ECE CONNECTIONS

Department of Electrical & Computer Engineering Magazine
UH Cullen College of Engineering
Spring 2016

ART MEETS SCIENCE

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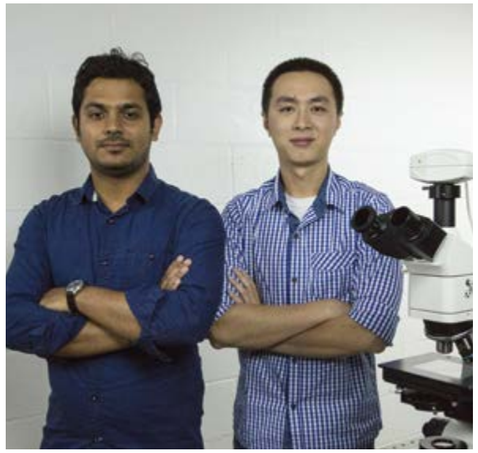

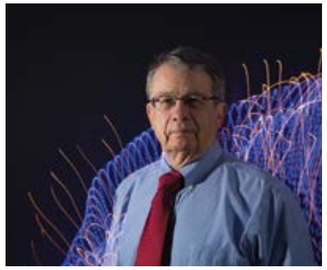

ECE CONNECTIONS

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CHAIR'S MESSAGE

Houston, we have a connection!

Welcome to the spring 2016 issue of *ECE Connections*. These are exciting times for the department, and we welcome the opportunity to share the stories of our progress with you. This year is off to a great start, with assistant professor Aaron Becker winning the prestigious NSF CAREER grant. We are delighted to have several new faculty members. Assistant professor Jiefu Chen, who received his doctorate from Duke University, has joined our electromagnetics well logging program led by professor Ji Chen. Assistant professor Miao Pan, an NSF CAREER awardee, joined us this year. Pan has a Ph.D. from the University of Florida, with expertise in underwater communication networks. Assistant professor Xin Fu, also an NSF CAREER awardee and graduate of the University of Florida, brings significant expertise in energy efficient GPU computing.

Our research and educational programs continue to grow. Notably, ECE faculty published a record number of journal publications last year, wrote new books and were featured internationally in the media. Our neuroaesthetics student team, led by professor Jose Luis Contreras-Vidal, was featured in the *Smithsonian Magazine*. This year, we are launching our new online programs in the area of electric power, led by instructional faculty members Jung-Uk Lim and Masoud Barati.

Houston is a global hub of opportunity, and we benefited from a surge in corporate support last year. A notable item of progress for 2016 is the funding of our Omron undergraduate student laboratory. Our Industry Advisory Board, led by IEEE Fellow Douglas Verret, grew its membership and member commitments to a new level. We had the pleasure of inaugurating our new Center for Subsurface Sensing and Characterization led by professor Ji Chen. This center enjoys exceptional support from Houston's energy industry.

As our enrollment continues to grow, our admission standards are also increasing. I am proud to say that our current body of ECE students at the UH Cullen College of Engineering is made up of the strongest and most talented individuals our department has ever had the pleasure of educating. Our student robotics team, led by instructional faculty member Julius Marpaung, continues to win competitions, and the student chapter of IEEE is as vibrant and active as ever. Our students, led by associate professor Wei-Chuan Shih, created a startup company to commercialize their DotLens invention that converts any smartphone into a sophisticated microscope.

On a personal note, I have been inducted into the Board of Directors of the ECE Department Heads Association (ECEDHA), where I serve as editor-in-chief of the *ECE Source* monthly newsletter. I have had the opportunity to serve this organization in other ways including the expansion of ECEDHA into Latin America.

Overall, these are truly exciting times for us in the ECE department at the Cullen College. We could not have achieved the level of success that we have without your continued dedication and support. Thank you for being a friend and supporter of our world-class academic and research programs!

Sincerely,

Dr. Badri Roysam
ECE Department Chair
Hugh Roy & Lillie Cranz Cullen Professor

POINTS OF PRIDE

1

UH engineering students ranked 15th in the U.S. for salary earning potential (Source: PayScale.com)

2

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

3

Located in **"America's coolest city"** and **"one of the best places to live in your 20s"** (Source: Forbes and Business Insider, 2015)

4

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

5

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

6

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

ECE BY THE NUMBERS

$64,081
AVERAGE STARTING SALARY WITH B.S. IN ELECTRICAL ENGINEERING

$62,553
AVERAGE STARTING SALARY WITH B.S. IN COMPUTER ENGINEERING

1323
AVERAGE SAT SCORE OF ENTERING FRESHMAN STUDENTS

GROWTH SINCE 2008

TOTAL B.S. STUDENTS 2015: 536 (+21%)

TOTAL M.S. STUDENTS 2015: 217 (+32%)

TOTAL PH.D. STUDENTS 2015: 97 (+59%)

TOTAL STUDENTS 2015: 850 (+27%)

TOTAL DEGREES AWARDED 2015: 154 (+26%)

TOP 50
GREAT AFFORDABLE PROGRAM FOR COMPUTER SCIENCE AND ENGINEERING (GREAT VALUE COLLEGES, 2014)

22:1
22:1 UNIVERSITY-WIDE STUDENT TO FACULTY RATIO

127
FACULTY PUBLICATIONS IN 2014

$6 MILLION
IN ANNUAL RESEARCH AND GIFT EXPENDITURES IN 2014

IN THE MEDIA SPOTLIGHT

RESEARCHERS OBSERVE EFFECTS OF ART ON THE BRAIN

Becky Valls, UH associate professor of dance

Featuring: Jose Luis Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen University Professor of electrical and computer engineering
Covered by:

SELF-ASSEMBLING GAUSS GUN IDEA WOULD HEAL PATIENTS FROM THE INSIDE

Featuring: Aaron Becker, assistant professor of electrical and computer engineering
Covered by:

UH ENGINEERS TURN SMARTPHONE INTO MICROSCOPE FOR 3 CENTS

Featuring: Wei-Chuan Shih, associate professor of electrical and computer engineering
Covered by: CNBC, Gizmag, Slate, Phys.org, UH Moment, iflscience.com

PROFESSOR ADDRESSES SAFETY CONCERNS OVER EXPLODING HOVERBOARDS

Featuring: Yan Yao, assistant professor of electrical and computer engineering
Covered by: KHOU 11 News

RESEARCHERS DEVELOP LESS INVASIVE METHOD FOR KIDNEY DIAGNOSTICS

Featuring: Wei-Chuan Shih, associate professor of electrical and computer engineering; Chandra Mohan, Hugh Roy and Lillie Cranz Cullen Endowed Professor of biomedical engineering
Covered by: Phys.org, Business Standard, Economic Times

MEET THE NEW ECE FACULTY MEMBERS! Q&A

by Natalie Thayer

MIAO PAN

Assistant Professor

Pan was an assistant professor of computer science at Texas Southern University before he joined the UH Cullen College faculty. His work has focused on cognitive radio networks, cybersecurity and cyber-physical systems, and he served as director of a laboratory devoted to this research in his prior university role. In 2014, he received the prestigious National Science Foundation (NSF) CAREER Award. Pan earned his doctoral degree in electrical and computer engineering from the University of Florida in Gainesville.

Q: What inspired you to pursue a career in academia?

A: When I was a graduate student in Beijing, I took a job teaching other college students, helping them prepare for English as a foreign language exams. During that experience, I had very positive interactions with my students and I started to see a future for myself in academia. I'm also drawn to academia because the field allows you the freedom to pursue the things you enjoy.

Q: What interested you in teaching at the University of Houston?

A: I wanted to teach at the University of Houston because, as one of the most prestigious schools in Texas, it has a lot of good students and researchers. There are a lot of talented students at UH and I believe I'll be able to connect and have positive interactions with them. I also think the students at UH have the potential to contribute to my future research.

Q: what kind of research do you hope to pursue at UH?

A: I'm very excited by the University's newly-established subsea engineering program and I'd like to further explore underwater communication networks. I'd also like to continue to work on cyber security. It's a very big issue in the digital world and I imagine that we will continue to make big advances and combat issues over the next 20 to 30 years.

Q: Can you tell us about your approach to teaching in the classroom and in the research lab?

A: There are several principles that I try to follow while teaching. One principle is that you can teach everyone, regardless of background or experience. This is especially important at UH because we have such a diverse student body. Another philosophy is that you teach through interaction. I believe you need to adapt your teaching style depending on students' strengths and weaknesses. If students understand what you're explaining in class, you can speed up; if they don't, you can slow down and explain concepts in more detail. I am also a big proponent of the group project because each group includes a variety of students. Some students will take on leadership roles and other students have the opportunity to better understand the content. In this way, everyone is likely to benefit from the project and, in turn, everyone can benefit from the class.

Q: What would like your students to take away from your courses and your research lab?

A: In an undergraduate course, I really want students to learn a specific technique or algorithm that they can use in the future. I would like students in my class to learn things that they can relate to and apply in real life.

For graduate students, I think the most important thing is that they learn logical thinking and problem solving. If a student can learn something in terms of logical thinking, that student can build up their own ideas.

JIEFU CHEN

Assistant Professor

Chen served as a scientist for Weatherford International, an oil and gas company in Houston, before he joined the UH Cullen College of Engineering faculty. His research and development projects have focused on well logging methods including electromagnetic propagation resistivity, azimuthal resistivity and micro-resistivity as well as oil-based mud borehole imaging, acoustic logging, electromagnetic telemetry and electromagnetic short-hop communication. He earned his doctoral degree in electrical and computer engineering from Duke University.

Q: How did you become interested in the STEM fields and what led you to study engineering?

A: When I was a young kid growing up in China, the government encouraged scientists to serve as role models. In the '80s and '90s, I think about 90 percent of children in China dreamed of becoming scientists. That was my first inspiration to pursue research and become a scientist.

I chose to major in engineering in college because engineers are people who can make something and literally change the world. I think that's the most amazing thing about the field. And when I was a college student, I met several great professors who became real role models to me and gave me real inspiration.

Q: What brought you to the University of Houston to pursue a career in academia?

A: The University of Houston has a stellar reputation in the oil and gas field and the school is in the heart of Houston, the energy capital of the world.

When I first moved from North Carolina to Houston for my job at Weatherford International, I attended several conferences at UH. So, I felt a connection to UH before I joined the University as a faculty member. Also, UH has a vibrant campus. You can see talented students and there are almost daily activities relevant to my research.

Q: Can you tell us about your approach to teaching in the classroom and in the research lab?

A: I feel that when there is a lot of information or data sometimes students or researchers can get overwhelmed by the amount of information. So, in my ideal world, teachers show students practical applications of abstract theories.

The most important thing for me is that my students learn something new and something useful that they can apply to their future careers.

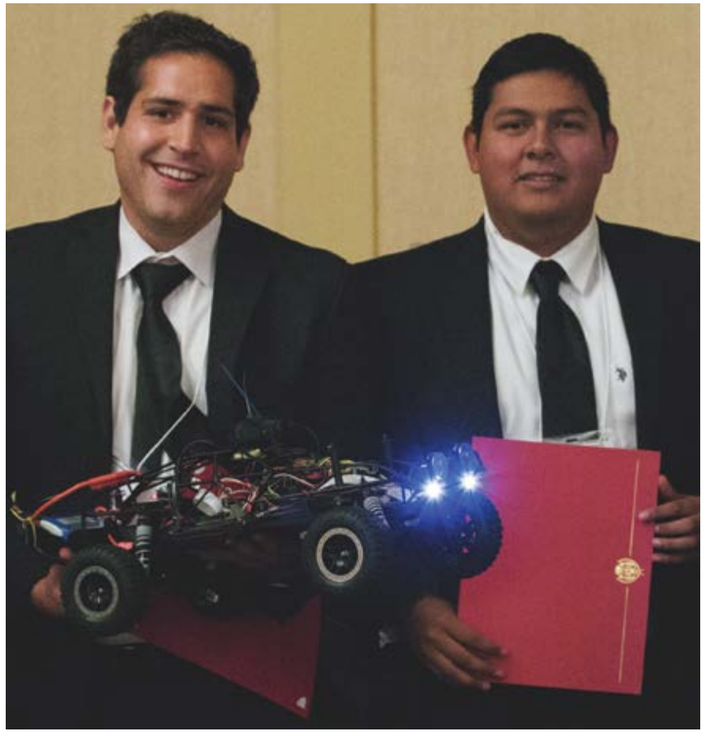
Q: What advice can you give to students taking your courses?

A: Because my courses will be heavily based on mathematics, computing and physics, they might not be easy – but they will be very rewarding. Students have the opportunity to learn a lot. I want to encourage students to raise questions at any time, to come see me in my office and to have discussions.

Q: Research is a large component of the academic culture at the University of Houston. How does your prior experience inform your future research plans?

A: The focus of my research includes computation and simulation for electromagnetic waves or other kinds of wave phenomena. It's based on modeling or simulation, which can be applied to several different areas so there are a lot of opportunities to explore.

Because I have previous experience with the oil and gas industry and the integrated circuits industry, I want to do more research to bridge academia and the energy industry. I'd also like to collaborate with professors with all kinds of backgrounds and bring my industry experience to future collaborations.



STUDENT RESEARCH SHINES AT CAPSTONE DESIGN AND GRADUATE RESEARCH CONFERENCE

The UH Department of Electrical and Computer Engineering hosted the Capstone Design and Graduate Research Conference last May at the UH Hilton. The day-long event included technical sessions where graduate and undergraduate students presented their research projects.

The Capstone Design Conference is designed for undergraduate students to showcase their research to faculty, staff and students as well as industry representatives from the Greater Houston area. For most engineering undergrads across the nation, hands-on research projects are difficult to come by, but there is no shortage of cutting-edge research for undergrads to get involved in at the Cullen College. Graduate students presented their research and met with current industry representatives at the Graduate Research Conference.

To learn more about the Capstone Design projects presented by ECE undergrads at the GRC/CDC, watch our video at www.egr.uh.edu/news/201505/video-capstone-design-conference-poster-session

To access our staff's favorite photos from the conference, please visit our Flickr page at https://flic.kr/s/aHskadoZKn

ENGINEERING STUDENTS NOW HAVE SEAMLESS TRANSFER OPTION WITH UH

Beginning in fall of 2015, San Jacinto College students will be eligible for a seamless transfer into the University of Houston Cullen College of Engineering.

San Jacinto College has signed an articulation agreement with the Cullen College, which offers San Jacinto College students who are currently taking courses for completion of the Associate of Science in Engineering Science an option to seamlessly transfer into the UH Cullen College of Engineering.

"This articulation agreement between the University of Houston Cullen College of Engineering and San Jacinto College will ensure that the transition process from one campus to another is as seamless as possible for engineering students," said Joseph W. Tedesco, Elizabeth D. Rockwell Dean of the Cullen College of Engineering. "It will also provide students with a better understanding of the course requirements for transferring to the Cullen College, allowing them to save time and money by making the best course selection choices."

Qualified engineers are in high demand across the country, but the supply of engineering talent continues to lag behind. Kelly Services, a workforce solutions provider, ranked Houston as the city with the highest demand for engineers in the U.S. In terms of average annual salaries, Houston is the highest paying metro area for civil engineers ($112,480), chemical engineers ($128,380) and petroleum engineers ($168,280).

"I am very excited about this important step toward graduating more world-class engineers into the city of Houston," Tedesco said.

San Jacinto College students who want to transfer to the UH Cullen College of Engineering must complete the Associate of Science degree in Engineering Science (60 hours) and meet the Cullen College's admission requirements.

For more information, please visit www.sanjac.edu/article/engineering-students-now-have-seamless-transfer-option-uh-articulation-agreement-helps

UH EXPANDS IN SUGAR LAND AND KATY, PLANS FOR BIG PARTNERSHIPS

State leaders have paved the way for a $54 million new construction at UH Sugar Land (UHSL), a campus of the University of Houston, and an entirely new campus in Katy worth $46.8 million. UHSL received the allocations in HB100, which the governor signed last June.

The 150,000-sq.-ft. Sugar Land facility, planned to be completed in 2019, will primarily house programs offered by the UH College of Technology. A portion of the college will relocate to Sugar Land, and additional programs in business, education and health-related fields are also expected in the next two to five years.

The addition of a fourth building to the 250-acre campus allows for expanded programs that complement the workforce needs of the area, which is home to a number of technology and engineering companies, such as Fluor, Schlumberger and Texas Instruments. Greater Fort Bend Economic Development Council CEO Jeff Wiley says the county is one of the largest in the state, boasts one of the most highly educated populations and consistently ranks nationally in the Top 10 for population employment growth rate.

"If UH is going to continue to meet the higher education needs of the Houston area, we need to be building where people live," said Provost Paula Myrick Short, UH senior vice president for academic affairs. "There is tremendous growth in Fort Bend County. We are grateful for the incredible support of the legislature, which will help further develop this campus and expand higher education opportunities in the region."

The new UH campus in Katy – one of the fastest growing areas in the Houston region – will offer degrees most relevant to current industry demands, including engineering, business and nursing.

Read more about this story in the Daily Cougar at thedailycougar.com/2015/08/19/uh-expansion-in-sugar-land-katy-plans-for-big-partnerships

NAVAL RESEARCH GRANT WILL SPEED UH WORK ON MATERIALS, ENERGY

A grant from the Office of Naval Research will help researchers from across the University of Houston's Cullen College of Engineering to more efficiently test advanced materials being developed with funding from the Department of Defense.

Venkat Selvamanickam, M.D. Anderson Professor of mechanical engineering, said he will use the $810,000 grant from the Office of Naval Research to purchase a physical properties measurement system (PPMS), which will allow researchers to more quickly test the advanced materials being produced in their laboratories.

Selvamanickam, who also is director of the Applied Research Hub at the Texas Center for Superconductivity at UH (TcSUH), said the new equipment will allow his lab to expedite its research on the development of improved superconducting wire.

The money comes from an Office of Naval Research (ONR) program to fund new equipment needed for research sponsored by that office or other Department of Defense research programs.

The new PPMS will benefit a variety of materials research, including solar cells, batteries, graphene, thermoelectrics and flexible electronics. It will allow testing at a wider range of temperatures, from near 0 degrees Kelvin to room temperature, and over a wide range of magnetic fields, up to 140,000 gauss. That's up from 90,000 gauss for the current equipment, which also is limited to use only for superconductor wires.

Yan Yao, assistant professor of electrical and computer engineering at the Cullen College, is among the other faculty who will use the new equipment. His research group focuses on green and sustainable organic materials for energy generation and storage. He also is a principal investigator for TcSUH.

"With the addition of PPMS, we will be able to obtain a fundamental understanding of how the transport properties of two-dimensional layered metal chalcogenides are influenced with the change of interlayer distance and the pillar materials," he said. That should offer valuable feedback for an effort funded by the ONR's Young Investigator Program to design better magnesium-ion intercalation materials.

Joseph W. Tedesco, Elizabeth D. Rockwell Professor and Dean of the Cullen College of Engineering, said the new testing system has the potential to double the number of samples tested each week, in addition to providing a much wider range of information from each test.

"Many of our UH engineers are investigating novel materials with better properties for applications ranging from energy storage to healthcare," Tedesco said. "As the volume of novel materials discovered and tested by UH engineers continues to grow exponentially, so will UH's reputation as the epicenter of materials engineering research and education."

BRANCHING OUT:
NEW BUILDINGS, NEW CAMPUSES

The UH Cullen College of Engineering will double its student enrollment by 2025 while continuing to raise admission standards and graduation rates. To accommodate the growth of its faculty and student body, the Cullen College will add new, state-of-the-art classroom and research spaces and extend its reach to UH branch campuses, satellite campuses and other locations across the Greater Houston area.

