UNIVERSITY of HOUSTON | ENGINEERING

PARAMETERS

Cullen College of Engineering
Magazine • Spring 2020

FOLLOW HER LEAD:

FAITH MALTON IS [RE] ENGINEERING A BETTER WORLD

*JEFFREY RIMER IS THE **ABRAHAM E. DUKLER PROFESSOR OF CHEMICAL AND BIOMOLECULAR ENGINEERING** AT THE UNIVERSITY OF HOUSTON CULLEN COLLEGE OF ENGINEERING.*

JEFFREY RIMER, Ph.D.

PIONEERING DISCOVERIES ABOUT HOW CRYSTALS FORM AND HOW THEY CAN BE DISSOLVED

WINNER OF THE

2020
TAMEST EDITH & PETER O'DONNELL AWARD IN ENGINEERING

FROM THE ACADEMY OF MEDICINE, ENGINEERING AND SCIENCE OF TEXAS

"DR. RIMER IS AN INTERNATIONALLY RECOGNIZED EXPERT IN CRYSTAL ENGINEERING WHOSE FRONTIER RESEARCH HAS PRODUCED DRUGS FOR TREATING KIDNEY STONES AND MALARIA AS WELL AS UNCOVERED CHEMICAL TECHNIQUES IN THE PETROCHEMICAL INDUSTRY."

- AMELIE RAMIREZ, TAMEST BOARD PRESIDENT

"[DR. RIMER] IS ANSWERING FUNDAMENTAL ENGINEERING QUESTIONS BUT FINDING VERY REAL SOLUTIONS TO MODERN PROBLEMS."

- JOSEPH W. TEDESCO, ELIZABETH D. ROCKWELL DEAN OF THE UH CULLEN COLLEGE OF ENGINEERING

LEARN MORE AT: WWW.TAMEST.ORG

UNIVERSITY of HOUSTON | ENGINEERING

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Houston Researchers Work to Create SWARMS of Tiny Robots to Attack and Magnetically Remove Blood Clots

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Improving medical delivery for teleretinal screening and organ transplant

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Cullen College of Engineering

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PARAMETERS

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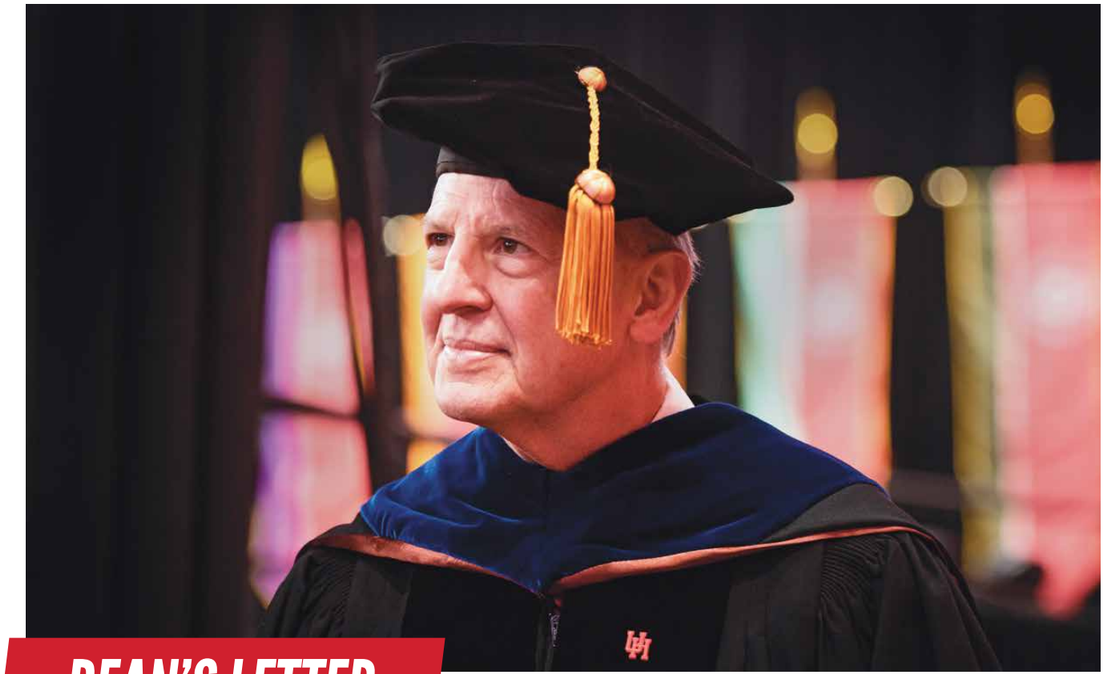


DEAN'S LETTER

At the Cullen College of Engineering, we strive for excellence and innovation, and we have emerged as a leader in game-changing research and technology. With more than $34 million in research expenditures, the highest of any academic unit at the University of Houston, we have proven ourselves to be a force to be reckoned with. Every day, our faculty and students conduct important, impactful research for the real-world, be it providing green solutions for the US power grid or pursuing more effective cancer treatments.

It begins as an idea, the nagging persistence that things could be better. Perhaps you grew up without access to clean water or saw first-hand the devastation brought on by a natural disaster. That idea sparks a desire to change things for the better, and then the work begins. The solutions to these everyday problems brought forth in the lab are the foundation of change, and when industry puts our research in action, things get truly exciting. Working directly with industry partners in the energy, medical and technology fields gives us the opportunity to create lasting impacts on the community, from optimizing processes to improving quality of life.

These impacts are not merely a positive pay off. They are the very reason we conduct research in the first place. As engineers, shaping the world we live in is not only our privilege, it is our responsibility.

That passion for moving society forward is a driving force at the Cullen College. It is what pushes us to think bigger and set the bar so high. Take civil engineering junior, Faith Malton, for example. Born with one arm, Malton has faced many challenges in her everyday life. She reminds us that the small things we often take for granted can prove to be big challenges for others. But where some might see an obstacle, Malton sees an opportunity for improvement and reminds us that we can, and should, do better. Today she has turned her knack for innovating solutions and adapting the environment around her to using her lens to impact communities around the world. Her hope is to one day develop sustainable cities.

I encourage you all to ask questions and challenge the status quo. By asking questions, we introduce the need for change. Why are we doing things this way? How can we do better and improve? As engineers, researchers, workers and educators, we have the power to create lasting impacts and perhaps, if we are lucky, leave the world a better place than we found it.

Warm regards,

Joseph W. Tedesco

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

UH ENGINEERING RESEARCH FOR A BETTER WORLD

DATA GATHERED FROM FY19 UH COLLEGE RESEARCH EXPENDITURES

UNIVERSITY OF HOUSTON RESEARCH FUNDING:

The University of Houston has emerged as a leader in education and research. With over $113 million in college research expenditures, topics range from social work to pharmaceuticals. The Cullen College is proudly leading the way with over $34 million, more than any other academic unit on the University of Houston campus.

This milestone is not only a point of pride, it is a reminder of the capacity for great change. Cullen College professors continue to strive for excellence in game-changing research with the goal of improving our communities and the world at large.

3% - BUSINESS
C.T. BAUER COLLEGE OF BUSINESS
$3.4M IN RESEARCH FUNDS

11% - LIBERAL ARTS/SOCIAL SCIENCES
COLLEGE OF LIBERAL ARTS/SOCIAL SCIENCES
$12.4M IN RESEARCH FUNDS

5% - OPTOMETRY
COLLEGE OF OPTOMETRY
$5.6M IN RESEARCH FUNDS

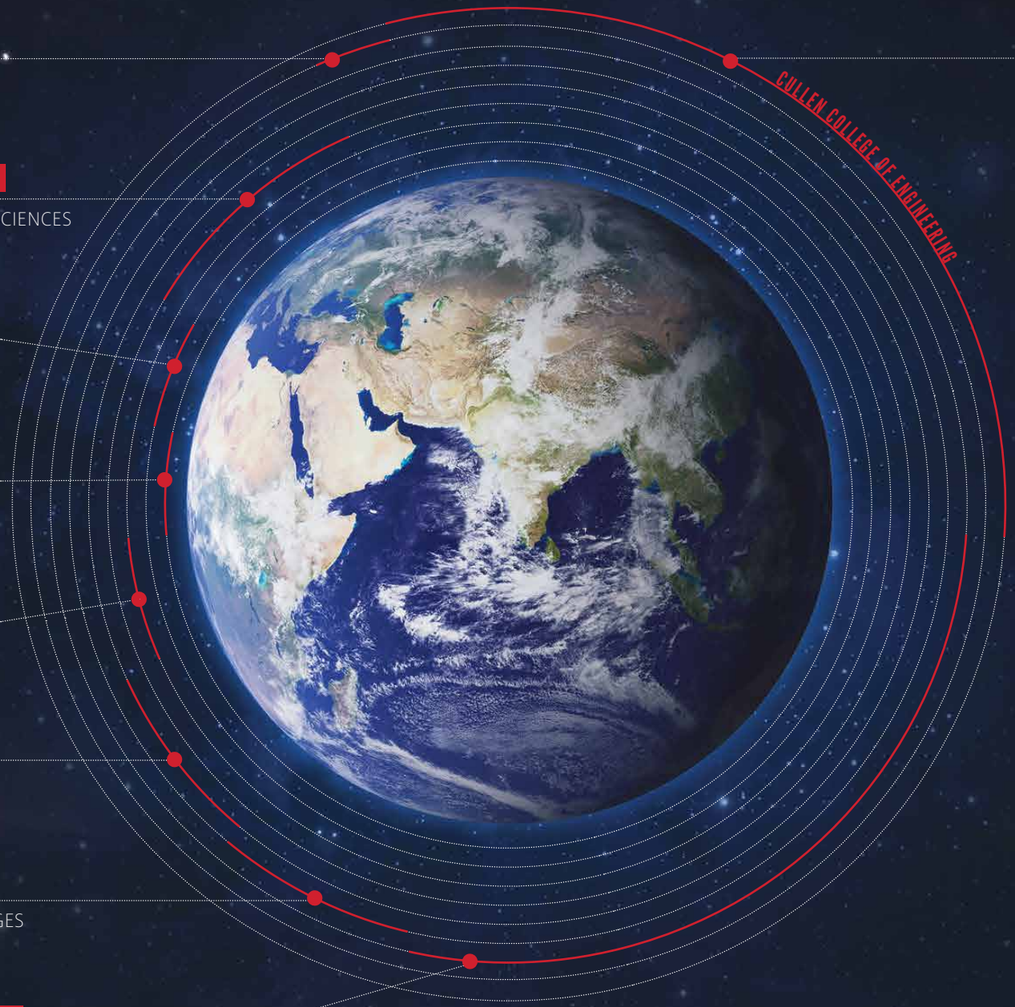
5% - SOCIAL WORK
COLLEGE OF SOCIAL WORK
$5.6M IN RESEARCH FUNDS

5% - EDUCATION
COLLEGE OF EDUCATION
$5.6M IN RESEARCH FUNDS

8% - PHARMACY
COLLEGE OF PHARMACY
$9M IN RESEARCH FUNDS

3% - OTHER
COMBINATION OF 7+ OTHER COLLEGES
$3.4M IN RESEARCH FUNDS

28% - NATURAL SCIENCES & MATHEMATICS
COLLEGE OF NATURAL SCIENCES & MATHEMATICS
$31.6M IN RESEARCH FUNDS



32% - ENGINEERING

CULLEN COLLEGE OF ENGINEERING HAS $34 MILLION+ IN RESEARCH FUNDING

HERE ARE A JUST FEW OF THE CURRENT RESEARCH PROJECTS:

