/200407/uh-engineering-professor-develops-intelligent-systems-presage-tomorrows-technology

Ken White (ME): In the absence of materials that could withstand extreme heat generated by high speeds upon reentry to Earth's atmosphere, engineers were forced to design blunt-edged spacecraft to slow their speeds and to thermally protect their structures as they returned from space. With part of a $1.7 million grant from the U.S. Air Force, White developed a new ceramic refractory material, a diboride-tungsten carbide solid solution alloy, to replace zirconium diboride in aircraft and spacecraft construction. The superior material will enable engineers to design aerodynamic new-generation reentry spacecraft and hypersonic aircraft that will withstand extremely high temperatures under load with improved maneuverability.

Link: https://www.egr.uh.edu/news/201503/professor-develops-stronger-material-spacecraft-construction

EXTREME ENVIRONMENTS

Credit: NASA

Extreme environments are places that are not generally conducive to human life, such as the depths of the ocean or the heights of outer space. Engineering for such environments has unique challenges, and experts working in this field must take a particularly holistic approach to problem solving. The world's leading expert in the field of extreme environments, Larry Bell, established UH's space architecture program, which is now part of the Cullen College's aerospace engineering curriculum.

Larry Bell (Aerospace Engineering/Space Architecture Program): Bell launched the world's first and only research and education program in space architecture at the University of Houston in 1987 – an asset attributable to Houston's reputation as the "Space Capital of the World" and the University's unique access to the NASA Johnson Space Center. Since then, Bell has both defined and led the field of space architecture, exploring environments that astronauts temporarily call home. From the ocean floor to distant planets, Bell and the UH Cullen College of Engineering are pushing the field of space architecture beyond terrestrial limits.

Link: https://www.egr.uh.edu/news/201309/shooting-stars-uhs-larry-bell-discusses-space-architecture

INTERNATIONAL SPACE STATION

The International Space Station (ISS) is a microgravity and space environment research laboratory that is the largest artificial body in low Earth orbit. The first component of the modular structure was launched into space in 1998. Astronauts have occupied the ISS since 2000 – the longest continuous human presence in space. To date, 215 individuals, some of them UH Cullen College of Engineering alumni, have visited the space station.

Peter Vekilov (ChBE): Thanks to a recent grant from NASA, Vekilov's theories on crystal formation will be tested onboard the International Space Station. Vekilov won the grant, valued at just less than $100,000, to study how proteins in a liquid solution nucleate, or form crystals.

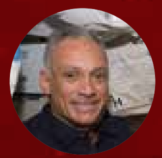
Link: https://www.egr.uh.edu/news/201303/professor-crystal-formation-theories-be-tested-space

FUN FACT:

Several Cullen College alumni went on to become astronauts, many of whom visited the International Space Station. Alumni of the Cullen College who became astronauts include:

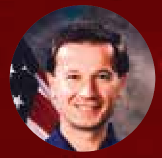
Bonnie Dunbar
(Ph.D. in Mechanical Engineering, '83)

Rex Walheim
(M.S. in Industrial Engineering, '89)



John "Danny" Olivas
(M.S. in Mechanical Engineering, '93)

Nancy Currie
(Ph.D. in Industrial Engineering, '97)



Maurizio Cheli
(M.S. in Aerospace Engineering, '94)

Akihiko Hoshide
(M.S. in Aerospace Engineering, '97)

Images courtesy of NASA

AEROSPACE ENGINEERING CURRICULUM LAUNCHES TO NEW HEIGHTS

From left: Nejc Trost and Sam Ximenes, alumni of the UH space architecture program

The mystique of the most populous city in Texas was imprinted in the imaginations of people around the world when astronauts uttered "Houston" in their first communications from space during NASA's heyday. Professor and former NASA astronaut ***Bonnie J. Dunbar,*** *who serves as director of UH Cullen College of Engineering's aerospace engineering and SICSA space architecture programs, looks forward to the day when space exploration again transfixes people of every nation.*

Bonnie Dunbar, director of the aerospace engineering graduate program

Unlike the mid-20th Century when rockets were first successfully developed and only two countries dominated space exploration, many nations now are space-faring. They are launching rockets and even astronauts into the cosmos as well as their own communication, weather, remote sensing and navigation satellites, Dunbar said.

"Both space exploration and space commerce are now internationally competitive," Dunbar said. "As the NASA budget is increased beyond its half-percent of the federal budget, and space commerce is moving to Texas, it is important that the University of Houston, with its proximity to the NASA Johnson Space Center and the Ellington Field spaceport, be poised to be part of this new bold future."

Last fall, the Sasakawa International Center for Space Architecture (SICSA), which is the only program of its kind in the world, moved from the UH Gerald D. Hines College of Architecture to the UH Cullen College of Engineering. The change ushered in an interdisciplinary space architecture education for graduate students that involves engineers and technical architects designing missions and operations from the ground up, including orbital mechanics, human habitats, logistics, design for extreme environments, life support systems, human factors and launch capability trades.

UH space architecture professor Larry Bell

"There's only one NASA human space flight center in this country, and it's right here in Houston – the Johnson Space Center," Dunbar said. "Our students are in a wonderful position to engage very easily with JSC engineers and scientists."

Both aerospace engineering and space architecture are yearlong, 30-credit-hour master's degree programs. The aerospace engineering curriculum offers students one of three concentrations: aerodynamics and heat transfer, structural mechanics and materials, or controls and automation. The space architecture program, which was established in 1987 and accredited in 2002 by the Texas Higher Education Coordinating Board (THECB), has both team studio and individual thesis options.

The aerospace engineering program is multidisciplinary, merging engineering and physics with course topics including smart structures, space radiation protection, robotic systems, spacecraft design and propulsion. In a unique agreement, UH students may also take complementary courses at Rice University and apply as many as six credits to their degrees.

Dunbar has submitted several grant proposals to NASA, and has revived space-related research projects with other UH professors since she inherited the aerospace engineering program in 2013. Her goals are to continue the program's award-winning small satellite antenna research and to expand the UH Small Satellite Research Laboratory to accommodate the full range of technologies necessary for CubeSat missions. She also plans to establish professional certificate and doctoral programs while she works to grow numbers of students enrolled in the aerospace engineering and space architecture master's programs.

"Space architecture is different from any other program, so it complements the college of engineering and enlarges our offering to the community," Dunbar said. "It's very much like a small company when engineers and architects team up to produce fully designed habitats, not just parts of systems, which they take into full operation, including logistical resupply."

Architecture professor **Larry Bell** founded the interdisciplinary space architecture program in 1987. For almost 30 years, his students also used holistic logic to create life support systems in space, subsea, Arctic and other extreme habitats.

"I believe Dr. Dunbar's presence is a game changer because she brings real experience of having been through NASA programs, and microgravity is a very different kind of environment," Bell said. "She brings the experiential side as well as being attuned to a broad comprehensive array of issues and technical challenges that bring something very special to the whole opportunity."

Space architecture and aerospace engineering programs take macro and micro approaches to the same problems, so their recent partnership gives engineers and architects opportunities to establish common languages that cut across disciplines, Bell said.

"There is an understanding of how fortunate we are to have this kind of two-sides-of-the-same-coin mating," Bell said. "It's not them and us – it's all us – and we're solving problems together."

Bell became a senior faculty member with the SICSA team when the program moved to the engineering college last year. He began his academic career as director of the graduate industrial design program at the University of Illinois, but Houston, which he described as "a dynamic bastion of free enterprise," attracted him to the University of Houston. He began teaching architecture classes in 1978.

"I really wasn't a space cadet at that time," Bell said. "I never had more than an average amount of interest in space in my past."

However, NASA's exotic challenges and problem-solving opportunities immediately captured Bell's fascination, and his interests were contagious among his fellow faculty members. The college soon implemented design studios and earned funded contracts from NASA and aerospace companies.

"We draw on experiences of people who have been to space, and then extrapolate lessons into conceptual designs," he said.

The central program priority is to provide a resource-rich, interactive learning environment that enables students to pursue professional goals that mesh with opportunities. The learning is not linear, which attracts proactive students.

"Academia is generally a narrowing process rather than an expanding one as students ascend the pyramid of learning," Bell said. "But space architecture is an expanding journey that looks at issues and problems holistically."

Olga Bannova, space architecture research professor

Human attitudes do not come in standards that engineers and architects can measure on scales. As individuals, people have different backgrounds, desires and expectations, and the additions of stress and gender dynamics in isolated situations make it more interesting, Bell said.

"We learn by jumping into the deep end of the pool together – full immersion – and, you know, I haven't drowned anyone yet," Bell said. "And then they go out into the world with confidence, skills and experiences essential for success."

Students and alumni work for organizations, including NASA, the European Space Station, the Houston Spaceport and commercial aerospace companies, which often pay their tuition. Many students have also worked for Bell, whom co-founded several commercial space enterprises throughout the years.

"Our students are very mature," Bell said. "I would put their work up against any professional organization."

Bell and Trotti, Inc. provided space station research, design and full-scale mockup fabrication services for leading aerospace firms. International Space Enterprises, a San Diego-based company, teamed up with Russian organizations to develop telerobotic rovers to explore lunar and planetary surfaces. The company then spun off a subsidiary that designed and built advanced hybrid buses and trucks. Still another company, Space Industries, Inc., grew from four co-founders to more than 8,000 professional employees through a series of mergers and acquisitions.

"Houston provided an ideal business climate for such enterprises," Bell said. "We can be very grateful for its rich diversity of talent and resources, which include the NASA community, the Texas Medical Center and a variety of other high-tech industries."

The Texas Medical Center, which is one of the largest medical centers in the world, provides tremendous technical resources for UH students and alumni, Bell said. Houston has the diversity of talent and resources to provide entrepreneurial know-how that supports commercialization.

"They could not have started space industries in Tucson, Arizona," Bell said. "It required some wildcat, risk-willing people who would invest in crazy ideas that turned out to be not so crazy after all."

CUBESATS OFFER UH ENGINEERS UNPRECEDENTED ACCESS TO SPACE

Steve Provence likes to talk about space, and engineering students at the University of Houston are benefiting from his conversations.

Steve Provence, NASA engineer and adjunct professor at the Cullen College

The NASA engineer and UH adjunct professor teaches several electrical engineering classes, but also makes time to visit his fellow professors on campus.

As an alumnus of the Cullen College, Provence has a history with electrical and computer engineering professors David Jackson and Ji Chen, and their conversations have sparked amazing developments in space engineering education at the Cullen College.

"Students love the experience of getting involved in the space program, to develop an actual functioning small satellite, and to see it go into orbit and perform its job," Jackson said. "It's a satellite that you can hold in the palm of your hand that's going to orbit the Earth, which you developed – it doesn't get any cooler than that."

These small satellites, called CubeSats, are revolutionizing engineering academia around the world. Universities are the primary developers of the technologies, which provide affordable ways to perform basic scientific research and to educate students. CubeSat research at the UH Cullen College of Engineering has taken flight in recent years, providing both students and faculty with unprecedented access to space research.

CubeSats are 10-centimeter sized cubical satellites that occupy low Earth orbit, LEO, typically at an altitude of two hundred miles above mean sea level. Packed with sensors, they usually take varieties of measurements pertaining to Earth or space and transmit the data to small-scale mission control centers on university campuses.

These small satellites orbit Earth about every 90 minutes for weeks or months either solo, 1U, or in two-cube, 2U, or three-cube, 3U, stacked configurations. Eventually, they decay and burn up upon reentry to Earth's atmosphere.

Compared to full-size satellites that require many millions of dollars to build and launch, the most expensive CubeSats cost less than $50,000 to develop and manufacture, and as little as $100,000 to launch. Although functionality is also reduced, CubeSats provide valuable scientific data and invaluable engineering opportunities for students, which are reasons enough for NASA and other agencies to show interest and provide funding.

"At NASA, we dream big, so the projects we're most interested in are the multibillion dollar ones that sit on the launch pad 100 stories high," Provence said. "CubeSats are seen as great tools and vehicles, so we're interested, but we don't want to devote a lot of time to them."

NASA issues solicitations to universities, awards funding, lends technical expertise and observes the results. University responses to solicitations have grown from dozens to hundreds in the last few years, Provence said.

"We have unique opportunities to collaborate with NASA through our CubeSat program," Jackson said. "Space is natural for us here at UH, being so close to the Johnson Space Center."