NEW BUILDINGS

The 120,000-square-foot Multidisciplinary Research and Engineering Building (MREB), a $51 million engineering research facility, will allow students to conduct industry-relevant research inside one of the most cutting-edge laboratories in the city of Houston

PARTNERING WITH INDUSTRY

UH Engineering will partner with industries throughout Houston to create mutually beneficial educational facilities located within local corporations and businesses

ONLINE COURSE OFFERINGS

UH Engineering will expand its online course offerings and introduce new, industry-relevant certificate programs

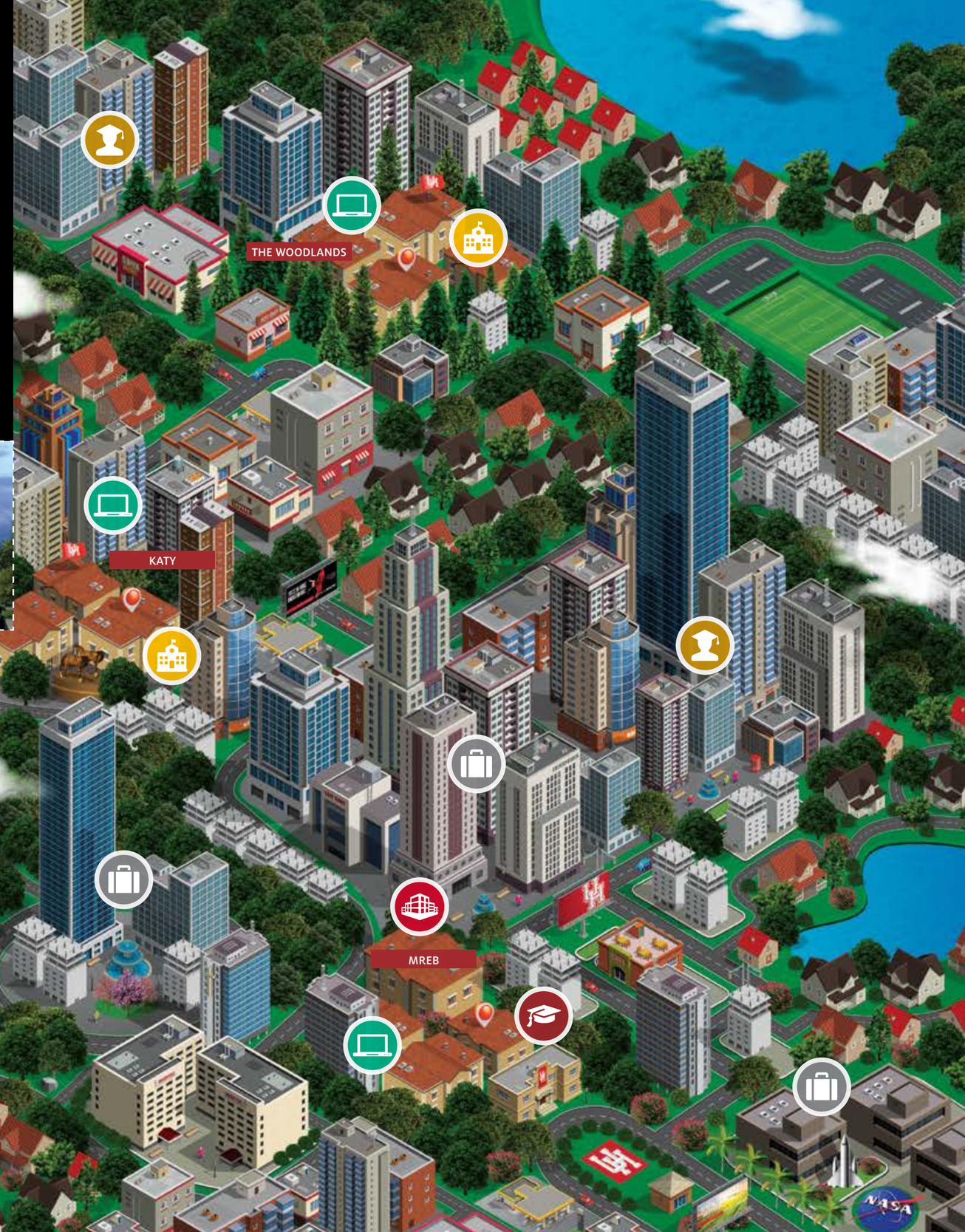
GRADUATION RATES

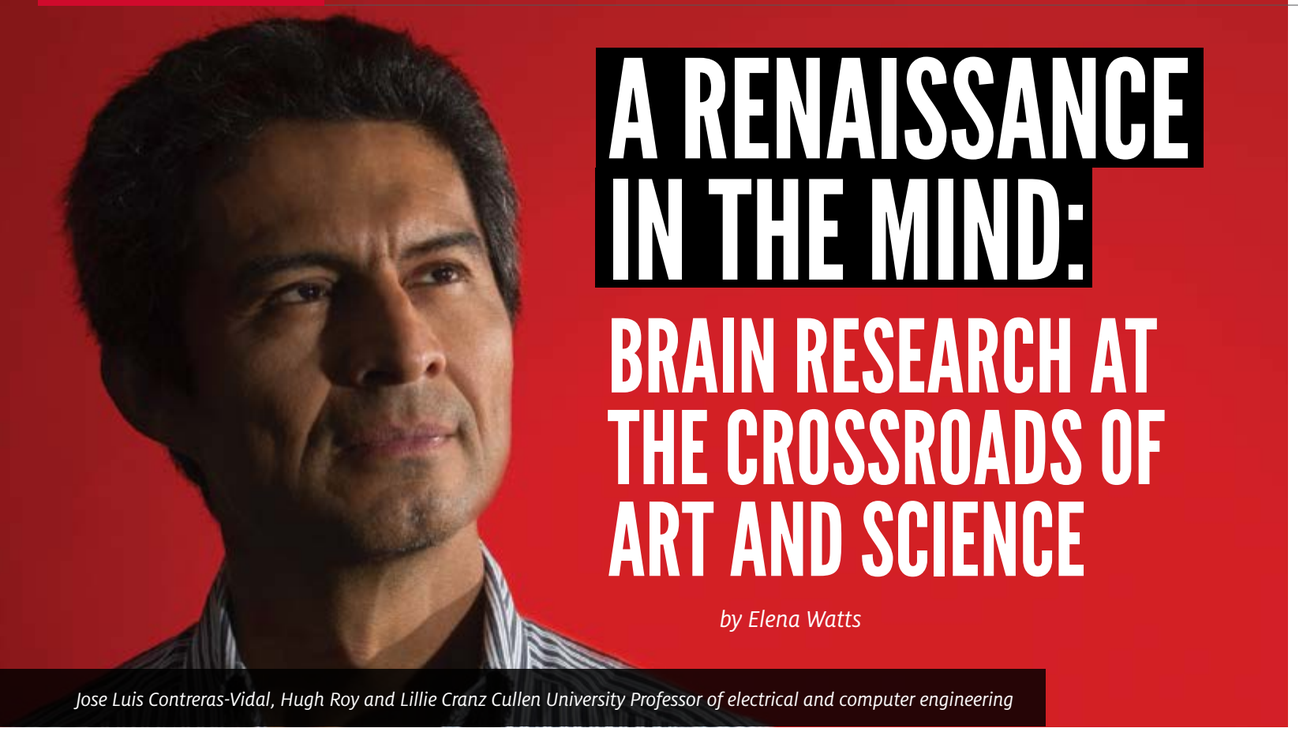
By 2025, 2,000 world-class engineers will graduate from UH each year

- 80% of all Cullen College graduates are employed in the state of Texas within one year of graduation

DIVERSIFYING STEM

600 female engineers, 700 Hispanic engineers and 300 African American engineers will graduate from UH and enter Houston's STEM workforce in 2025





A RENAISSANCE IN THE MIND: BRAIN RESEARCH AT THE CROSSROADS OF ART AND SCIENCE

by Elena Watts

Jose Luis Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen University Professor of electrical and computer engineering

Among other definitions, the Merriam-Webster Dictionary defines balance as, "equipoise between contrasting, opposing or interacting elements; a state in which different things occur in equal or proper amounts or have an equal or proper amount of importance; and the ability to move or to remain in a position without losing control or falling." Perhaps balanced is the best way to describe the Renaissance, a period of immense innovation in world history that struck a balance between art and science.

To ensure a prosperous future for America, leaders in art, science and education fields are pushing for another period of innovation with efforts to convert STEM (science, technology, engineering and mathematics) into STEAM by adding the arts back into education. In 2012, the National Science Foundation (NSF) granted almost $3 million to the Art of Science Learning initiative for a project aimed at fostering innovation through a combination of STEM and arts-based learning. The Rhode Island School of Design amassed support to launch the STEM to STEAM Initiative, which prompted the 2013 bipartisan Congressional caucus held in Washington, D.C., to discuss ways to implement STEAM education.

"I argue that art and science are on a continuum in which artists work with possible worlds whereas scientists are constrained to working in this world," wrote physiologist Robert Root-Brownstein in "The International Handbook of Innovation." "But sometimes perceiving this world differently is the key to making discoveries. Thus, arts and sciences are on a continuum in which artistic thinking produces possibilities that scientists can evaluate for efficacy here and now."

Leonardo da Vinci, an artist, scientist, architect, engineer and inventor, best embodied the Renaissance movement, which began in Italy in the 14th century and spread throughout Europe for 400 years. His masterpiece, "The Last Supper," a mural painted on an interior wall of a convent in Milan, depicts immediate reactions of the 12 apostles to Christ's announcement about imminent betrayal by one of them. Da Vinci described those reactions as "motions of the mind," according to the Metropolitan Museum of Art website. The genius intended to provide outward interpretations of his subjects' inner minds with his artistry, which is echoed five centuries later by scientists intending to reveal relationships between behavior and brain activity with complex modeling systems.

Important inventions such as the printing press, compass and telescope emerged during the Renaissance movement, as well as prestige and financial support for visual artists, musicians and writers. For the first time, philosophers made it acceptable to challenge longstanding beliefs, artists used mathematics and geometry to achieve perspective and proportion in their compositions, and scientists established mathematical relationships with the natural world.

Specialization during the last century has widened the schism between art and science so much that intellectuals have trouble straddling the divide, according to a 2005 *Nature* journal editorial by Alison Abbott and Adam Rutherford.

"It is hard to find today a true artist–scientist like Leonardo da Vinci, as noted for his science and engineering skills as his 'Mona Lisa' and 'Last Supper'," the authors wrote. "But in the past decade there has been an increasing awareness on the part of some artists of the heritage of scientists and vice versa."

At the University of Houston, **Jose Luis "Pepe" Contreras-Vidal**, Hugh Roy and Lillie Cranz Cullen University Professor of electrical and computer engineering at the Cullen College, is reestablishing the balance between art and science for exploration of the human brain. In collaborations with conceptual artist Dario Robleto and UH dance faculty member Becky Valls, Pepe is mapping activity in brains of both expert and amateur observers and creators of art to determine neural bases for their creativity and insight. The U.S. Food and Drug Administration is supporting their efforts.

"By recognizing signatures in the brain for creative processes, maybe we can help people reach those levels of innovation through assimilation training," Pepe said. "Understanding what it takes to innovate and think outside the box could also be very useful for education and for engineering new technological innovations."

Pepe's research also can assist efforts to reverse-engineer the human brain and to develop advanced therapies and medical applications. For example, art therapies are known to help patients with mental and movement disorders but researchers cannot explain the reasons. Patients with Parkinson's disease, which causes poverty of movement, can move normally to rhythmic music of marching bands, yet the mechanisms that allow external music to bypass their internal motor pathways are inexplicable. Furthermore, researchers do not understand additional positive effects they observe in Parkinson's patients who dance with partners. Many believe reward and affective signals are important aspects of these benefits.

Most likely, creativity shares commonalities in the brain across different domains such as visual art, music, language and dance, but to confirm this, researchers must map regions of the brain engaged during these aesthetic experiences.

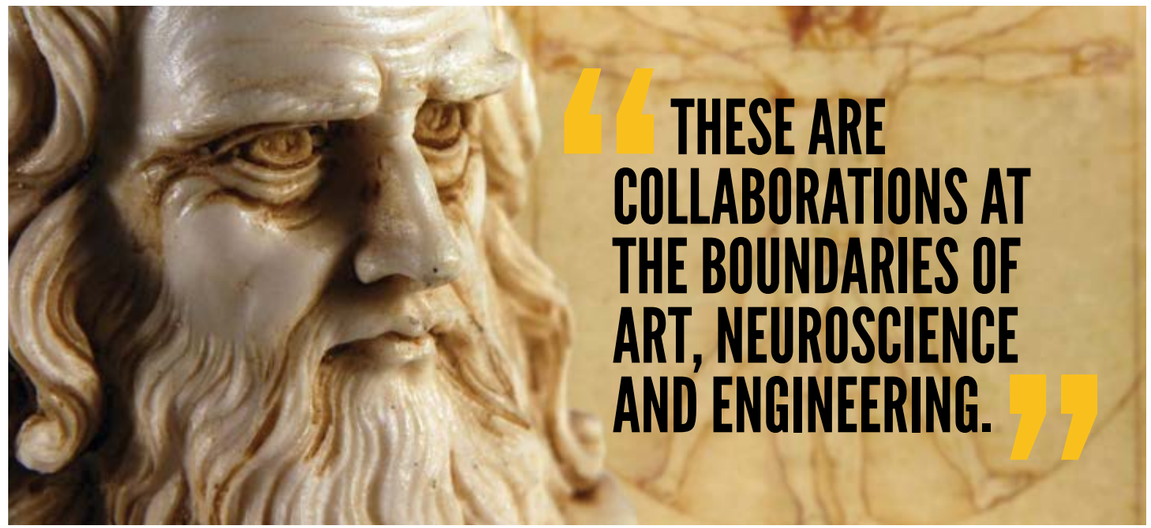
"There are many ramifications of understanding this process that have been neglected for a long time because it was hard to quantify, hard to measure," Pepe said. "But now we have technology, algorithms and partnerships, so it's the right time to start asking questions that were unthinkable just a few years ago."

Art museums moonlight as laboratories for brain research

Driving to an art exhibit, an individual might crank up the radio's volume when an old song stimulates memories of someone from the past. Perusing the exhibit, that same person might stop at a particular sculpture that stimulates a sense of camaraderie with its creator. Engaging with an interactive piece, that individual might repeatedly navigate a virtual reality that stimulates motivation for some reason.

Graceful or jarring dance movements, understated or electrifying theatrical performances, and budding or shriveling landscapes can provoke both common and different responses among observers. The mechanisms in the brain behind these aesthetic experiences are not understood.

To study human brains operating under innumerable influences such as food, stress, mood, medication, genetics and personal experiences, Pepe and his team must mine data from thousands of freely behaving individuals across wide ranges of demographics including gender, age, occupation and educational background.



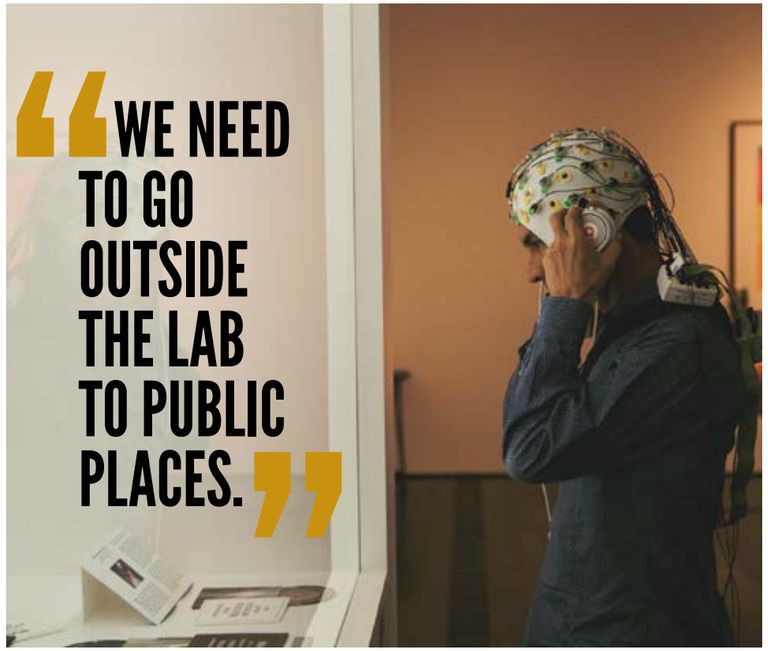
"If we want to understand how the brain works, we need to capture all of those aesthetics, and that's very difficult in a lab with just a few volunteers," Pepe said. "So we need to go outside the lab to public places."

Last fall, Pepe partnered with the Menil Collection to record electrical signals in the brains of 450 individuals as they engaged with the work of artist Dario Robleto in a public art installation. The demonstration led to a $300,000 grant from the NSF, in support of the BRAIN Initiative, to further explore individuality and variation in neural activity among large and diverse groups of people (including children) who are experiencing aesthetics at the UH Blaffer Art Museum and other venues.

"Having the opportunity to collaborate with our colleagues from the arts provides a very constructive way of understanding the process of creativity and uncovering in very large numbers of people any patterns associated with enjoyment, pleasure and beauty," Pepe said. "For the first time, we have a way to capture activity in action and in context, in a real public setting, from many, many people from different backgrounds and demographics. That provides very valuable information that we can use to learn a little bit more about the brain and how the brain responds, in this case, to art."

Robleto's installation at the Menil Collection, "The Boundary of Life is Quietly Crossed," combined sculpture, historical recordings of heartbeats and brainwaves, and objects belonging to the museum. The inspiration for the exhibit originated with an early version of an artificial heart that Robleto studied as an art-research fellow at the Smithsonian Institute in Washington, D.C., which led to early recordings of heart and brain activity and interesting associated stories.

On his artistic journey into science, Robleto discovered the recordings of brainwaves and heartbeats belonging to Ann Druyan, executive producer and writer for the television series "Cosmos: A Spacetime Odyssey," just after she fell in love with Carl Sagan, famous cosmologist and author. Sagan included the recordings on the Golden Records that were among other contents in a time capsule launched beyond Earth's atmosphere aboard



the Voyager 1 space probe in 1977. Robleto found the consummation of art and science in NASA's project to reach unknown expanses of the universe with an encapsulation of humankind.

Although technology to detect emotion in EEG and EKG recordings did not exist on Earth, Sagan and Druyan hoped that some form of extraterrestrial life might find the Golden Records and have the means to decipher human love in her brainwaves and heartbeats. Almost 40 years later, the idea of extracting emotion from such recordings did not seem so outlandish to Robleto, and his search for technology led to Pepe.

Although the large-scale study is still underway, Pepe and his team developed computer algorithms to analyze the brain recordings in a subset of the 450 participants who found one particular work of art most pleasing. In unison with timing of their activities captured with local positioning devices, their answers to questions about their perceptions of the artwork and their demographics, the team mapped the neural networks engaged while the participants experienced aesthetically pleasing visual art. Appropriately, Robleto's scientifically inspired artistic installation and Pepe's artistically inspired scientific study crossed boundaries. Pepe recently submitted the first of a series of papers, which is currently in review.

"Beauty is in the eye of the observer, it's very difficult to define that," Pepe said. "We want to see if there is a pattern by looking at the brain activity generated at that moment – it will not lie to you, it's very dynamic. It's going to use sensory information, prior experience, and situational and emotional context as ways to generate these sensations, these judgments."

Pepe's groundbreaking Menil Collection collaboration led to funding to expand his research. With a recent NSF grant, he is partnering with the UH Blaffer Art Museum to map brain activity in thousands more subjects fitted with EEG skullcaps as they respond to still art. With an interactive exhibition, he also intends to explore patterns in the brain related to the process of creating art.

"We all create at some point, but we don't understand the mechanisms that make some

more creative than others – the people who innovate and see things in different ways," Pepe said. "We need a permanent collection where everyday people can go to contribute their data to science and be part of the exhibit."

Pepe and his team are extending their neuroaesthetic studies to other venues like the Children's Museum of Houston as well as to other artistic mediums, such as dancing.

Dancers open their minds for advanced understanding of expressive movement

Pepe is no stranger to visual and performance art. When the neuroscientist is not developing algorithms to analyze complex communication in the brain, he is designing pieces of contemporary stained glass and practicing the expressive movements associated with Spanish Flamenco dancing. He selected dance for his first dip into understanding brain mechanisms involved in aesthetic experiences.

In a 2014 collaborative paper that published in the *Frontiers in Human Neuroscience* journal, Pepe explored brain activity in dancers modulating functional movement to express messages. The partnership with dance professor Karen Bradley at the University of Maryland led to a collaborative demonstration with Becky Valls at the UH School of Theatre and Dance earlier this year. This semester, Pepe and Valls are expanding their partnership to study brain activity in dancers through monthly performances on the UH campus.

"Dancers want to communicate intent, an emotional state or a conceptual idea with expressive movement, so it goes beyond functional movement like walking, which has a purpose in terms of action," Pepe said.

For the University of Maryland project, Pepe fitted professional and amateur dancers with EEG skullcaps to record brain activity while they danced, and he developed computer algorithms to determine patterns of brain signals associated with specific expressive movements. He and his team determined 16 patterns related to different dance efforts, such as feeling light or heavy and moving quickly or slowly. By the end of the study, they could successfully predict the dancers' movements based on their brain activity alone.

"We were able to match the grammar of expressive dance with the grammar of emotional brain activity," Pepe said.