GREEN SOLUTIONS FOR THE **US POWER GRID**
$370,000+ IN RESEARCH FUNDS

WATER RESOURCE SOLUTIONS USING SATELLITES
$660,000+ IN RESEARCH FUNDS

QUICKLY LOCATING **SEIZURE ONSET ZONE** IN THE BRAIN
$2,300,000+ IN RESEARCH FUNDS

$3 DOCTOR'S OFFICE TEST TO DETECT **PROSTATE CANCER**
$390,000+ IN RESEARCH FUNDS

UNDERSTANDING AND OPTIMIZING **BATTERY LIFE**
$1,000,000+ IN RESEARCH FUNDS

PURIFYING WATER WITH SURFACE CHEMISTRY SOLUTIONS
$300,000+ IN RESEARCH FUNDS

ROBOTIC **BLOT CLOT REMOVAL**
$750,000 IN RESEARCH FUNDS

ANTI-ICING SURFACE COATING PRODUCTS
$470,000+ IN RESEARCH FUNDS

THE NATIONAL SCIENCE FOUNDATION (NSF) *FUNDS GROUND-BREAKING RESEARCH AND EDUCATION IN SCIENCE AND ENGINEERING, THROUGH GRANTS AND CONTRACTS.*

READ MORE ABOUT OUR CUTTING-EDGE RESEARCH PROJECTS IN THE ***LEAD NEWS*** *SECTION OR VISIT:* ***WWW.EGR.UH.EDU***

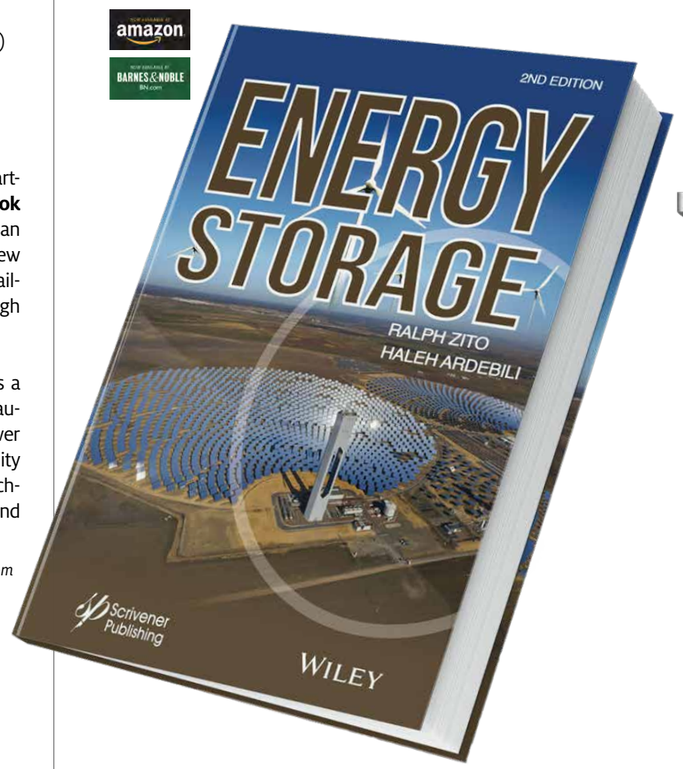
IN THE MEDIA **SPOTLIGHT**

SURFELLENT FEATURED IN INNOVATIONMAP

InnovationMap Houston recently spotlighted UH-based start-up, SurfEllent and its co-founder, **Hadi Ghasemi**, **Bill D. Cook** associate professor of mechanical engineering. SurfEllent is an anti-icing coating technology company focused on bringing new technologies to market. SurfEllent's products are currently available as aerosol sprays and paints. They can be purchased through their online shopping platform www.surfellent.com.

According to Ghasemi, icing is a major problem that impacts a wide range of things, including aircraft wings and engines, automobiles, buildings and bridges, ships and vessels, and power transmission systems. The ultimate goal is to improve the quality of human life. Ghasemi hopes to continue advancing the technology and is looking to collaborate with various industries and business partners.

SEE THE FULL STORY AT:
www.houston.innovationmap.com



HALEH ARDEBILI PUBLISHES NEW BOOK

Haleh Ardebili, Bill D. Cook associate professor of mechanical engineering and director of innovation and entrepreneurship at the Cullen College of Engineering, recently published her second book, **"Energy Storage: A New Approach."** The book focuses on practical solutions to issues regarding mass-scale energy storage and the overall impact on today's society. Ardebili's current work is centered around materials for energy storage and the development and advancement of flexible, stretchable lithium-ion batteries and next-generation polymer nanocomposite electrolytes.

BOOK AVAILABLE FOR PURCHASE AT:
www.amazon.com & www.barnesandnoble.com

UH STUDENT FINDS NEW COMPOUND IN APOLLO 17 LUNAR DUST

Monica Martinez, mechanical engineering undergraduate student, was recently spotlighted in the Houston Chronicle for her discovery of a previously unrecognized compound in lunar dust samples that were collected during the Apollo 17 mission in December 1972. (Apollo 17 was the last trip to the moon that carried human passengers.) Martinez found calcium-sulfide, which is often used as a base for luminescent materials. After extensive research, Martinez found the presence of calcium-sulfide had never been documented. She plans to continue running tests on the lunar dust samples in search of other undocumented elements and compounds. Her work could provide insight into whether the moon could be utilized as a potential resource for oxygen and hydrogen.

SEE THE FULL STORY AT:
www.houstonchronicle.com

YOLANDA NORMAN INTERVIEWED BY FOX 26 ABOUT FIRST GENERATION

FOX 26 Houston featured **Dr. Yolanda Norman** and a few University of Houston Engineering students. Students shared their first-generation stories and their efforts to support others at the University of Houston.

SEE THE FULL STORY AT:
www.fox26houston.com

CHECK OUT OUR FEATURE VIDEOS ON **YOUTUBE**

BRAIN ON ART: UH Engineering professor and local artist collaborate on a study of how art and science come together in neuroaesthetics.

SAFELY REMOVING BLOOD CLOTS: UH engineers develop magnetically navigated robots to non-invasively attack and remove blood clots.

VIEW OUR NEWEST VIDEOS AT:
www.youtube.com/UHCullenCollege

SEE THE FULL STORY AT:
www.advanceseng.com

BRANKOVIC'S RESEARCH FEATURED IN **ADVANCED ENGINEERING BLOG**

Stanko Brankovic, a professor of electrical and computer engineering at the Cullen College, was recently featured in **Advances in Engineering**, a news source focused on the promotion of timely engineering research news. The article recognizes Brankovik's work on the adoption and evaluation of lead monolayer deposition on Ru(0001). His work was most recently published in the *Journal of the Electrochemical Society*.

View Cullen College videos online at youtube.com/UHCullenCollege YouTube

NEW ENGINEERING ACADEMY PUTS UH AT KATY IN THE LIMELIGHT

BY RASHDA KHAN

The recently announced partnership between the new University of Houston at Katy and Houston Community College (HCC) to enable Katy-area students to earn engineering degrees right in their neighborhood has the Greater Houston community buzzing with excitement.

The story has been covered both in the Houston Chronicle and Houston Community Impact, and the partnership was the topic of conversation at a recent Katy Area Chamber of Commerce luncheon.

There is good reason for the excitement about the UH/HCC Engineering Academy scheduled to launch in the fall of 2020.

*"The student will have access to a world-class engineering education. The quality of education and research at the UH Cullen College of Engineering contributes to UH's ranking as a Carnegie-designated Tier One public research university," said **J.R. Rao**, associate dean for engineering at UH at Katy.*

"The curriculum in the Engineering Academy is structured so that students get to take all their engineering classes with the Cullen College faculty at UH at Katy, whereas other core non-engineering courses will be taught by HCC," he said. "Under this model, the students will have significantly lower costs in the first two years, thus increasing access to UH engineering degrees, and they will also enjoy shorter commutes by attending classes at the conveniently located UH at Katy."

The 80,000-square-foot UH at Katy building, which is near completion, is at the intersection of Interstate Highway 10 and the Grand Parkway.

How it works

Unlike traditional transfer programs, students admitted into the UH/HCC Engineering Academy are UH Cullen College of Engineering students from day one and are co-enrolled at both partner institutions.

After successfully completing the academy, students will then transition to the UH main campus to complete their bachelor's degrees in one of five engineering areas offered to UH at Katy students: civil, electrical, computer, industrial or mechanical engineering.

In addition, the college is launching three new undergraduate engineering programs specifically designed for UH at Katy: systems engineering, construction engineering, and computer engineering and analytics.

"These new programs will have their upper division in Katy itself. They start in Katy and finish in Katy," Rao said. "We're very excited about that."

Cullen College engineering solutions

It's a forward-looking and ambitious plan that addresses the needs of the Katy community as well as the workforce needs of the many companies located along the Energy Corridor.

"Given the demand for engineering talent across the Greater Houston area, the expansion of UH Engineering programs in Katy is both imperative and inevitable," said **Joseph W. Tedesco**, Elizabeth D. Rockwell Dean of the UH Cullen College. "The city of Houston needs a homegrown workforce trained to take on the engineering jobs of the future while filling in the skills gaps of today."