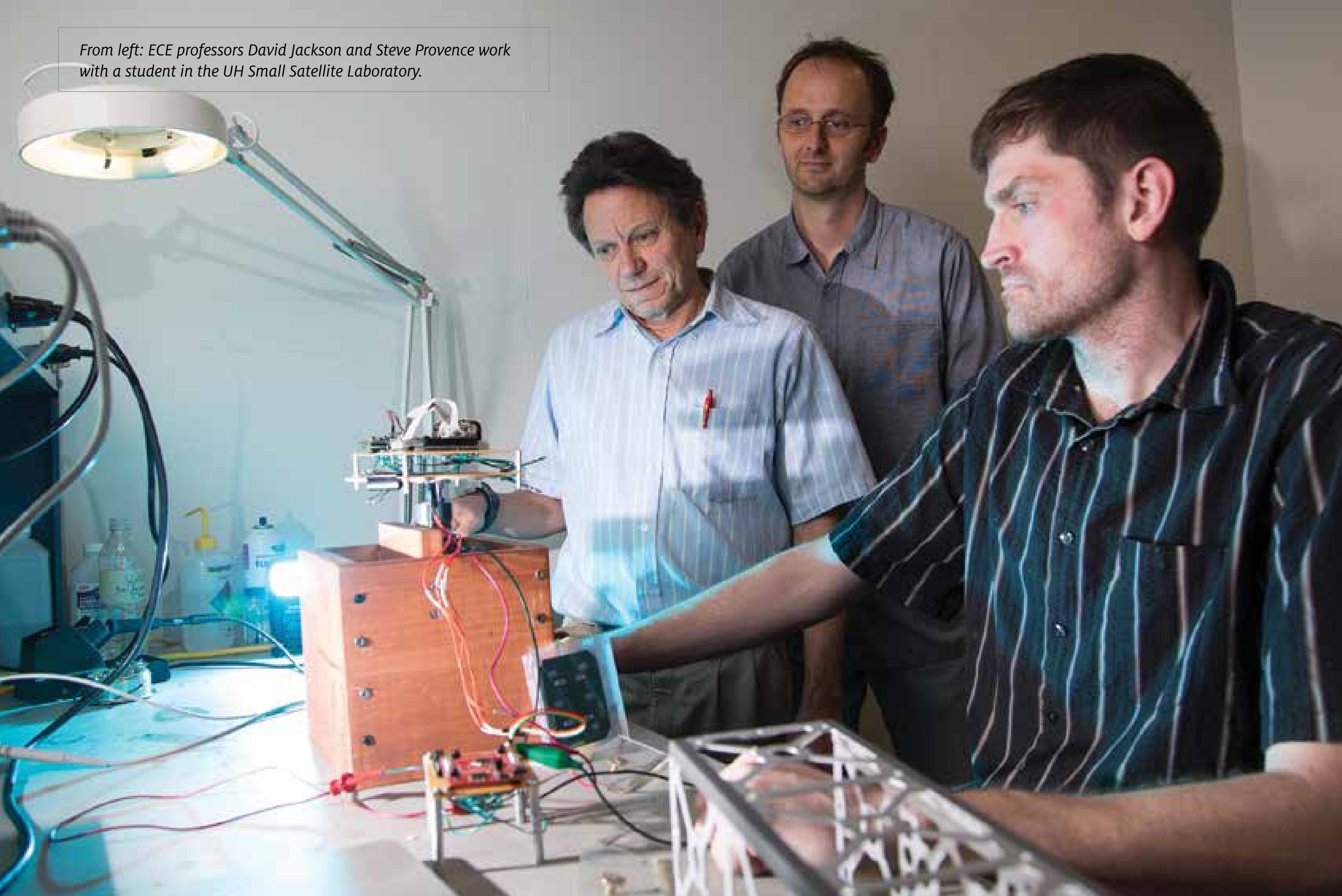
David Jackson, professor of electrical and computer engineering

During one of many casual conversations outside their classrooms, Provence showed Jackson and Chen videos of the unreliable, off-the-shelf antenna technology used for CubeSats.

"We can do better,"
Drs. Jackson and Chen told Provence.

And they did.

From left: UH Engineering students Xinyu Liu and Jingshen Liu



From left: ECE professors David Jackson and Steve Provence work with a student in the UH Small Satellite Laboratory.

Wire whip antennas are one of the main limitations of CubeSats, Jackson said. Existing small satellite antenna technology consists of mechanically-deployed antennas, such as a system wound around the top of a CubeSat and held in place by wires. After satellites are deployed, mission control centers send signals to burn the holding wires, thereby releasing the antennas. Unfortunately, signaling the release of spring-loaded wire whip antennas from Earth has presented opportunities for technological failures, which have occurred often enough to make the development of new antenna technologies a priority.

The UH Cullen College of Engineering provided seed money for students to explore better antenna options. Nicole Neveu, Joseph Casana, Richie Dettloff and Mauricio Garcia, all electrical and computer engineering undergraduates, rose to the challenge and adopted the research as their senior design project. Professor John Glover, with expertise in embedded computing, and professor Jack Wolfe, an expert in advanced micro- and nanofabrication, joined the students and other professors as the program progressed.

The students won the Best Paper award for their antenna design at the 2013 Institute of Electrical and Electronics Engineers International Conference on Wireless for Space and Extreme Environments, outmatching industry, government and academic researchers.

"I am so glad I came to UH and not somewhere else," Neveu said. "I am very privileged to have had this opportunity to collaborate with NASA."

The challenge was to develop transparent microstrip antennas that mounted flush on CubeSat frames with adequate functionality. Transparency was necessary to allow light to reach the CubeSat's solar panels. The students succeeded with the development of a functional antenna on a quartz substrate, similar to antennas built into cellular phone circuit boards, but transparent.

"Even before I began working with the UH group, I always wanted an antenna that would mount on the surface of the CubeSats," Provence said. "I told the students my dream for a new small satellite antenna, and they not only made it a reality, they made it far better than I ever expected."

The student team designed and developed its antenna design in a mere three months with little overhead and a limited budget.

"These students just move faster than NASA could have – they don't see obstacles, they see the possibilities, the opportunities," Provence said. "And the best part is that they did this entirely by themselves – all I did was present them with the problem."

In 2014, NASA awarded Jackson and Chen a two-year, $200,000 grant to continue their research at the UH Small Satellite Research Laboratory. The award was one of only 13 granted to universities to develop new small satellite technologies.

"For the most part, the students don't see the projects from beginning to end," Provence said. "They hand them off to the next team with full disclosure, so they can't hide their flaws and mistakes – that's the real world."

Several UH senior design teams have worked on the CubeSat antenna technology project. The work is currently in the capable hands of several graduate students who continue to develop and improve the antennas. The process is long because students must design and fabricate the antennas to withstand the rigors of space, which requires thermal, vibration and vacuum testing, among other evaluations, Jackson said.

"We are in the middle of our two-year NASA contract so the technology is still in the development phase, but it looks to be far superior to what we have now," Jackson said. "The hope is that we'll have a successful product ready for future missions at the end of our contract."

On the heels of the award-winning small satellite antenna technology developed by UH engineering students, Provence introduced another more recent CubeSat challenge to a new group of Cullen College undergraduates: James Annis, Brian McNeil, Sean Strickland and Tori Speer-Manson.

Provence, who also works closely with the AggieSat group at Texas A&M, described an unsuccessful 2009 CubeSat mission to his students: A team of Texas A&M engineering students designed and launched a 13-centimeter CubeSat, called AggieSat2, mated to an identical satellite, Bevo-1, built by engineering students at the University of Texas. When deployed from the payload bay of space shuttle Endeavour, Bevo-1 and AggieSat2 were to separate. They never did, and Bevo-1's mission was unsuccessful. With little evidence of what caused the failure, the students were left without definitive answers. Ultimately, AggieSat2 downlinked limited data and was, on several occasions, commanded from the ground.

Once again, the UH team decided to address the challenge through a senior design project. Working closely with both NASA and AggieSat students, the Cullen College team designed and built a visual data capture system (VDCS) to photograph the ejection of a CubeSat into low Earth orbit from a full-size satellite.

Later this year, AggieSat4, containing the VDCS technology, will hitch a ride to the International Space Station (ISS) on a Space-X flight. The UH team's system will capture any mechanical failures that might happen as UT's CubeSat, Bevo-2, detaches from the larger satellite.

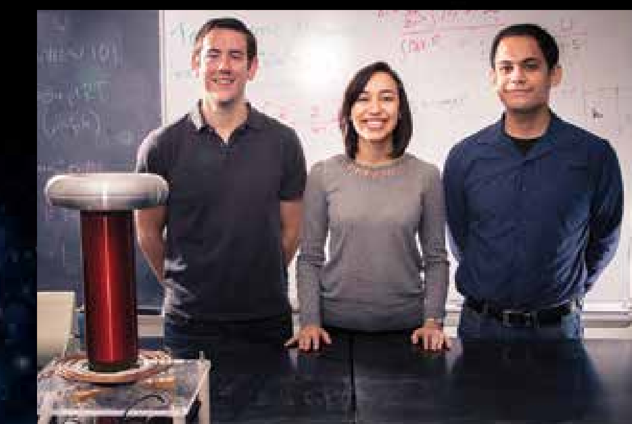
"It's an excellent partnership in which we integrate the new antennas and VDCS onto the CubeSats," Jackson said of the collaboration with the AggieSat lab at Texas A&M. "They've had a lot of experience developing and flying CubeSats, and by merging our forces together, we can develop an improved product."

With a fish-eye lens that captures almost 180 degrees, the camera in the VDCS will capture images in the seconds directly before deployment to record any conditions affecting the bay door. As Bevo-2 detaches from AggieSat4, the camera will take 10 rapid-fire sequences in about 10 seconds. The VDCS will have several other photographic missions once the satellite is launched from the bay of the ISS.

"I want to have a picture on my wall that I can show and say, 'I took a picture in space,'" McNeil said.

Bonnie Dunbar, director of the UH aerospace engineering program, plans to expand the Small Satellite Research Laboratory to leverage its tremendous teaching potential.

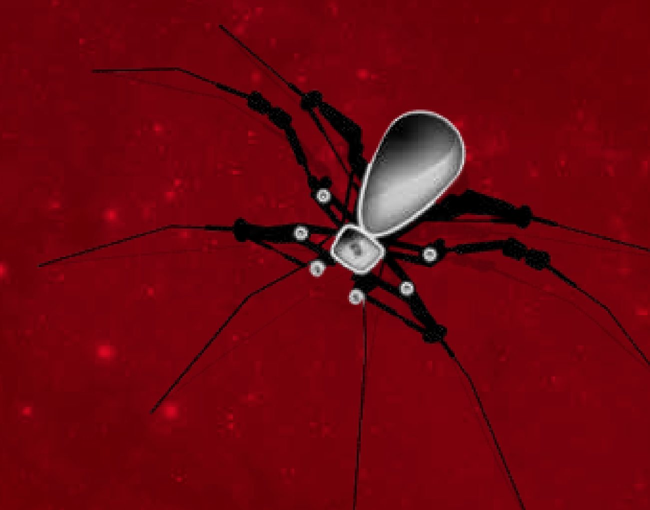
"We'd like to build an autonomous, complete capability where we build and launch our own CubeSats and monitor them from our own mini-mission control center," Dunbar said. "It gets students into engineering and keeps them in engineering."



Left: ECE students James Annis, Brian McNeil, Sean Strickland and Tori Speer-Manson take a "selfie" using their visual data capture system for cubesats.

Below: from left: ECE students Richie Dettloff, Nicole Neveu and Joseph Casana.

DID YOU KNOW?



As precursor missions to full-scale NASA asteroid missions, senior aerospace engineering design students at the Cullen College are exploring the launch of tethered fleets of CubeSats with nets strewn between them to envelop asteroids in low Earth orbit. They are also designing spider-like robots with sensors as CubeSat payloads to traverse the net grids and investigate asteroid compositions.

THE FUTURE OF SPACE: UNCOVERING THE COSMOS

For the first time in history, scientists are confident that exploration beyond Earth could realistically yield space tourism, Moon colonies, Mars missions and settlements, and extraterrestrial life, adding to the inevitable technological outgrowths that improve everyday life on Earth.

Historically, civilizations that have engaged in exploration have thrived, which alone should motivate nations to unceasingly pursue unknowns. The 21st Century could prove especially rewarding for intellectually curious trailblazers, and Cullen College aerospace engineering and space architecture students could help lead the charge.

"The whole concept of exploration is a litmus test for the curiosity and health of a community or civilization," said former astronaut Bonnie Dunbar, director of the UH aerospace engineering and space architecture graduate programs. "When nations cease to explore, they're no longer curious, they begin to atrophy, and that's when they need to worry."

Chinese treasure ships, for example, dwarfed Spanish carracks in the 15th Century, yet the Chinese fleet never sailed beyond the Indian Ocean at that time. It was Christopher Columbus' voyage across the Atlantic Ocean in Spain's Pinta that led to global expansion. Although China had dominated the oceans for 500 years, the country collapsed into a primitive feudal system for another 500 years when a xenophobic leader thwarted exploration just decades after the discovery of the New World.

"Great leaders exert curiosity, which expands their circumference of knowledge and innovation," Dunbar said.

In more recent times, China has slowly gained momentum in space exploration, which the United States has dominated for the last half-century. While NASA's space program has dwindled, the China National Space Administration, CNSA, has built a small space station to which it has flown 10 taikonauts – two of them women. CNSA plans to build a larger space station by 2020, and another Moon mission is likely on China's horizon, Dunbar said.

"This cultural heritage is exciting the people of China, and they get more productive and more innovative when they get excited," Dunbar said. "So I think exploration is not just about acquiring knowledge – it's an engine for civilizations."

POTENTIAL FOR LIFE ON OTHER PLANETS

When Dunbar graduated from high school in 1967, her physics book reported that the Earth's Sun was the only sun orbited by planets. By the early 1990s, scientists had discovered the first exoplanet outside Earth's solar system, and they also had learned that many stars in the Milky Way galaxy hosted planets. The telescope on the Kepler spacecraft, which launched in 2009, has since discovered more than 1,800 exoplanets, and approximately 30 of those are located within habitable, or "Goldilocks," zones of their mother stars.

Goldilocks planets, like Earth, are "not too hot, and not too cold." Their distances from their mother stars allow for the existence of life-supporting liquid water on their surfaces. Within the next decade, the world's largest telescope, which is currently in development, is expected to shed light on these potential other Earths. From its post in Chile, the Giant Magellan Telescope is anticipated to have enough power to penetrate exoplanet atmospheres.

"And so the discovery of these planets outside our own solar system with the potential for life is really exciting," Dunbar said. "Has any type of life, whether it be microbial or another level, ever tried to start on another planet, and has it progressed?"

These are the types of questions scientists ask about Mars, which they know had oceans, active volcanoes and a denser atmosphere at one time. Understanding Mars, which is the same age as Earth, could reveal valuable information about Earth's natural climate changes and their effects on humans, Dunbar said.

"Should we be thinking somewhere down the line that we might need to leave the planet, not because of what we've done to it, but because of natural changes?" Dunbar asked. "Ultimately that's what engineers do – we protect life on our planet."

MISSIONS TO MARS

Manned missions to Mars with potential for human settlements have revived interest in exploration even among amateur space enthusiasts. Meanwhile, engineers and scientists are researching ways to overcome the many challenges associated with realizing these goals.

Mars, the fourth planet from the Sun, has a relatively cold, high-radiation environment composed mainly of carbon dioxide. With three-eighths Earth's gravity and one-thousandth the pressure of Earth's atmosphere, the planet is not a complete vacuum. While an abundance of data exists on the space station's gravity, Zero G, and, of course, Earth's gravity, One G, not much data exists on fractional gravitational forces that fall between them.