In February of 2015, Valls sported an EEG skullcap when she performed her mesmerizing composition, "Red Square," in the Jose Quintero Theatre on the UH campus. As Ravi Shankar's music played, she danced against a backdrop featuring projections of her brainwaves. Pepe used patterns of Valls' emotional brain activity to modulate the stage lighting in real time, so the environment evolved with the internal states of her brain.

This semester, Pepe and Valls are hosting dance performances each month on the UH campus. Pepe is recording brain activity in three types of dancers – the choreographer, the professional dancer and the amateur dancer – as they perform the same composition. He and his team are developing computer algorithms to analyze the differences in brain activity between deliveries of the performance art by dancers with varying levels of skill and creative input.

Neuroaesthetic studies of dance and visual art offer potential for understanding and developing therapeutic art treatments, but also provide potential for creating new types of media art installations and for teaching the arts.

"These are collaborations at the boundaries of art, neuroscience and engineering that could tell us a little more about the process of creating art – creativity – the process of understanding art, making judgments about art, and understanding how that processing, those judgments, are affected or modulated by your cultural background, your past training, your age and your life," Pepe said. "This is still an open question, and we're just starting, so we're very excited about the initial results we're getting."

To learn more about Contreras-Vidal's ongoing neuroaesthetics research projects, watch our video at https://youtu.be/eoJI19nlFAc

ARTS

THREE APPOINTED AS ENGINEERING ARTISTS-IN-RESIDENCE IN NEUROAESTHETICS

by Elena Watts

Three prominent visual artists, Dario Robleto, Jo Ann Fleischhauer and Lily Cox-Richard, were recently appointed Cullen College of Engineering Artists-in-Residence in Neuroaesthetics.

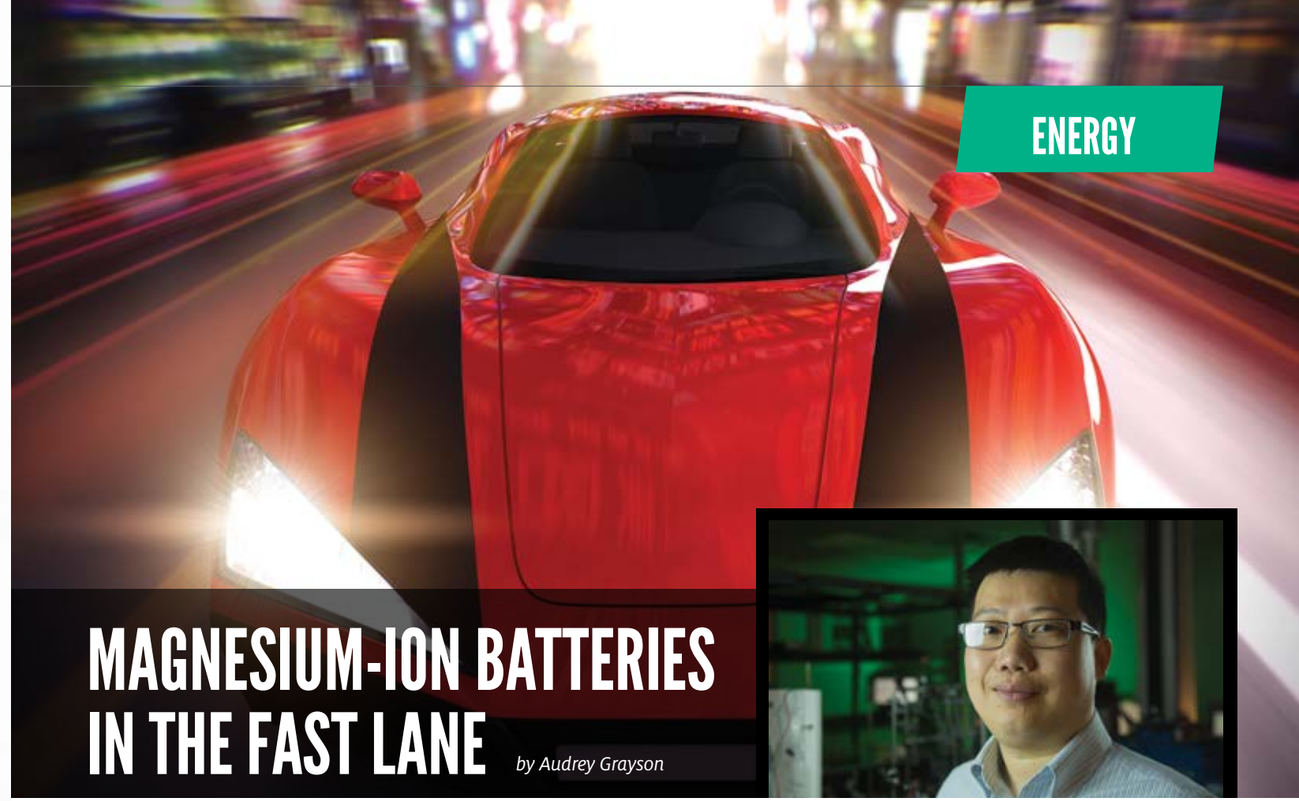
As part of a Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative project funded by the National Science Foundation, the artists are collaborating with **Jose Luis "Pepe" Contreras-Vidal,** UH Cullen College professor of electrical and computer engineering, on his scientific approach to the study of aesthetic perceptions of art and music.

The honorary positions provide the artists with access to Contreras-Vidal's laboratory, to university computer accounts and to university libraries, among other resources. The appointments also allow for more interaction between the artists and the engineering students and faculty members.

Robleto was also appointed the 2015-2016 Texas State Visual Artist (3-D), the state's highest recognition for excellence in the arts, by the Texas Commission on the Arts.

To learn more about Contreras-Vidal's ongoing neuroaesthetic research projects, watch our video at https://youtu.be/eoJI19nlFAc

Pictured: Dario Robleto



ENERGY

MAGNESIUM-ION BATTERIES IN THE FAST LANE

by Audrey Grayson

Yan Yao, assistant professor in the Cullen College's electrical and computer engineering department, is developing alternatives to popular lithium-ion batteries, which are used to power much of the modern world. Recent breakthroughs in this research were published in the journals *Nano Letters* and *ACS Applied Materials and Interfaces*.

Yao's batteries use magnesium ions instead of lithium ions, which are expensive and dangerous under certain conditions, as seen in recent media coverage of exploding hoverboards.

Magnesium-based batteries carry many benefits over their lithium-ion counterparts. Magnesium ions are safer, discharching twice as much energy as lithium ions without the risk of flammability or explosion. And magnesium is an earth abundant material, making it cheaper and more environmentally-friendly.

But magnesium ions also have some drawbacks. Namely, they move very slowly in traditional host materials due to the strong interaction between the magnesium ions and the negatively charged host lattices inside of the batteries.

"In the *Nano Letters* paper, we demonstrated for the first time an interlayer expansion approach to transform an inactive host into efficient magnesium storage materials," Yao said. The interlayer expansion was realized by inserting a thin layer of ionic conducting polymer into the layered materials' lattice, which boosts magnesium's diffusivity by two orders of magnitude.

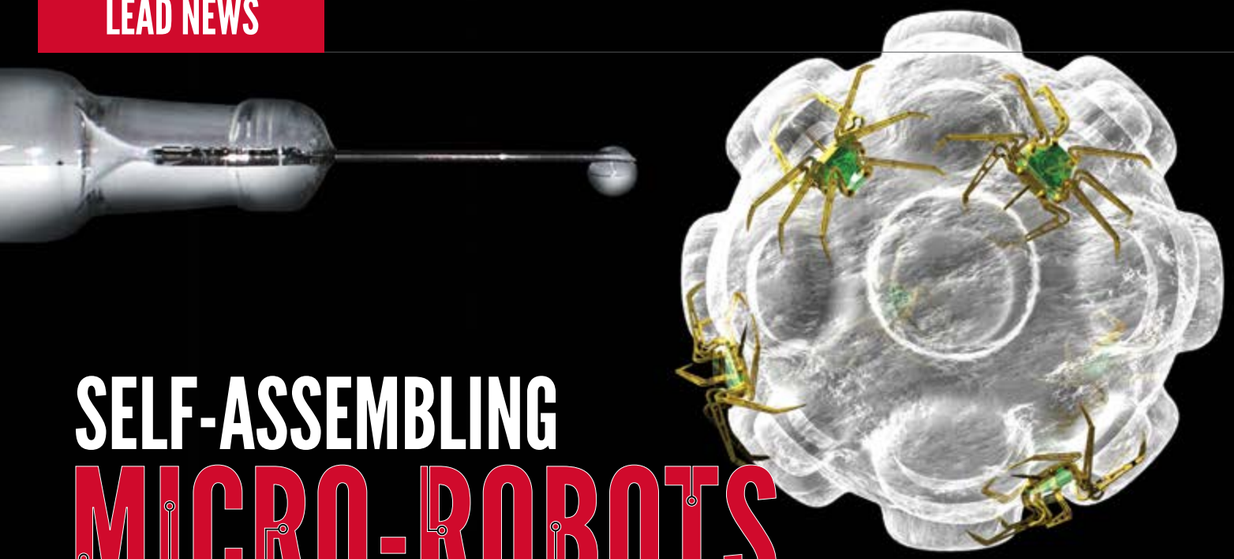
The interlayer expansion approach could be leveraged to a wide range of host materials for the storage of various ions, leading to novel intercalation chemistry and new opportunities for the development of advanced materials for next-generation electric vehicles, Yao said.

In the paper published in *ACS Applied Materials and Interfaces*, Yao reported another key advantage of magnesium-ion over lithium-ion batteries.

"The dendrite-free deposition behavior of the magnesium-metal anode at high current density condition ensures safe operation, which is considered the Holy Grail for beyond lithium-ion technologies," Yao said.

Yanliang Liang and Hyun Deog Yoo, both postdoctoral research fellows in the electrical and computer engineering department, were first authors of the two papers. Graduate students Yifei Li and Jing Shuai were coauthors on the papers. The work published in *Nano Letters* was in collaboration with Lars Grabow, assistant professor of chemical and biomolecular engineering at the Cullen College, professor Hector Calderon of the School of Physics and Mathematics at the National Polytechnic Institute in Mexico City, Mexico, and associate professor Francisco Hernandez from the UH College of Technology.

The magnesium ion research was funded by a grant from the U.S. Navy's Office of Naval Research Young Investigator Program (YIP) to develop safer and longer-lasting batteries for everything from electric vehicles to Navy vessels. In addition to research on magnesium-ion batteries, Yao and his team also work on aqueous-based batteries and sodium-ion batteries funded by the Advanced Research Projects Agency – Energy (ARPA-E) and the National Science Foundation, respectively.



SELF-ASSEMBLING MICRO-ROBOTS

COULD HEAL PATIENTS FROM THE INSIDE

by Elena Watts

Hydrocephalus is a nightmarish medical condition. Accumulating fluid in the skull ratchets up pressure on the brain and can cause lifelong mental disabilities. Current treatment requires physicians to cut through the skull and implant pressure-relieving shunts.

The necessary surgery is effective but invasive. For surgeries like these, science fiction authors have long dreamt of shrinking surgeons to mere millimeters to allow them to navigate interior passageways of the body instead of cutting large access holes. Arriving at problem sites, the fictional physicians might provide targeted drug delivery or surgical intervention.

Aaron T. Becker, assistant professor of electrical and computer engineering at the UH Cullen College of Engineering, is developing a robotic version of this micro-surgeon for conditions such as hydrocephalus to provide targeted drug delivery or surgical intervention.

Becker's conceptual research maps routes to problem sites on high-quality brain images using a clinical Magnetic Resonance Imaging (MRI) scanner. With colleagues at Harvard Medical School, he uses a hypodermic needle or lumbar puncture to introduce the tiny, maneuverable robotic components into the spinal canal, he hacks the MRI scanner to enable it to use its own magnetic field to direct the components to deliver medical interventions and he steers the components out of the body afterwards.

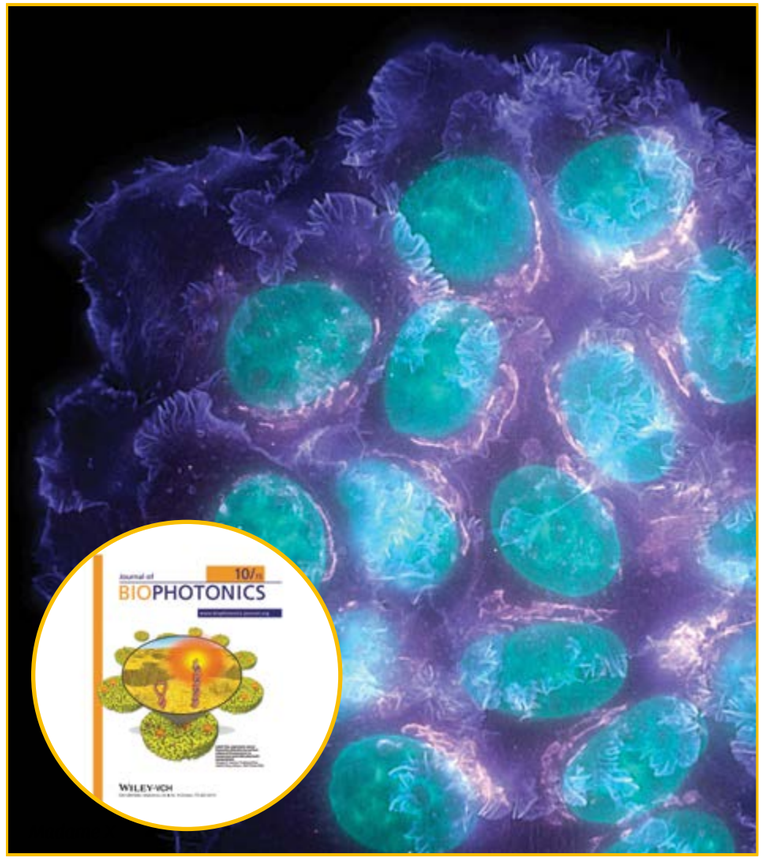
However, MRI scanners are not designed to push robots around, so they cannot apply enough force to pierce tissues or insert needles. A toy called a Gauss gun inspired Becker's solution. Spacing between linear magnets and steel balls stores potential energy that is converted to speed when the first ball hits the next, setting off a sequential reaction that fires each ball at increasingly higher speeds.

The medical robot operates similarly, but divides the Gauss gun into multiple components that individually navigate through the body. Each 3D-printed, high-impact plastic component contains two steel balls separated by a slender titanium rod spacer. Magnets are unnecessary because the MRI scanners magnetize the steel balls. One end component is a specialized delivery vehicle equipped with an 18-gauge needle tip used to pierce membranes or deliver drugs, and the other end component is the trigger.

> "SCIENCE FICTION AUTHORS HAVE LONG DREAMT OF SHRINKING SURGEONS TO MERE MILLIMETERS TO ALLOW THEM TO NAVIGATE INTERIOR PASSAGEWAYS OF THE BODY."

JOURNAL FEATURES BREAST CANCER DNA BIOMARKER SENSOR ON COVER

by Elena Watts



The October cover of the *Journal of Biophotonics* featured molecular sensing research conducted by **Wei-Chuan Shih,** associate professor of electrical and computer engineering at the UH Cullen College of Engineering.

The study describes the development and testing of a novel sensor based on surface-enhanced fluorescence (SEF). The sensor provides a more economical and convenient means for detection of sequence-specific DNA biomarkers, challenging the current gold standard, polymerase chain reaction (PCR), which is labor-intensive, time-consuming and costly. Specifically, Shih's SEF sensor possesses recognition elements that can signal the detection of a breast cancer DNA biomarker with sensitivity in the attomole range.

Unlike PCR, the SEF sensor does not require time-consuming duplication of trace amounts of the DNA biomarker. Instead, light-excited localized surface plasmon resonance (LSPR) on the surface of a special gold nanostructure provides the needed signal amplification. The gold nanostructures, known as nanoporous gold disks (NPGDs), were first prepared by Shih's group in 2012. Their findings on NPGDs were featured on the cover of *Nanoscale* in 2013.

The NPGD features a tunable diameter between 100 and 1,000 nanometers, a thickness from 50 to 100 nanometers, and a three-dimensionally distributed porous network with 10-nanometer pores. The disk drastically enhances the electrical field, and consequently, the ability to amplify optical signals near the surface. The hierarchical nanostructural architecture is unique among all plasmonic nanoparticles.

In 2014, Shih published a paper that described the use of NPGD for breast cancer DNA biomarker detection via surface-enhanced Raman spectroscopy (SERS), another highly sensitive technique for molecular sensing. They demonstrated the detection of single, individual DNA biomarkers when the sensor recognized them.

Shih's sensors enable sensitive and rapid DNA sequence detection down to the single-molecule level without the need for PCR and its associated sample preparation. The sensors can potentially enable faster and more affordable DNA biomarker detection at resource-limited settings and point-of-care facilities.

"Bypassing PCR, which is the process of reproducing large amounts of targeted molecules for analysis, our sensors can operate at an extremely low count of DNA copies – from one to a few hundred," Shih said.

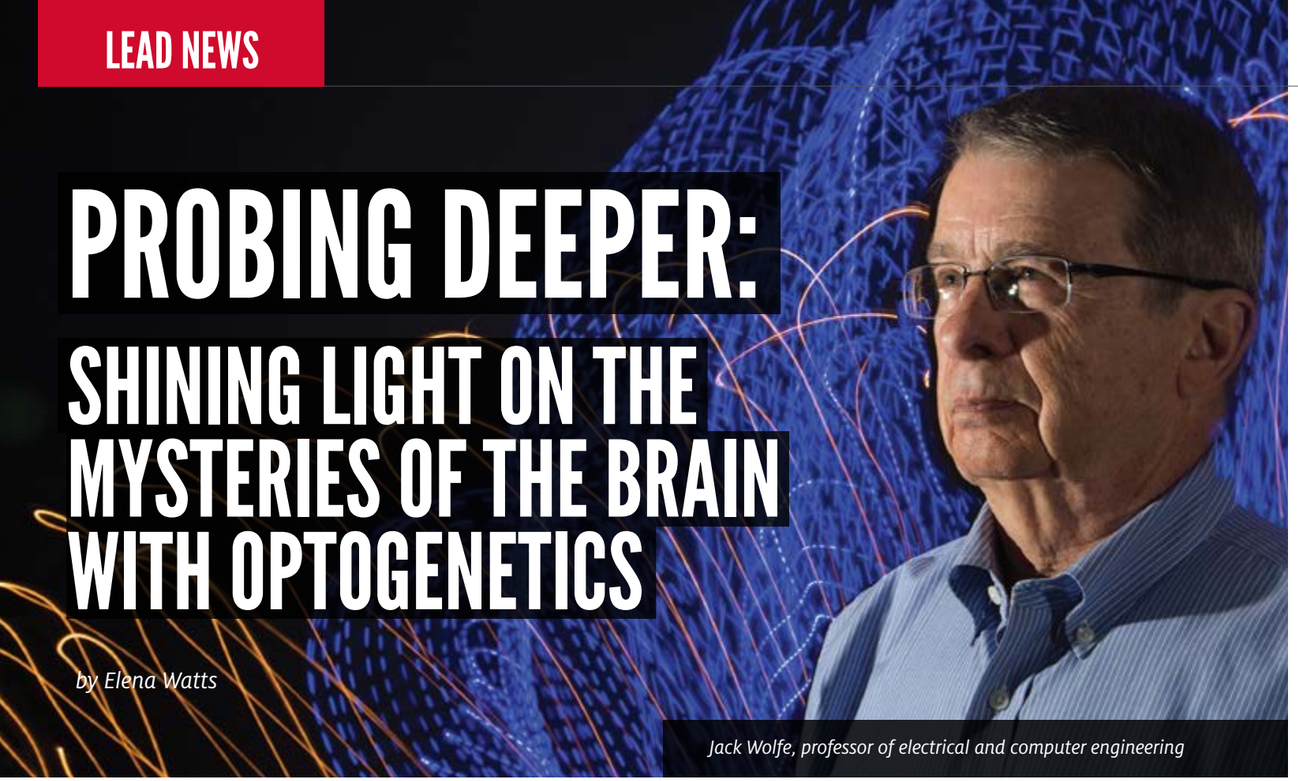
Commercialization of these sensors could benefit clinics around the globe where women are examined for breast cancer, especially in poor countries where costly PCR is not an option and shipping DNA samples cross-country is unrealistic.

"You have to be able to conduct a highly sensitive test right there without sophisticated instrumentation and skilled laboratory personnel," Shih said. "Optical instruments are much less demanding in terms of environment – they're less expensive and more portable."