Dean Tedesco shared some insight into the bigger plan at work. "My vision is for the University of Houston Cullen College of Engineering to be the global leader of engineering education and research, and our expansion into Katy is a key step in this mission," he said. "That's what the city of Houston needs, and we are the only college in the world with the expertise, resources and ingenuity to make it happen."

UH Cullen College of Engineering Hosts Students from South China University of Technology for

FIRST-EVER CIVIL SUMMER WORKSHOP

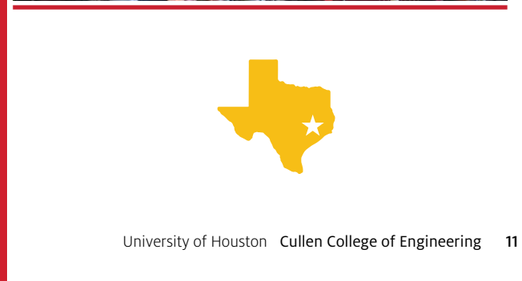
BY INEZ HUTCHINSON

This past summer, UH Engineering hosted over 40 college students from the South China University of Technology for the first-ever, three-week resilient civil infrastructure summer workshop.

The program led by **Yi-Lung Mo**, John and Rebecca Moores professor of civil and environmental engineering, and **Gangbing Song**, John and Rebecca Moores professor of mechanical engineering, provided students an inside look into college life at the University of Houston. From July 19-Aug. 12, the students lived in a UH dorm, interacted with Cullen College faculty, visited research labs and attended course lectures concentrated on two areas — civil infrastructures and structural health monitoring.

Song stressed the importance of sharing knowledge of structural health monitoring with other universities. There are many rural areas around the globe that do not have access to modernized infrastructure, leaving them especially prone to damage caused by earthquakes and other natural disasters. Creating a broader base of knowledge for better monitoring and preparing building structures could have the potential to alleviate devastation and save countless lives in the future.

Song and Mo plan to continue growing the program over the coming years. In addition to growing in size, they also hope to expand their research beyond the lab and to use this program as a platform to work directly with communities in developing countries. Additionally, the program will encourage students from South China University of Technology (SCUT), along with other foreign universities, to relocate and pursue graduate studies at the University of Houston. The hands-on experience involved in the summer workshop will also make students aware of research career options available in the United States.



UH at Katy to Offer

THREE NEW ENGINEERING DEGREES

BY JEANNIE KEVER

In a significant move to expand higher educational offerings across the Houston region, the University of Houston has received approval from the Texas Higher Education Coordinating Board to offer three new undergraduate engineering degrees in Katy.

"The UH at Katy and UH at Sugar Land instructional sites offer a University of Houston Tier One education to residents across our region in disciplines that are in great demand," said Paula Myrick Short, senior vice president for academic affairs and provost.

"These new undergraduate classes and programs are yet another step in making higher education and a UH degree accessible to the greater Houston metropolitan area."

The UH Cullen College of Engineering will begin offering undergraduate degrees in computer engineering and analytics, construction engineering and systems engineering at UH at Katy in Fall 2020. The coordinating board approved the new degrees on Jan. 23.

Thanks to a new collaboration with Houston Community College, the UH/HCC Engineering Academy at Katy, students will be able to complete all classes for the four-year degree in Katy, said J.R. Rao, associate dean for UH Engineering in Katy.

All engineering courses will be taught by UH faculty, while students will take lower division classes and core requirements, such as math and English, through HCC, he said.

Enrollment for the new degree programs will begin with the freshman class in fall 2020. Rao said enrollment is expected to grow to about 750 students when classes are fully enrolled, with about 180 graduates anticipated annually.

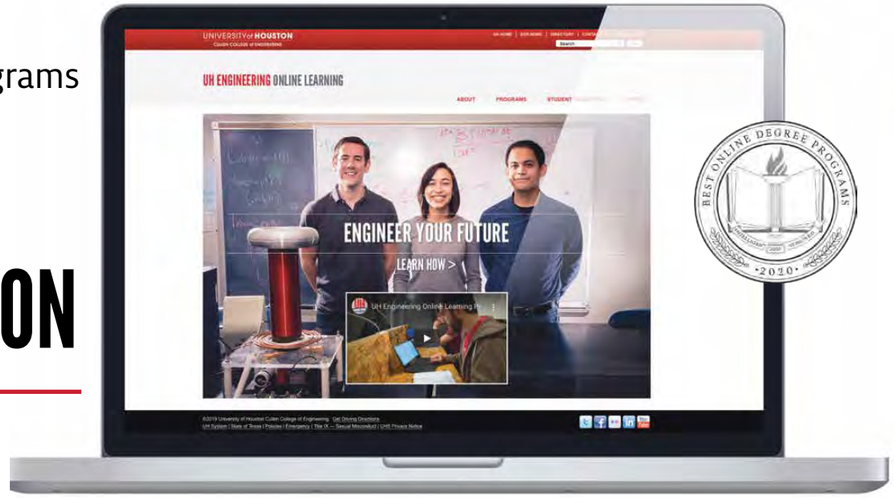
Jay Neal, associate vice president for academic affairs and chief operating officer at UH at Sugar Land and UH at Katy, said the expansion of programs at the two instructional sites has been an intentional process.

"We want to provide our students with courses and degree plans that have relevance to the industry around us," he said. "As leaders and good neighbors, we want to be part of what strengthens the community."

UH currently offers a master's degree and a certificate in subsea engineering at UH at Katy. More information on UH engineering programs in Katy can be found on the college's website.

Three Online UH Engineering Programs Rank Among

BEST IN THE NATION



BY RASHDA KHAN

***Intelligent.com**, a student-focused website, included three online programs offered by the UH Cullen College of Engineering in its 2019/2020 national rankings list of best public institution programs.*

The college's online master's program in civil engineering, offered through the Department of Civil and Environmental Engineering, ranked No. 9 and received special recognition as the "Best Blended Program."

The program prepares students to solve present and future challenges in the civil and environmental engineering field. Located in Houston, a city with one of the highest concentrations of civil and environmental engineering companies in the country, the Cullen College offers unique opportunities to enrolled students.

The Department of Electrical and Computer Engineering (ECE) was recognized for offering one of the "Best Electrical Engineering Degree Programs." The online master's program was ranked No. 12.

"Our research found your degree program to be one of the best in the nation, with a unique distinction for its power and energy systems focus," wrote Erica Fagien, director of communications at Intelligent.com, in the notification email.

The online master's program in mechanical engineering ranked No. 16. Fagien commended all three UH engineering programs for providing top quality education that helps students achieve their career goals.

*The rankings are calculated using a unique scoring system, which includes **student engagement, potential return on investment and third-party evaluations**.*

Intelligent.com analyzed hundreds of schools with comparable programs on a scale of 0 to 100. The methodology uses an algorithm that collects and analyzes multiple rankings into one score to easily compare different programs, according to Intelligent.com.

"We are a college on the move, and these most recent rankings are a wonderful reflection of this," said **Joseph W. Tedesco**, Elizabeth D. Rockwell Dean of the UH Cullen College of Engineering.

"Graduate programs at the UH Cullen College of Engineering provide a solid foundation of technical know-how for our students," he added. "We are excited to offer these degrees online and make them accessible to even more people seeking professional development in the dynamic field of engineering."

According to the U.S. Bureau of Labor Statistics, employment of engineers in the nation is projected to grow over the 2016-2026 period, adding about 139,300 new jobs.

"These three national rankings demonstrate the exceptional academic scholarship of the Cullen College of Engineering, and are a reflection of the college's distinguished faculty, led by Dean Joseph Tedesco," said **Paula Myrick Short**, UH senior vice president for academic affairs and provost. "I am proud more students are able to obtain their graduate degrees online from the University of Houston through these outstanding programs."

About Intelligent.com

***Intelligent.com** provides unbiased research to help students make informed decisions about higher education programs. The website offers curated comprehensive guides, including the best degree programs, as well as information about financial aid, internships and even study strategies.*

What Happens As SOLID-STATE BATTERIES BEGIN TO FAIL?

BY JEANNIE KEVER

> *Solid-state batteries aren't flammable, making them safer than traditional lithium ion batteries, but they are also different, and scientists don't know enough about them.*
>
> -LEONARD LIANG

Solid-state lithium batteries have generated interest because they don't carry the same risk of fire and explosion as conventional batteries with liquid electrolytes, but full-scale commercialization has been slowed, in part, because ***scientists don't fully understand what causes the batteries to fail****.*

Not knowing what has gone wrong makes it more difficult to optimize the batteries, so they work more efficiently for longer periods of time.

Yan Yao, associate professor of electrical and computer engineering at the UH Cullen College of Engineering, said most battery research has focused on developing new materials and design. But current diagnostic tools aren't compatible with solid-state batteries, leaving fundamental questions.

"When a solid-state battery cell dies, what has gone wrong?" Yao asked. Yao is the principal investigator for a $1 million project funded by the U.S. Department of Energy to develop a new platform to study the chemical, structural and mechanical interactions at the interface between a battery's solid electrolyte and the cathode and anode. The project involves researchers from UH and Rice University.

The work will provide fundamental insights into interactions at the interface but ultimately will be useful for applications including drones and electric vehicles, said Yao, who is also a principal investigator at the Texas Center for Superconductivity at UH.

Being able to see and record the interactions at the interface – using tools including secondary ion mass spectrometry, focused ion beam scanning electron microscopy, in-SEM nanoindentations and atomic force microscopy – will allow the researchers to watch in real-time as solid-state battery performance changes.

Zheng Fan, assistant professor of engineering technology at UH and a co-principal investigator on the project, said the researchers would build a small battery cell prototype to use in the project. The microcell will be subjected to changes in temperature, pressure and current flow as the tools measure reactions at the interface.

"It is a human instinct," Fan said. "We want to see what happens."

Yanliang "Leonard" Liang, research assistant professor of electrical and computer engineering at UH, said the resulting analysis will provide valuable information about how solid-state batteries perform, information that can be used to improve battery performance and reduce the risk of failure. Liang is also a co-principal investigator for the project.

Solid-state batteries aren't flammable, making them safer than traditional lithium-ion batteries, he said. "But they are also different, and scientists don't know enough about them."

In addition to Yao, Fan and Liang, researchers on the project include Jun Lou and Hua Guo, both with the Department of Materials Science and NanoEngineering at Rice University.