One of Dunbar's research projects aims to understand flows of liquid and gas in fractional gravity using the rotation of small satellites called CubeSats to reproduce gravity on Mars.

"Our weather is driven by convection, so hot air rises," Dunbar said. "If there's no gravity, the air doesn't go anywhere, and if there's partial gravity, it rises at a different rate."

Also critical to Mars missions is shielding to adequately protect astronauts whom must travel through radiation showers and live in the planet's radiation environment for extended periods of time. NASA's Curiosity Mars rover and Radiation Assessment Detector (RAD), which launched in 2012, continue to provide scientists with invaluable measurements to develop this technology.

The orbits of Earth and Mars present different challenges. The planets circle the Sun at different rates, and the distance between them changes constantly because their orbits are elliptical, rather than circular. Therefore, travel between the planets is limited to a best window every 26 months.

The optimal Mars mission lasts about two years, with six months spent traveling there, one year spent on the planet waiting for the best window of return and six months spent traveling back.

"Once an astronaut starts her trip to Mars, she can't turn around three weeks out because she has a problem," Dunbar said. "It's just the way orbital mechanics works – it's physics."

For this reason, the Moon could serve as a valuable stepping-stone to Mars.

A LUNAR LABORATORY

Conveniently, the same side of the Moon faces Earth at all times, and the mission is always only three-and-a-half days each way.

"If I have a problem on the Moon, I can abort and come back to Earth," Dunbar said. "That's even better than Antarctica, where scientists winter in for six months because the environment is too hazardous, cold and dark."

From an engineering standpoint, the Moon could serve as an ideal site to test landing and life support systems in preparation for Mars missions, Dunbar said. Scientists could use the Moon's fractional gravity and high radiation environments to research their long-term effects on humans, which are currently not well understood. Opportunities to explore vacuum environments and extreme temperature variations would also exist on the Moon.

"The Moon could function as our laboratory and as a weigh station en route to Mars and other destinations," Dunbar said. "Once we get there again, we should stay."

Ralph Metcalfe, professor of mechanical engineering at the Cullen College, also views the Moon as a realistic first step towards Mars. Metcalfe studied lava bed formation on the Moon decades ago as a student, and conducted propulsion and turbulent flow research for NASA early in his career.

The Moon is superior to Earth for launching missions to Mars, Metcalfe said. To colonize Mars, rockets would need tremendous power to lift two years' worth of supplies through Earth's atmospheric drag and gravitational field. The Moon offers an ideal launch site because it does not have an atmosphere that creates drag, and its gravity is one-sixth the Earth's.

"Rockets could be launched using an electromagnetic slingshot called a railgun," Metcalfe said. "The power necessary for launches is already on the Moon."

In 2009, NASA's Lunar Crater Observation and Sensing Satellite, LCROSS, and its Lunar Reconnaissance Orbiter, LRO, verified the existence of water ice in recesses of deep craters located on the Moon's South Pole.

"It's much like the narrow, steep Black Canyon of the Gunnison River in Colorado that cuts into the Earth and creates spaces with minimal or no sunlight," Metcalfe said. "The spacecraft dropped a probe that hit the bottom of the Moon crater and lifted water ice."

Scientists speculate that four billion years worth of collisions with rocky asteroids and icy comets could account for the Moon craters and the significant water ice they contain. Without an atmosphere, the water ice that never sees the sun does not evaporate, but rather accumulates in permanently shadowed lunar craters.

These craters that contain water ice could provide perfect sites to build Moon bases, Metcalfe said. Perpetual, uninterrupted sunlight at the top of the craters could power solar cells, the craters could serve as protection against solar radiation, and melted water ice could be used to generate rocket fuel as well as grow plants.

A SYMBIOTIC RELATIONSHIP

NASA has worked with commercial companies on space exploration since the Apollo moon landing, so the notion that the administration and commercial aerospace companies do not want to work together is invented, Dunbar said. Conversely, NASA administrators have always hoped to spawn a commercial aerospace industry.

"When we, the taxpayers, invest in these great exploration missions, we create technologies that build new commercial markets, which is very much how the airplane was born," Dunbar said.

The U.S. Army intervened when the Wright brothers were unable to sell their airplane to investors whom considered the invention too dangerous. During the World Wars, the U.S. Department of Defense expanded the technology and ultimately established the U.S. Air Force. The fleet of warplanes evolved into passenger airplanes that hatched the commercial airline industry.

"So we have a commercial airline industry now because of a partnership," Dunbar said. "Everyone at NASA wants to see the commercial aerospace industry succeed."

Locally, partners collaborating to build a robust commercial aerospace industry include the Houston Airport System, NASA, the University of Houston and more than 80 commercial aerospace companies, among other organizations. Their objective is to make Houston an epicenter for space research and exploration, much like California's Silicon Valley is for high-tech innovation.

In 2013, the Houston Airport System awarded XArc Exploration Architecture Corporation a contract to study economic viability for a spaceport at Ellington Airport, which is located near NASA's Johnson Space Center. Sam Xiemenes, the owner of the company and an alumnus of the UH space architecture program, enlisted the help of his alma mater and then-space-architecture-student Nejc Trost, who has since graduated. They found that a launch site for government and commercial spacecraft and a campus for academic learning, research, development and manufacturing would enhance Houston's already strong space infrastructure.

"Our space architecture program encourages people to enlarge their perspectives," said Professor Larry Bell, space architecture program founder and commercial aerospace industry entrepreneur. "They can dream a bit and recognize that dreams can lead to tangible achievements."

Around the world, NASA already develops high-risk technologies for commercial aerospace companies. SpaceX, for example, signed Space Act Agreements to work with NASA engineers on human life support systems, Dunbar said.

"It's difficult to put people into a Zero Gravity space environment," Dunbar said. "NASA mitigates the risks for the commercial sector."

Under contract with NASA, SpaceX's Dragon spacecraft has flown several resupply missions to the International Space Station in low Earth orbit, and SpaceX's Falcon 9 spacecraft has delivered DSCOVR, a U.S. space weather research and Earth observation satellite, to deep space.

Future SpaceX missions are already planned in collaboration with NASA, the U.S. Air Force and other agencies to make deliveries to the space station, to test engineering systems and to launch full-size and small satellites into space.

UH STUDENTS MAKE STRIDES IN SPACE

UH aerospace engineering and space architecture students are uniquely positioned to help advance exploration at an exciting time in space history.

"We're learning increasingly what we don't know at a faster rate than what we do know," Dunbar said. "This is not an end point we're going to find in our lifetimes."

NASA partners with several universities on development of small satellite, or CubeSat, technologies ranging from manufacturing and communications to propulsion and navigation. However, UH engineering students have the unique opportunity to conduct their research 25 miles up the road from NASA's Johnson Space Center.

"It's a natural partnership with NASA, and we encourage our students to interact with our sponsor," said David Jackson, professor of electrical and computer engineering at the Cullen College.

In 2013, a team of UH students developed award-winning CubeSat antenna technology, which led to a NASA grant to continue their research. The students tested their antenna technology in the UH Small Satellite Research Laboratory, and they verified its performance in NASA facilities.

"NASA sponsors were involved in the winning research, and their feedback about our students was topnotch," Jackson said.

Steve Provence, NASA engineer and adjunct professor of electrical and computer engineering at the Cullen College, works with UH and other university students to develop CubeSat technologies. He eagerly anticipates missions beyond low Earth orbit within the next decade.

"We're going to send these small satellites into the cosmos," Provence said. "We'll send them to asteroids, comets and perfect points in space with balanced gravity."

NASA's Orion spacecraft is scheduled to make its first unmanned mission around the Moon in two years, followed by manned missions, Provence said. The exploration vehicle is designed to eventually take humankind farther into space than they have ever traveled.

"Orion will take us not only to the International Space Station, but also to the Moon and Mars," Provence said. "So we are on the cusp of great exploration beyond low Earth orbit with CubeSats and manned spacecraft."

DID YOU KNOW?

NASA provides almost 19,000 jobs, generates $5 billion in revenue and reduces costs by $18.6 billion, according to the 2015 NASA Spinoff publication. The administration accounts for one-half of one percent of the federal budget, which translates to $18 billion for both robotic and manned space missions as well as aeronautics research.

"This amounts to about a penny per person, per year," said professor and former NASA astronaut Bonnie J. Dunbar who serves as director of the Cullen College graduate aerospace engineering and space architecture programs. "So it's about choices and priorities."

THE 2015 U.S. FEDERAL BUDGET PROVIDED NASA WITH $18 BILLION.

BY COMPARISON...

Americans spent **$65.8 BILLION** on alcoholic beverages in 2014.

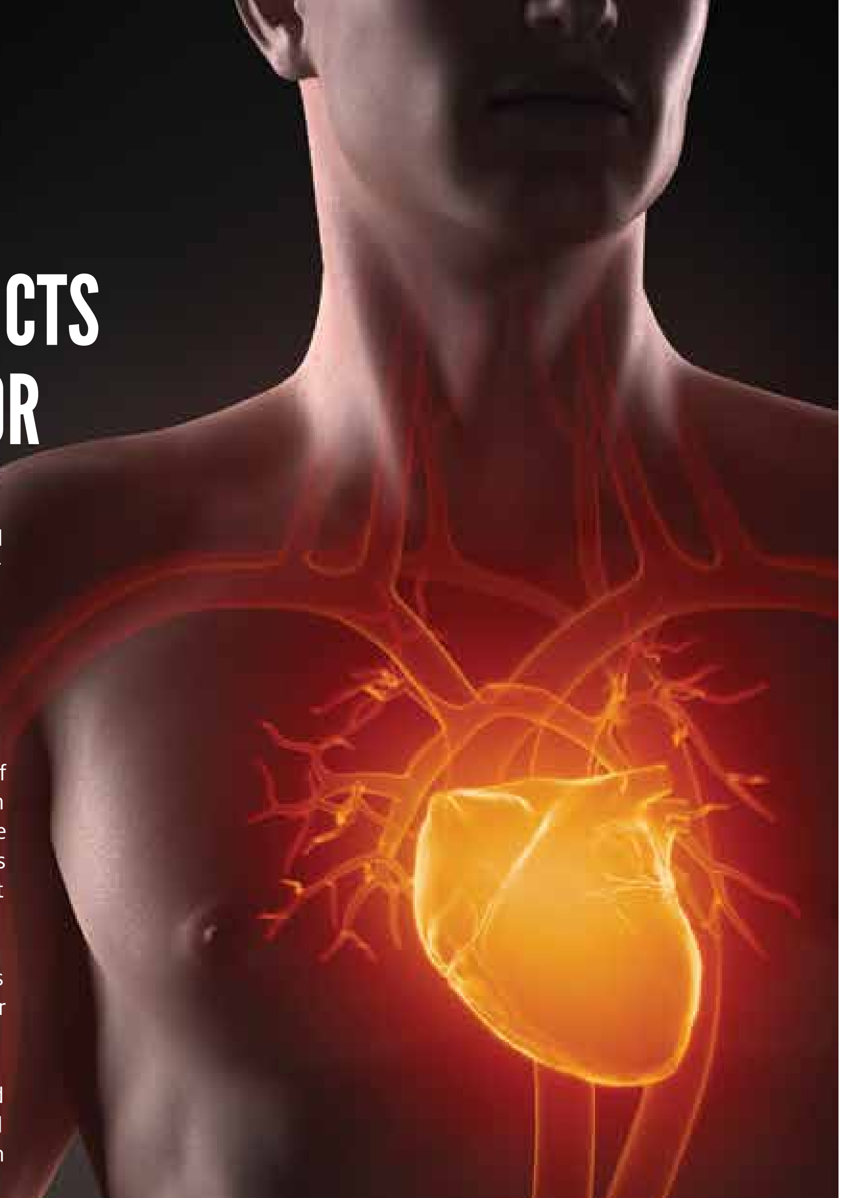
Americans spent **$50 BILLION** in hair and nail salons in 2014.

Americans are forecasted to spend **$60.6 BILLION** on cosmetics in 2015.

Filmed entertainment revenue in the U.S. is expected to reach **$32.7 BILLION** in 2015.

Americans spent **$22 BILLION** at golf courses and country clubs in 2014.

Courtesy of Statista.com



PRESTIGIOUS SOCIETY INDUCTS UH ENGINEERING PROFESSOR

Since 1955, the international society for optics and photonics, SPIE, has inducted fellows each year to recognize their significant scientific and technical contributions to optics, photonics and imaging fields as well as service to the society and to the greater scientific community.

Kirill Larin, associate professor and director of the biomedical engineering graduate program at the UH Cullen College of Engineering, was one of the 2015 SPIE Fellows added to the prestigious membership roster. Of the SPIE's 256,000 members, just over 1,000 have been named fellows since 1955.

"Kirill Larin was selected on the basis of achievement for his contributions to biophotonics in optical imaging," said Brent Johnson, SPIE coordinator for the fellows program.

Larin's most recent research projects include the noninvasive functional and structural imaging of mammalian embryonic development using optical coherence tomography and the noninvasive study of tissue elasticity with optical coherence elatography.

"We are the first to be able to directly image cardiovascular system formation in live mammalian embryos with high resolution," Larin said. "And the optical elastography is an emerging field which can assess tissue mechanical properties at depths typically exceeding the imaging depth."

Both projects involve the development of innovative imaging processes through novel applications of light. One study involves early cardiovascular system developmental processes in mice embryos. The most prevalent type of congenital birth defect, which is also the leading cause of birth defect-related death, is abnormality in growth and development of the cardiovascular system, Larin said. The technology also allows for the assessment of the effects of alcohol and tobacco smoke on congenital diseases.

Human hearts form and begin to beat before researchers can safely use clinical ultrasound imaging to view them. Hearts in mice measure half a millimeter when they begin to beat, and Optical Coherence Tomography offers advantages of spatial resolution and sensitivity with millimeters of depth penetration, Larin said.