PROBING DEEPER:

SHINING LIGHT ON THE MYSTERIES OF THE BRAIN WITH OPTOGENETICS

by Elena Watts



Jack Wolfe, professor of electrical and computer engineering

A scientific breakthrough that combines optics and genetics provides researchers with unprecedented insight into one of life's most challenging puzzles – the human brain.

Coherent processes in the brain that prompt unconscious movements such as walking with seamless fluidity are complex enough that they have remained somewhat mysterious. Methods for tracking singular conversations among the hundreds of thousands of neurons necessary to perform even the simplest body movement remained elusive until 2005, the year *Nature Neuroscience* journal published the first paper on optogenetics.

The ability to manipulate targeted neurons within specific neural circuits in the human brain – important in understanding the organ's overall function – has spawned studies around the world. One such groundbreaking research project is in full swing at the University of Houston Cullen College of Engineering.

Jack Wolfe, professor of electrical and computer engineering at the Cullen College, is leading an effort to develop a new tool for optogenetics. Wolfe's collaborators are Wei-Chuan Shih and Ji Chen, also UH electrical and computer engineering professors, Valentin Dragoi, professor of neurobiology and anatomy at UT Medical School-Houston, and a cadre of talented graduate students.

Fabrizio Gabbiani at Baylor College of Medicine, John A. Dani at the University of Pennsylvania, and particularly, Gopathy Purushothaman, formerly with Vanderbilt University, provided Wolfe with neuroscience mentorship in the early stages of the project.

The implantable neural probe delivers light to photosensitive neurons in deep regions of the brain and simultaneously records and maps their optically-stimulated electrical signaling. The tool can provide a more detailed understanding of the neuronal networks near the probe to help researchers answer basic questions about microscopic structures in the brain. The project, which is supported by a $425,000 grant from the National Institutes of Health and additional funding from the Cullen Foundation and the Texas Center for Superconductivity, relies heavily on the unique toolset developed in the UH Nanosystem Manufacturing Center, directed by Wolfe.

Primitive meets modern to shine light on age-old brain

Remarkably, primitive microorganisms that form slimy green coatings on pools of still water make a modern scientific method possible. Optogenetics uses tools of molecular biology to insert a gene from green algae, a unicellular photosynthetic plant, into the neurons of living, freely behaving animals. Whether in a plant or a neuron, the gene enables the cell to produce a protein that detects light and generates electrical impulses by opening ion channels in the cell wall. In algae, these impulses move the cell toward regions of higher light intensity to increase photosynthesis. In neurons, the impulses are transmitted to each of the neurons that normally receive inputs from the photo-activated cell.

"The journey of optogenetics shows that hidden within the ground we have already traveled over or passed by, there may reside the essential tools, shouldered aside by modernity, that will allow us to map our way forward," wrote Karl Deisseroth, a leading developer of optogenetics, in a 2010 *Scientific American* article. "Sometimes these neglected or archaic tools are those that are most needed – the old, the rare, the small and the weak."

For 60 years, scientists have known that inducing electrical currents to flow in a region of the brain known as the lateral hypothalamus, LH, can trigger overeating in well-fed mice. It was concluded that the LH drives the primal functions, which include sexual activity and aggression in addition to eating. Exactly how the current induced overeating was not clear since electrical stimulation activates many different types of neurons both inside and outside the LH.

A 2013 *Science* magazine article describes the use of optogenetics to pinpoint the neurons that provide the triggering input to the LH that causes overeating. Their hypothesis was that neurons in a region bridging the amygdala, responsible for emotion, and the LH could provide the spark. They tested their hypothesis by sensitizing just those neurons to light. As anticipated, shining a light on the cells induced overeating in well-fed mice. A surprising video that accompanies the paper shows the mouse's overeating switched on and off by the light.

Electrical stimulation experiments helped determine the region of the brain that drives eating, but optogenetics was the key to identifying the specific neurons that trigger it. The study shows that a biological mechanism, not a lack of discipline, is responsible for binge eating and that potential exists for the development of drugs to target the pinpointed nerve cells to control binge eating and other disorders.

Among numerous accolades, the prestigious journal *Nature* named optogenetics the 2010 Method of the Year and Denmark's Lundbeck Foundation split the $1 million Brain Prize between six of the method's developers in 2013, which could serve as indicators of events to come. Murmurs circulating in scientific circles suggest that lead developers of the new technique might one day meet the King of Sweden and walk away with 3-inch solid gold medals. Many expect the scientific breakthrough to win a Nobel Prize.

"We find meaning for the modern world – not just for science, but also for medicine and psychiatry – that makes a strong and clear statement for environmental protection, for preservation of biodiversity and for the pure quest for understanding," Deisseroth wrote in the same magazine article about his discovery.

> "[THIS PROJECT] WILL PROVIDE A USEFUL PUSH FOR NEUROSCIENCE AND TECHNOLOGY."

Wolfe joins hunt for better tools to explore the brain

The brain integrates the information generated by the sensory organs to build an internal model of the external environment. This is carried out by neurons, cells that process the inputs they receive from local and long-range connections and send outputs to other neurons. In the visual system, which is the focus of this study, retinal cells encode the visual image as electrical impulses that travel from neuron-to-neuron to a switching center in the middle of the brain. From there, information flows through a complex network to the visual cortex where a mental image is formed. Thus, understanding the visual system requires the ability to probe electrical activity in deep as well as shallow brain structures.

Mapping these circuits is typically done by stimulating a population of neurons chemically, electrically or optically, and recording the resulting spike activity with an array of electrodes on an implanted probe. Probes may be planar blades or cylindrical needles. Planar probes can accommodate large, 24-to-48 electrode arrays at very low costs by leveraging semiconductor manufacturing technology. However, this approach is suitable only for flat substrates, not the curved surfaces of cylindrical probes. Because of this limitation, most cylindrical probes today have only four electrodes.

Wolfe has developed a powerful technique to fabricate dense electrode arrays on fine cylindrical substrates, thereby providing the design flexibility of planar probes in the cylindrical format required for deep brain applications. His approach is like printing letters on a pipe using a stencil and a can of spray paint – except the stencil is a thin membrane with etched open windows and the spray paint is a beam of energetic ions.

"These are not run-of-the-mill flat substrates we're printing on, which would make tools used to manufacture them ubiquitous," said Apeksha Awale, electrical and computer engineering graduate student and research assistant to Wolfe for five years. "It is difficult to print electrodes 2 microns wide on a cylinder."

An optical fiber as thin as a single strand of human hair, about 60 microns, serves as the base material for Wolfe's neural probe. The fiber is pointy enough at one end to penetrate brain tissue, long enough to reach the core of the brain and flexible enough to sway with the organ to activities as subtle as breathing. With modified integrated circuit design technology, Wolfe prints approximately 70 electrodes, each 5 microns wide, in dense

tiers at varying depths around the diameter of the fiber.

"We are developing a very dense electrode pattern that no one has ever produced because it can provide a very detailed map of the active neurons in the neighborhood of the tip of the probe," Wolfe said. "The real sweet spot for this technology is the thalamus – trying to understand parts of the circuitry that are very deep inside the brain."

The UH team produced a prototype of the probe that Purushothaman tested in nonhuman primates to study the brain's vision system. This led to their most recent design, which has the high electrode count necessary to pinpoint the photo-activated neurons.

"Activating a region anywhere in the visual system circuitry enables us to observe the signals that propagate downstream," Awale said. "We can follow the impulses generated by the neurons as they travel through the neural circuitry."

Neural probes are not built in a day

Before the manufacturing began, Awale, graduate student Pratik Motwani, and Mufaddal Gheewala, their predecessor in Wolfe's lab who has since graduated and gone to work at Intel, helped to build the hardware and tools that make printing dense patterns of electrodes on cylindrical surfaces possible.

"The research assistants are learning techniques beyond integrated circuit manufacturing, though they're all derived from the same principles," Wolfe said. "I would hope to stimulate some of them to enter the neuroengineering field and solve some of the big problems that are still open."

Manufacturing the probes raises challenges – mainly cost and time associated with production – that are entirely different from those encountered in research. The graduate students are currently refining processes to maintain optimal efficiency and reliability of the probes during mass production.

Wei-Chuan Shih, associate professor of electrical and computer engineering

"We won't produce anything we can't mass manufacture, because what's the point if you can only make one a year," Awale said. "And we must be able to manufacture enough of them to bring the cost down and build a market for them."

Wolfe and his assistants have developed tools and methods to manufacture 50 neural probes at once, and they have filed patents for their most important technological advancements. They expect to demonstrate the probe's manufacturability this year.

"We ought to be able to make all the probes as good as the best probe," Wolfe said.

Collaborators join Wolfe's research pack

Initially, Wolfe intended to print high-density patterns of electrodes on wire for recording neuronal activity rather than optical fiber for activating and recording. He replaced the base material for his neural probe in 2009 when Shih, an optics engineer, arrived at the University with ideas about optogenetics. Because optics technology was already mature, Shih suggested Wolfe use optical fiber as the substrate to instantly achieve half of the probe's function, delivering light stimulation to sensitized neurons.

"We had lots of interesting meetings where we collaborated on how to make these things, and some of the early work that is still very important was developed jointly during these discussions," Wolfe said. "You have to know where the light is going, and its intensity at different distances from the tip, so Shih would be the one to design that type of probe."

A novel probe design evolved out of these meetings for an optrode that encapsulated a twisted-wire tetrode, a traditional four-channel probe, in a capillary tube. Easy to make, the invention made it possible for anyone making electrical recordings with tetrodes to produce a tool for optogenetics. The idea was published in *Optics Letters* in 2012.

While Wolfe began applying his prior research to the new substrate, a possibility because both were cylindrical, Shih and his graduate student, Arnob Masud, began building a 3D model to analyze the power and intensity of the light in the brain tissue ahead of the fiber tip.

"Mapping light-brain interaction – writing code to understand how light is scattered and distributed from the excitation point and how it interacts with brain tissue – is very challenging for us," Masud said.

Chen, their Cullen College colleague with expertise in modeling electromagnetic waves, especially in the biological sphere, joined the project to make sense of the immense amounts of data the Houston probe can generate. He and his graduate student are developing an algorithm to precisely map the patterns of electrical impulses emitted by the sensitized neurons.

Next year, neurobiologist Valentin Dragoi plans to begin testing the latest version of the neural probe on nonhuman primates, the modeling system genetically closest to humans. In his UT Medical School lab, his intention is to excite and record large-scale neuronal activity while primates perform behavioral tasks.

"Substantial progress has been made in rodents in the experimental world," Dragoi said. "In primates, less is known about the ability of neurons to respond to optical stimulation and the control of behavior using optogenetic stimulation."

Wolfe's probe offers flexibility and large-scale recording of neural populations not available with existing state-of-the art technology, such as chronic implants. Dragoi can position the Houston Probe, or many of them, in different regions of the brain daily to record fresh, active neuronal activity with minimal damage to brain tissue. Implantable probes are printed with about 100 electrodes for large-scale neuronal recording, but remain fixed in one location, cause micro-bleeding at the penetration site and destroy neurons within months, resulting in a steady decline of signal recording.

"Essentially, Wolfe wants to develop his probe with our feedback, and we'll test them, so it's a handshake project that will provide a useful push for neuroscience and technology," Dragoi said.

Better treatments for brain diseases

By mapping the ways billions of neurons interact through trillions of connections in the human brain, researchers hope to find better treatments for incurable brain disorders, such as Alzheimer's disease, Parkinson's disease, epilepsy and depression.

"Ultimately, the goal is to map brain circuits to understand how they work with the idea that if we have all that information, and we have something not working right, we can develop a therapy to address it," Wolfe said.

In the meantime, while the field of neuroscience is still in its infancy, the National Institutes of Health, one of the federal BRAIN Initiative's lead institutions, has urged scientists to shift their research approaches from practical to theoretical, like physicists who study the pure science behind particle collisions rather than practical applications for them, Dragoi said.

"We may not understand precisely how the brain works in our lifetime, but we can uncover fundamental principles applicable to sensory, memory, language and other systems," Dragoi said. "The benefits will come, but they will take time."

Despite lengthy lab-to-clinic approval processes for new medical technology, optogenetics could eventually benefit patients with drug-resistant brain disorders whose only approved treatment options are currently electrical and chemical stimulation.

With optogenetics, physicians could excite targeted neurons without disrupting others, alleviating negative side effects experienced by patients who undergo less accurate treatments. Furthermore, the new method does not seem to harm the neurons like the existing methods.

"While the benefits of electrical and chemical stimulation outweigh the drawbacks for some patients with drug-resistant brain diseases, injecting electrical currents into the brain is still detrimental," Awale said. "Optogenetics is potentially a more benign way to stimulate activity in the brain for treatments of these disorders."

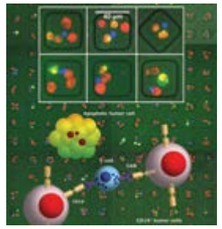
Wolfe's neural probe also shows promise for examining microcolumns, vertical arrangements of about 100 interconnected neurons that form 30-micron diameter structures prevalent in the outer layer of the brain called the cerebral cortex. Researchers have noticed potential links between abnormalities in microcolumn structures and patients with aging and diseased brains, but questions have remained unanswered because probes capable of exploring such small structures have not existed – until now.

"Our probe is very small in diameter, so we hope to observe communication that controls activity in these structures," Awale said. "It's terrible to have a disease of the brain and not understand what causes it or how to treat it, and this gives us a better chance for therapies – that's the motivation for the whole project."

To learn more about Wolfe's ongoing neural probe research, watch our video at https://youtu.be/AceXKhfS21k

UH ENGINEERS DEVELOP ADVANCED CELL SCREENING TECHNOLOGY FOR CANCER IMMUNOTHERAPY

by Jeannie Kever


Pictured (from left): Navin Varadarajan and Badri Roysam

Researchers have created a new method for screening cells used in immunotherapy cancer treatments, allowing high-performing immune system cells to be studied in isolation and potentially expanding the number of patients for whom the breakthrough treatment proves successful.

Engineers from the University of Houston, working with physicians from the University of Texas M.D. Anderson Cancer Center, describe the method – Time-lapse Imaging Microscopy in Nanowell Grids, or TIMING – and its ability to more accurately analyze large numbers of cells for use in the cancer therapy, in a paper published in *Bioinformatics*. They also demonstrated its potential in research evaluating how effective various types of T cells – a type of white blood cell key to fighting infection – are in killing cancer cells. Papers on that work were published last year in *Cancer Immunology Research* and in *OncoImmunology*.

"This is a case of biologists, clinicians and computer scientists coming together toward a common purpose," said **Badri Roysam,** chairman of the UH Cullen College of Engineering's department of electrical and computer engineering and lead author of the *Bioinformatics* paper.

He and Navin Varadarajan, assistant professor of chemical and biomolecular engineering, collaborated with M.D. Anderson's Laurence J.N. Cooper on the research, along with a number of other UH researchers.

Clinical studies have reported life-saving results from cancer immunotherapy, a biological therapy which uses the immune system – or specific cells of the immune system – to fight cancer. But they don't work for everyone, not even everyone with one of the cancers for which the treatments have proven most successful.

TIMING could change that by allowing researchers to study many more interactions between immune cells and cancer cells, thanks to its ability to automatically analyze thousands of cell interactions at a time. Conventional analysis is done manually, the researchers said, making it impossible to study every combination.

Most conventional methods assess a limited number of samples from a test – between 10 and 100, compared with the 10,000 or even 100,000 samples that can be assessed with the new method, according to the paper. That matters, the researchers wrote in *Bioinformatics*, "since many biologically significant cellular subpopulations like tumor stem cells, multi-killer immune cells and biotechnologically relevant protein secreting cells, are rare."

With TIMING, a nanowell grid – an expandable structure – allows discrete samples of immune cells and cancer cells to be confined and studied over time using time-lapse video recording.

"We've developed a game-changing piece of software that can accurately analyze an entire grid of nanowell videos and make quantitative measurements," Roysam said.

It is essentially, he said, "the combination of a supermicroscope and a supercomputer to screen cell-to-cell interactions on a large scale."

"The proposed algorithms dramatically improved the yield and accuracy of the automated analysis to a level at which the automatically generated cellular measurements can be utilized for biological studies directly, with little [or] no editing," the researchers wrote.

Varadarajan said the system allows "high-performing outliers" to be identified for further research. Several types of immune cells were used, including T cells, CAR cells – T cells modified with chimeric antigen receptors, which allow them to hone in on and kill cancer cells –and what are known as NK or "natural killer" cells, which can detect tumors without modification.

Researchers used both leukemia cells and melanoma cells in their testing.

"If you know the best cells (to fight a particular cancer), it just becomes a manufacturing problem," Varadarajan said. "But right now, we don't always know which cells are the best."

Using the TIMING system, the researchers have deepened the scientific understanding of immunotherapy, including how different types of T cells function against cancer cells. As a result, they demonstrated for the first time at a single-cell level that CD4 T cells directly participate in the killing of multiple tumor cells.

CD8 T cells are known for their tumor-fighting properties, but Varadarajan said the finding, published in *Cancer Immunology Research*, suggests that CD4 cells also would be effective. Research on this question is ongoing.

MINECRAFT-PLAYING KIDS CONTRIBUTE TO GROUNDBREAKING BRAIN RESEARCH AT UH

by Audrey Grayson

Thousands of visitors flocked to the Children's Museum of Houston last August to play the top selling video game *Minecraft* while contributing to invaluable ongoing brain research at the UH Cullen College of Engineering.

A team of Cullen College students led by **Jose Luis Contreras-Vidal,** Hugh Roy and Lillie Cranz Cullen University Professor of electrical and computer engineering, collected brainwave data on hundreds of children while they played *Minecraft* at the museum.

"Once we analyze the data it will likely show there's a heightened connectivity and heightened attention span that is given to the game," said Anastasiya Kopteva, an undergraduate electrical and computer engineering student who assisted with the event. "We are bringing more science to the idea that video games can actually be beneficial."

Contreras-Vidal, who also serves as the director of the UH Non-Invasive Brain Machine Interface Systems Laboratory, said the ultimate goal of this research is to map as much of the human brain as possible. His laboratory specializes in the development of robotic exoskeletons that can help patients with mobility impairments such as paralysis to regain control of their limbs using only the power of their thoughts.

By the end of the event, Contreras-Vidal and his team had collected data on over 400 children while they played the video game.

Watch our video of the "*Minecraft* Mayhem!" event at the Children's Museum of Houston at www.egr.uh.edu/video-minecraft-brain

> "WE ARE BRINGING MORE SCIENCE TO THE IDEA THAT VIDEO GAMES CAN ACTUALLY BE BENEFICIAL."

NEW METHODS FOR LESS-INVASIVE KIDNEY DISEASE DIAGNOSTICS

Wei-Chuan Shih

Chandra Mohan

by Audrey Grayson

Two UH engineering professors have developed novel optical probes with potential applications in improving diagnosis and treatment for patients with kidney disease. Exciting new results on the two probes were recently published in *Biomedical Optics Express*, the flagship journal of the Optical Society of America, and the *Journal of Biophotonics*, another top journal in this field published by Wiley.

Wei-Chuan Shih, assistant professor of electrical and computer engineering, and **Chandra Mohan,** Hugh Roy and Lillie Cranz Cullen Endowed Professor of biomedical engineering, began collaborating just over a year ago. Shih's expertise is in molecular sensing using light-based sensing technologies such as optical probes. Mohan is a renowned expert on the genomics and proteomics of lupus and other autoimmune diseases; the central goal of his research is to find new biomarkers and targets for treating these diseases.

Although their research interests may not appear so compatible at first glance, the two professors realized an ideal partnership in one another. Shih's optical probes – which have been used for applications ranging from non-invasive glucose monitoring to detecting bacteria and sensing environmental hazards such as oil spills – can also function as a less invasive method of determining creatinine levels in patients with kidney disease.

One of the most common organs to be attacked by lupus is the kidney, manifesting in lupus nephritis. An estimated 40 percent of lupus patients develop this condition, which causes inflammation of the kidneys, impairing their ability to get rid of waste products and other toxins from the body effectively. Lupus nephritis is a leading cause of lupus-related deaths and results in tens of thousands of hospitalizations per year.

In order to track the kidney health of lupus patients, physicians must closely monitor the levels of creatinine, a chemical waste molecule, in the patients' blood and urine streams. Creatinine is a fairly reliable indicator of impaired kidney function; as a patient's kidneys become more impaired, the creatinine levels in the patient's blood will increase.

"Currently, patients need to go into a doctor's office or hospital to provide blood and urine samples. Doctors then use a chemical assay to determine creatinine levels in the patient's blood and urine, and those are expensive and time consuming," Mohan said.