Yao notes that the resulting diagnostic platform will be useful, not just for researchers in his lab but also for others working to improve solid-state batteries.

UH Engineer Offers Proposals to

IMPROVE NATION'S ELECTRIC GRID

BY JEANNIE KEVER

***Balancing electricity supply and demand is challenging**, and the prospect of blackouts carries a substantial economic risk. An engineer with the University of Houston is working on solutions.*

Xingpeng Li, assistant professor of electrical and computer engineering at the UH Cullen College of Engineering, submitted two winning proposals to the U.S. Department of Energy's Electricity Industry Technology and Practices Innovation Challenge. In all, seven projects at six institutions were selected for funding. Li is the only researcher with two winning submissions.

DOE, through its Office of Electricity, targeted two goals in launching the competition. The first was to identify ways that new technologies might improve current power-industry practices. The second was to address existing or emerging threats to the country's electricity supply.

Academic and industry researchers, and other innovators, were invited to compete for a total of more than $300,000 for continued research.

Li received $70,000 for his two winning projects, which deal with both real-time and longer-term approaches to improving electricity grid performance, especially in ways that involve alternative energy sources.

"Renewable power generation isn't completely controllable, so we need better procedures to handle the uncertainty," he said. "The current planning model assumes no uncertainty, but in reality there are always forecasting errors, and the planning model needs to be able to account for that."

Thinking smaller

In one of his proposals, Li suggests changes that can enable transmission networks to become more nimble in turning to nontraditional power sources when demand for electricity is high. By contrast, most current systems cannot easily add energy from sources outside their own generation systems.

One answer is microgrids – smaller, individual rooftop solar-power systems. Energy from microgrids could feed into the large grid as needed to provide necessary boosts in capacity.

Looking larger

In his other winning proposal, Li takes on long-term planning goals to ensure the country's power supply efficiently keeps up with demand while it accommodates uncertainties inherent in power generation from renewable resources. For this study, Li looked at ways to determine the best locations for generating plants and transmission lines.

Next competition

The 2019 competition was the program's first. DOE officials have announced the agency will again sponsor the competition in 2020.

ENERGY

New Catalyst Would Boost

BIOMASS CONVERSION TO FUELS, CHEMICALS

BY JEANNIE KEVER

Efforts to use biomass, including wood and agricultural products, have played an important role in the search for a sustainable alternative to fossil fuels for transportation fuels and chemicals. But biomass has high concentrations of oxygen, making it more energy and labor-intensive to convert into those desirable end products.

Praveen Bollini, assistant professor of chemical and biomolecular engineering at the UH Cullen College of Engineering, says a catalyst using bulk cerium oxide – the most abundant of the rare earth elements in the earth's crust and already commercially available – can efficiently remove the excess oxygen, allowing biomass to be economically converted to fuels and chemicals. He was awarded a $364,984 grant from the National Science Foundation to build the catalyst and improve molecular-level understanding of the chemical and physical processes that occur when cerium oxide is used to remove the oxygen.

The oxygen is removed from the biomass through a process known as hydrodeoxygenation, which involves adding hydrogen. The hydrogen then combines with the oxygen to produce water as a harmless byproduct.

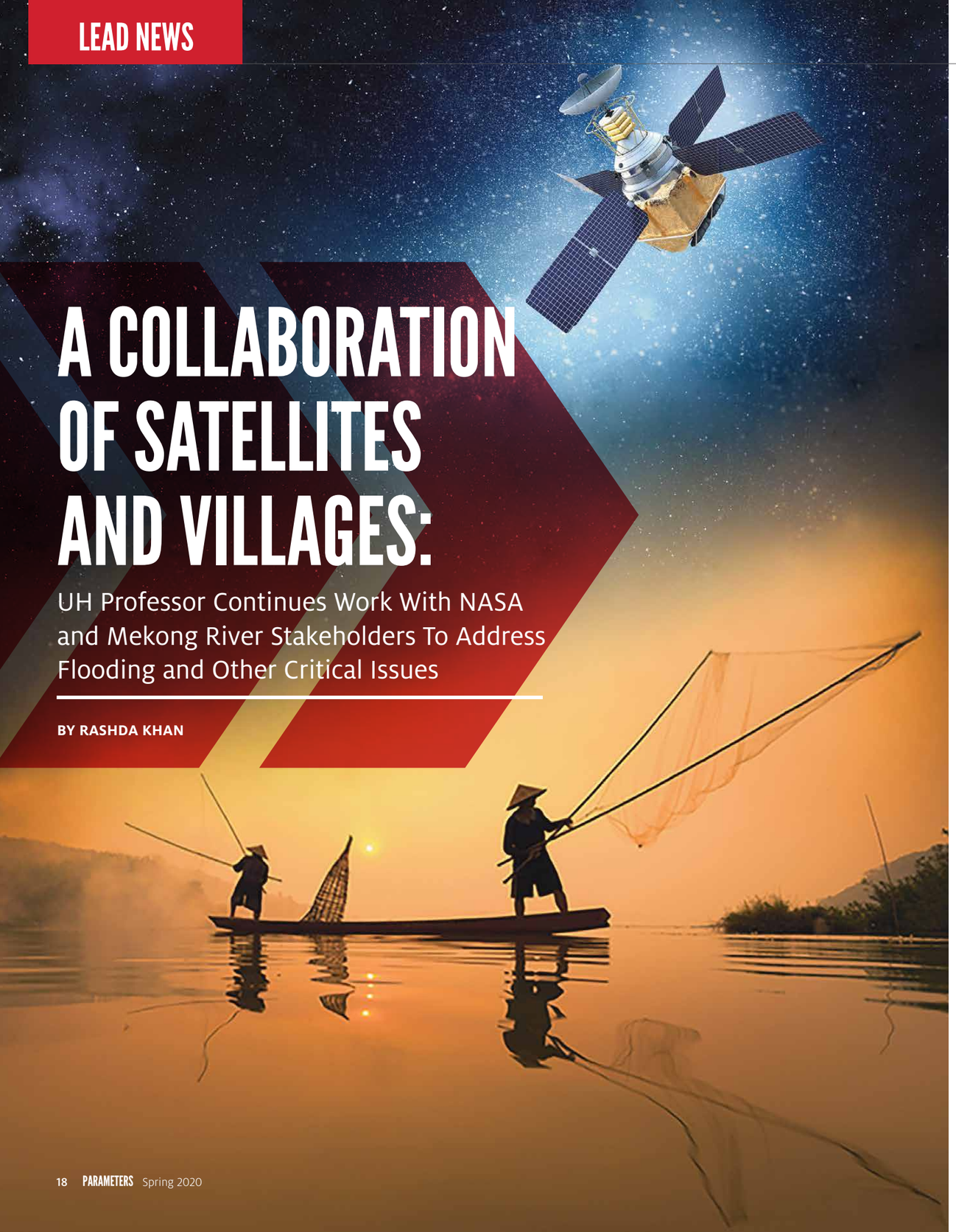
"The fuel value you get (after conversion) is dependent on the oxygen content. The lower the better," Bollini said. "Fossil fuels pulled from the ground have very low oxygen content."

Cerium oxide is already used commercially in automobile exhaust systems, he said, valued for its ability to take up and release oxygen at will. It hasn't previously been used for biomass conversion, but he said a prototype synthesized in his lab can successfully remove oxygen from a sample of biomass and when hydrogen is fed into the mix, convert the oxygen and hydrogen to water.

Bollini works in catalysis and reaction engineering, focused on making chemical transformations more energy and atom efficient in order to reduce both energy use and the release of carbon into the atmosphere.

The search has been ongoing for an inexpensive and easy way to use catalyst that is also effective, selective in removing only oxygen and able to use hydrogen fed into the mix. Bollini said the cerium oxide fits all the criteria.

It is abundant, inexpensive and already well understood because of its use as an oxygen storage component in automobile exhaust systems, he said.



A COLLABORATION OF SATELLITES AND VILLAGES:

UH Professor Continues Work With NASA and Mekong River Stakeholders To Address Flooding and Other Critical Issues

BY RASHDA KHAN

Hyongki Lee, associate professor of civil and environmental engineering at the UH Cullen College of Engineering, has a lot of experience using data collected by Earth-observing technologies (such as satellites) for solving water management issues on Earth.

*With his latest grant, Lee is diving deeper into addressing critical concerns such as land subsidence, **flood forecasting and groundwater management** in the Mekong region of Southeast Asia.*

Principal investigator Lee and his co-investigator Faisal Hossain of the University of Washington recently won their second NASA SERVIR program grant. The three-year project, titled "Operational Services for Water, Disaster and Hydropower Applications for Lower Mekong Populations using NASA Earth Observations and Models," received $661,443 in funding. It is one of 20 projects selected this round.

The project will use satellite data and feedback from local stakeholders in the Lower Mekong River basin to develop customized software tools to provide missing pieces of information on the real-time availability of water for the entire area.

The issues

The Mekong, one of the longest rivers in the world, stretches from China in the north to Cambodia in the south, crossing through Myanmar, Vietnam, Laos and Thailand along the way. The people of all these countries are affected by the river – relying on it for food and water as well as facing dangers from flooding and shortages.

The low-lying deltas of the Mekong are especially vulnerable to water availability due to increasing population, extensive irrigation and unchecked industrial development farther upstream. For many years locals relied on groundwater as the go-to water source, leading to land subsidence and increased risk of flood. Couple that with climate change and an inability to quantify changes in water storage levels across the region, and countries not sharing information with each other. The end result is troubled and unequally distributed waters.

Meanwhile, there are various satellites orbiting Earth and collecting vast amounts of data that is available to the public for free and could be used for the greater good. However, NASA distributes its data in raw binary form with different data fields, basically in formats aren't very easy to understand by lay people. That's where Lee and his team are useful.