"Despite numerous developments in mouse genomics during the last decade that have identified genes that influence cardiovascular development and disease, better tools are needed for earlier detection of defects that lead to cardiac failure and long-term disorders," Larin said.

Another of Larin's research projects delves into new noninvasive ways to observe and assess biomechanical properties of tissues that comprise human organs such as hearts, brains and eyes. His goal is to develop a technique to quantitatively measure tissue elasticity, which is not ascertainable through touch.

"Previous attempts to measure tissue elasticity, compressibility and shear forces in vivo have met with limited success and little agreement," Larin said. "Successful in vivo measurements of the biomechanical properties of different tissues could lead to significant scientific and clinical breakthroughs in our understanding of disease development and progression, and the impact of clinical treatments."

Outside the lab, Larin has chaired three SPIE conferences each year for six years. The international events are taking place in San Francisco and Russia this year.

"It's knowledge that attracts all of us," Larin said of his inspiration to pursue engineering. "My research has a heavy medical focus, and most of my grants come from the National Institutes of Health."

Larin studied physics and math in Russia before he earned his master's degree in cell biology and biophysics as well as his doctoral degree in biomedical engineering from the University of Texas-Medical Branch. He has been a member of the faculty at the University of Houston for 10 years.

"It's an honor to be a SPIE Fellow," Larin said. "It enables me to participate in decision-making activities that can affect policy changes in my field."

PROFESSOR WINS IEEE TECHNICAL FIELD AWARD

Don Wilton, professor emeritus of electrical and computer engineering, has been named the recipient of the 2015 Technical Field Award in Electromagnetics from the Institute of Electrical and Electronics Engineers (IEEE). Only 35 technical field awards are given by the IEEE each year. Wilton was named a winner for his outstanding and fundamental contributions to integral equation methods in computational electromagnetics.

Wilton received a bronze medal and certificate, and he made arrangements to donate the associated honorarium to the fund created at his retirement, which will provide travel support for UH graduate electromagnetic students to attend professional meetings.

Wilton earned his B.S., M.S., and Ph.D. degrees from the University of Illinois at Urbana-Champaign in 1964, 1966 and 1970, respectively. Wilton joined the UH Cullen College of Engineering in 1983 as a professor of electrical engineering, a position he held for the duration of his tenure at UH. From 1965 to 1968, he worked for Hughes Aircraft Company, engaged in analysis and design of phased array antennas, and from 1970 to 1983, he was a faculty member in the department of electrical engineering at the University of Mississippi.

Wilton is well 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.

Wilton's research on computational electromagnetics established a number of important fundamentals for the entire field, including methods for modeling wires, cylinders and bodies of revolution. 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 is a life fellow of the IEEE and received the IEEE Third Millennium Medal in 1999. He has served the IEEE Antennas and Propagation Society as an associate editor of the *Transactions on Antennas and Propagation*, as a distinguished national lecturer, and as a member of its administrative committee. He received the society's 2014 Harrington-Mittra Award in Computational Electromagnetics. Wilton is also a fellow of the Electromagnetics Academy and a member of Commission B of the International Radio Science Union (URSI). He has held various offices in URSI, including chair of U. S. Commission B. He is also a member of the Applied Computational Electromagnetics Society (ACES) and received that society's 2013 Computational Electromagnetics Award.

TWO PROFESSORS WIN GRANTS FROM UH'S NEW FACULTY RESEARCH PROGRAM

Julius Marpaung and **Jung-Uk Lim,** both instructional faculty members in the Cullen College's electrical and computer engineering department, have won awards through the University of Houston's New Faculty Research Program. Marpaung and Lim both received $6,000, the maximum amount a researcher can be awarded through the program.

The New Faculty Research Program is administered through UH's Division of Research. The purpose of the program is to assist faculty who wish to initiate research for the first time and who have not had previous internal or external support. The program represents part of the University of Houston's effort to support research and scholarly activity that constitute an integral part of the University's instructional program.

ACCOLADES

- **Dan Luss** (ChBE) celebrated his 30th anniversary as a member of the prestigious National Academy of Engineering (NAE). Luss was named a member of the NAE in 1984.
- **Vincent Donnelly** (ChBE) received the Fluor Corporation Faculty Excellence Award from the Cullen College of Engineering.
- **Gangbing Song** (ME) received the W.T. Kittinger Teaching Excellence Award from the Cullen College of Engineering.
- **John Glover** (ECE) received the Career Teaching Award from the Cullen College of Engineering.
- **Lars Grabow** (ChBE) received a Teaching Excellence Award from the Cullen College of Engineering.
- **Mo Li** (CEE) received a Teaching Excellence Award from the Cullen College of Engineering.
- **Fritz Claydon** (ECE) received a Teaching Excellence Award from the Cullen College of Engineering.
- **Eylem Tekin** (IE) received a Teaching Excellence Award from the Cullen College of Engineering.
- **Marvin Karson** (Lecturer) (IE) received a Teaching Excellence Award from the Cullen College of Engineering.
- **Dan Burleson** (TA) (CEE) received a Teaching Excellence Award from the Cullen College of Engineering.
- **Anitra Sur** (TA) (ME) received a Teaching Excellence Award from the Cullen College of Engineering.
- **Navin Varadarajan** (ChBE) received the Junior Faculty Research Award from the Cullen College of Engineering.
- **Mina Dawood** (CEE) received the Junior Faculty Research Award from the Cullen College of Engineering.
- **Yashashree Kulkarni** (ME) received the Junior Faculty Research Award from the Cullen College of Engineering.

PETROLEUM ENGINEERING PROFESSOR WINS SPE INNOVATIVE TEACHING AWARD

Christine Ehlig-Economides, William C. Miller Endowed Chair Professor of petroleum engineering, was a winner of the 2014 Society of Petroleum Engineers (SPE) Faculty Innovative Teaching Award. The award recognizes petroleum engineering faculty members who have demonstrated innovative teaching techniques in order to encourage and equip others in academia to use similar teaching methods.

Ehlig-Economides began her second stint at the University of Houston Cullen College of Engineering after serving as a petroleum engineering professor at Texas A&M University for over a decade. Prior to that, she spent 20 years traveling the world as an engineer for Schlumberger. Ehlig-Economides said the decades of industry experience under her belt helped to prepare her for the next chapter of her career as a petroleum engineering educator.

The course that won Ehlig-Economides the SPE award was titled "Energy Resources, Their Utilization and Importance to Society," and was available as an elective course during her tenure at Texas A&M. The class was open to all students at the university – not just engineers or other STEM majors.

"Good citizens should understand energy," Ehlig-Economides said. "So that's how it got started."

The overarching goal of the class was to enable non-engineers to understand the basic fundamentals about energy resources, how they are produced, how to use them with minimal adverse impact to the environment, and their local and global importance to society, Ehlig-Economides said.

Content included in the course was strongly influenced by the university's proximity to the city of Houston, the energy capital of the world, she added.

"Look at the benefit to society," she said. "If we're teaching lawyers, teachers, doctors, and other future Aggies that are not necessarily engineers – individuals who may be making laws and influencing our communities – then we are providing a beneficial service to our city."

The course consisted of a standard lecture-driven class and a discussion-oriented recitation laboratory led by undergraduate peer instructors who had previously completed the course. This method of employing undergraduate students to help engage their peers in discussions proved to be particularly effective, Ehlig-Economides said.

"That is definitely something I want to carry over to my courses here at the University of Houston."

Another innovative and effective tool for engaging students in the learning process was implementing student-generated quizzes in the course, she said.

"If the students were thinking about a good question to ask while I was teaching, then that means they're actually engaged," she said. "This is a teaching method that I'm currently using in my classes at UH."

She also asked students to form a team on the first recitation day and come up with a preliminary plan for developing and marketing an energy-related product or service. The student teams were required to deliver elevator speeches to market their project ideas to experienced project managers.

"I felt really good when they did their projects at the end and presented them to their peers," Ehlig-Economides said. "When their peers started questioning them and they were answering their questions, it was clear they had knowledge and background on the topic and were standing their ground and defending what they've done using energy and engineering language – then I'm thinking, 'Yep, that's what I'm trying to accomplish.'"

Ehlig-Economides also involved the students in the development of an electronic textbook about energy that was funded by the National Science Foundation (NSF), working with collaborators at Pennsylvania State University, Stanford University, the University of Massachusetts Lowell and the University of California at Long Beach.

Ehlig-Economides designed the iBook specifically for her innovative energy course.

The iBook, titled "LiveEnergy," was also inspired by the notion that high-level energy concepts aren't just for engineers or STEM workers. Rather, all citizens can benefit from understanding energy resources, their utilization and their impact on society. Moreover, by involving individuals from a variety of different disciplines and backgrounds in energy discussions, the entire energy community can benefit.

"Traditionally, very few engineering courses are offered to non-engineers, but this was an exception," Ehlig-Economides said. "This course was inspired by the conviction that sustainable energy solutions must involve all disciplines, not just engineering."

To access and learn more about "Live Energy," please visit: http://live-energy-project.com/.

PROFESSOR HONORED FOR WORK IN NANOMATERIALS

Debora Rodrigues, assistant professor of civil and environmental engineering at the University of Houston, received the Emerging Investigator award from the Sustainable Nanotechnology Organization (SNO).

Rodrigues has worked with nanomaterials since arriving at UH in 2010, using the technology to develop new methods for water purification and treatment. In addition to her research, she was recognized for her work with students and her outreach to other educators.

This was the first year the award was given. Vicki Grassian, editor-in-chief of the journal *Environmental Science*, said Rodrigues was selected for her pioneering and outstanding contributions to the field of sustainable nanotechnology, including nanotoxicology and applications of nanotechnology in water remediation.

The award was announced at the conclusion of a SNO conference in Boston last November.

Rodrigues said she wasn't expecting the honor, but it wasn't her first. She received a National Science Foundation (NSF) CAREER Award in 2011. That award, worth up to $450,000 over a five-year period, is given to promising junior faculty to help launch successful careers in research and education.

By then, Rodrigues was serving as co-principal investigator on another NSF grant aimed at offering middle and high school teachers an opportunity to spend their summers assisting in nanotechnology-related research projects conducted by faculty in UH's Cullen College of Engineering. This project received the U.S. President's Community Service Award in 2013. She also has mentored high school students to encourage them to enter engineering or other science fields.

Her twin passions for education and research also came together this spring when a team of UH entrepreneurship students developed a business plan based on Rodrigues' technology – nanocomposite coating used for water purification that is capable of removing heavy metals, radioactive materials and micro-organisms. The students took their plan to competitions around the country and won several honors before they decided to form a startup business.

Rodrigues now serves as an advisor to the company, WAVVE, while continuing her research.

She said the Emerging Investigator award, which included a cash award and a plaque, isn't just about her.

"It is for my whole research group," she said. "It means we are making a difference. We are getting recognized."

PROFESSOR PUBLISHES PAPER ON POLYMERS WITH HIGH THERMAL CONDUCTIVITY

Expensive and weighty metals play crucial roles in heat transfer applications because of their high thermal conductivity. For example, cases for cellular phones and some other electronics are made of metal rather than inexpensive materials with lower thermal conductivity because the metal is necessary to dissipate induced internal heat. Similarly, seawater desalination treatments use expensive titanium heat exchangers rather than exchangers made of more economical metals because titanium withstands corrosive characteristics of saltwater.

Until recently, polymers, which are cost-effective, lightweight and corrosion-resistant materials, were not alternatives to metals in heat transfer applications because their thermal conductivity was too low. A few years ago, a group of MIT researchers developed nanofibers of polyethylene with thermal conductivity of 100 watts per meter kelvin. This value of thermal conductivity is higher than the values for half of the metals. However, sheets of the polyethylene were needed to implement the material for practical applications.

An engineering professor at the University of Houston and his collaborators at MIT have since developed a method for large-scale production of the high thermal conductivity polyethylene.

Hadi Ghasemi, assistant professor of mechanical engineering at the UH Cullen College of Engineering, published a paper in the journal, *Technology*, about a process for continuous fabrication of highly aligned polyethylene sheets with high thermal conductivity.

"Replacing titanium heat exchangers with polyethylene heat exchangers will have a significant impact in cost reduction of desalination," Ghasemi said. "Also, this new material will lead to lighter and more cost-effective electronics."

Polymers contain the same types of molecular chains, or carbon-carbon bonds, as graphene and graphite, which are materials with high thermal conductivity. However, misalignment of the bonds in bulk polymers scatters the heat carriers resulting in reduced thermal conductivity. The team of researchers discovered that realignment of the bonds in the direction of heat flux produced high values of thermal conductivity.

The newly developed process includes three-steps: sol-gel preparation, extrusion and drawing. The developed platform accomplishes the steps automatically and fabricates polyethylene sheets with thermal conductivity of more than 30 W/(mK).

Polyethylene, which accounts for approximately 50 percent of the polymer industry, is already used widely in applications ranging from chemical to biotechnological. The new platform opens a window for use of polyethylene in heat transfer applications with advantages including lower cost, lighter weight and higher energy efficiency during manufacturing than metals, Ghasemi said.

UH ENGINEER NAMED TO NATIONAL ACADEMY OF INVENTORS

Richard Willson, Huffington-Woestemeyer Professor of chemical and biomolecular engineering, has been named a fellow of the National Academy of Inventors for his contributions to scientific and technological innovation.

Willson was among 170 people elected as National Academy of Inventors (NAI) Fellows, representing 114 universities and governmental and nonprofit research institutes. With the new fellows, membership in the NAI has grown to 414, including 21 Nobel Laureates. The new fellows were inducted last March during the annual conference of the National Academy of Inventors at the California Institute of Technology.

Those elected to the rank of NAI Fellow are inventors on U.S. patents, nominated by their peers for outstanding contributions to innovation in areas such as patents and licensing, innovative discovery and technology, significant impact on society and the support and enhancement of innovation.

Willson, who also has an appointment as a professor of biochemical and biophysical sciences in the UH College of Natural Sciences and Mathematics, studies nanotechnology and biomolecular technologies in medical diagnostics in an effort to recognize diseases at earlier stages, when treatments are more effective.