"More importantly, a patient can't assay these at home, for sure," he added.

Shih's optical probe, however, provides a cheaper, faster and less invasive alternative for monitoring a patient's creatinine levels. The probe is made up of a biochip integrated with a gold plasmonic nanostructure consisting of light-excited electrons. Plasmonics enables very strong light-matter interactions near the surface of these gold nanostructures, which Shih said will allow certain "hotspots" on the biochip to interact with nearby molecules.

Based on how excited the electrons become – that is to say, how much they oscillate in response to a certain interaction – Shih develops "fingerprints" of various molecules.

Because creatinine has a unique Raman scattering signal, Shih said the optical probes can detect creatinine levels with far higher sensitivity than the chemical assay tests that are currently used to quantify creatinine levels in urine or blood. Moreover, the probe only needs a tiny sample of urine – 5 microliters to be exact – to provide an accurate read of creatinine levels in a matter of seconds.

The increased sensitivity of this probe could allow for earlier detection of renal impairment and earlier intervention for patients with kidney diseases, Mohan said.

The ultimate goal of this research is to miniaturize the probe so that patients can purchase it over-the-counter and monitor their creatinine levels at home.

Applications for the optical probe could be expanded beyond renal disease, but the researchers said more work needs to be done before the probes are available to patients.

Shih and Mohan published this study as an open access paper titled, "Reagent- and separation-free measurements of urine creatinine concentration using stamping surface enhanced Raman scattering (S-SERS)," in the January 2015 issue of *Biomedical Optics Express*.

In another study, published in the *Journal of Biophotonics*, Shih and Mohan outline a novel method for using Raman spectroscopy to provide diagnostic information on kidney conditions.

Currently, physicians rely on an invasive procedure called a renal biopsy, or kidney puncture, to directly observe a patient's kidney function. In addition to potential side effects, renal biopsies cannot be repeated serially because of the damage it causes to the kidney tissue. Shih and Mohan believe the optical probes they developed can offer a far less invasive alternative for diagnosing kidney disease.

In this study, Shih and Mohan did not have a specific molecule or biomarker, such as creatinine, that they were looking to identify using Raman scattering. What they did have, however, was the knowledge that a diseased kidney and a healthy kidney give off two different Raman signals.

Using mouse models with induced kidney disease, Shih and Mohan were able to use the optical probe to differentiate between a healthy and a diseased kidney without puncturing the organ's tissue. Shih's research team developed a metric to broadly quantify the level of disease using the Raman scattering signals.

"We are proposing the nephrologist will puncture the patient's skin, go to the surface of the kidney, and not puncture kidney, but probe the surface of the tissue and acquire Raman signals," Mohan said. "The patient will feel a little pinch and poke through the skin, but the kidney is not hurt at all."

The morbidity and mortality associated with the optical probe would be significantly less than the kidney puncture procedure. Shih and Mohan urged that more research is needed before the optical probe can replace the kidney biopsy for patients with renal disease.

"We hope that the Raman signals on the surface of the kidney are as good as a microscopic pathology, but we don't know yet," Mohan said. "The next step is to see if spontaneous models of lupus kidney disease can also be accurately diagnosed using the Raman probe."

HEALTH & MEDICINE

ENGINEER IMPROVES DIAGNOSTIC TECHNIQUES FOR PATHOLOGISTS

by Elena Watts

When performing diagnoses, pathologists rely heavily on qualitative chemical staining techniques that date back to the 19th century to detect signs of disease in tissue biopsies, to serve as bases for treatment plans and to measure disease progression in patients.

Medical schools train physicians extensively to recognize microscopic molecular and structural abnormalities using colorful patterns created when chemical stains are applied to tissue samples.

"Chemical staining has disadvantages, though," said **David Mayerich**, assistant professor of electrical and computer engineering at UH Cullen College of Engineering. "The method is sensitive to many factors that are difficult to control, so pathologists in different labs can get different results when they analyze the same tissue sample."

In a collaborative project, Mayerich has developed a technique to produce digital versions of popular chemical stains, relying instead on quantitative molecular information collected using mid-infrared light. Their research published in the journal *Technology* last March. The team hopes to provide technology that can either complement or replace current chemical staining, resulting in more reliable histopathological diagnoses and fewer mistakes.

Mayerich, who joined the UH faculty in 2014, arrived with a three-year, $750,000 grant from the National Institutes of Health that he earned as a postdoc at the University of Illinois. He has since earned an additional $2 million grant from the Cancer Prevention Research Institute of Texas to continue his scholarly pursuits. The collaborative project includes Rohit Bhargava, professor of bioengineering at the University of Illinois at Urbana-Champaign, and Michael Walsh, professor of pathology at the University of Illinois at Chicago, among other researchers.

The primary focus of the project is cancer detection in needle biopsies, Mayerich said. Currently, pathologists place tissue samples in wax blocks and dye sections with contrasting stains, such as hematoxinylin-eosin (H&E), to examine them for molecular features and patterns.

Uniformity is difficult to achieve in histopathology because of the complicated chemical processes, Mayerich said. Some laboratories use automated systems that attempt to support pathologists by achieving color consistency in application of chemical stains to tissue samples. However, numerous variables that are difficult to control still influence results, and diagnoses of the same tissue sample by different pathologists can vary.

Mayerich and the other researchers aim to diminish or eliminate the detrimental effects of variables, such as different environments and tissue preparation methods, inherent in chemical staining.

"We want to duplicate these chemical stains digitally to enable pathologists to use their years of training and experience with better results," Mayerich said. "The goal is to replace chemical stains whenever possible with digital versions that give pathologists information that they can trust more."

The researchers are simultaneously developing an automated, quantitative system for disease detection. They are utilizing mid-infrared microscopy to identify and classify exact chemical compositions of various tissues to which they can apply their universal digital stains.

"We shine beams of light through the tissue samples to determine their chemical composition, so we expect the same diagnoses when we apply digital stains to the same tissue images at different labs," Mayerich said. "We get very accurate results based on tissue classification, so the results are very promising."

Unlike the chemical staining technique that destroys tissues, digital staining allows pathologists to apply different stains repeatedly to the same samples. Reliability and repeatability of histopathological diagnoses are the main focuses of the research, but the technology could also save laboratories costs associated with expensive chemical stains and specimen storage and spare patients the additional expense and discomfort of multiple biopsies.

"After initial equipment investments, the staining is basically free for laboratories," Mayerich said. "They purchase the instrumentation that measures data, and they store the results on computer systems that are backed up so they never worry about losing them."

In the past, mid-infrared imaging required too much time to make much mainstream progress, but new, speedy laser instrumentation could remove that barrier. The University of Houston is acquiring mid-infrared imaging systems to aid Mayerich with his software development.

"I believe that recent advances in instrumentation combined with continued increases in computer resources are pushing this technology to the point where it can be clinically viable in the near future," Mayerich said.

MATERIALS

UH ENGINEERS DISCOVER SUPERIOR METALLIC MONOLAYER CATALYST

by Audrey Grayson

Researchers at the UH Cullen College of Engineering have synthesized and characterized a novel metallic monolayer catalyst with far superior catalytic properties than those currently used in industry.

Stanko Brankovic, professor of electrical and computer engineering, and **Lars Grabow**, professor of chemical and biomolecular engineering, published their findings in a special issue of the journal *Surface Science*. Out of the over 25 papers chosen for publication in the special issue, Brankovic and Grabow's paper, titled "Novel 2D RuPt core-edge nanocluster catalyst for CO electro-oxidation," was chosen as the journal's featured cover story.

Brankovic and his Ph.D. student, Qiuyi Yuan, successfully synthesized nanostructures with catalytic properties far superior to currently available industrial catalysts.

The core of Brankovic's idea was to create a two-dimensional monolayer made up of clusters of one metal, such as ruthenium, with a perimeter made up of another metal, such as platinum.

After confirming the remarkable catalytic properties of the material, Brankovic recruited Grabow, whose primary research interest is in running complex computer simulations to predict how and why some catalysts perform better than others in certain chemical reactions.

"Lars had a hunch that the reason this material performs so well as a catalyst is due to the finite size effect," Brankovic said.

The finite size effect relates to the bonds that form between atoms in a cluster. In a body of atoms, the atoms in the center of the cluster form strong bonds with the surrounding atoms. Atoms located on the periphery of the cluster form weaker bonds because there are no atoms on the other side to keep them in equilibrium.

Grabow, along with his graduate student Hieu Doan, began running computer simulations to try to identify structures that could obtain extremely favorable catalytic properties due to the finite size effect. Using theoretical calculations to test their hypothesis, Grabow and Doan confirmed that the finite size effect contributed to the materials' catalytic qualities.

"They found that the finite size effect in this particular system is huge and leads to reconstruction of the whole cluster, where the morphology of the monolayer has ripples," Brankovic said.

The unique ripples in this system have positions for higher energy absorption and lower energy absorption, Brankovic added. "This leads to a net spectacularly high catalytic effect, so the finite size effect in particular systems such as this one can promote catalytic properties that until now have not been understood."

After characterizing precisely what was happening inside of the metallic catalyst, Brankovic, Grabow, Yuan and Doan tested the material in carbon monoxide oxidation. The team used spectroscopy to measure the absorption energetics in the reaction.

"It turned out that everything Lars and Hieu had calculated was reconfirmed in these tests," Brankovic said.

In addition to discovering a new method of synthesizing monolayer metallic catalysts, Brankovic and Grabow noted that this research represents a turning point for monolayer catalysis in general.

"Many catalysts can do the job, but chemical reactions can go many different pathways," Brankovic said. "This particular structure of catalyst takes a pathway in the chemical reaction that has the most desired outcome, with better activity and selectivity."

Although the researchers noted that more fundamental research is needed in this area, they hope that in the future these catalysts can be used for methanol or ethanol fuel cells as well as synthetic oxidation, such as the conversion of natural gas to methanol.

Both Brankovic and Grabow are winners of prestigious National Science Foundation CAREER Awards, which helped partially to fund this research. Funding for this work also came in the form of a University of Houston GEAR Award for both researchers, which offers seed funding to young researchers looking to get projects inside their laboratory off the ground.

"There's a lot left to do in this area, and we hope to continue working on this. Our ultimate hope is to attract more funding to continue this work," Brankovic said.

To access the full article, please visit: www.sciencedirect.com/science/article/pii/S0039602815000813

UH ENGINEERS LAUNCH CUBESATS INTO ORBIT

Elena Watts

Pictured: Sean Strickland, Brian McNeil, Tori Speer-Manson, James Annis

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

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.

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

“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.”

Recently, Provence introduced a CubeSat challenge to a 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 the 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.

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.

“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.”

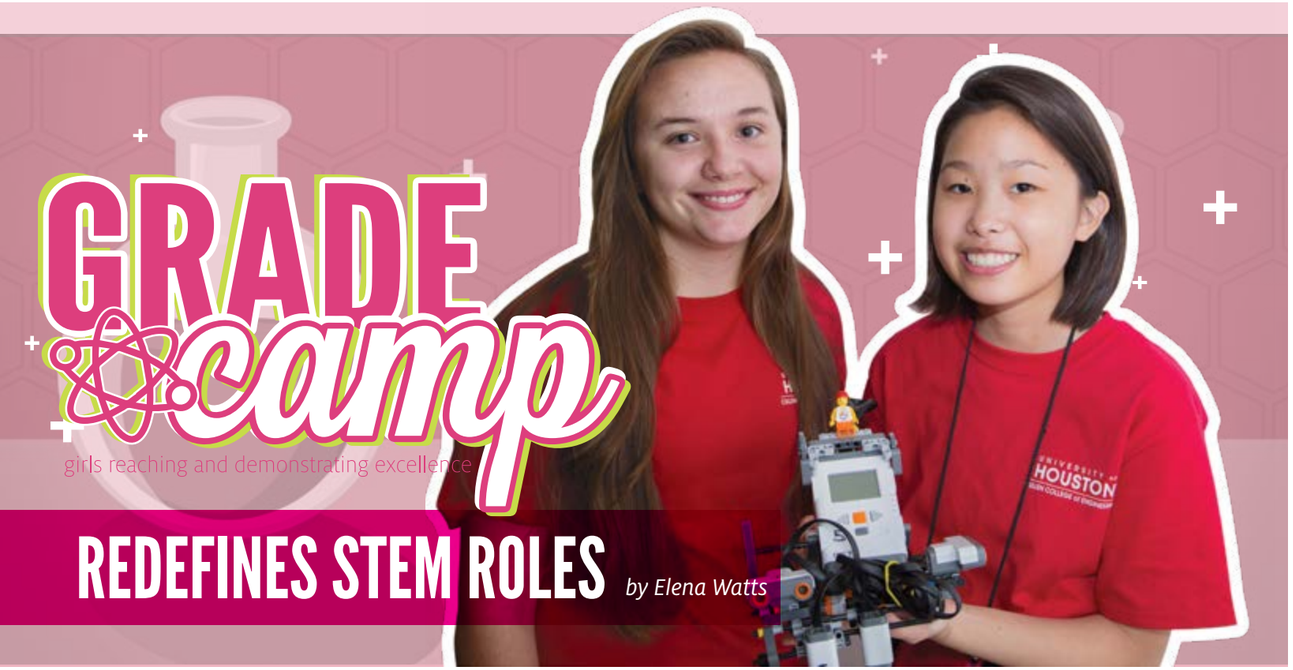
Last December, AggieSat4, containing the VDCS technology, hitched a ride to the International Space Station (ISS) on a Space-X flight. On Jan. 29, 2016 at 10:25 a.m., astronaut Scott Kelly deployed AggieSat4 from the Japanese Experiment Module (JEM), a Japanese science module on the ISS.

With a fish-eye lens that captures almost 180 degrees, the camera in the VDCS captured 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 also have several other photographic missions.

“I want to have a picture on my wall that I can show and say, ‘I took a picture in space,’” McNeil said.

To learn more about CubeSat research at the Cullen College, watch our video at https://youtu.be/kS7T1Pp5xSg

Steve Provence, UH alumnus, adjunct professor and NASA engineer



REDEFINES STEM ROLES

by Elena Watts

Engineering and computer science professions attract fewer women than other STEM (science, technology, engineering and mathematics) fields in the United States. For more than a decade, professors at the UH Cullen College of Engineering have worked to change this longstanding tradition by hosting summer engineering camps strictly for girls.

Since 2002, G.R.A.D.E. Camp – which stands for "Girls Reaching and Demonstrating Excellence" – has introduced approximately 850 girls between the ages of 13 to 17 to the fundamentals of engineering through team-based, interactive activities. Each summer, the Cullen College's two week-long sessions have exposed campers to basic engineering concepts, career options and mentorship opportunities.

"The G.R.A.D.E. Camps inform young ladies about career paths they might not know exist for them," said Fritz Claydon, Cullen College professor of electrical and computer engineering who has also co-coordinated the camp since its inception in 2002.

Providing students with sufficient STEM education early is important because they need strong backgrounds in chemistry and physics to master calculus, which is often the first math course they encounter in college, said Claydon, who also serves as director of both the UH Honors Engineering Program and the Cullen College's Division of Undergraduate Programs and Student Success.

"Those preliminary courses that they take in 8th through 12th grades are so important because they build the foundation so they're well prepared after high school to pursue difficult degrees such as engineering," he continued.

Stuart Long, developer and co-director of the camp who has taught electrical and computer engineering at the Cullen College for more than four decades, said the camp curriculum is a product of many years of trial and error using hands-on activities and project-based demonstrations rather than theories about how students learn. Intervals of short lessons, fun activities and snack breaks have proven the best way to keep the girls engaged in learning.

"We don't put them in a room and lecture to them in hour chunks," Long said. "That's not going to work for anybody."

Problem-solving techniques, teamwork and presentation skills are emphasized during the summer camps. Teams of campers build and program LEGO Mindstorm robots to navigate a maze, and they present their projects to an audience of family and friends on the final day of camp.

"Communication is an important part of being an engineer," said John Glover, Cullen College professor of electrical and computer engineering who has co-directed G.R.A.D.E. Camp since it began. "So they work on their oral presentations – straight-forward explaining of what they did in G.R.A.D.E. Camp."

The campers learn to write computer algorithms by outlining detailed steps necessary to make peanut butter and jelly sandwiches. Among other principles, they learn about voltages, currents, motors and generators during morning classes, and they apply their knowledge to their LEGO Mindstorm robot projects during afternoon labs. Camp mentors help the girls overcome challenges by teaching them debugging techniques rather than giving them answers.

"We don't just tell them what to do in the labs," Glover said. "We switch them into problem-solving mode, so they feel that they – and it's true – solve the problems themselves."

Many campers have commented to Claydon over the years that they wished their schools taught science and engineering principles the way G.R.A.D.E. Camp taught them because they learned so much in one week.

Data suggests that approximately 70 percent of the G.R.A.D.E. Camp alumnae who have graduated from high school chose to pursue engineering in college. Some alumnae have even enrolled at UH and become G.R.A.D.E. Camp mentors.

FINDING THE WOMEN

Women are not adequately represented in engineering classrooms, and the differences between men and women are needed in the field, said Glover.

"Right now, culturally, girls are led to believe that engineering is for boys, so they stay away from it and that doesn't make any sense," Glover said.

Many studies link the scarcity of women in STEM fields to attitudes about gender differences, and some trace the situation back to gender stereotyping that begins with childhood toys. For example, LEGOS Friends sets, currently popular with young girls, place dolled-up female minifigures in stereotypical environments such as hair salons and shopping malls. Yet, advocacy and consumer pressure are slowly changing such cultural norms.

Last year, LEGOS introduced the Research Institute, a limited-edition set of three female minifigures including a paleontologist, a chemist and an astronomer, which immediately sold out. LEGO Space Port sets also included mould-breaking female scientists and astronauts among their minifigures.

Sluggish recruitment and retention of women in engineering colleges and careers likely result from complex combinations of implicit and explicit cultural, environmental and even biological influences, but job availability and pay rates are certainly not among them.

Last year, *Forbes* published a list of the 20 best-paying jobs for women, which included petroleum, aerospace, and electrical and electronics engineering as well as positions in sales engineering and engineering management. Based on salary, work-life balance and expected employment growth, both mechanical and civil engineering made *U.S. News and World Report's* "25 Best Jobs of 2015" list. *CNN Money's* top 100 jobs, based on pay, 10-year growth potential and work satisfaction, included biomedical, civil, transportation and structural engineering.

In spite of these reports, women account for less than 20 percent of engineers with bachelor's degrees in the United States, according to the National Science Foundation's (NSF) "Women, Minorities and Persons with Disabilities in Science and Engineering" statistics. A paltry 6 percent of those are classified as underrepresented minorities and Asian women. Furthermore, only 25 percent of engineers with master's and doctoral degrees are women.

The 2014 U.S. Bureau of Labor and Statistics' "Women in the Labor Force Databook" lumped engineering and architecture occupations together and reported that only 14 percent of professionals who worked in those fields were women. The bureau also reported that female engineers earned 18 percent less than their male counterparts. Similar percentages of women earned degrees in computer sciences, while women outnumbered men in other STEM fields, such as biosciences, social sciences and psychology.

"If we're looking for ways to find more students to major in engineering, one way is to tap underrepresented sources, such as female students," said Long. "Only 2 percent of female high school students choose to major in engineering in college... so there are large numbers of qualified girls who could be engineers who never see the direction."

STEM OUTREACH

WOMEN INSPIRE WOMEN

Serrae Reed, a mechanical engineering undergraduate student at the Cullen College and co-director of G.R.A.D.E. camp, attended similar STEM camps her sophomore and junior years in high school, which she credits, in part, for her decision to major in engineering.

"At these camps, I had the opportunity to talk to students who were going through classes I was going to be taking soon, professors who were teaching them and women in industry," Reed said.

Reed chose the University of Houston because of the curriculum, the professors and the Honors Engineering Program. In her opinion, dispelling preconceived notions about engineers was G.R.A.D.E. Camp's most important achievement.

"At G.R.A.D.E. Camp, they have the opportunity to see that engineers come in all different shapes and forms, and that they have all kinds of interests," Reed said. "They get to see that women engineers are just as successful as men, and that there's a support system – people who want them to come into this field and people to help them when they arrive."

Women bring different skills to the table. While some might have missed introductions to coding, building and AutoCAD in middle school, they still have the ability to learn those disciplines and to use different ways of thinking to their advantage, Reed said.

Samantha Branum, also an undergraduate student at the Cullen College and camp co-director, said G.R.A.D.E. Camp helps to build the girls' confidence. She most enjoyed watching the skeptical girls transform into enthusiastic participants as they engaged in activities such as the speaker lab. The campers built speakers from Styrofoam plates, magnets and metal wires that they plugged into their phones with auxiliary cords to play music.