Building blocks

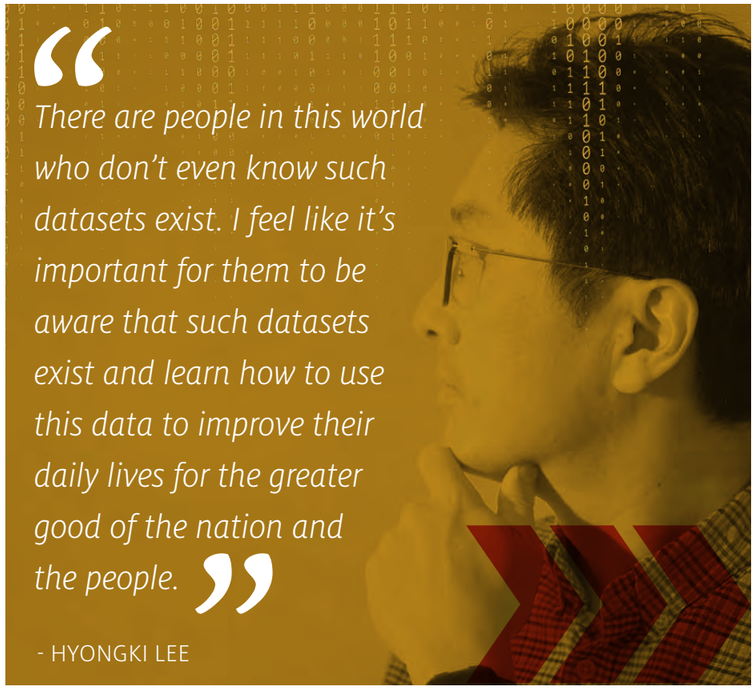
In 2016 Lee was selected by the NASA SERVIR program to lead a project managing water resources in Indochina by gathering data from satellite observations of the region and building a user-friendly software tool that allowed government officials to view information on water levels in real time. The three-year project, called "Building Lasting Capacity for Water Management in Vulnerable Deltas of Indochina," just wrapped up.

That project involved analyzing and processing raw data then developing real-world tools of interpretation that stakeholder agencies in Indochina could learn to use in their decision making on water policies.

The 2019 project built on the foundations of the previous one. Instead of just bringing space data to South Asian villages, the investigators collected feedback from the stakeholders to create customized products for the end-users.

"My approach is to actually listen to their needs and candid feedback first, instead of just giving them the U.S. data and technology," Lee said. "Sometimes I may be excited about some particular research dataset, but it may not be something really applicable to local needs."

The plan is to present existing datasets and techniques to the local stakeholders and gather feedback. "We'll bring that back to the office and build the product they need," Lee said, adding that the responses could also be shared with the science team of each satellite mission. "So we will have products or tools that are better understood and utilized by the locals." »»



THE OBJECTIVES OF THE NEW PROJECT ARE TO DEVELOP:

(1) A more frequent operational flood forecasting system. Initially, the researchers had thought daily forecasts would be adequate. However, local partners informed them that more frequent forecast data would be more useful to avoid flash floods that plague the area. So instead, the researchers will create a system to issue flood forecasts twice a day.

(2) Operational real-time reservoir monitoring system for all dams in Mekong Basin to track inflow and outflow. Since the Mekong is a transboundary river, many governments are involved. "Each country wants to build their own dams for their own interest," Lee said. Meanwhile, there's no real information sharing between countries. NASA data would allow anybody accessing it a more holistic view of the amount of water actually in the reservoirs in the region.

(3) Operational land subsidence monitoring system over the deltas and their major coastal cities. Over-pumping of groundwater in an area causes the land to gradually subside or sink. That and the sea-level rising can combine to result in more catastrophic flooding in the area.

Lee shared some examples of how this information could be useful. Local governments could use the land subsidence map to establish better policies to control the groundwater pumping or they could use the flood forecasting system to evacuate people when needed, thus minimizing lives beings endangered.

All of this data would be publicly available to everyone.

The challenge

The local people are not familiar with satellite observations and so are doubtful about the trustworthiness of the information. The researchers want users to have confidence in the new data so they plan to do extensive training comparing the satellite data with information collected by more traditional means (such as available ground and gauge measurements or hydraulic models). The idea is to validate the satellite data using more familiar information.

UH Cullen College Engineering Faculty Win

NSF GRANT FOR WATER PURIFICATION STUDY

BY SARA STRONG

The National Science Foundation (NSF) recently awarded $300,008 to two UH Cullen College of Engineering professors for their research into the development of coatings designed to play a role in water purification.

The award began in summer 2019 and will last three years for the project titled "Rates and Mechanisms of Biofouling and Mineral Scaling on Zwitterionic Amphiphilic Copolymer Surfaces." The researchers, both associate professors of civil and environmental engineering, believe the project may take longer.

"What we're trying to do is prevent any buildup of contaminants by coating a membrane with a special polymer," explained **Yandi Hu**, who is the principal investigator for the research project at UH. "Our goal is to end up with pure water by rejecting all unwanted matter, like toxic metals, ions and biohazards."

The study addresses two types of foulants or contaminants – chemical scales, which are the focus of Hu's research, and biofouling, which is the specialty of the project's co-principal investigator **Debora Rodrigues**.

*The research has the potential to help **ease the global water crisis** by developing water filters so efficient they far surpass current options to make water safe to drink. Such better, smaller filters could help make it more practical to transport and operate water purification systems in rugged or impoverished regions of the world where clean drinking water is frequently absent.*


YANDI HU AND DEBORA RODRIGUES

Industries such as petroleum and shipping are likely to benefit too from new ways to prevent unwanted foulant formation. For example, improved pipe linings could help transport oil more efficiently and special coatings could make ship hulls easier to maintain – two of the possible outcomes likely to yield significant economic benefits.

Potential results could eventually affect many aspects of society and commerce. But for now, the two researchers stress, the project is still in early phases of discovery and much work remains to be done in the laboratory.

The UH research project operates independently but in coordination with a project at Tufts University. That research is led by Ayse Asatekin, a Tufts chemical and biological engineering associate professor, who is an expert on ZACs (zwitterionic amphiphilic copolymers). ZACs are compounds that show impressive qualities against organic contaminants.

Testing the waters

"We depend on the Tufts team to prepare the ZAC coatings on the membranes and other surfaces, which are sent to us here at UH. We then perform the investigation within a water-treatment process called the reverse osmosis (RO) system," Rodrigues said.

As their research shows new understanding of how ZACs affect mineral scaling and biofouling on the study membranes, Hu and Rodrigues will explore ways to adapt the components in search of the most suitable variation.

*The ultimate benefit, they explained, would be to identify a single **coating whose properties have excellent abilities against both biological and mineral foulants**. But in the end, specific needs may call for multiple types of coatings to be developed.*

As their research findings become clear, Hu and Rodrigues plan to share the new knowledge at national and international conferences that draw attendees from utility groups, corporations and consulting firms, as well as academic researchers. More immediately, the information will be included in several graduate and undergraduate classes at UH and beyond.

"It's a lot of work. But still, it's something we love to do. And if it's fun, I don't really consider it to be work," Rodrigues said. "We see something positive that, hopefully, will bring something good to the society in the end."

New Techniques for COPOLYMER PRODUCTION

BY SARA STRONG

The National Science Foundation (NSF) awarded a three-year grant to a UH Cullen College of Engineering research team led by **Alamgir Karim**, professor of chemical and biomolecular engineering. The team's project, titled "Ordering of Block Copolymer Systems with Enhanced Molecular Interactions and Diffusional Dynamics," received $399,718.

*Karim is developing a **revolutionary method to use solvents**, instead of heat, to bond individual single-layer polymers into a multi-layered copolymer.*

"The new technique will not only lower manufacturing costs, it also will give engineers the ability to customize copolymers for special uses," said Karim, who is also director of the materials engineering program and director of the International Polymer and Soft Matter Center. "That factor is especially promising for high-tech markets."

Copolymer products are all around us. Pick up a clear soda bottle, for example. Even after a close look you might assume it is made from a single material that was molded into shape. But it was more than likely made from single or multiple layers of polymer sheets that were melted inside a hot mold under pressurized gas to form a single or multi-layers of copolymer material, shaped into the bottle you hold in your hand.

Karim compares copolymer layers to the rock strata in the Grand Canyon, only copolymer layers are much, much thinner — maybe as tiny as one-millionth the width of a human hair — with the multi-layers aligned by the new system he proposes, called direct immersion annealing (DIA).

Game-changing impact

In the marketplace, two benefits are expected with DIA technology, according to Karim and research assistant Ali Masud, a UH chemical engineering doctoral student. First, the energy saved with the new process would make manufacturing familiar products like soda bottles more cost-effective.

Second – and this is the game changer – engineers will be able to tweak either the recipe or the process (or both) to produce a material that has the highly specific qualities that its end use requires. Product packaging could become more biodegradable or astronauts' space suits more flexible. There may be infrared coatings that help keep buildings cool, car bumpers that are incredibly resilient, and food wrappings that defy more hot summer days than any food preservation system now in use.

*In some cases, highly refined copolymer materials might inspire advances in other fields. For example, they could help make bendable cell phones commercially viable, or perhaps bring **improved batteries to the next generation of nano-devices**.*

Marketplace frontiers

"With this new technology, possibilities are wide open," Karim said, adding his team's job is to perfect the science. Once in the marketplace, the improved process will inspire industry scientists to become the new explorers by testing DIA-produced copolymers in applications not yet imagined in technology, industry, medicine, and commerce. But that's getting ahead of the story. For now, Karim and Masud are at work transforming the concept into reality and at the same time, maintaining its practicality. "The idea has to be faster, cheaper, better if it is to succeed in the marketplace," Karim said.

As he now envisions the process, raw materials will be unrolled from supply spools and passed together through a bath of solvents; the finished copolymer material will be dried and rolled onto a single take-up spool. The large format can be more accommodating than the individual sheets produced by the current heat-based method.

"We must work out the new design systems. Nobody yet even knows the design rules," Karim said. "So far, the system has not been tested."

A lot of critical factors, including submersion time and controlling solvent evaporation, need to be determined. But the first challenge is to match the correct polymers with the appropriate solvents to produce the exact properties needed. Those demands vary widely according to use.

Many medical applications demand membranes that are absolutely impervious to specific components. "Safety depends on it," Karim said. "In working with the AIDS virus, for example, not a single viral particle can be allowed to pass through, not a single one," Karim said.

Automotive engineers protect lives in a very different way. Their ideal car bumper of the future will demand copolymers that have the strength to endure hits, softness to cushion shock, resilience to return to original shape after impact ("self-healing" as in nature), and tolerance to stand extreme weather, season after season.

Such diversity of needs requires the Karim's team to balance three basic types of solvents in the immersion mixture that, only half-joking, he refers to as The Good, The Bad and The Ugly.

"The 'good' solvents do the work," Karim explained. They contain the chemistry that do the actual formation of the polymer layers.