He has been issued 16 U.S. patents since joining the UH faculty with another 13 patents pending, according to the University. He said his total number of patents, including pending foreign patents, is about 80.

Willson's NAI recognition was based on his body of work. One innovation highlighted was his co-invention of the first technology for single-molecule DNA sequencing, which led to a UH spinoff company, VisiGen Biotechnologies, headed by Susan Hardin. Several other UH faculty members were also involved in the company, which was acquired by Life Technologies in 2008. Willson was chief technology officer.

In all, he has been involved with five startup companies, either directly or as an adviser.

While much of Willson's work has focused on biotech, he also is well known as the sole inventor of a catalyst testing process that allows for the rapid testing of multiple chemical reactions at once. Although that work was done in the 1990s, the technology continues to be used by most major chemical companies. The core patent has been referenced by 105 other U.S. patents and has led to at least 10 active U.S. patents and a large number of foreign counterparts.

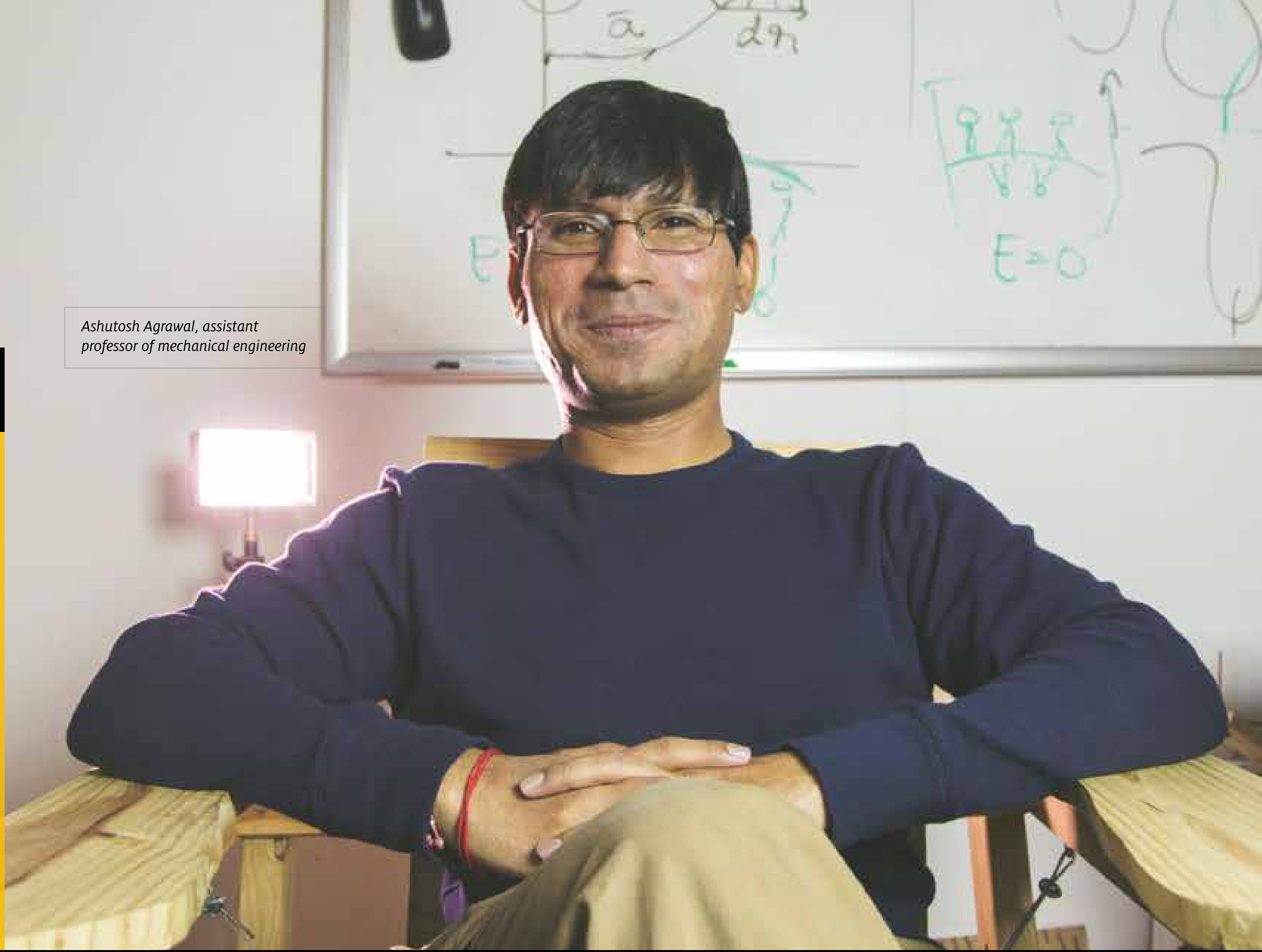
Willson is a fellow of several other prestigious professional societies, including the American Association for the Advancement of Science, the American Chemical Society and the American Institute of Medical and Biological Engineering, but he said election to the National Academy of Inventors is a special honor, in part because both his father and his son are patent attorneys. The NAI also remains a fairly small group, he added.

"Some people in the academy are my personal heroes," he said.

Previously inducted fellows from the UH Cullen College of Engineering include: Benton Baugh, adjunct professor of mechanical engineering; Paul Chu, chief scientist of the Texas Center for Superconductivity at UH; Dan Luss, Cullen Professor of chemical and biomolecular engineering; Dmitri Litvinov, dean of the Graduate School and John and Rebecca Moores Professor of electrical and computer engineering; Zhifeng Ren, principal investigator at the Texas Center for Superconductivity; and Venkat Selvamanickam, M.D. Anderson Chair Professor of mechanical engineering and director of the Texas Center for Superconductivity's Applied Research Hub.

FACULTY SPOTLIGHT

ASHUTOSH AGRAWAL Q&A



Ashutosh Agrawal, assistant professor of mechanical engineering

WHAT IS YOUR TEACHING PHILOSOPHY?
I try to make sure the students understand the fundamentals in a way that it is fun. I don't want it to be a boring experience, because [the subject] isn't. If you look around, engineering has contributed to everything that we see in our lives. Therefore, we have numerous demonstrations all around us that can be used to communicate different physical concepts.

HOW WAS THE ADJUSTMENT FROM LIFE IN INDIA TO LIFE IN THE UNITED STATES?
One of the culture shocks I had was my first lunch at Rice University. We'd just landed in Houston, and we were served something wrapped in aluminum foil. We did not know what it was, we were all clueless. We opened it up and it was a big baked potato, and we didn't know what to do with it. In India, we eat potatoes, but not just a baked plain potato. We eat it cut up and covered in spices. It was the first culture shock I had: my first baked potato. Barring this trivial point, the transition was a valuable learning experience. The professional work environment, and interactions with people from diverse countries and cultural backgrounds gave new perspectives in life.

WHAT HAVE YOU FOUND TO BE THE MOST EFFECTIVE METHOD OF TEACHING?
Personally, I prefer complementing theory with videos and demonstrations to explain the fundamentals and develop intuition. For teaching theory, I heavily rely on the whiteboard.

WHAT INSPIRED YOU TO PURSUE ACADEMIA?
I found inspiration in graduate school. Prior to that, I feel that I was just following the path that many other children in India are encouraged to follow: to either become a doctor or engineer. But after moving to Berkeley [in California] for graduate school, I worked with a professor and I saw the excitement in him about research, and that was infectious. I started enjoying research. The notion of finding something new and creating something new excited me. I also started enjoying my experience as a teaching assistant. While working towards your Ph.D., you have highs and lows, and the teaching experience is what made me happy every week. I found it truly rewarding to interact with the students and see them understand what I was explaining – this motivated me to further continue this route to academia.

WHAT DO YOU DO FOR FUN?
I have a hobby of doing interior decoration. I spend my time creating different art pieces for my house, or something in the backyard. One of the most recent pieces is a modification of the kitchen light. I used some recycled material to create a design on the light.

WHAT'S YOUR FAVORITE PART OF YOUR WORK DAY?
Brainstorming to get down to the bottom of a scientific mystery. Going to a café, sitting outside and just thinking about a problem. I find that the most gratifying.

WHAT ADVICE AND ENCOURAGEMENT DO YOU GIVE TO YOUR STUDENTS?
I think the students here know what they want to do. I tell them that they should be aware of the opportunities out there in Houston. There are more opportunities than they think there are. The basic notion is that there is the oil industry, and the companies that support the oil industry. But we also have the world's largest medical center. We can help in creating the future technology for health sciences. I advise students to have a broader frame of mind with respect to career options. They should be daring. It's simply remarkable what they can do, what they can create. And that's what engineering is about. They shouldn't just go to companies and work for companies; they should start their own companies. Engineering students at the University of Houston have the potential, they can think outside the box.

JOURNAL FEATURES PROFESSOR AND PH.D. STUDENT'S HEART MUSCLE RESEARCH ON COVER

Researchers at the Cullen College's biomedical engineering Artificial Heart Laboratory (AHL) recently accomplished a feat valued by artificial organ researchers around the world. Their revolutionary work on regenerating 3-D heart muscle was chosen for publication in the January/February issue of the *American Society for Artificial Internal Organs* (ASAIO) journal, and their illustrations were selected to serve as the journal's cover art.

Ravi Birla, associate professor of biomedical engineering, and his doctoral student **Nikita Patel** are developing a 3-D cardiac patch that can repair, replace and augment lost ventricular function in heart attack patients. The article on their significant milestone in the field of tissue fabrication is titled "Engineering 3D Bio-Artificial Heart Muscle: The Acellular Ventricular Extracellular Matrix Model."

"It's a focus on heart failure," Patel explained. "What happens when the heart fails is that some of the tissue dies in one specific section [the left ventricular muscle], so what they do to try and fix it is either use heavy pumps, so there will be a lot of pipes and mechanical parts, or they can't do anything because the tissue is completely dead."

Once heart tissue dies, it is dead forever.

Birla's study focuses on the development of a novel model to bioengineer 3-D heart muscle. His toolbox of tissue and organ models includes 3-D heart muscle, blood vessels, tri-leaflet heart valves, tissue engineered heart pumps, bioartificial ventricles and total artificial hearts.

The patch is designed either to cover dead tissue or to replace dead tissue entirely. Once in place, the healthy cardiac cells around the patch begin to regenerate and produce new cardiac tissue to replace the dead, failing tissue.

The patch is a smaller and far less invasive treatment of chronic heart failure than the current method, which uses a left ventricular assist device (LVAD). LVADs assist the left ventricular muscle with pumping blood into the aorta, but they are bulky and highly invasive. Pumps and power sources are located outside the body, and tubes connect the pumps to the heart through holes in the abdomen. While patients using an LVAD are able to remain mobile, their quality of life is greatly impacted after implantation.

The novelty of this heart muscle model is the utilization of acellular scaffolds to support tissue fabrication, Birla said. To fabricate the acellular scaffolds, whole heart explants were obtained from adult rats. The tissue was essentially scrubbed clean of its current cells to create an acellular total organ.

"It's like having a sponge with nothing on it," Patel said.

The excised ventricles were repopulated with neonatal cardiac cells isolated from neonatal rat hearts.

"We were wondering if we could get it to beat and function by itself," Patel said. "And once we put the [neonatal] cells on it and cultured it, that's exactly what we saw – it's able to beat by itself as a normal heart muscle would."

In fact, observable muscle contractions, which began as arrhythmic but became more synchronized and steady, occurred on the tissue within 48 to 72 hours of cell loading.

In the future, this research could allow doctors to implant a patch with healthy cells harvested from a donor heart to regenerate new, healthy heart tissue that would replace dying tissue.

Access the January/February 2015 issue ASAIO at: http://journals.lww.com/asaiojournal/.

PH.D. STUDENT WINS POSTER AWARD AT GRAVITATIONAL AND SPACE RESEARCH MEETING

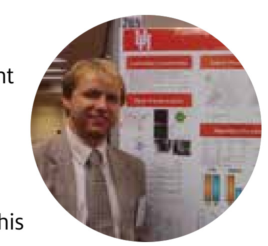
A chemical and biomolecular engineering Ph.D. student from the UH Cullen College of Engineering was awarded best poster at the 2014 annual meeting of the American Society for Gravitational and Space Research in Pasadena, Calif.

Maria Vorontsova's poster was titled "Coulomb-independent aggregation in protein solutions." Her poster demonstrated that the electrostatics are not the principal force in clustering mechanisms and that to control cluster populations, the water structuring and hydrophobic interactions need to be tuned.

"Presenting at the annual meeting was a great opportunity for me to meet professors and students from diverse research areas and share our experience towards solving major scientific questions," Vorontsova said.

Vorontsova is a member of Peter Vekilov's research group. Vekilov, a professor of chemical and biomolecular engineering, researches the nucleation precursors of protein crystals, protein-rich liquid clusters.

AICHE AWARDS BEST POSTER TO CHEMICAL ENGINEERING PH.D.



Matt Oleksiak is a talented Ph.D. student in the Cullen College of Engineering's chemical engineering department, performing highly technical research on zeolite catalysis. But he has another skill that's gaining attention: explaining his research through posters.

Oleksiak recently received the best poster award at the American Institute of Chemical Engineers (AIChE) Meeting in the category of Catalysis and Reaction Engineering. His poster was entitled "Synthesis of Zeolite Catalysts in the Absence of Organic Structure Directing Agents."

"It was exciting to have the opportunity to present my work to experts on what I do and being chosen to receive the poster award was exhilarating," he said. He said the AIChE conference was a "wonderful experience."

"I was exposed to many intellectually stimulating concepts and was able to exchange ideas with some of the brightest minds in our field," he said. More impressive, it's not Oleksiak's first poster award. Just last spring, he received top honors at the Southwest Catalysis Society's meeting for his poster, "Controlling Crystal Polymorphism in Organice-Free Synthesis of Zeolites."

STUDENT'S POSTER RECEIVES HONORS AT GORDON RESEARCH CONFERENCE

Last year, a professor and student in the Cullen College's chemical engineering department published an article in the journal *Science* that revealed the secrets behind gold's unexpected oxidation activity.