"The girls never think it's going to work, and then when it does, it blows their minds, and that's the coolest part," Branum said. "They never knew they could do these things as girls because nobody told them."

While the obvious benefit of G.R.A.D.E. Camp is student recruitment, the unintentional consequence is student retention, Long said. The camp pays about a dozen female engineering students, typically after completion of their freshmen years, to mentor the middle school and high school girls.

"We found that the very act of mentoring the girls changes the undergraduates' attitudes about engineering," Long said. "As a result, they are much more likely to stay in engineering, to do well in their classes and to graduate on time than the girls not involved in the mentoring."

CAMPERS GAIN CAREER INSIGHTS

Devyn Yanello, a 16-year-old junior at Hargrave High School in Huffman, and Kennedi Mitchell, a 14-year-old sophomore at Travis High School in Fort Bend ISD, said they gained better understandings of the many branches of engineering and their respective objectives.

"Overall, I think engineering is just going out and fixing problems, making sure things are done the right way and making sure things are safe," Mitchell said.

The Cullen College offers majors in mechanical, industrial, biomedical, petroleum, chemical and biomolecular, civil and environmental, and electrical and computer engineering. Subsea engineering, materials engineering, aerospace engineering and space architecture programs offer students additional opportunities.

"There are so many different types of engineering, so it's nice to know what each kind does," Mitchell said. "I don't think it's fair for people to assume that women can't do everything guys can do."

Torn between architecture and engineering, Anisha Lal, granddaughter of UH System Board of Regents member Durga Agrawal, also attended the camp to gain clarity about career opportunities. Consequently, she said she is more optimistic about engineering.

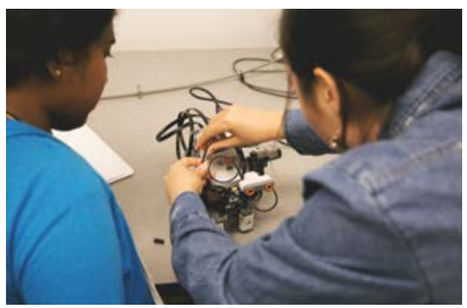
Questionnaires are given to the girls on the camps' opening and closing days and often reveal transformations in their attitudes toward engineering. During their final presentations, they always impress their parents with their explanations of the control theory behind the operation of their robots, Long said.

G.R.A.D.E. Camp was originally funded in 2002 by student tuition and a state grant aimed at increasing numbers of electrical engineering students in Texas. The National Science Foundation (NSF) funded the camps for the next five years followed by several years of support from Houston-area engineering firms.

"The tuition is a small part of the actual expenses," Long said. "And we give scholarships to those with financial need."

Watch our video about the 2015 G.R.A.D.E. Camp at www.egr.uh.edu/grade-camp-2015-video

"GIRLS ARE LED TO BELIEVE THAT ENGINEERING IS FOR BOYS, SO THEY STAY AWAY FROM IT AND THAT DOESN'T MAKE ANY SENSE."

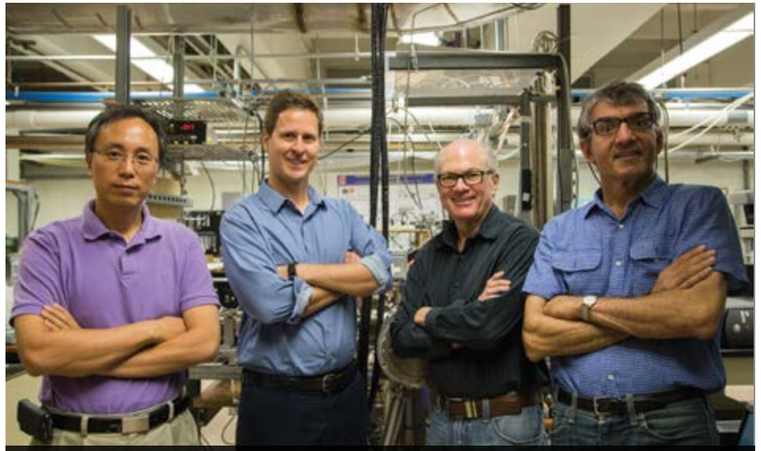


ENGINEERS EARN $1.5 MILLION TO PURSUE NOVEL NANOPATTERNING TECHNOLOGY

by Elena Watts

Last October, four UH Cullen College of Engineering professors earned a four-year grant amounting to almost $1.5 million from the National Science Foundation (NSF) to pursue their nanopatterning discovery that could lead to next-generation transistors for integrated circuitry, among other advanced nanodevices.

With new capabilities developed through this grant, the researchers can explore potential materials to replace ubiquitous silicon transistor switches, the building blocks of computers that are reaching their technological limitations. Specifically, they are studying the effects of nanopatterning on the scientific supermaterial, graphene, to invent faster transistors for computers of the future that consume less energy as they operate more quickly.



Pictured (from left): Jiming Bao, Paul Ruchhoeft, Vincent Donnelly, Demetre Economou

Several years ago, **Vincent Donnelly**, principal investigator on this project, and **Demetre Economou**, both Cullen College chemical and biomolecular engineering professors, along with **Paul Ruchhoeft**, Cullen College electrical and computer engineering associate professor, invented nanopantography, a novel nanopatterning technique. An array of lenses disperses a broad ion beam into billions of beamlets that each bend to the same spot, approximately 100 times smaller than the diameter of one lens, on a 2D substrate. The substrate is then tilted so each beamlet can simultaneously etch the desired pattern on its surface.

"In the initial stages of this research, we were able to make features as small as 10 nanometers, which approaches state-of-the-art," Donnelly said. "More recently, we have reduced features to 3 nanometers, and we believe we can go even smaller, which is something no one has done."

The lens array was originally fabricated permanently on the substrate, which presented challenges from a long-term manufacturing perspective. Ruchhoeft joined the new project to develop a reusable stencil mask lens array that the engineers can move to cover large substrate surface areas.

The stencil mask is fabricated with posts that secure a 1-micrometer gap between its lens array and the substrate. The positive voltage applied to the lens array for etching also electrostatically clamps the mask to the substrate. Removal of the voltage after processing releases the stencil mask for repeated use on other substrates, the print-and-repeat process.

"We improved the throughput and resolution of this nanopatterning method with a two-step process," Donnelly said. "Nanopatterns are first formed in a very thin masking layer by nanopantography and then transferred to the underlying material by highly selective plasma etching."

Donnelly, Economou and Ruchhoeft are collaborating with **Jiming Bao**, another Cullen College electrical and computer engineering associate professor. Bao joined the project to provide expertise in development of applications for graphene. He intends to explore potential for creating transistor channels from the nanopatterns etched on the highly conductive one-atom-thick carbon sheets. Four doctoral students and several graduate students will also work on the project.

"The proposed work will provide students with rich scientific and educational payoffs," Donnelly said. "We will also incorporate nanopatterning of 2D materials into our NSF-seeded, multidisciplinary Nano-Engineering Minor Option, NEMO, a subset of the undergraduate curricula."

Economou and Donnelly are developing molecular dynamic simulations to follow atomic evolution of the system, primarily the effects of ion bombardment energy on substrate surfaces, to determine the smallest features that exhibit the desired behaviors.

"With this grant, we will develop a unique tool that prints over large areas through the print-and-repeat process, we will demonstrate nanopatterning of graphene sheets and other 2D materials, and we will measure and characterize these materials," Ruchhoeft said. "It's not just a continuation of existing integrated circuit manufacturing approaches since we will have an opportunity to develop new and better performing materials that can displace those currently used."

RESEARCHER OPTIMIZES CELLULAR NETWORK PERFORMANCE

by Elena Watts

Zhu Han, UH professor of electrical and computer engineering, earned a $140,000 grant from the National Science Foundation to enhance software-defined network planning and administration of wireless cellular infrastructure.

In collaboration with Arizona State University, Finland's University of Oulu and VTT Technical Research Centre of Finland, Han's research project aims to realize efficiencies for the dense and heterogeneous software-defined cellular network to improve user experiences. The software-defined network provides opportunities for dynamics and layers at the edge, or user access points, which were not available with the original, flat version of the radio access network. Han plans to dynamically optimize cellular network performance with resource allocation for hierarchical structures.

"It's routing cellular signals to servers in different network layers, similar to the concept of optimizing traffic on highway ramps," Han said. "We are concentrating on the consumption-based, human-machine interface."

The project involves network architecture design, theoretical modeling and analysis, and experimental simulations to quantify performance benefits, Han said. The research addresses challenges that include coexistence of interfering mobile clusters and elastic resource allocation in novel frameworks, he added.

"The intellectual merit originates from the interdisciplinary fusion of different technologies including software-defined radio and networking, wireless communications, machine learning and game theory," Han said. "The proposed scheme offers reduced overhead control and system latency through exploration of locality, which enhances system scalability."

The research project enriches game theory curriculum at the involved universities and strengthens wireless research communication collaborations between the United States and Finland, Han said. Han also plans to engage minority and underrepresented students and to promote science and engineering among K-12 students with this venture.

The grant will continue through 2017.

ENGINEER EARNS NSF CAREER AWARD TO STEER SWARMS OF MICRO-ROBOTS

by Elena Watts

Aaron T. Becker, assistant professor of electrical and computer engineering, earned a five-year, $550,000 CAREER award from the National Science Foundation (NSF) for his robotic research proposal titled, "Massive Uniform Manipulation: Algorithmic and Control Theoretic Foundations for Large Populations of Simple Robots Controlled by Uniform Inputs." The NSF Faculty Early Career Development Program awards 600 grants each year to help promising young faculty members lay the foundations for successful academic careers.

In the 2014 Disney movie "Big Hero 6," the protagonist, Hiro, offers a profound view into the future by manufacturing a swarm of 105 micro-robots. Hiro controls them to self-assemble, to build structures and to transport goods and materials. While the micro-robots of the film are fantasy, the ideas are rooted in reality. Producing large numbers of micro- and nano-robots is possible today. Micro-robots can be manufactured in large numbers by MEMS processes. Also, biological agents such as bacteria and paramecium can be grown to achieve large swarms.

Becker's vision is for large swarms of robots remotely guided through the human body to cure disease, heal tissue and prevent infection. The biggest barrier to Becker's vision is a lack of control techniques that can reliably exploit large populations despite incredible under-actuation.

"Robotic manipulation at micro- and nano-scales can fundamentally transform how we treat diseases and assemble objects," Becker said. "My goal is to precisely deliver materials and assemble structures from the bottom up."

This precision manipulation must be coupled with a large population of manipulators to enable rapid progress. The potential impact is broad: large populations of micro-manipulators could provide targeted drug-delivery, perform minimally invasive surgery and engineer tissue.

Manipulation with these robots requires motion control. However, the small size of micro- and nano-robots severely limits computation, sensing and communication. Distributed control is infeasible – building autonomous robots is currently impractical at the micro-scale and seems impossible at the nano-scale. Instead, robots at this scale are currently powered by global force fields, such as a magnetic gradient or light broadcast at a specific frequency. Centralized approaches are feasible, but individually controlling a million robots requires an equally large amount of communication bandwidth, ultimately limiting the population size. Becker is designing new techniques for centralized control under the constraint that every robot receives exactly the same input commands. The unifying theme is using obstacles to efficiently control the shape, arrangement and position of the swarm.

In a drug-delivery application, blood vessels and other lumens serve as natural passageways to every part of the human body, so theoretically, external control algorithms could steer concentrations of drug particles to precise targets for more effective treatment of diseases.

Such a technique could revolutionize chemotherapy. Current treatment regimes flood cancer patients' veins with toxins carefully calibrated to kill fast-growing cells. This targets tumors, but unfortunately also destroys cells that form hair and fingernails. With the controllers Becker is designing, physicians could use the body's passageways to deliver concentrations of drugs with higher toxicity to specific areas with fewer patient side effects.

Furthermore, current robotic micro-assembly techniques use sophisticated micro-scale tweezers to individually place one component at a time. Becker's lab is designing maze-like structures that, when actuated, simultaneously assemble multiple copies of a desired structure.

"In parallel, the process would look like a factory on a microchip," Becker said.

Many researchers are exploring ways to give intelligence to small swarms of robots to make them perform particular tasks in an environment. In contrast, Becker is looking for intelligent ways to exploit the environment to make large robot swarms perform particular tasks.

NSF CAREER awards require an emphasis on broader outreach that extends the research into society. Becker's lab hosts externships with local HISD high school teachers, internships for a select group of high school students and outreaches to local robotics clubs. He seeks to empower high school students and teachers, especially those from under-represented groups, to perform STEM outreach to younger students using rapid prototyping, intelligent online gamification and hands-on learning.

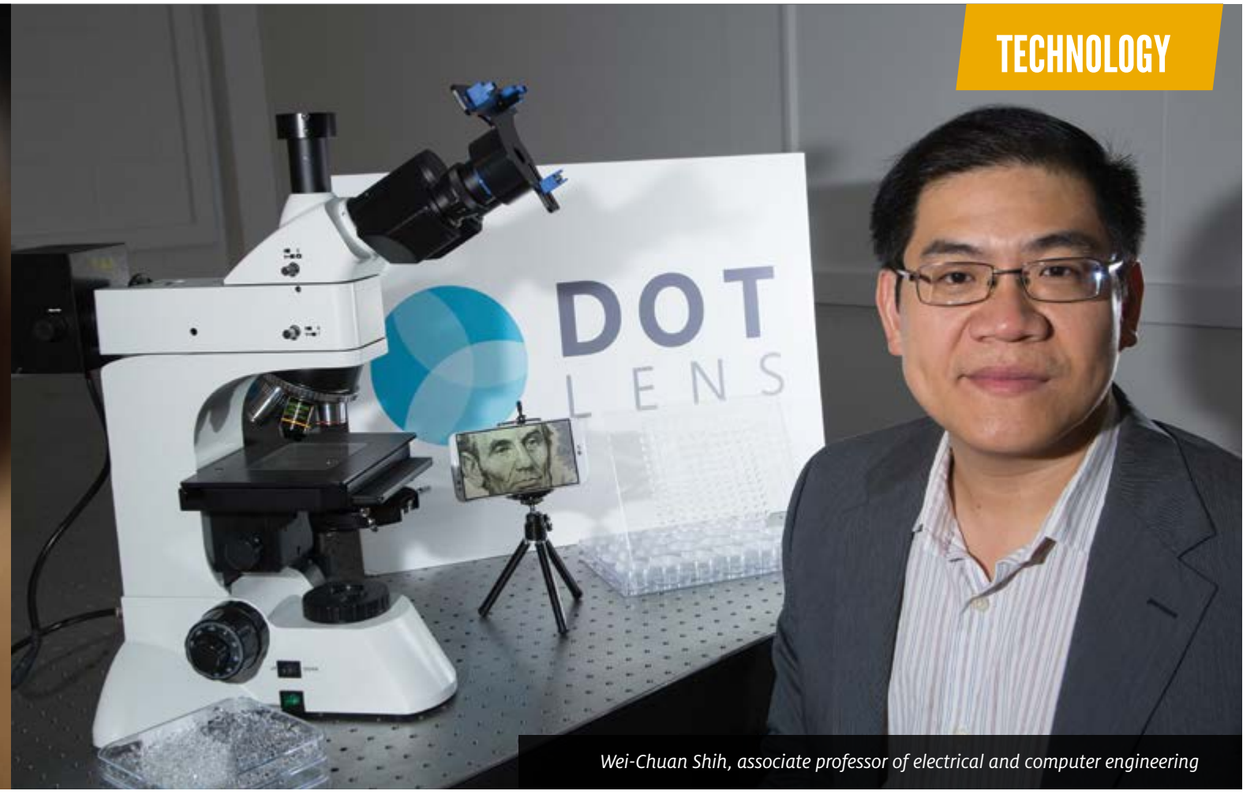
Becker developed a website, SwarmControl.net, that allows visitors to play games that compare and contrast several control theories for directing swarms of simulated robots. More than 10,000 people have participated in the two-year study thus far.

"SwarmControl.net gives us an ideal sandbox to test our theories. We have game challenges such as using a swarm of robots to push a ball through a maze," Becker said. "For each game, we can test whether increasing the number of robots from 50 to 1,000 makes the challenge easier or harder, or test if it is better to have a swarm attracted or repelled by a user's mouse click. Anyone interested in robots who has a computer can help us understand how best to control swarms."

In his laboratory, Becker uses a swarm of 100 small robots to test control laws and algorithms. These robots are each about the size of a quarter. One experiment steers the robots to act as compliant manipulators that push around a slightly larger toy piano. These same control techniques will be implemented using global forces to make tiny particles perform useful tasks.

"The key insight is rather than steer individual particles, we treat the swarm as an entity," Becker said. "We then push the swarm into walls to squeeze the swarm, collect the swarm into a dense mass or shape the swarm into a useful tool."

PROFESSOR AND STUDENT COMMERCIALIZE SMARTPHONE MICROSCOPE LENS



TECHNOLOGY

Wei-Chuan Shih, associate professor of electrical and computer engineering

by Audrey Grayson

A professor and student in the UH Cullen College of Engineering received the National Science Foundation's (NSF) Innovation Corps (I-Corps) award for their research on inexpensive lenses that can turn smartphones into microscopes. The grant provided the UH engineers with seed funding and guidance to take their invention out of the laboratory and into the consumer market.

Wei-Chuan Shih, associate professor of electrical and computer engineering, and Ph.D. student **Yulu Sung** said they stumbled upon their invention by accident. The engineers were experimenting with polydimethylsiloxane (PDMS) to look for new uses for the material, which is most commonly used in soft lithography and microfluidics.

One day, a few droplets of PDMS spilled onto a hot plate in the laboratory. After it had cooled, Sung picked up the material and commented that it looked like a lens.

"Using PDMS as a lens material was certainly on our radar, but we didn't set out to make a lens for a smartphone camera. As soon as we put it on the camera, which was not obvious in the first place, we realized this is something extraordinary," Shih said.

Upon further examination, Shih and Sung discovered that the lens can magnify microscopic objects by 120 times when placed over a smartphone's camera – and all for the raw material cost of 3 cents per lens.

The low cost and ease of using the lens make it ideal for researchers working in the field or for students in the classroom. It also could have clinical applications, allowing small or isolated clinics to share images with specialists located elsewhere.

"But ultimately, the application is only limited by one's imagination," Shih said.

The goal of the NSF I-CORPs program, according to the NSF website, is to prepare scientists and engineers to extend their focus beyond the laboratory and broaden the impact of their NSF-funded research projects. I-CORPs teams are required to identify a principal investigator, an entrepreneurial lead and an industry mentor.

The UH I-CORPs team consisted of Shih and Sung as the principal investigator and entrepreneurial lead, respectively. They recruited Ken Jones, director of the Wolff Center for Entrepreneurship at the UH Bauer College of Business, as their industry mentor.

The team's journey officially began last October when they traveled to Ann Arbor, Michigan to attend an entrepreneurial bootcamp consisting of workshops, training sessions and meetings with future customers and potential competitors. By the end of the six-week program, the team was required to accumulate at least 75 contact hours with potential customers.

Shih said the team is exploring the education market first. After presenting the research at workshops for science teachers last summer, the UH I-CORPs team received an overwhelming response from educators hoping to incorporate the lenses into their classrooms.

"Matthew Wells, president of the Science Teacher's Association of Texas, told me that every science teacher should have one. That was among the most exciting comments," Shih said.

Katherine Garcia, program coordinator of the Alief Independent School District, has set out a plan to integrate the lenses in a nine-week study across several 7th-9th grade classrooms.