The "bad" solvents do not actively contribute to the process, but they offer major value in simply staying put. By keeping the polymers coated, they help the good solvents stay in contact with the surfaces where the job of layering and bonding is done.

That leaves the "ugly" solvents, which take on the less exciting-sounding task of adjusting molecules, rearranging them into a logical, permanent order that resembles shingles on a roof. The phenomenon is referred to as directed self-assembly.

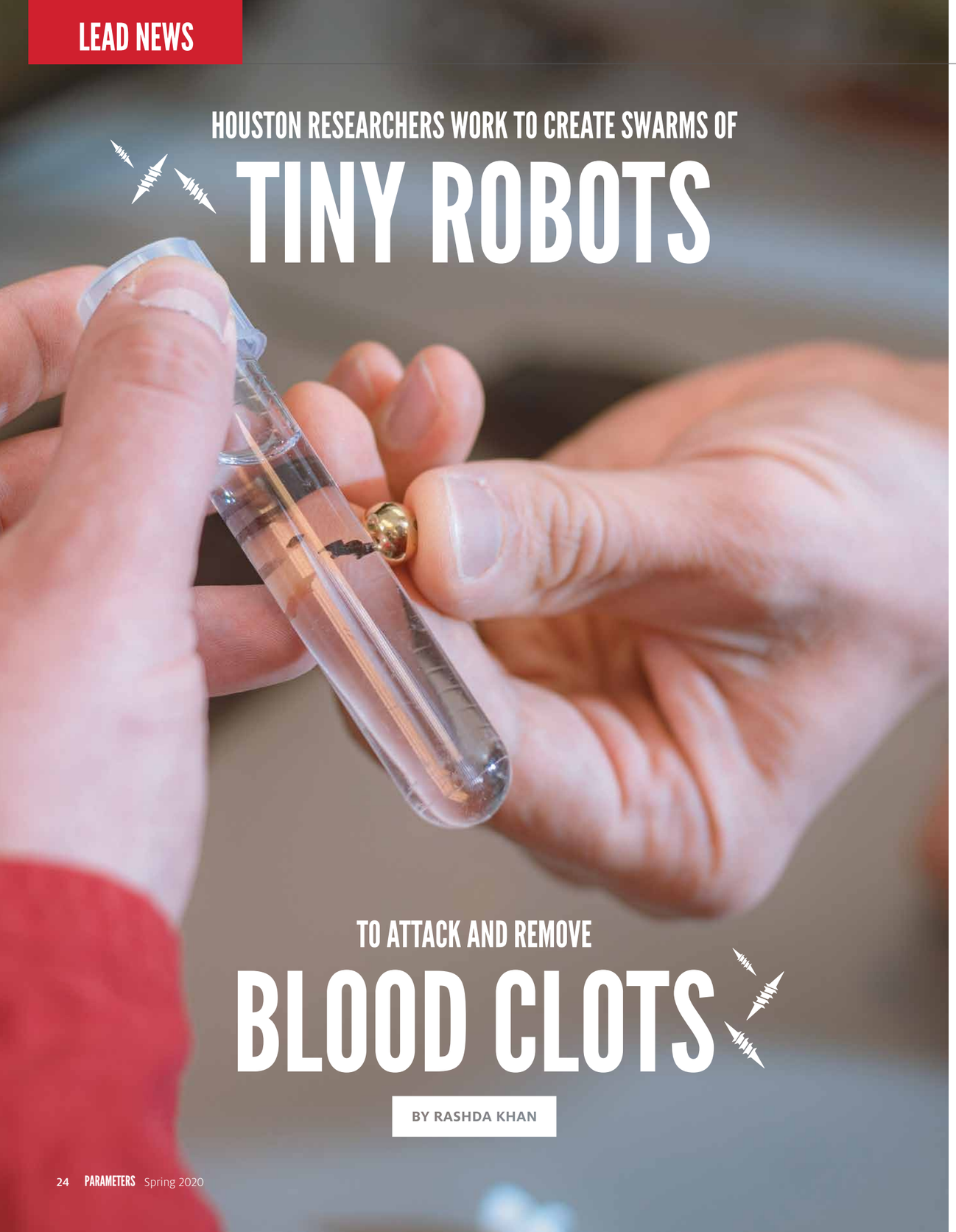
Reaching out

Karim and Masud will be joined later in their UH labs by aspiring science students from Yates High School near the UH campus.

"That target for that is sometime in Spring 2020 semester, so the students may continue over the summer as a science project, if interested," Karim said.

The goal is to stoke the high school students' interest in research in soft materials science, a growing field. In addition, the opportunity would provide lab experience and enhance the students' chance in getting into well-ranked colleges in STEM fields.

The NSF award period started last June and continues through May 2022.



HOUSTON RESEARCHERS WORK TO CREATE SWARMS OF TINY ROBOTS TO ATTACK AND REMOVE BLOOD CLOTS

BY RASHDA KHAN

In America pulmonary embolism (PE) causes between 200,000 and 300,000 deaths annually, according to information from the National Institutes of Health. PE is the third highest occurring cardiovascular disease after acute myocardial infarction (AMI) and stroke.

A pulmonary embolism is a blood clot that gets stuck in the lungs' arteries, restricting blood flow, decreasing oxygen levels and affecting other organs. Multiple blood clots, or a very large one, can cause life-threatening blockages.

Current treatments rely on clot-busting medication, sometimes along with a surgical procedure, to alter the clot. However, both these options have been linked to unintended adverse events for patients.

This is where Houston being home to the Texas Medical Center – the world's largest medical center – and the University of Houston – a Carnegie-designated Tier One public research university – come in. Researchers from UH's Robotic Swarm Control Laboratory and Houston Methodist Hospital are working on an innovative solution.

"Our lab is at the forefront of developing magnetically controlled tiny robots and we have a strong collaborative relationship with the Methodist Research Institute," said **Aaron Becker**, assistant professor of electrical and computer engineering at the UH Cullen College of Engineering. "This research is motivated by clinical problems [physicians] deal with."

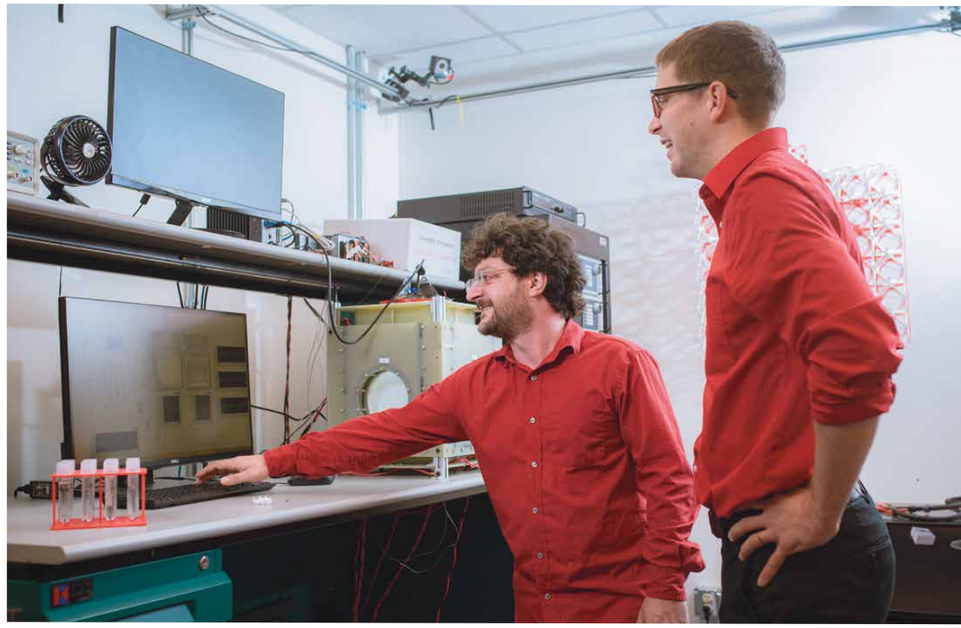
The project

The National Science Foundation recently awarded a three-year $752,871 grant for a project titled "CPS: Medium: Collaborative Research: Wireless Magnetic Millibot Blood Clot Removal and Navigation in 3D-Printed Patient-Specific Phantoms using Echocardiography." Becker is the principal investigator, and the UH share of the funding is $515,059.

The project introduces a novel non-invasive method of clot removal. *The idea involves using a magnetic field to wirelessly steer tiny (6 millimeters long with a diameter of 2.5 mm), corkscrew-shaped robots through large arteries to break up blood clots in patients.*

Each robot – known as a miniature magnetic rotating swimmer (MMRS) – is equipped with a magnet. A set of electromagnets placed around the patient generates a controlled rotating magnetic field that causes the robot to spin, move forward and grind up blood clots. Ultrasound imaging will be used to locate the robots.

Julien Leclerc, a Cullen College research associate specializing in applied electromagnetics, is the UH co-principal investigator and an integral part of the project. "I was previously using my knowledge of electromagnetism to study superconductors, now I use the same knowledge... the same mathematical tools and methods to control miniature magnetic swimmers," Leclerc said. He is excited to be part of this project.

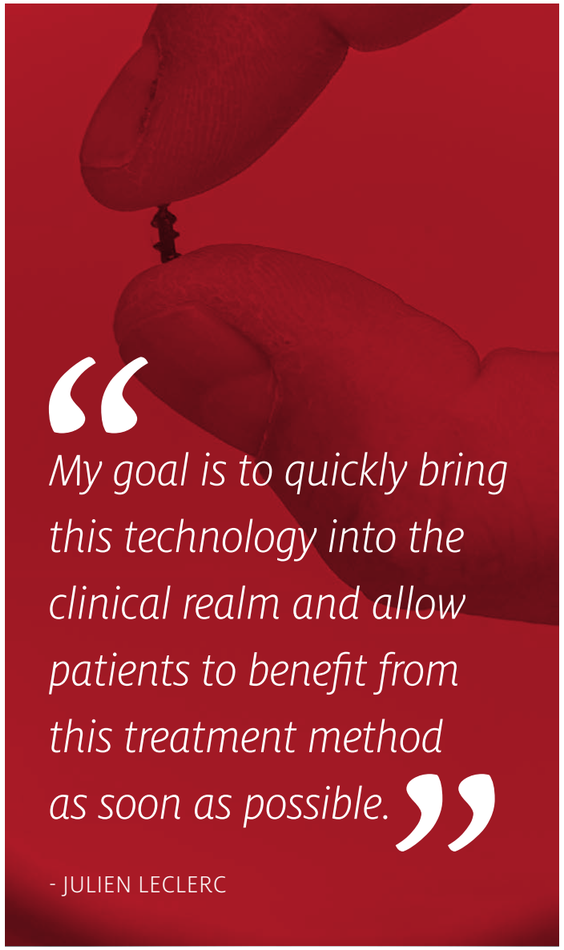


"It reminded me of an episode of 'The Magic School Bus' where the vehicle is miniaturized and navigates inside Ralphie, a student, to find the cause of his sickness," Leclerc said. "I immediately liked the concept of using magnetic fields to control tetherless miniature robots inside a patient."