Hieu Doan, the chemical engineering Ph.D. student who was a co-author on the *Science* paper, recently gave an oral presentation about this research at the prestigious Gordon Research Conference (GRC). Out of the over 100 research posters accepted into the conference, Doan's poster was one of only five that was selected by the GRC organizers to be presented to the conference attendees.

"I felt very honored that my poster was chosen and I was able to present our research at the conference," said Doan.

The Gordon Research Conferences take place every two years, bringing together scientists from around the world to exchange ideas and present research on the biological, chemical and physical sciences. This year's conference on the topic of "Chemical Reactions at Surfaces" was held in Ventura, Calif.

"The Gordon Research Conference is a bit more selective than many other research conferences, in that you must submit your research and an application to be considered to attend the conference," said Lars Grabow, assistant professor of chemical engineering at the Cullen College. Grabow is Doan's faculty advisor and was a co-author on the *Science* article on which Doan's award-winning GRC poster was based.

"I was so proud to see his poster get chosen for this honor and to witness Hieu do such an excellent job at explaining the research to an expert audience," Grabow added. "Hieu's poster even beat the one that I entered into the conference!"

Doan's poster outlined research he conducted alongside Grabow, which was focused on determining why gold, one of the least reactive of all metals, performs so well as a catalyst when oxidizing carbon monoxide (CO) into carbon dioxide (CO_2). The collaborators on this project were Bert Chandler, Johnny Saavedra, and Christopher Pursell at Trinity University in San Antonio.

Together, the team discovered that the reason for gold's unexpected oxidation is water.

Although people have been experimenting with CO oxidation using gold catalysts for nearly 30 years and many researchers have reported that water can change the reaction kinetics quite drastically, Grabow noted that until now no research has ever reported the exact mechanism that his group identified in their *Science* article.

"I did notice that several other researchers at the GRC were presenting work on the role of water in other chemical reactions, so it seems that our research has laid out the groundwork for other groups to build upon," Grabow said.

Doan is currently in his final year as a chemical engineering doctoral student at the University of Houston. After graduation, Doan plans on pursuing a career in the oil and gas industry. "I think I will miss doing research with Dr. Grabow," Doan said. "But I am looking forward to my future experience in the industry."

CIVIL ENGINEERING PH.D. ATTENDS SIAM CONFERENCE IN COMPUTATIONAL SCIENCE AND ENGINEERING

Civil engineering doctoral student **Saeid Karimi** received a travel award from the Society of Industrial and Applied Mathematics (SIAM) to attend the 2015 SIAM Conference in Computational Science and Engineering (CSE15) held in Salt Lake City, Utah last March. The award included a registration fee waiver and cash award.

Karimi's advisor is civil engineering assistant professor Kalyana Babu Nakshatrala. Karimi delivered a talk and presented a poster for the student competition at the conference. The title of his talk was "Monolithic multi-time-step coupling methods for transient systems."

Under this research, funded by the National Science Foundation, robust numerical frameworks have been developed for problems involving multiple mathematical scales, which has been a subject of great interest in computational mathematics and engineering. A systematic theoretical study has also been performed on the proposed numerical formulations. The research work provides the much-needed accurate simulation tools for solving multi-scale and multi-physics problems like fluid-structure interaction (for example, blood flow in deformable arteries) and soil-structure interaction.

The research on a multi-time-step method for elastodynamics has been published in the *Journal of Computational Physics*, and the research on multi-time-step methods for advective-diffusive-reactive systems has appeared in *Computer Methods in Applied Mechanics and Engineering*.

"I was quite excited to receive the award," Karimi said. "Some of the past winners have become faculty members or scientists in national laboratories. It's one of the most important gatherings in my research area."

Learn more about CSE15 at http://www.siam.org/meetings/cse15/.

CHEMICAL ENGINEERING STUDENT WINS OVERSEAS POSTER CONTEST

One of the Cullen College of Engineering's chemical and biomolecular engineering students took the college's tradition of excellence overseas this summer, winning the Best Poster Award at the International Summer School in Denmark.

Graduate student **Sashank Kasiraju's** poster was entitled "Hydrodeoxygenation of furan vs. hydrodesulfurization of thiophene: A first principles investigation."

According to Lars Grabow, professor of chemical and biomolecular engineering and Kasiraju's advisor, the summer school is attended by students and postdoctoral researchers from "the best theoretical groups in the world," and the award is quite prestigious, particularly for early graduate students.

CIVIL ENGINEERING STUDENT DELIVERS AWARD-WINNING ELEVATOR PITCH

Jingjing Fan, a graduate student in the Cullen College's civil and environmental engineering department, delivered an award-winning elevator pitch at the Sustainable Nanotechnology Organization's (SNO) first ever Nano Pitch Contest.

The contest, which was held in Boston as part of the SNO's annual conference, challenged 16 graduate students hailing from universities across the country to deliver a 100-second pitch about their nano-related research. The contestants could only rely on a single slide to back-up their pitch.

Typical research pitches, also known as elevator talks, last about 2-3 minutes. For the Nano Pitch Contest, participants were limited to only 100 seconds because, as the SNO notes, "nothing is nano beyond 100nm."

Fan received a cash prize for her elevator pitch, which explained her research on antimicrobial activity of nanostructured molybdenum disulphide. Her advisor on this work is Debora Rodrigues, assistant professor of civil and environmental engineering at the the Cullen College and the winner of last year's Emerging Investigator award from the SNO.

AMERICAN SOCIETY OF INDIAN ENGINEERS RECOGNIZES STUDENTS WITH SCHOLARSHIPS

Last fall, the American Society of Indian Engineers (ASIE) took notice of several Cullen College of Engineering students and awarded their academic excellence with scholarships ranging from $1,000 to $5,000.

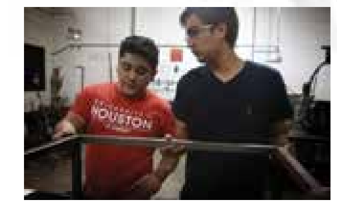
Mechanical engineering students Sonika Gahlawat, Abhilash Reddy and Himani Agrawal were just a few of the students honored by the ASIE at their banquet last November. Ken White, professor of mechanical engineering, also attended.

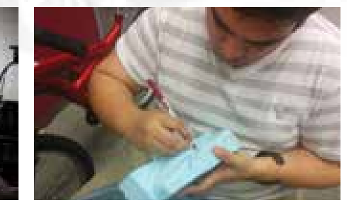
Gahlawat said her scholarship of $1,500 was the fourth scholarship she received this fall. White is her advisor. She said the scholarships are helpful financially because, due to visa limitations for international students, they often are unable to work off-campus. She said her scholarship would cover her semester fees.

Reddy's advisor is Hadi Ghasemi, assistant professor of mechanical engineering. Ghasemi said only 11 students in the Houston area are awarded an ASIE scholarship annually. Reddy and Ghasemi are currently working on development of a new platform for remote actuation of fluid flow with laser.

ENGINEERING STUDENTS REVVING UP FOR SHELL ECO-MARATHON

In the end, it's all about the cars. But for students from the University of Houston and Elsik High School, the path to the Shell Eco-Marathon Americas 2015 has offered much more – learning, mentoring and the opportunity to put classroom lessons into action.





Three UH students headed to Detroit last April for the Eco-Marathon – a competition sponsored by the energy company challenging students from around the world to design, build and drive the most energy efficient cars. Students from the Alief Independent School District (AISD) also competed, driving a car built with help from the UH students.

What started as a plan for UH students to mentor the high school students and share their work space has grown into a true partnership, as the high school students stepped up to provide welding, craftsmanship and other support.

"We knew it would be a big and complex project," said Robert Guerra, leader of the UH team, Red Octane. "We didn't expect the Alief students to play such a major role."

He and UH teammates Alberth Chavez and Giovani Guzman, all senior mechanical engineering students, entered the competition with a car using a compressed natural gas (CNG) engine. The AISD students' car has an engine using "gas-to-liquids" or GTL fuel. Shell will provide the fuel; they use diesel for testing.

Students from the Elsik High School's automotive technology, welding and aerospace engineering program, as well as from Hastings High School, are involved in the project, working as Team Blue Cetane. Both high schools are in AISD.

Ernest Lozano, the auto technology instructor at Elsik, said the students have used math and other academic skills in learning to read a blueprint as they build the car frames, fit the driver's seats and complete other details.

"They've had to apply geometry, physics, which they've never done before," he said. "I've had to step back and just be the tour guide. To watch them just blossom, it's what school ought to be like."

Guerra and his UH classmates built a prototype car for last year's Eco-Marathon – the competition had been held at Houston's Discovery Green for the past few years but moved to Detroit this year – and when he mentioned the project to his girlfriend's sister, who is a counselor at Elsik, she suggested it as an opportunity for students there. Elsik Principal Hilda Rodriguez agreed, as did Bill Marshall, director of career & technical education, and other district administrators.

Still, Guerra said he didn't expect the students to take such ownership. He said the UH students have functioned as true engineers – providing blueprints and working with the Alief students to offer direction, helping with the work when necessary.

And just as the work has given the Elsik students a real-world taste of what they are learning in the classroom, the UH students say the Eco-Marathon – which they are using as the senior project required of all engineering and engineering technology students – has brought their own classwork to life.

"We've learned all the fundamentals," Chavez said. "Now we're trying to prove them through building something."

Eco-Marathon rules limit each car to 500 pounds, although Raresh Pascali, instructional associate professor of engineering technology at UH, set the limit at 450 pounds to add an additional challenge. Chavez said the cars will probably average about 15 mph – top speed allowed is 25 mph – and the UH students are hoping to attain the equivalent of about 250 mpg with the CNG engine.

UH is one of only two teams entered in the CNG category, illustrating how tricky it remains to design and build a CNG engine. But winning in Detroit isn't the only goal.

"Whatever happens in Detroit is a bonus," said Lozano, noting that the high school team includes a sophomore and several junior students, building a foundation for the future.

Guerra is thinking of future Eco-Marathons, too, even though he will graduate from UH in May.

"One thing we want to do is make sure the high school students leave a legacy," he said. "We want to do all the training we can, to leave them with the tools to compete in future years."

Watch a video of UH engineering students mentoring high schoolers from Alief ISD at https://youtu.be/HVOshEoMfgU.

Photos and concept art courtesy of Team Red Octane (source: http://cot-mect4276.tech.uh.edu/~gguzman/ teamredoctane.weebly.com)

CULLEN COLLEGE NAMES 2015 OUTSTANDING STUDENTS

With over 3,000 undergraduate students enrolled at the UH Cullen College of Engineering, standing out from the crowd is no small feat. Each year, college faculty are charged with the difficult task of combing through throngs of bright, talented and motivated students and picking just a handful of front runners.

This year, college administrators named an outstanding junior and senior in each Cullen College department as well as one outstanding junior and senior overall. The 2014-2015 outstanding junior is civil engineering student **Seth Pedersen,** and the year's outstanding senior is **Tessy Lal** from biomedical engineering.

OUTSTANDING JUNIOR: SETH PEDERSEN

Although still a junior, Pedersen has completed more undergraduate research than the majority of his senior peers, and his primary research interest is one that impacts every corner of the globe: clean water.

Pedersen currently works in the laboratory of civil and environmental engineering professor Shankar Chellam. Under Chellam's guidance, Pederson is studying water purification processes in east Houston. He started his research endeavors with the Summer Undergraduate Research Fellowship (SURF) in 2013.

In addition to the hands-on experience he gained in Chellam's lab, Pedersen also worked at an engineering consulting firm last summer. Although Pedersen said he enjoyed his experience in private industry, he preferred his time in the laboratory more because it allowed him to delve "deeper into how things actually work," he said.

After working with water and sanitation research for a few years, Pedersen said the field has become a passion. "I see it as a big need in the world," he said. "It's also pretty cool to take disgusting water and turn it into something you can drink." He said he hopes to continue his research in graduate school and is considering a research career.

As for being named Outstanding Junior, Pedersen said the honor was unexpected. "I have classes with really great students, I was really surprised because there are so many great students in the college," he added.

He attributes his success to the balancing act of work and play. "Keeping the right balance between focusing on your studies and building the right relationships with people is important," he said. "You can be too social and not focus on your studies, but you can also be really isolated and miss out on another side of life." In his spare time, Pedersen said he loves music and plays bluegrass with his siblings.

OUTSTANDING SENIOR: TESSY LAL

Lal's educational journey at the University of Houston began long before her college years. As a sophomore in high school, she attended the Cullen College's annual G.R.A.D.E. (Girls Reaching and Demonstrating Excellence) Camp, where she experienced hands-on engineering for the first time.

"[G.R.A.D.E. Camp] really excited me about engineering and introduced me to some of the people here at UH. When I came back, I recognized those people and got to talk to them again. It was definitely a factor in my decision to come to UH," she said. "It helped me learn more about UH and the different engineering departments here. It's how I heard about biomedical engineering."

As she began her education in biomedical engineering, Lal said her interests quickly turned to brain-machine interface (BMI) technologies. She worked in Jose Luis "Pepe" Contreras-Vidal's BMI lab early in her college career, and said the technology fascinated her. "One of the things that really interested me from the time I heard about neuroengineering is the development of prosthetics for people who have lost control of their limbs, or even amputees to give them that range of motion back," she said.

After her sophomore year, she began volunteering at the Baylor College of Medicine's Laboratory for Addiction and Brain Imaging, where she helps with analyzing MRI images used to understand the connections in the brain associated with different addictions and disorders.