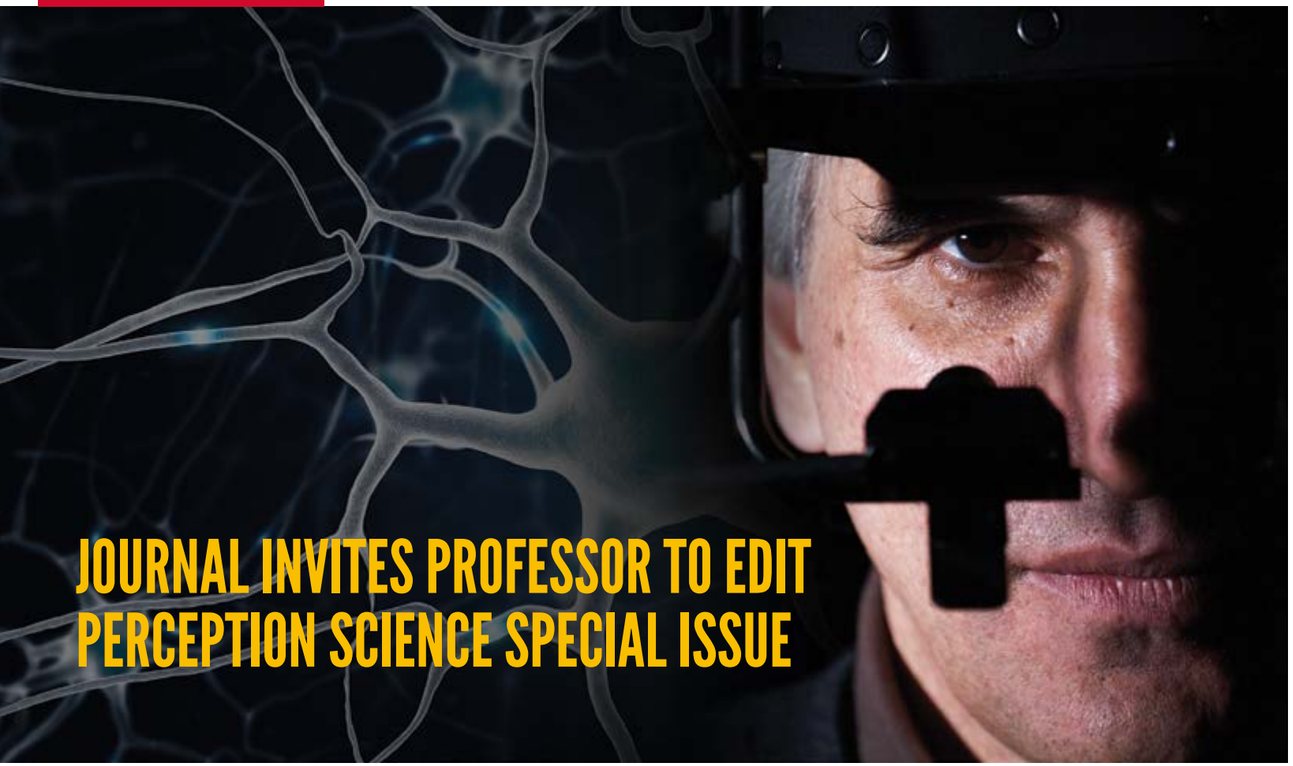
"We think these lenses could have a really big impact in K-12 STEM education," Shih said. "We all care about impact, and if we can actually enhance STEM education in K-12, then there is nothing better than that."

Beyond making the right contacts in the industry and identifying distribution channels, Shih said another potential obstacle is identifying a manufacturing facility for mass production. Although the raw material to make the lenses is relatively cheap, streamlining the manufacturing and packaging processes is essential to managing the overall cost. Shih has been proactively seeking business advice and partnerships in this area.

Regardless of whether the company thrives, Shih said the group is determined to see the lenses make a positive impact in classrooms all over the world.

"We want success, but we treasure the learning process first before whether the company is successful or not. We want education to be the first application of these lenses because, no matter what, this can generate an impact in kids' education," Shih said. "That's going to happen no matter what."

> "ULTIMATELY, THE APPLICATION IS ONLY LIMITED BY ONE'S IMAGINATION."



JOURNAL INVITES PROFESSOR TO EDIT PERCEPTION SCIENCE SPECIAL ISSUE

by Elena Watts

Haluk Ogmen, professor of electrical and computer engineering at the UH Cullen College of Engineering, his former doctoral student Hulusi Kafaligonul and his colleague Bruno Breitmeyer, UH professor of psychology, were invited to edit a Perception Science special issue of the journal *Frontiers in Psychology* last year. Titled "Feedforward and Feedback Processes in Vision," the online special issue was also presented as an e-book.

"There are a number of different theories, so we are bringing people and the most updated ideas together in this special issue," Ogmen said. "It's not comprehensive – many more people work on this question – but it's a good sample of what's out there."

Human brains are adept at operating both positive and negative feedback systems, while most electronic systems are capable of efficiently running only negative feedback systems. Engineers have used negative feedback loops in engineering applications for more than 75 years, but they have experienced limited success in stabilizing systems with positive feedback loops. As they join forces across the country to reverse-engineer the brain, a goal of the U.S. BRAIN Initiative, engineers are studying positive feedback systems, which were mostly ignored in the past, as much as they are exploring negative feedback systems.

"From an engineering and mathematical standpoint, positive feedback systems are highly complex and unstable, but the brain remains stable and operates with massive amounts of positive feedback," Ogmen said. "This is the major puzzle we still have not solved."

Ogmen's interest in feedforward and feedback systems, both positive and negative, began two decades ago with his mathematical model of the human visual system circuitry and his theory that proposed feedback as necessary for flexibility in operations.

He found that positive feedback systems could operate without stability by storing ongoing work in memory and resetting the system as often as necessary before system crashes. Since then, he has continued to refine the positive feedback reset loop with an emphasis on sensory memory.

"The advent of optogenetics and neuroimaging has provided additional remarkable investigative tools for refining our theories," Ogmen said. "We hope this issue will inspire the readers and act as a catalyst for future work on the issues of feedforward and feedback processes in vision."

One study in the special section addresses ways the brain's visual system distinguishes foreground from background in the natural environment, while another study focuses on attention as a feedback mechanism that uses prior knowledge, assumptions and hypotheses to selectively choose information from the environment.

"We know the brain uses feedback processes, both positive and negative, but we don't know exactly how and when it uses them," Ogmen said. "So unlocking that core brain function can help us to inform engineering principles and to design systems."

PROFESSOR EARNS BEST PAPER AWARD FOR COLLABORATIVE SPECTRUM SENSING STUDY

by Elena Watts

Zhu Han, professor of electrical and computer engineering at the UH Cullen College of Engineering, earned the 2015 EURASIP Best Paper Award for a paper he co-authored in the *EURASIP Journal on Advances in Signal Processing*.

The European Association for Signal Processing (EURASIP) was established in 1978 to provide a platform for the dissemination of signal processing information and for the facilitation of discussion about all aspects of the technology, according to the association's website.

Han and three other authors received certificates and travel allowances to attend the 2015 European Signal Processing Conference in Nice, France last summer for their paper, "Securing Collaborative Spectrum Sensing Against Untrustworthy Secondary Users in Cognitive Radio Networks." Hans' collaborators include Winkai Wang and Yan Sun, professors of electrical, computer and biomedical engineering at the University of Rhode Island, and Husheng Li, professor of electrical engineering and computer science at the University of Tennessee.

Cognitive radio spectrum sensing is a revolutionary secondary user network that improves primary network performance by optimizing scarce spectrum resources. However, untrustworthy secondary users can significantly degrade the performance of collaborative spectrum sensing, according to the journal paper.

In this computational study, Han and his colleagues used an onion-peeling approach to analyze cases involving both individual and multiple attackers. They identified secondary users, calculated their trust values, defined damage metrics, investigated attacks that maximized damage and proposed defense schemes, according to the paper. Those with highly suspicious reports were excluded from decision-making.

"Compared with existing defense methods, the proposed scheme can effectively differentiate malicious nodes from honest nodes," the authors wrote in their paper. "As a result, it can significantly improve the performance of collaborative sensing."

PROFESSOR HOSTS 2015 MEETING FOR PETROPHYSICISTS AND WELL LOGGING ANALYSTS

by Elena Watts

Ji Chen, professor of electrical and computer engineering, hosted the 2015 Society of Petrophysicists and Well Log Analysts (SPWLA) Resistivity SIG Meeting on Oct. 23.

The workshop provides a forum for presentation and discussion of resistivity, dielectric and other oilfield electromagnetic-related topics.

The 2015 SIG Committee called for presentations or posters on interesting field logs as well as resistivity and dielectric topics. Those who have presented talks or posters on related subjects at other workshops were welcome to give the same or expanded versions of their presentations.

SPWLA is a nonprofit corporation dedicated to advancing the science of petrophysics and formation evaluation through well logging and other techniques applicable to exploitation of gas, oil and other minerals. Founded in 1959, the organization serves as a voice of shared interests for scientists in the petroleum and mineral industries, strengthens petrophysical education and increases awareness of roles petrophysics play in the oil and gas industry as well as the scientific community.

To learn more about SPWLA, please visit www.spwla.org

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

Pictured from left: Julius Marpaung and Jung-Uk Lim

by Audrey Grayson

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, exclusive of that as a student or postdoctoral fellow. 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.

RETIREMENTS

BEN JANSEN

Professor, Electrical and Computer Engineering

Contributed by: Haluk Ogmen, professor of electrical and computer engineering

Ben Jansen came to the electrical and computer engineering (ECE) department at the UH Cullen College of Engineering after a postdoc assignment at Vanderbilt University, which he attended after earning his Ph.D. from the Free University of Amsterdam. The professor with whom Jansen was doing his postdoc at Vanderbilt knew Peri Ktonas, who was already in the ECE department, and recommended Jansen for a faculty position at UH. Ktonas was aware of Jansen's research work at the time, which was on clinical applications of the automated analysis of the electroencephalogram (EEG), and thought that Jansen could be a promising addition to the department's bioengineering activities. Jansen was invited for a seminar at UH and was soon after offered a tenure-track position.

Jansen made significant and long-lasting contributions to the ECE department's research, in particular to the department's bioengineering activities. He developed a world-renowned group on the analysis and modeling of the EEG and the EEG visual evoked-response (EEG response to a light flash stimulus), with very useful applications in neurological and psychiatric disorders. In his research, which was funded by the NIH and the State of Texas, he collaborated with several colleagues at UH, clinical groups at the Texas Medical Center, as well as with researchers from various medical schools such as Yale.

Jansen was also a key player in reshaping the ECE department's undergraduate and graduate offerings. He led a department-wide effort in transforming the undergraduate curriculum into a well-balanced mixture of depth and breadth and offered fundamental courses in signal processing at both undergraduate and graduate levels.

Jansen has also provided outstanding service to the department. In addition to his role on numerous committees, he served with great dedication as the department's director of graduate studies for many years.

Jansen's creativity is not expressed just in his academic endeavors; he has also a deep involvement with arts. He is a well-known patron of several artists and art galleries in the greater Houston area, and is an accomplished artist himself, exhibiting a great talent in woodworks.

JOHN GLOVER

Professor, Electrical and Computer Engineering

Contributed by: Len Trombetta, associate department chair and professor of electrical and computer engineering

Professor John Glover joined the ECE department in 1975, when the department was only "electrical engineering." It is hard to overestimate his contributions to undergraduate education and graduate research since that time. In addition to teaching computer-related courses including "Microprocessor Systems" and "Digital Signal Processing," he was a pioneer in the development of the department's ECE freshman year courses, "Introduction to ECE" and "Computers and Problem Solving." Although his time is now spent primarily on teaching, he has a distinguished record in the area of biomedical signal processing research as well.

Glover is a favorite of ECE students, especially those interested in robotics and microprocessor systems. Even in semi-retirement, he continues his favorite activities: supervising the robotics club, serving as faculty advisor to the IEEE Student Branch, and teaching microprocessor systems and embedded microprocessor systems. He also supervises students doing senior design projects wherever embedded systems are involved. He has earned numerous teaching awards, including the W. T. Kittinger Award, which is the highest honor bestowed on a UH engineering educator. He was also a major contributor to the development of the Engineering Computing Center, the ECE department's Telecommunications Laboratory and the Undergraduate Robotics Laboratory.

Glover earned his bachelor's and master's degrees in electrical engineering from Rice University. He earned a Ph.D. in electrical engineering from Stanford University. Before joining UH, Glover had positions at Collins Radio Co., Texas Instruments, and served in communications electronics with the U.S. Army Security Agency.

PAULINE MARKENSCOFF

Professor, Electrical and Computer Engineering

Contributed by: Haluk Ogmen, professor of electrical and computer engineering

Pauline Markenscoff obtained her electrical engineering degree from the National Technical University in Athens, Greece and completed her graduate studies at the University of Minnesota. After obtaining her Ph.D., she joined the ECE department at UH and has been the key person in the department for research and education in the computer engineering area.

Markenscoff's research is in the areas of modeling of computer systems, computer architecture, distributed processing and microcomputer systems. Her research projects have included the use of graph theoretical methods to determine the optimum partitioning of tasks for fast execution on multiple processor systems; the performance evaluation of bus architectures for multiple processor systems using both analytical (queuing techniques) and simulation experiments; the design of real-time software for a hierarchical process control system consisting of microcomputers dedicated to control tasks and a general purpose host; and the design of a multiple processor architecture for a printer and a communication controller for interfacing it to the IEEE-488 bus. She published in these areas and guided numerous theses and dissertations.

When Markenscoff joined the department, it was called the "department of electrical engineering." With the rise of computer engineering as a core technical field, the department, like many others in the country, changed its name to the "department of electrical and computer engineering" and started to offer an undergraduate degree in computer engineering. All these changes were successfully executed thanks to Markenscoff's leadership, efforts and contributions. In addition, Markenscoff served as the co-director of the college's interdisciplinary master's degree program in controls and computer systems, allowing many engineers with various backgrounds to obtain advanced training in computer systems and engineering.

In addition to her contributions to the computer engineering area, Markenscoff also served as the director of undergraduate studies for the department, providing exemplary service and dedication.

Markenscoff is among the few faculty members who significantly shaped the ECE department. She has been a model faculty member with the highest level of professionalism, in addition to her collegial, dedicated, supportive and friendly interactions with her colleagues.

ACCOLADES

- Professor **E. Joe Charlson** won the college's Career Teaching Award
- Lecturer **Gulin Aksu** won the college's Teaching Excellence Award
- Associate professor **Wei-Chuan Shih** won the college's Research Excellence Award at the junior faculty level
- Professor **Zhu Han** won the Award for Excellence in Research, Scholarship or Creative Activity from the University of Houston Division of Research

DOCTORAL STUDENT EXPLORES NEUROENGINEERING WITH FELLOWSHIP AWARD

by Natalie Thayer

The city of Houston, home of the largest medical center in the world, is known for being at the forefront of cutting-edge medical research. By partnering with Houston Methodist, a hospital at the heart of the medical center, the UH Cullen College of Engineering offers its students a unique opportunity to gain hands-on experience in authentic clinical environments. One example of this partnership can be found in the University of Houston/Houston Methodist Research Institute (UH/HMRI) Graduate Fellowship in Translational Research, a two-year fellowship offered to doctoral students pursuing engineering and translational biomedical research.

The award's most recent recipient, electrical and computer engineering doctoral student **Jesus G. Cruz-Garza,** is currently in his second year of the fellowship researching common and unique neural patterns that occur in humans during unconstrained social interaction and artistic reflection and production. Cruz-Garza is working side-by-side with faculty mentor Jose Luis "Pepe" Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen University Professor of electrical and computer engineering, Todd Frazier, managing director of the Methodist Hospital Center for Performing Arts Medicine, and Christof Karmonik, director of the Translational Imaging Core Facilities at HMRI.

During the first year of the fellowship, Cruz-Garza facilitated experiments to gather "in action" and "in context" normative data, or data from normally-developing individuals collected in an environment outside of the laboratory. These data collection sessions took place at various locations throughout the city of Houston, including the Menil Collection and the Children's Museum of Houston.

Collecting normative data is an essential first step in this research, he said. Once the data is analyzed by Cruz-Garza and his fellowship mentors, it can be used to create a baseline for comparison for studying neurological disorders and treatments, he explained.

This year, Cruz-Garza is focused on developing a machine learning algorithm to interpret the collected data.

"This type of data is very difficult to analyze," he said, adding that the algorithm will work by "[helping] the computer understand what the signals mean so that the next time the computer sees the signals it can interpret them accordingly."

Cruz-Garza moved from Mexico to Texas to pursue his Ph.D. at UH after interning with Contreras-Vidal in 2013. He said he was immediately drawn to neuroengineering because he felt the field would encourage him to grow both academically and professionally.

"In neuroscience, there are many questions that are still unanswered and most of our studies are exploratory," he said. "Everything is exciting."

STUDENT EARNS SILVER NANO RESEARCH POSTER AWARD

by Elena Watts

Yanliang (Leonard) Liang, electrical and computer engineering research associate at UH Cullen College, won the Silver Nano Research Poster Award at the 10th Sino-U.S. Symposium on Nanoscale Science and Technology last June.

Liang's poster titled, "Rational Nanostructure Design for Efficient Mg Rechargeable Batteries," was among more than 200 posters submitted and was one of only eight that earned awards. The symposium, sponsored by Tsinghua University Press, attracted more than 1,000 attendees.

"No one expects to win anything because the environment is pretty competitive with scientists from all over China and the United States," Liang said. "The work started long before this forum, so it's good to be recognized for our contribution to the field and to know that people are interested in our work."

Under the supervision of Yan Yao, assistant professor of electrical and computer engineering at UH Cullen College, Liang helped to develop an alternative to traditional lithium-ion batteries, and papers about their breakthrough published in the journals *Nano Letters* and *ACS Applied Materials and Interfaces*.

Instead of lithium ions, Liang and Yao opted for safer and more economical magnesium ions to produce their battery. Magnesium is an abundant material and discharges twice as much energy as its lithium counterpart. However, magnesium ions move slowly in host materials because of their interaction with the batteries' negatively charged lattices.

Liang and Yao created an interlayer expansion method to boost magnesium's diffusivity by two orders of magnitude, and researchers could potentially leverage this approach across a range of host materials that store various ions. Their discovery provides opportunities for the development of advanced materials for next-generation electric vehicles, among other sustainable development innovations.

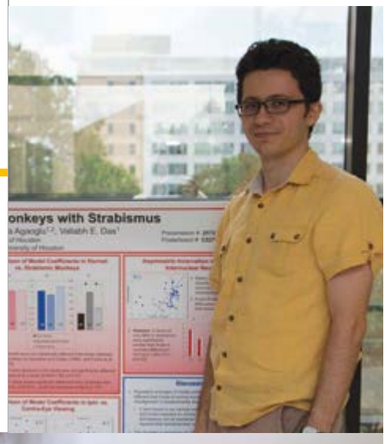
The symposium provides a forum for researchers to share their work in the field of nanotechnology to optimize solutions for energy shortages, environmental contamination and life science challenges, according to the event's website.

"Yanliang joined my research group in the fall of 2012 as a postdoc researcher, and he has undoubtedly shown a high level of excellence and distinction in materials and battery research," Yao said. "I am confident that he has great potential in making more significant achievements and becoming a young leader in the future. This award recognizes his past achievements and motivates him to achieve a higher level of success in his career."

PH.D. GRADUATE WINS COLLEGE'S BEST DISSERTATION AWARD

by Audrey Grayson

Mehmet Agaoglu, a recent Ph.D. graduate from the UH Cullen College of Engineering, won the college's 2015 Best Ph.D. Dissertation Award. Agaoglu's dissertation was titled "Nonretinotopic reference frames for dynamic form and motion perception."



Working with faculty advisor Haluk Ogmen, professor of electrical and computer engineering, Agaoglu researched ballistic eye movements during his time as a doctoral student. The human eye moves involuntarily at least three times per second in order to keep retinal images from fading or losing contrast. Agaoglu performed computational experiments to determine how the brain accounts for these eye movements and processes the information in the scene.

Agaoglu received a plaque and $1,000 for his award, in addition to being recognized at the spring 2015 commencement at UH.

Since graduating from the Cullen College, Agaoglu accepted a post-doc position at the College of Optometry at the University of California, Berkeley, one of the highest-ranked optometry programs in the country.

HOW TO WIN FRIENDS & INFLUENCE THE TECH INDUSTRY:

Advice from the Chair of the ECE Industry Advisory Board

Doug Verret

by Audrey Grayson

Doug Verret is a high school physics and math teacher turned university physics professor turned tech industry engineer. After three decades with Texas Instruments, Verret retired from his post, but remains a key player in the semiconductor industry. He is a member of the Board of Governors of the IEEE Electron Devices Society (EDS) and served for five years as editor and 11 years as editor-in-chief of the *IEEE Transactions on Electron Devices*. He is an IEEE Fellow and a Texas Instruments Fellow Emeritus.

Most recently, Verret took on the post of chairman of the ECE department's Industry Advisory Board, which consists of leaders from government, industry and academia who support the department in its mission to provide a world-class educational and research experience to its students. It's a role that he's comfortable with thanks to many years of teaching, guiding and interacting with STEM (science, technology, engineering and math) students of all ages, he said.

Verret often finds time to visit with current electrical and computer engineering students to offer his advice on how to succeed as an engineer in the semiconductor industry. In 2013, he was asked by the IEEE to conduct a webinar titled "Working Successfully in the Semiconductor Industry."