The Houston Methodist co-principal investigators are Dr. Dipan Shah, chief of the Division of Cardiovascular Imaging, and **Mohamad Ghosn** (MSBME '06, Ph.D. BME '09), a research scientist with the DeBakey Cardiac and Cardiovascular Center.

The technology of magnetic manipulation could potentially improve many surgical procedures – from blood clot removal to eye and brain surgery.

"Using non-invasive miniature magnetic agents could improve



> *My goal is to quickly bring this technology into the clinical realm and allow patients to benefit from this treatment method as soon as possible.*
>
> - JULIEN LECLERC

patient comfort, reduce the risk of infection and ultimately decrease the cost of medical treatments," Leclerc said. "My goal is to quickly bring this technology into the clinical realm and allow patients to benefit from this treatment method as soon as possible."

Outreach efforts

Outreach to broaden participation in computing is a key component of this project. Both Becker and Leclerc spent summer 2019 testing out a curriculum based on the project with high school students.

About 130 Texas students, part of NASA's High School Aerospace Scholars (HAS) program, spent time in Becker's lab getting hands-on experience. They were involved in activities such as "Build a (3D) Catheter and Remove a Playdough Blood Clot" and "Magnetic Abrasion of Clot Models."

They beta-tested both activities with 38 participants of G.R.A.D.E. (Girls Reaching and Demonstrating Excellence) Camp, offered by the Cullen College to introduce girls ages 13-17 to the wonders of engineering as well as undergraduate participants of the two Cullen College's Research Experience for Undergraduates (REU) programs offered this summer.

The two UH researchers also served as mentors with Methodist Hospital's 2019 Pumps and Pipes summer program for teachers, which brings real-world science to the classroom by offering Houston-based STEAM industry externships. Becker and Leclerc hosted three local K-12 teachers, each of whom will implement a classroom project related to their externship and in partnership with the Swarm Lab.

"Each program is distinctive, but they are all designed to increase participation of women and people from underrepresented groups in science and engineering," Becker said. "A lot of them have a domino effect. Campers go home and tell their friends, the teachers reach a variety of children – of different ages and grades, from different socio-economic backgrounds, with different challenges and interests."

WANT TO KNOW MORE ABOUT THIS STORY? GO BEHIND THE SCENES OF THIS RESEARCH AND VISIT OUR YOUTUBE CHANNEL:

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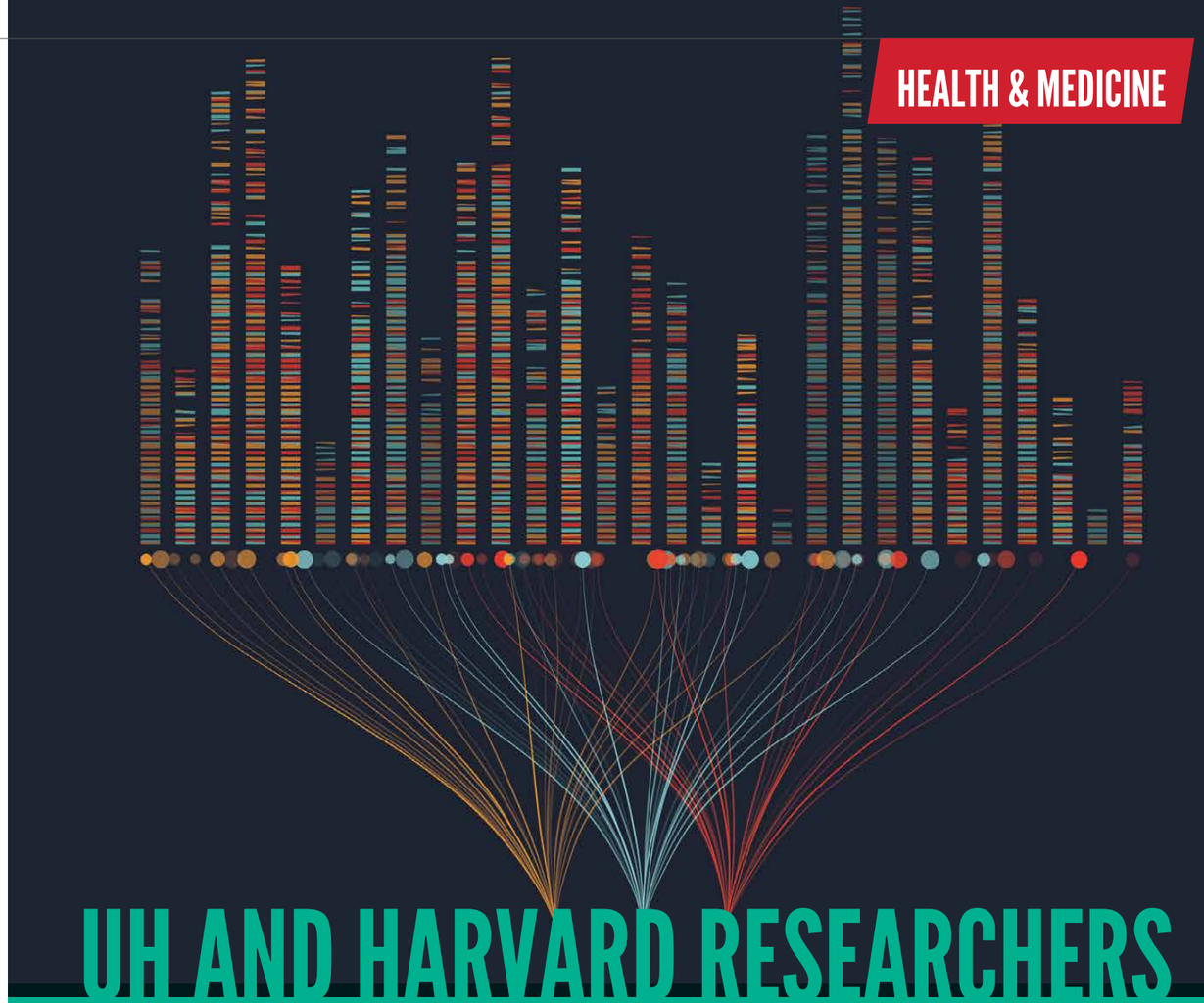
JULIEN LECLERC AND AARON BECKER



UH AND HARVARD RESEARCHERS

JOIN FORCES FOR USHER SYNDROME RESEARCH

BY RASHDA KHAN

A collaboration with two specialties could some day provide new hope for sufferers of Usher Syndrome, a rare but devastating genetic disorder.

Usher Syndrome is characterized by partial or total hearing loss and progressive vision loss. It accounts for about half of all hereditary deaf-blindness cases in the U.S., according to the National Institutes of Health. Throughout the country, it affects between four and 17 people per 100,000, which is about .02% of the population. Each of the three types of Usher syndrome is associated with a single gene defect.

The University of Houston's **Muna Naash**, John S. Dunn Endowed professor with joint appointments at the Cullen College and the College of Optometry, is a world-renowned expert in genetic mutations associated with hereditary retinal disorders. She has been working to eradicate eye diseases since the 1980s.

Joining Naash in the project is Gwenaelle Gělěoc, a researcher with Boston's Children's Hospital and Harvard Medical School who specializes in diseases and disorders of the ear, nose and throat.

NIH awarded a one-year $354,000 grant for the research project, titled Gene Therapy of Usher Syndrome. The UH share of the funding is $85,000.

The beginning

Naash, who is often invited to speak to scientists and patients, became aware of patients with Usher syndrome during visits sponsored by the Foundation Fighting Blindness and the Usher Syndrome Coalition.

"Meeting them, hearing about their issues, really just broke my heart," Naash said. "We are talking about children. They're born with very low hearing and very low vision, and it progressively gets worse. It's devastating."

She decided to study one of the most common mutations in the genes involved. "The gene is very big and difficult to work with," Naash said. "But we were able to design it in a smart way so that I can track where the protein responsible originates and whether it has any side effects when it's mutated."

The research project

The research project focuses on the cochlea, which is the spiral cavity of the inner ear. Being surrounded by bone, the cochlea is difficult to reach. "I follow the science," Naash said, explaining how she proceeded down this particular research path.

"We want to correct the disease by delivering the normal protein or gene to the hair cells in the cochlea so they have what they need to function properly," she said.

Delivering anything into a cell is challenging, but reaching the hair cells and the spiral structure of the cochlea is especially difficult. Naash and her research partners have learned how to do this in the eyes, and she is hopeful that this new challenge will also be tackled successfully.

"Gělěoc is an expert in her field and I'm an expert in mine," she said. "We're going to take these challenges step by step and figure out how to overcome them one at a time and move forward to address the next challenge."

Both Naash and Gělěoc are working with animal models, a crucial step to prove their concept, before the proposed gene therapy can be applied to people with Usher syndrome.

"If we're successful with this, then we use the information to do more research until we can correct the defect for the eye, the cochlea and other impacted organs at the same time," Naash said. "The ultimate goal is to create a product that we can give doctors to help their patients."

UNDER THE LENS: LINK BETWEEN MACULAR DEGENERATION AND RETINITIS PIGMENTOSA

THE WORK IS FUNDED BY A $2.5 MILLION GRANT FROM THE NATIONAL EYE INSTITUTE.

NIH National Eye Institute

BY LAURIE FICKMAN

Four words you never want to hear from the eye doctor are retinitis pigmentosa and macular degeneration. ***Both are genetic disorders that can cause loss of vision and neither has a cure.***

A team of biomedical researchers at the University of Houston's Cullen College of Engineering is now tackling both eye diseases by exploring a protein in the retina that links them: peripherin2 (prph2).