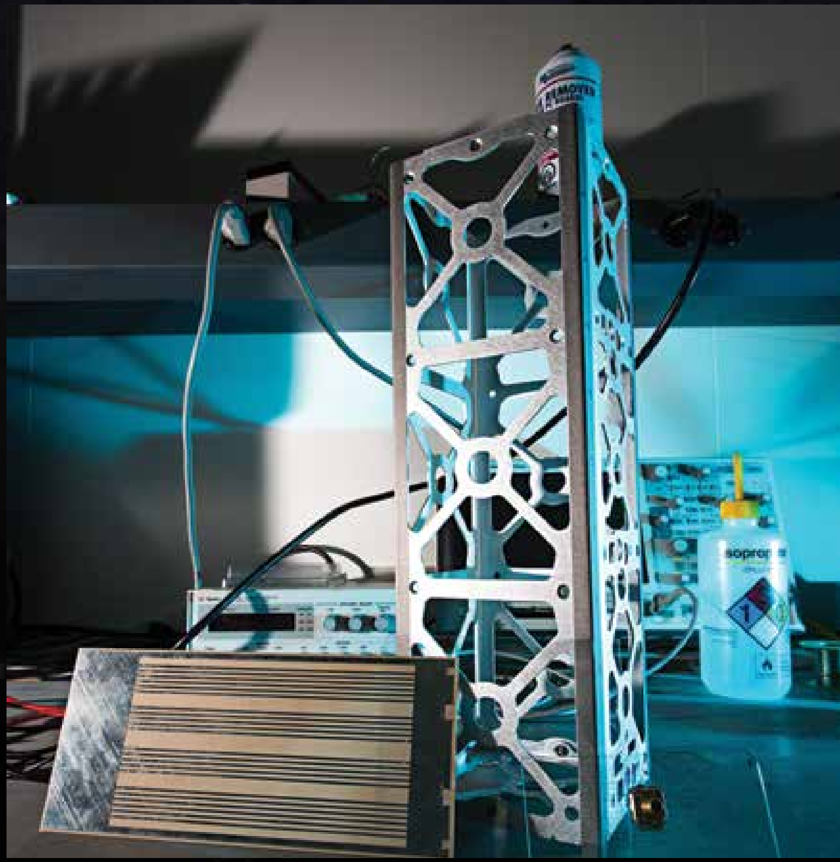
"I've learned so much about conducting research," she said of her time at Baylor. "I've learned just how important it is to follow procedure when you're analyzing, and it's taught me a lot of patience."

Lal says the hands-on experience has been instrumental in understanding engineering theories taught in the classroom. "Since it's engineering, you need practical experience. In addition to doing well in your classes, you have to get practical experience, whether it's research in a lab or an internship. Because once you get out of college, it's all about applying what you've learned." She is currently applying for various Ph.D. programs and hopes to work in biomedical research after completing her doctoral degree.

This year, Lal was also chosen to receive the Cynthia Oliver Coleman P.E. Women in Engineering Rising Star Award from the Cullen College of Engineering.

See below for the other outstanding students from the Cullen College of Engineering.

DEPARTMENT	OUTSTANDING SENIOR	OUTSTANDING JUNIOR
Biomedical Engineering	Tessy Lal	Marwa Kharboutli
Chemical Engineerig	Connor Fernandez	Evan Manuel
Civil Engineering	Ryan Byrd	Seth Pedersen
Computer Engineering	Daniel Romero	Don Nguyen
Electrical Engineering	Brian McNeil	Andrew Maicke
Industrial Engineering	An Trinh Vivian	Acero Ramirez
Mechanical Engineering	Borith Seng	Juan Carlos Martinez
Petroleum Engineering	Brandon Saavedra	Daniela Arciniegas Murillo



From left: Brian McNeil, Sean Strickland, Tori Speer-Manson and James Annis

STUDENT CUBESAT TEAM LAUNCHES INTO ORBIT

For the vast majority of mankind, outer space is just that: outside the realm of possibility. It's not something most people will ever have the opportunity to see, touch or even research.

But four students in the UH Cullen College of Engineering's electrical and computer engineering (ECE) department got the rare chance to be a part of space history when they joined forces with Texas A&M University last fall to complete design work for a satellite to be launched by NASA later this year. Their contribution to the satellite, called AggieSat4, is a visual data capture system (VDCS) used to take photos of the moment the satellite ejects a smaller satellite (known as a "CubeSat") into low Earth orbit.

The senior design team is made up of James Annis, Brian McNeil, Sean Strickland and Tori Speer-Manson. They work in the Cullen College's Small Satellite Laboratory under the direction of Steve Provence, a full-time NASA engineer and adjunct professor of electrical and computer engineering at the Cullen College.

The AggieSat group in College Station created the main satellite to serve the purpose of helping smaller CubeSats in low Earth orbit track one another's relative positions in space. In early 2014, the AggieSat lab mentioned to Provence that they could use some summer help, and he relayed the information to Annis and McNeil. After working on electrical and data subsystems over the summer, they teamed up with Strickland and Speer-Manson to complete the VDCS for their senior design project.

Satellites contain many subsystems, such as the power, solar cell and mission systems. The UH group is building the VDCS subsystem for AggieSat4 to take pictures of several events once the satellite is deployed from the bay of the International Space Station (ISS).

AggieSat4 will hitch a ride to the ISS with an upcoming Space-X flight. After ejection from the ISS, AggieSat4 will release a smaller CubeSat ("Bevo-2," created by an engineering team at the University of Texas), and the VDCS will take 20 seconds worth of images of Bevo-2 as it drifts away to relay feedback to researchers on Earth about what, if anything, goes wrong during ejection.

It may seem like a small part of a large mission, but the lack of a visual capture system in the last AggieSat launch in 2009 proved to be a major oversight. AggieSat2, a smaller but similar version of the current AggieSat4, was launched along with a second identical satellite called Bevo-1. AggieSat2 and Bevo-1 were to separate upon jettison from the space shuttle.

However, when the satellites deployed from the payload bay of shuttle Endeavour, the separation mechanism failed. Without conclusive visual evidence as to what happened during the deployment of the satellites, the Aggie team was left to speculate as to the cause of the malfunction.

The VDCS on AggieSat4 will manage the camera hardware and interface with the main satellite to perform the image capture at the precise moment that the launch occurs. The team has had to determine the most efficient framerate and resolutions to provide the most comprehensive pictures to be relayed to a ground team on Earth.

The camera hardware will take 10 rapid-fire sequences in about 10 seconds as Bevo-2 detaches from AggieSat4. After the initial 10-20 seconds, Bevo-2 will be too far from AggieSat4 to capture visually. The camera hardware will also capture images in the seconds directly before the launch, and by using a fish-eye lens that captures almost 180 degrees of imagery, they researchers will be able to see any conditions potentially affecting the bay door before launch.

The group spent all of the fall 2014 semester designing the VDCS, and "this semester will be all about de-bugging and finding errors in the subsystems," Speer-Manson said. The AggieSat lab will produce the finished product to NASA this spring, and while the final launch date is to be determined, they expect it to take place next fall. "I'm excited and hopeful," Strickland said of the launch.

The team of UH engineering undergrads said the prospect of working with NASA was a source of motivation and excitement to continue their cutting-edge research within the Small Satellite Laboratory.

"I love space and science, and I'm excited as all get-out about us and about the University of Houston having a part in this process," Annis said.

"It's definitely motivating. I want to have a picture on my wall that I can show and say, 'I took a picture in space,'" McNeil added.

EAA PAST PRESIDENT ELECTED TO UHAA BOARD OF DIRECTORS

A distinguished member of the Cullen College community has been granted the opportunity to make her mark on a new alumni board – this time, at the university-wide level.

Cynthia Oliver Coleman received her bachelor's degree in chemical engineering from the Cullen College of Engineering in 1971. Now, she's been elected to the University of Houston Alumni Association (UHAA) Board of Directors for a three-year term; she'll also be eligible for two term extensions during her service to the UHAA.

Coleman is also a past president of the UH Engineering Alumni Association (EAA), and she is the founder and chair emeritus of EAA Engineers Week. She is a retired chemical engineer for ExxonMobil, and also serves as counselor to the UH Society of Women Engineers as well as a board member on the UH Petroleum Engineering Advisory Board. She is an advocate and donor for the UH Women in Engineering Program as well.

2015 E-WEEK RECEPTION RAISES THOUSANDS IN SCHOLARSHIPS

For the 11th year in a row, the Engineering Alumni Association (EAA) hosted its annual EWeek Reception on Feb. 26 in honor of National Engineers Week. This year, the EAA raised over $54,000 in scholarships for 61 students and several student organizations. Since its inception, the EAA has raised over $383,000 in scholarships.

Approximately 210 people attended the gathering, which took place at the UH Hilton. The Ryder Scott Company Friends of UHPE earned the top sponsor spot with a donation of over $10,000.

Other event sponsors were AADE Houston Chapter, AECOM, American Society of Indian Engineers, Black Cougar Engineers, BP, Cameron, Civil Engineering Cougars, ConocoPhillips, Energy cougar engineers, ExxonMobil, ExxonMobil Women Cougar Engineers, Fluor Corporation, FMC Technologies, Friends of Cougar Biomedical Engineering, Marathon Oil Corporation, Phillips 66, Ryder Scott Company Friends of UH PE, Society of Women Engineers Houston Area, UH Petroleum Engineering Advisory Board, UH PROMES Alumni and the UH EAA.

At the event, the engineering society Pi Tau Sigma received recognition for their tremendous outreach efforts throughout the year.

Learn more about the EAA at www.egr.uh.edu/eaa/welcome.

UH ALUMNUS DESIGNS NASA'S NEW SPACESUITS AT OCEANEERING INTERNATIONAL

Phil Swanson (BSME '86) is over the moon about where his career his taken him since graduating from the University of Houston Cullen College of Engineering. As deputy manager for spacesuits at Oceaneering International, Swanson plays a central role in designing new launch-entry spacesuits and exploration spacesuits for NASA astronauts who will fly to Mars and beyond in NASA exploration missions.

Swanson joined Oceaneering, a leading offshore oil and gas services provider, in the 1990s. In his current role, which he took on in 2007, Swanson and his team are developing capabilities and design features for NASA spacesuits that can be used on asteroid capture missions or to explore the surfaces of Mars and the Moon.

NASA's existing spacesuits were specifically designed for astronauts to float within the space shuttle payload bay or on the International Space Station. "It is really more of a microgravity suit," Swanson said.

Spacesuits required for future exploration missions to planetary surfaces and for launch/re-entry missions from Mars will need differing capabilities from current suits, such as life support systems with reduced maintenance footprints and added mobility features for walking. These additional features cannot come with more weight or operational complexity, Swanson said, as logistics and maintenance for the suits must also be minimized. "This means we need to develop new batteries, new CO_2 scrubbing components, new methods for extracting heat from the spacesuits, new communications systems and many more technologies," he said.

It's an incredibly rewarding, albeit challenging, day-to-day grind, but Swanson said his education at the UH Cullen College of Engineering prepared him to tackle the engineering challenges of space exploration head-on.

"The [Cullen] College prepared me well. I was able to walk into the business environment and employ my skills," Swanson said. "It has been fundamental to my ability to succeed in this area and every other area."

Although Swanson's work day requires his mind to remain focused on the far reaches of outer space, his interests and hobbies lie much closer to Earth. When he isn't hard at work inside of Oceaneering's spacesuit laboratories, Swanson can be found tailgating with his former classmates at the new UH stadium.

As an undergraduate at the Cullen College, Swanson pledged to a fraternity and tried out for the UH cheerleading team in 1983. He made the squad, and "for two of the most exciting basketball years in UH history," Swanson had the opportunity to cheer on UH's basketball legends from the courtside. "I have one good memory after another about my time at UH," he said. "I have stories, so many stories."

With his cheerleading days now behind him, Swanson is focused on parenthood (his son is almost two years old) and giving back to the University that he said has given so much to him. Swanson is a committed supporter of both athletic and academic programs at UH.

"Almost everyone who went to the University of Houston gained more than they paid for," Swanson said. "It is a bargain in my mind. You can go in and learn the skills you need for a high paying job that is very rewarding that you can't really do without something like that."

As a professional engineer in Houston, Swanson said he also sees a direct benefit to supporting the Cullen College's students, faculty and academic and research programs. "In my role at Oceaneering, we interview and hire UH engineers all the time," he said.

"University of Houston engineering college graduates I have found on a repetitive basis excel in their analytical skills. It's repetitive. And I count on that," Swanson said. "So as a hiring manager here in Houston, the quality education these students receive directly benefits our work and our company."

As a strategic partner with NASA and many companies operating in the aerospace industry, the Cullen College has a wide range of ongoing research with space and aerospace applications.

"Conducting this research and making a pitch for these exciting new technologies and discoveries costs money," Swanson said. "If I can help out and support researchers at the Cullen College to develop a new type of battery that might help me with my spacesuit, well that helps me, too, and that helps all of Houston."

LARRY & GERRI SNIDER

"We've always felt that education is so important, and it has helped us in so many ways... we hope that this gift will help a bunch of people," said Gerri Snider.

ARE YOU A STUDENT

who is interested in applying to the R. Larry and Gerri R. Snider Native American Scholarship or the Melody Kathryn and Becky Snider Women in Industrial Engineering Scholarships? Contact Sharon Hall, 713-743-4181, sdhall@uh.edu.

ARE YOU AN ALUMNUS OR ALUMNA

who is interested in learning more about supporting the Cullen College with a charitable gift annuity? Contact Russell Dunlavy, 713-743-4209, rtdunlavy@uh.edu.

Over the course of his career as an engineer, Larry Snider (BSIE '55) lived and worked all around the world. Larry and his wife, Gerri, have called many places "home," from California and Iran, to Ohio and Pakistan. Yet no matter where his career took him, Larry said there was one place he always returned to: the University of Houston.

"My education at the University of Houston Cullen College of Engineering has helped me and my family in so many ways," Larry said. "That's why we feel it is so important to give back to the University that has given us so much."

Larry and Gerri decided to support the UH Cullen College of Engineering with a testamentary charitable gift annuity in the amount of $4.5 million. The gift is unique in that it allows the Sniders to provide an annual income to both of their adult daughters throughout their lifetimes. "This plan for supporting the University is really a win-win," Larry said.

A charitable gift annuity is a contract between a donor and UH wherein the donor agrees to make a gift to the University while also agreeing to pay a designated beneficiary a fixed amount each year for the rest of their life.