Verret's words of wisdom for engineering professionals working in the technology and semiconductor industries are in high demand, but the advice itself isn't so tech-y.

"I talk to students more about soft skills than anything else," Verret said.

Read on for Verret's top pieces of advice for a successful career in the tech and semiconductor industries:

DON'T UNDERESTIMATE THE SOFT SKILLS.

"Before you can thrive at a company, you must first get hired, and to get hired you must develop some soft skills," Verret said. "Having the right degree from the right university with the right GPA is not sufficient for landing your dream job."

Soft skills include communication, selling yourself, networking and ability to collaborate with others, he said.

SELL YOURSELF.

Verret said he often encourages engineering students to pursue internships and other professional opportunities while they are still in college. With UH's location in the city of Houston, working an internship part-time at a local company while attending classes is very doable.

LEARN HOW TO SPEAK, WRITE AND COMMUNICATE WELL.

Communication is an often-underestimated skill in the world of science and engineering, but Verret said learning how to write and speak well is one of the cornerstones to succeeding in the profession. Acquiring strong communication skills is also central to successfully collaborating within a diverse team of individuals – something that engineering professionals in nearly every field will need to do well.

"Being able to communicate, write and speak at all levels of the organization – from managers and technicians to engineers, finance professionals, planners and attorneys – is a big part of what it takes to succeed," Verret said.

ACQUIRE GENDER AND CULTURAL SENSITIVITY.

Being sensitive to different genders, cultures and backgrounds is key to communicating effectively and collaborating successfully with others, Verret said.

"It's amazingly difficult to communicate well if you don't understand the person to whom you're speaking," he said. "Learning about and being open to different cultures and backgrounds doesn't just make you a better professional, it makes you a better person all around."

AVOID COMMON MISCONCEPTIONS AND MISTAKES.

According to Verret, some of the most common misconceptions and mistakes made by engineers entering into the semiconductor industry are:

- Thinking that you know most or all of the technical information you need to do the job.
- Assuming that gaps in your knowledge will be filled via formal training on the job.
- Assuming that the best technical solution to a problem is also the best business solution.
- Thinking your education is finished when you have earned your degree.
- Dismissing the necessity of having business acumen.

Although this is only an abbreviated list of the common mistakes engineering professionals can make, keeping these ideas in mind as a new employee in the semiconductor industry can certainly be of benefit, Verret said.

NETWORK!

Verret said one of the biggest mistakes that engineering professionals can make is underestimating the importance of networking.

"You should think of networking as an investment," he said. "Spend time cultivating your network and it will pay you back."

If you're just embarking on your professional engineering career, Verret's tip for expanding your network is to seek out the most knowledgeable individual either inside of or outside of your company to ask about an issue or problem you are facing on the job.

"If you keep doing this, before you know it you will have 40 different people you can call on at any given time about a problem," Verret said.

WHAT YOU HAVE TO OFFER YOUR EMPLOYER IS YOUR CREDIBILITY.

At the end of the day, what you have to offer your employer is your credibility. This, Verret said, is the most important piece of advice he gives to engineering professionals.

Verret defines credibility by its four key components: technical competence, honesty, ethics and integrity.

"In terms of being successful as an engineer, your credibility is at the top of the pyramid," Verret said. Your ability to influence others and to create customer value are the next most important factors for achieving success, he added.

"All of these things require the skills we already discussed, including communications skills, business acumen, networking skills, and cultural and gender sensitivity," Verret said.

Read more of Verret's advice for Cullen College students at www.egr.uh.edu/news/201507/chairman-ece-industry-advisory-board-talks-advice-engineering-students

To learn more about the ECE Industry Advisory Board and the resources the group offers to students, please visit www.ece.uh.edu/people/industry-advisory-board

ENGINEERING STUDENTS LEAD STEM OUTREACH EVENT IN BRAZIL

by Natalie Thayer

Last summer, three Cullen College of Engineering students and one alumnus boarded a plane bound for Brazil for the third annual Society of Women Engineers (SWE) "One Day in Engineering" outreach event. Held in the city of Teresopolis and nearby rural areas, the event aims to inspire excitement about STEM (science, technology, engineering and math) fields and encourage local high school students to pursue higher education.

This year, the event's founder, mechanical engineering graduate student Gabriela Bernardes, was joined by fellow SWE members Mah-rukh Muhammad and Debjani Chakravarty and mechanical engineering alumnus Ben Richardson. Bernardes, who came to the University of Houston from Brazil, originally founded the event in conjunction with her grandmother's social project, Nadir Furtado. In preparation for the trip, members of SWE's Houston student chapter collaborated with Nadir Furtado to plan travel and event logistics. While SWE members developed workshops for the event, Nadir Furtado coordinated local volunteers, booked venues and connected with Brazilian high schools to get the word out about "One Day in Engineering."

The two-day event introduced over 100 students from more than 11 high schools to an array of engineering principles through hands-on workshops, activities and games. Students were divided into small groups and rotated between workshops on civil, chemical, mechanical and electrical engineering.

In the civil engineering workshops, led by civil engineering student Muhammad, students designed and built structures out of lightweight materials such as straws and tape. Muhammad then applied weights to the seemingly flimsy structures to test their strength. Students were amazed by how strong the structures could be when triangles were incorporated into the design, she said.

Muhammad added that the most exciting part for her was seeing the students explore their creativity through the design process. "It isn't easy at first to get into the engineering mind frame, figuring out how to be creative and coming up with something on your own...but once they got into it, once it clicked, they just kept going and building really fast," she said.

Chakravarty, who is also a civil engineering student, led two chemical engineering workshops. In the first workshop, students learned about polymers by creating glow-in-the-dark putty out of household materials. In the second workshop, students were introduced to thermodynamic principles by making homemade ice cream with rock salt.

Bernardes taught students how to build water bottle rockets powered by a bicycle pump in the mechanical engineering workshops and, in the electrical engineering workshops led by Richardson, students played challenging games of "circuit bingo" for prizes.

Muhammed said she was impressed by the students' overall engagement. "I felt that the kids were very open to learning and new ideas. It was a good experience. They were very interested," she said.

The interest even extended beyond the workshops with several students asking about college life, said Chakravarty. Between workshops, she was able to answer questions about scholarships, SWE and her experience at the University of Houston. "Helping men and women understand their potential and actually take initiative, like we're taking initiative to do something for their community...for me, that was probably the greatest part," she said.

Bernardes said seeing the impact the event has had on the Teresopolis community is the biggest reward. Some of Bernardes' family members who live in Teresopolis said that children in their community have pursued engineering in college after attending the event. Bernardes added that several former participants also attended this year's event to volunteer as translators and facilitators.

For both Muhammed and Chakravarty, who had never visited Brazil before this event, the biggest takeaway from their experience was bonding with the students and the community. "Even though we didn't speak the language, [working with international students] gives you an overwhelming view that we're all the same," said Chakravarty.

Muhammed added that the experience reinforced the interdisciplinary nature of engineering. "[At first] it seems like everyone's so different, but once we're all working together toward a common goal, we form a team to get things done," she said.

> "GETTING CHOSEN FOR AN AWARD AMONG ALL THE GOOD WORK WAS EXHILARATING."

Pictured (from left): Md Masud Parvez Arnob and Hoang Nguyen

DOCTORAL STUDENTS, PROFESSOR HONORED AT NEUROENGINEERING SYMPOSIUM

by Elena Watts

Md Masud Parvez Arnob and **Hoang Nguyen,** both doctoral students at the UH Cullen College of Engineering, won 2nd place for their poster abstract at the 5th Annual Neuroengineering Symposium sponsored by the Gulf Coast Consortia on Oct. 2.

Arnob, an electrical and computer engineering student, and Nguyen, a materials science and engineering student, work together under the supervision of **Wei-Chuan Shih**, associate professor of electrical and computer and biomedical engineering at Cullen College.

Shih, also an associate professor of chemistry and materials science, was invited to present a broad talk on light-based techniques in neuroscience and neuroengineering relating to the topic of his students' poster.

Shih presented an array of optoanalytical technologies that he and his team developed for molecular sensing, imaging and stimulation. One project uses a tiny lens to convert a smartphone camera into a powerful microscope. Another focuses on development of a neural probe for delivering light to deep brain regions for simultaneous stimulation and recording of neuronal signals.

"I immediately received feedback regarding potential applications for DotLens Smartphone Microscopy from my colleagues," Shih said. "The symposium provides an excellent platform for crosscutting idea exchange."

Arnob and Nguyen competed against 28 other submissions to win one of three awards with their poster, "Micro-machined optical fiber with multiple stimulation sites for optogenetics applications."

"It was exciting to participate in the symposium and to meet experts in the field of optogenetics, but getting chosen for an award among all the good work was exhilarating," Arnob said. "We have designed a novel tool for light delivery inside brain tissue and modeled the light-brain interaction, which will facilitate the efficient positioning of recording systems along with the estimation of recorded brain region."

A grant from the National Institutes of Health (NIH), a CAREER award from the National Science Foundation and another Career award from NASA support Shih's optics research. The NIH grant specifically funds the neural probe project, which is a collaboration with Jack Wolfe, also a professor of electrical and computer engineering at Cullen College.

"Our novel design addresses the current barrier of having single-fiber waveguide with multiple stimulation sites covering 360-degree excitation capability," Nguyen said. "It's always inspiring to be recognized, especially in a competition of excellent peers."

UNDERGRADUATE RESEARCH OPPORTUNITIES IN THE ECE DEPARTMENT

by Stuart A. Long,
Professor of Electrical and Computer Engineering,
Associate Dean of Undergraduate Research

There are two main undergraduate research programs administrated by the UH Office of Undergraduate Research which can allow an ECE undergraduate student the opportunity to do one-on-one mentored research with an ECE faculty member and their research team.

The first is UH's Summer Undergraduate Research Fellowship (SURF) program, which provides funding for rising UH sophomores, juniors and seniors to participate in a focused, full-time, 10-week research experience under the direction of a UH faculty member. This fellowship is open to students of all disciplines. The SURF program provides a $3,500 stipend to students and a $300 reimbursement stipend to faculty for any expenses incurred in mentoring the SURF student. In the summer of 2015, approximately 75 students were supported by this program.

The second is the Provost's Undergraduate Research Scholarship (PURS) program, which provides talented UH juniors and seniors with the opportunity to participate in a semester-long research project under the direction of a UH faculty mentor. Recipients receive a $1,000 scholarship to conduct a one-semester research project with their faculty mentors. Students are expected to work five to seven hours per week over the course of a semester. About 50 students participated in the PURS program during the past academic year.

The Office of Undergraduate Research also supports Undergraduate Research Day in the fall of each year. This signature research event has grown significantly in the past several years and most recently was held on Oct. 22, 2015. It was a campus-wide gathering with 170 students presenting posters and with approximately 700 in attendance. As such, it was the largest such event in UH history and featured the research of more than 30 UH engineering students.

ECE students can also be involved in research by choosing to enroll in the Senior Honors Thesis Program, which is also administered by the Office of Undergraduate Research. This endeavor requires a full year of work and can substitute for up to two regular three-hour elective courses. Those completing their thesis and defending it to their faculty committee will graduate with an "honors" distinction.

ENGINEERING ALUMNUS PIONEERS LARGE-AREA GRAPHENE FILM

by Elena Watts

Peng Peng, an electrical and computer engineering alumnus of the Cullen College of Engineering at the University of Houston, is pioneering mass production of large-area graphene film based on groundbreaking research that started at his alma mater.

A special 2014 "Ten years in two dimensions" edition of *Nature Nanotechnology* journal featured articles about graphene capacitive touch panel technology and the world's first commercial graphene touchscreen smartphone, both developed by Peng in 2012 and 2013, respectively.

"As recognized by Konstantin Novoselov in his 2010 Nobel Lecture, the CVD graphene started with our UH paper published in the July 2008 issue of *Applied Physics Letters*," said Steven Pei, UH electrical and computer engineering professor and deputy director of the Center for Advanced Materials. "It was followed by the MIT paper published in 2008 and the Korean and UT-Austin papers published in 2009."

In 2007, Peng was part of a team led by Pei and fellow alumnus Qingkai Yu that synthesized graphene films on metal substrates by chemical vapor deposition (CVD) and transferred them to other substrates for the first time. The doctors' research opened the door for commercial application of CVD graphene films.

"Based on the basic principles we established in Dr. Pei's group, we have continued to develop a new growth system and transfer technique in China with focus on industrial mass production and application," Peng said.

In 2011, Peng founded 2D Carbon Tech in China with the help of almost a dozen venture capital investors. The company scaled up single graphene film production to half a square meter and introduced the world's first graphene capacitive touch panel in 2012.

The next year, the company developed the first mass-production line with capacity for 30,000 square meters of graphene film per year. By the end of 2014, the company expanded production capacity to 150,000 square meters of graphene film per year and started a subsidiary company, 2D Optronics, to develop applications for the fourth-generation technology. The company grossed almost $1 million in sales last year.

Compared to the conventional, rigid transparent conductive material, indium tin oxide (ITO), used to manufacture touchscreen panels, flexible graphene film is less expensive, easier to fabricate and more environmentally friendly, Peng said.

"Indium tin oxide is inflexible and fragile, and the raw material indium is an expensive rare metal that is not environmentally friendly," Peng said. "Our goal is to partially replace indium tin oxide material in conventional touch panels and to dominate the transparent conductive material market in emerging flexible, wearable electronics."

Peng and his team continue to improve yield rates, to cut costs and to develop new applications for the technology. Graphene film has potential for applications such as biosensors, e-skins, thermal sink films and gas barrier materials.

"Both industry and end consumers will benefit from this new material," Peng said. "Within the next few years, we expect to see a lot of graphene industry products on the market."

DEPARTMENT HOSTS ANNUAL ALUMNI MIXER AT SAINT ARNOLD'S BREWERY

by Natalie Thayer

The Cullen College's Electrical and Computer Engineering (ECE) Department held its annual alumni mixer last November at the Saint Arnold Brewing Company, Houston's oldest craft brewery.

Fritz Claydon, director of the Cullen College's Division of Undergraduate Programs and Student Success, led the evening's festivities as ECE alumni, senior students, faculty and staff enjoyed free beer and barbeque. Throughout the event, attendees played games of darts with friends and colleagues and won raffle prizes, including tickets to the University of Houston vs. Navy football game on Thanksgiving Day.

You can view the photos from the 2015 ECE alumni mixer at www.flickr.com/photos/cullencollege

ALUMNUS SUPPORTS COLLEGE WITH $4.5M CHARITABLE GIFT ANNUITY

by Audrey Grayson

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 UH Cullen College of Engineering."

The Sniders have specified 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.

Larry and Gerri Snider

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.

DEAN HONORS TWO ORGANIZATIONS WITH INDUCTION INTO THE BRIDGEBUILDER SOCIETY

by Natalie Thayer

At the Energy Leadership Board (ELB) dinner on Nov. 5, two organizations were honored with inductions into the Bridgebuilder Society for the Cullen College of Engineering.

Established in 2000, the Bridgebuilder Society recognizes and honors those who have made transformational and impactful gifts to the Cullen College of Engineering. Induction into the society is the highest honor the Cullen College bestows upon a donor.

This year, Joseph W. Tedesco, Dean of the Cullen College, recognized The Institute for Rehabilitation and Research Foundation, also known as TIRR Foundation, and the Offshore Industry Crawfish Boil Committee for their significant financial contributions and commitment to the future of the college.

The TIRR Foundation is a nonprofit 501(c)(3) organization that seeks to improve the lives of people who have sustained central nervous system damage through injury or disease. The TIRR Foundation created, directs and funds Mission Connect, a collaborative neurotrauma research project. Mission Connect is focused on supporting the discovery of preventions, treatments and cures for central nervous system damage caused by brain injuries, spinal cord injuries and neurodegenerative diseases.

Led by executive director Cynthia Adkins, the TIRR Foundation has provided significant support to Jose Luis "Pepe" Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen University Professor of electrical and computer engineering, and his Non-Invasive Brain Machine Interface Systems Laboratory at the UH Cullen College.

The Offshore Industry Crawfish Boil Committee has organized, managed and lead efforts to host the annual offshore industry, pre-OTC crawfish boil for 27 years. The popular on-campus event draws several thousand individuals to the University each year, including industry partners, alumni and community members. The tireless efforts of the committee members have resulted in more than $1 million dollars of financial support for programs and student scholarships in the Cullen College of Engineering.

Tedesco honors TIRR Foundation

Tedesco honors Crawfish Boil Committee

AMERICAN JEREH SUPPORTS ENGINEERING STUDENTS WITH NEW SCHOLARSHIP

by Audrey Grayson

Oilfield-equipment manufacturer American Jereh International Corporation showed its support for the University of Houston Cullen College of Engineering by granting scholarships to two engineering students for the 2015 fall and 2016 spring semesters.

The demand for skilled engineers in the city of Houston, the energy capital of the world, is higher than in any other major U.S. city. Company leaders at American Jereh hoped to give back to the Houston community by helping engineering students at UH to successfully complete their degrees.

The academic curriculum at the UH Cullen College of Engineering is widely regarded as one of the most rigorous engineering programs in the nation. On top of the challenging course work, the majority of UH Engineering students work full-time or part-time to finance their education.

Consequently, many Houston companies in the energy industry choose to support the college and its students through academic scholarships, providing students with funding for textbooks, tuition and even on-campus housing.

American Jereh is the latest Houston-based company to provide such support.

Ricca Leatherman, vice president of human resources for the manufacturer, said that the company's chief executives were very impressed with the caliber of graduates from the college.

"We have some very successful UH alumni here that were hired right out of college. UH engineering students come across as highly intelligent, creative and innovative problem-solvers who are ready for the challenges ahead of them," Leatherman said.

While the purpose of the scholarship funding is primarily to ease students' financial burdens, it's also an opportunity for companies to recruit talented individuals to join their teams, Leatherman added.

As a global manufacturer of advanced oilfield equipment, American Jereh serves clients in over 30 countries with custom, integrated technology for land and offshore operations. When the company's North American headquarters was established in Houston, American Jereh's leadership was adamant on giving back to the community in a way that would have true impact.

"In our brainstorming sessions, giving back to UH Engineering was one of the first things that came up," said Leatherman. "We decided on UH Engineering because it's an excellent, up-and-coming program and because we want to help the students in Houston who are the future leaders of our community."

American Jereh provided scholarships in the amount of $3,000 for two undergraduate students pursuing degrees in electrical and mechanical engineering, respectively.

To learn more about giving opportunities at the UH Cullen College of Engineering, please visit advancement.egr.uh.edu/giving-opportunities/ways-give

To learn more about American Jereh International Corporation, please visit www.americanjereh.com

2015 ECE ALUMNI MIXER







The Electrical and Computer Engineering (ECE) Department held its annual alumni mixer last November at the Saint Arnold Brewing Company, Houston's oldest craft brewery.

11TH ANNUAL GRC/CDC CONFERENCE

The 11th annual Capstone Design and Graduate Research Conference was held last May at the UH Hilton Hotel. The day-long event included technical sessions in which graduate and undergraduate student research and projects were presented.






CULLEN COLLEGE CELEBRATES FEMALE ENGINEERS WITH 2015 WOMEN IN ENGINEERING DAY

The Cullen College's Women in Engineering Program held its annual Women in Engineering Day event last April at the UH Hilton Hotel.



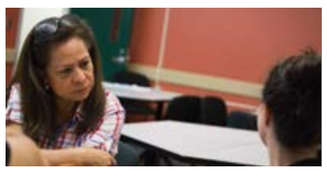


2015 WOMEN IN ENGINEERING NETWORKING & WELCOME EVENT

The Women in Engineering (WIE) Program hosted a Networking & Welcome Back Event last October at the UH Hilton Hotel.







2015 UNDERGRADUATE RESEARCH DAY



The UH Office of Undergraduate Research hosted the 11th annual Undergraduate Research Day last October at the Rockwell Pavilion, where over 175 undergrad students showcased their research with poster and oral presentations.



2015 WILLIAMS NETWORKING BBQ LUNCHEON AND RECRUITING EVENT

Energy infrastructure company Williams hosted a BBQ luncheon and recruiting event for Cullen College students last September.






SOUTHWEST ECEDHA CONFERENCE

The UH ECE Department hosted the Electrical and Computer Engineering Department Heads Association (ECEDHA) Southwest Conference last October.



2015 ENGINEERING CAREER FAIR

Last September, over 2,500 engineering students flocked to the UH Hilton Hotel to attend the Cullen College's fall Career Fair and meet with representatives from 114 companies.

View more photos from the Cullen College of Engineering at https://www.egr.uh.edu/news/photo-gallery

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