"You can give money to the University and at the same time use that money to fund a charitable gift annuity, which pays an income to your children all of their lifetimes," he said. "Your children get a current income every year during their lives, and when they pass, the residuum of the annuity goes to the University of Houston Cullen College of Engineering."

The Sniders have specified exactly how the residuum will be used once it is transferred to the Cullen College. The first funding priority is for an endowed department chair. The remainder of the funds will go towards funding professorships and full-time scholarships.

The Sniders said they felt it was particularly important to share the news about their gift to the Cullen College in order to raise awareness among alumni who may not have known such a gift agreement was a possibility.

"If God has blessed you with financial success as he has done us, we would like to invite you to consider investigating whether establishing a charitable gift annuity is a good fit for your portfolio, as the Cullen College would really benefit from having many more alumni establish these win-win gift agreements," Larry said.

In addition to their most recent gift, the Sniders have supported the University of Houston and its Cullen College of Engineering by funding scholarships.

The R. Larry and Gerri R. Snider Native American Scholarship, established by the Sniders in 2003, offers $10,000 per year to any engineering student entering their sophomore year or above who is a citizen of a federally recognized tribe. Larry is a citizen of the Cherokee Nation, and gives preference to Cherokee student applicants.

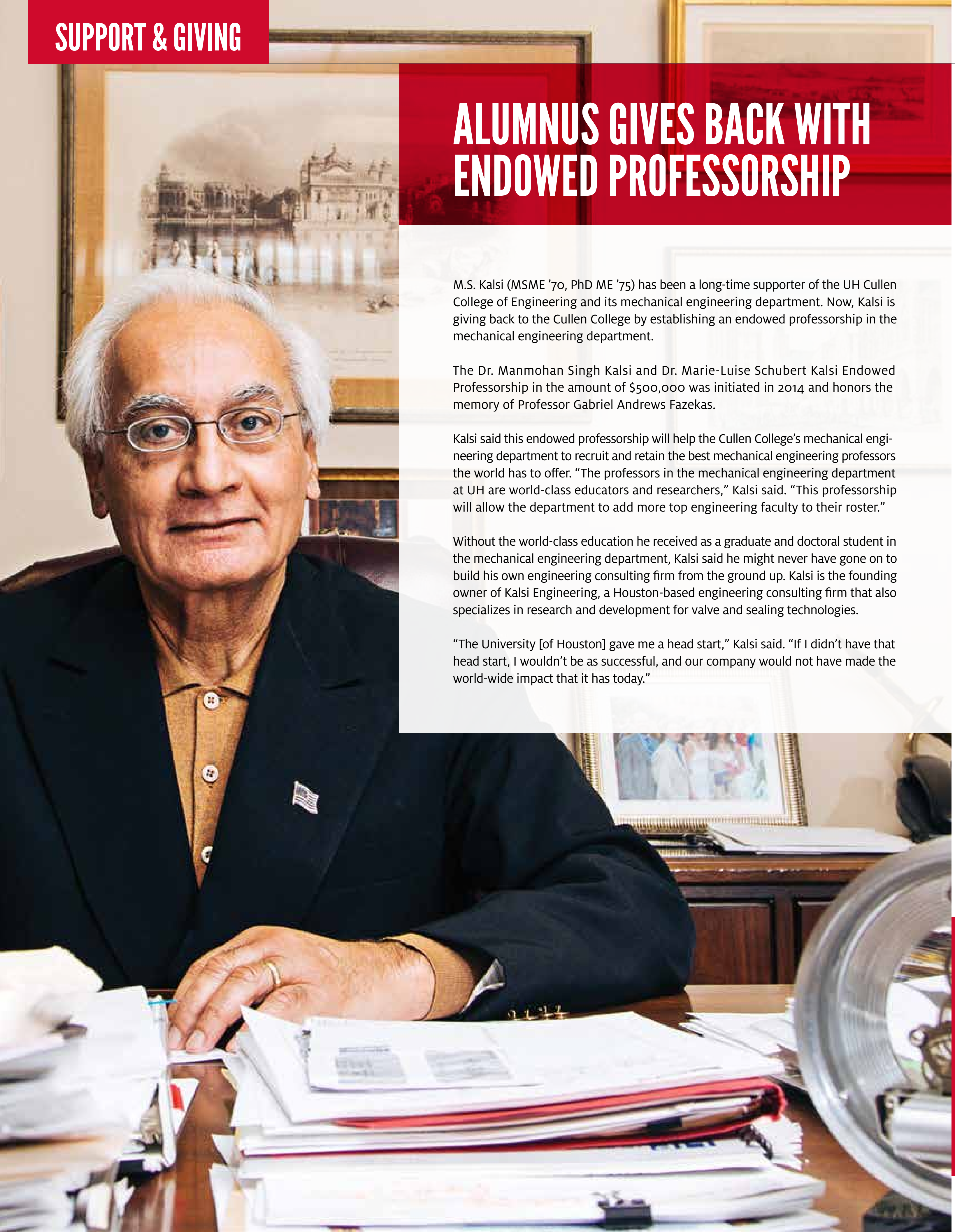
In 2009, the Sniders also established two other scholarships at the Cullen College. Named after their daughters, the Melody Kathryn and Becky Snider Women in Industrial Engineering scholarships are available to female engineering students.

"We've always felt that education is so important, and it has helped us in so many ways," Gerri said. "We hope that this gift will help a bunch of people."

The Sniders said they feel very passionate about supporting hard working students who have to put themselves through college, as they can personally relate to such a struggle. Larry worked 40 hours per week while attending the Cullen College full-time. Gerri also worked full-time and managed their household.

After five years at the Cullen College, Larry earned his bachelor's degree in process engineering, a combination of industrial and chemical engineering. From there, Larry's engineering career took him around the world, moving his family a total of 35 times. He has worked for Sheffield Steel Corp., Kaiser Steel, Booz Allen Hamilton, Peat Marwick & Mitchell, Sterling Electronics, RAPOCA Energy, Korn Ferry International, and Coopers and Lybrand. Upon his retirement in 1995, Larry established RLS Professional Services LLC.

Larry received the UH Engineering Alumni Association's Distinguished Engineering Alumni Award in 1991 and the Lifetime Achievement Award in 2013. He and Gerri are also members of Cullen College Bridge Builder Society.



ALUMNUS GIVES BACK WITH ENDOWED PROFESSORSHIP

M.S. Kalsi (MSME '70, PhD ME '75) has been a long-time supporter of the UH Cullen College of Engineering and its mechanical engineering department. Now, Kalsi is giving back to the Cullen College by establishing an endowed professorship in the mechanical engineering department.

The Dr. Manmohan Singh Kalsi and Dr. Marie-Luise Schubert Kalsi Endowed Professorship in the amount of $500,000 was initiated in 2014 and honors the memory of Professor Gabriel Andrews Fazekas.

Kalsi said this endowed professorship will help the Cullen College's mechanical engineering department to recruit and retain the best mechanical engineering professors the world has to offer. "The professors in the mechanical engineering department at UH are world-class educators and researchers," Kalsi said. "This professorship will allow the department to add more top engineering faculty to their roster."

Without the world-class education he received as a graduate and doctoral student in the mechanical engineering department, Kalsi said he might never have gone on to build his own engineering consulting firm from the ground up. Kalsi is the founding owner of Kalsi Engineering, a Houston-based engineering consulting firm that also specializes in research and development for valve and sealing technologies.

"The University [of Houston] gave me a head start," Kalsi said. "If I didn't have that head start, I wouldn't be as successful, and our company would not have made the world-wide impact that it has today."

BROWN & GAY ENGINEERS, INC. SUPPORTS CULLEN COLLEGE WITH SCHOLARSHIP ENDOWMENT

Brown & Gay Engineers, Inc. (www.browngay.com), an engineering consulting firm based in Houston, established an endowed scholarship in the UH Cullen College of Engineering's civil and environmental engineering department. The gift totals $52,000. Of that total, $50,000 will be used to establish the endowment and $2,000 will go towards current scholarships for fall 2015.

Alumni of the Cullen College of Engineering are employed in leadership positions throughout the city of Houston and around the world. Brown & Gay Engineers (BGE) is no exception: Cullen College alumnus Ronald L. Mullinax served as the chairman of the board at BGE until his retirement at the end of 2014.

Mullinax's plans for retirement first spurred on the decision to provide support to his beloved alma mater. Lee Lennard, president of BGE, also noted that the endowed scholarship will help to train world-class engineers like Mullinax who may one day be employed at BGE.

"BGE is in business to serve clients, to lead with excellence and to solve complex problems," said Lee Lennard, president of BGE. "Creating an endowed scholarship at the University of Houston in honor of our retiring chairman of the board and UH alumnus, Ronald L. Mullinax, allows us to further partner in developing bright young professionals."

"These bright young civil engineering professionals will go into the world and make a profound difference by serving, leading and solving," he added.

The gift of an endowed scholarship represents a permanent asset at the Cullen College of Engineering from which engineering students can receive support toward their education. Endowments provide stability to scholarship programs because the principal gift is retained to produce income on an annual basis, in perpetuity, while a portion of the annual investment return is used for a scholarship award. The rest of the investment yield is returned to the principal and, over time, the fund grows.

To learn about other giving opportunities at the UH Cullen College of Engineering, please visit

http://www.egr.uh.edu/giving/opportunities

or contact Russell Dunlavy, chief advancement officer at the UH Cullen College of Engineering, at rtdunlavy@uh.edu.

UH CREATES MEHTA FAMILY ENGINEERING RESEARCH CENTER

The Mehta family has provided support to establish the Mehta Family Engineering Research Center on the ground floor of the University of Houston's new Multidisciplinary Research and Engineering Building (MREB).

The Mehta Family Engineering Research Center will house the University's new High Performance Computational Center, five state-of-the-art wet labs, the new Mass Spectrometry Lab, a large multipurpose room, conference room and student lounge.

The High Performance Computational Center will promote research and teaching on campus through integrating leading-edge high performance computing and visualization for UH faculty, staff and students.

The new wet labs are designed to allow researchers to work with chemicals, drugs or biological matter. The labs will handle liquid solutions or volatile phases requiring direct ventilation. The wet labs will be fitted with specialized piped utilities supplying water and various gases used during research.

The new Mass Spectrometry Lab will allow researchers access to the most current equipment designed for analytical chemistry.

Dean Joseph Tedesco said the Mehta family contribution is an example of the community support that allowed the Cullen College of Engineering and the University to move forward with the new building.

"This building will allow us to expand both our educational offerings and our research facilities," Tedesco said. "It will allow more students to participate in research opportunities. We appreciate the Mehta family for this generous gift."

The four Mehta siblings all attended the University of Houston.

"We have all benefited from the outstanding faculty and opportunities the engineering school provided us," said Rahul Mehta. "We are grateful for the dedication and excellence of the faculty."

Supporting the MREB is their way of showing appreciation for the opportunities afforded to them from the University, as well as to show their support for the faculty and other members of the UH community, the family said.

"It is educational investments like this that will keep the University of Houston at the forefront of research and education, and continue the tradition of excellence we all experienced during our time here," Jainesh Mehta said.

The MREB is scheduled to open in 2016.

SHELL OIL COMPANY COMMITS $3.5 MILLION TO UH

Shell Oil Company is contributing $3.5 million to the University of Houston in support of the new Multidisciplinary Research and Engineering Building (MREB) and other educational initiatives.

The collaboration between Shell and the University will ensure the continuation of research programs over the next three years, and through its social investment efforts, Shell will continue to support programs that develop talent for a future workforce.

"Energy is one of our main priorities at UH," said University of Houston President Renu Khator, "and this latest example of Shell's unrivaled generosity will allow us to considerably expand our efforts to become the Energy University. We deeply appreciate Shell's enlightened commitment to community improvement, social responsibility and innovative research."

"The University's programs increase energy education and engineering advancement for students, right here in our backyard, and that's something we value," said Marvin Odum, President of Shell Oil Company. "Energy leadership and innovation each have a long history in Houston, and it is imperative that we continue to provide support to the bright young minds of tomorrow."

When UH established its Energy Research Park (ERP) in 2009, Khator announced her vision for the facility as a collaborative endeavor, with the world's leading energy companies represented throughout the park's 75 acre campus.

Groundbreaking on the $51 million, four-story research and engineering building was Oct. 6, with occupancy set for 2016. The Shell contribution will ensure adequate teaching and physical resources are available to meet the industry demands for quality personnel.

2015 BEGINNING OF SEMESTER PARTY FOR UH ENGINEERING STUDENTS

LAUNCH INTO ENGINEERING STEM OUTREACH EVENT

(HOSTED BY THE SOCIETY OF WOMEN ENGINEERS)

Read more about this STEM outreach event for local high school students on page 38!

ENGINEERING 101 STEM OUTREACH EVENT

(HOSTED BY PI TAU SIGMA)

Read more about this STEM outreach event for local elementary school students on page 38!

SPRING 2015 ENGINEERING CAREER FAIR

John Lienhard

ENGINES OF OUR INGENUITY:

Taken from Episode 2628

Excerpted from "The Edge of Space"

By Michael Baratt, NASA astronaut and physician

Where does space begin?

The answer is, "it depends."

Defining space implies some threshold of removal from all that earth has to offer its objects and inhabitants.

The UN Treaty for the Peaceful Use of Outer Space dictates that space is the province of all mankind. For a sovereign nation, the question is, where does airspace give way to outer space, and we lose our jurisdiction? Where this border should be set remains unsettled and is a keen topic for international space law.

But step back from that issue. The very question of where space begins smacks of arrogance, of geo-centrism. It's akin to the non-traveled inhabitants of a tiny island debating where the sea begins. A more appropriate question might be, "where is the border of earth in the vast ocean of space?"

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

UNIVERSITY OF HOUSTON
CULLEN COLLEGE OF ENGINEERING

ALUMNI AWARDS

Gala

THURSDAY, JUNE 11, 2015

HOSTED BY THE ENGINEERING ALUMNI ASSOCIATION

www.egr.uh.edu/eaa/activites/gala