"Mutations in peripherin2 are associated with a variety of retinal degenerative diseases, including retinitis pigmentosa, cone-rod dystrophy and multiple forms of macular dystrophy," said **Muna Naash**, John S. Dunn Endowed professor of biomedical engineering and principal investigator. "Peripherin2 mutations can also cause secondary defects in adjacent tissues including the retinal pigment epithelium and choroid, which hampers the development of therapeutics for these diseases."

When healthy, prph2 is essential for the structure and function of the outer segments of the retinal photoreceptors. The two types of photoreceptors involved in sight are rods, which work at low levels of light, and cones, which are used to see color. Damaged rods cause retinitis pigmentosa; degeneration of cones causes macular degeneration.

"We are focused on advancing current knowledge on the role of peripherin2 in outer segment rim and disc formation, and in understanding the pathogenic mechanisms of associated diseases," said **Muayyad Al Ubaidi**, professor of biomedical engineering and project partner. The work is funded by a $2.5 million grant from the National Eye Institute.

"Periphen2 is an incredibly exciting protein to study and understand because, depending on which part of the protein has a mutation, it can cause different phenotypes in each patient," said Al-Ubaidi.

Prph2 does not always work alone. It has a partner, a photoreceptor-specific gene called ROM1 (rod outer segment membrane protein 1). The two proteins combine in different ratios, subsequently causing different diseases.

In prior research, Naash found that by changing the ratio of prph2 and ROM1 she could convert cases of the more dangerous macular degeneration to the less severe retinitis pigmentosa.

"We found we could convert the pattern dystrophy or macular degeneration phenotype to retinitis pigmentosa phenotype by modulating ROM1 level," said Naash. This suggests that elimination of the mutant protein will be a pre-requisite for any curative therapeutic strategy.

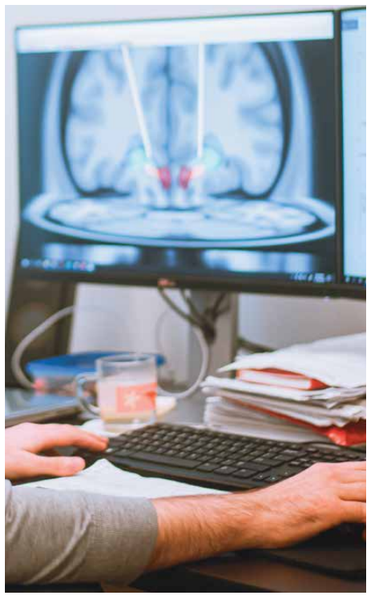
Naash and Al-Ubaidi will examine how different mutations in prph2 lead to different disease phenotypes; what contributes to variability among patients carrying the same mutation; what role ROM1 plays in these events; and, how to shift prph2-associated severe phenotypes to milder ones.


MUNA NAASH AND MUAYYAD AL UBAIDI

TESTING NEW TREATMENT FOR EPILEPSY PATIENTS

BY LAURIE FICKMAN

NURI INCE



University of Houston Associate Professor of Biomedical Engineering **Nuri Ince**, who pioneered a dramatic decrease in the time it takes to detect the seizure onset zone (SOZ) in the brain, has been awarded $2.3 million by the National Institutes of Health to expand his testing in a large number of adult and pediatric epilepsy cases.

Current treatment protocols for detecting the actual part of the brain that causes seizures, the SOZ, require prolonged monitoring of intracranial EEGs (iEEG) for days or weeks following surgical insertion of electrodes. The prolonged monitoring adds to the risk of complications that can include intracranial bleeding and potentially death. Using his newly-created machine learning algorithms, Ince observed that high frequency oscillations (HFO) in the seizure onset zone form repetitive waveform patterns that identify their location. Using these stereotyped HFOs, Ince knows he can find the zone in an hour. He thinks he can do it in about 10-to-20 minutes.

"We believe that accurate detection of high frequency oscillations in brief iEEG recordings can identify the SOZ, eliminating the necessity of prolonged monitoring and reducing the associated risks," said Ince, who is with the UH Cullen College of Engineering.

"A patient could be operated on at the same time he is having the electrodes attached to his brain, eliminating the patient being sent to an epilepsy monitoring unit for days or weeks to be observed. This would mark a totally new treatment and dramatically reduce risks and burdens to families."

Each year 150,000 people are diagnosed with epilepsy, and 30% of them will suffer from a drug resistant form of the disease. When medication fails, the next course of treatment is surgical resection, or removal, of the SOZ. But first it must be located.

Location of the seizure onset zone varies in each patient. The procedure to locate it begins with surgical insertion of electrodes. Then the patient is bedridden until seizures occur and can be observed. Ince's method not only saves weeks of hospitalization, but reduces side effects and costs associated with what has traditionally been an arduous, and often painful, procedure.

He said speed is especially important for the treatment under the current procedure of infants and children who are asked to endure brain surgery to implant electrodes and then lay still in a hospital bed for an almost impossible amount of time.

"Nature is not fair. Infants and children often suffer the same problems as adults, and if we can bring this new procedure to the operating room, it will be amazing," said Ince. His team plans to develop an online neural signal processing system for the rapid and accurate identification of SOZ with brief invasive recording.

He is joined on the work by Baylor College of Medicine neurologists Michael Quach and Jay Gavvala and neurosurgeons Dan Curry and Sameer Sheth; and University of Minnesota neurologists Zhiyi Sha and Tom Henry.

BLOOD CLOTTING PROTEINS

Discovered as Biomarkers of Lupus

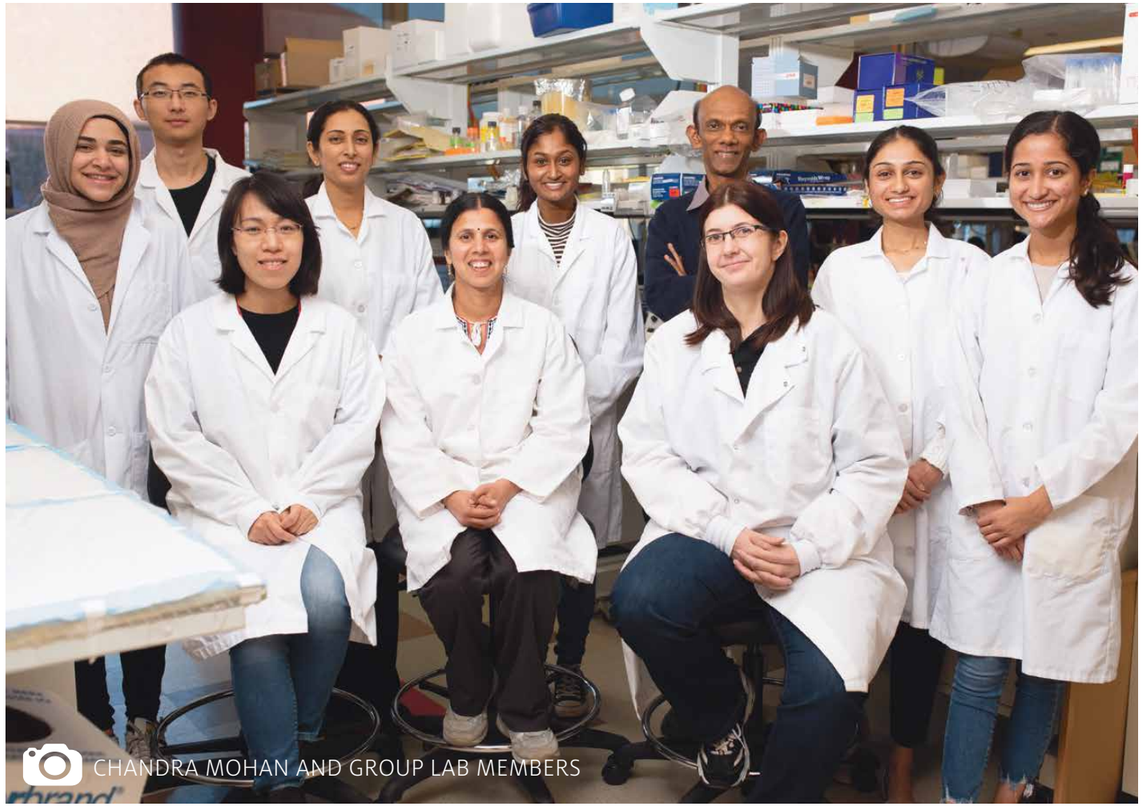
BY LAURIE FICKMAN

University of Houston researcher **Chandra Mohan** is reporting in *Arthritis Research and Therapy* that clotting proteins, both those that promote blood clots (pro-thrombotic) and those that work to dissipate them (thrombolytic), are elevated in the urine of patients who suffer from lupus nephritis (LN).

"Among the proteins examined, urine plasmin emerged as the strongest independent predictor of kidney function and renal disease status," reports Mohan, Hugh Roy and Lillie Cranz Cullen Endowed professor of biomedical engineering at the UH Cullen College of Engineering. "Urine biomarkers represent promising candidates for the early diagnosis as well as the monitoring of disease activity and therapeutic responses in lupus nephritis." The discovery of the new biomarker for active LN opens the door for clinical monitoring of the disease.

Systemic lupus erythematosus (SLE) is an autoimmune disease that occurs when the body attacks its own tissues and organs. Inflammation from the disease can impact many different parts of the body, including joints, skin, kidneys, blood cells, brain and heart. Lupus nephritis is one of the most frequent and severe clinical manifestations of SLE, representing a leading cause of morbidity and mortality.

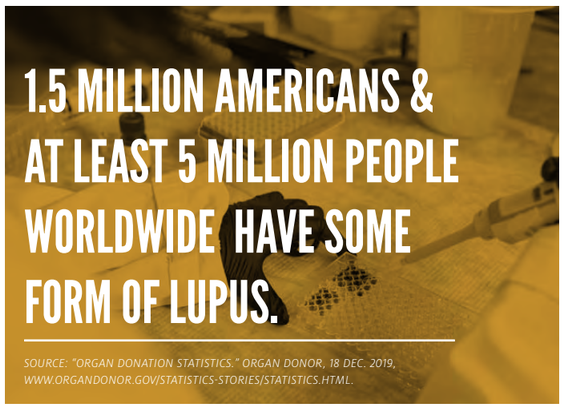
New immunosuppressive drugs and biologics have brought improvements in recent SLE and LN survival rates,



CHANDRA MOHAN AND GROUP LAB MEMBERS

but early diagnosis and monitoring disease flares are still challenges that need to be addressed.

Renal biopsy remains the gold standard for the diagnosis and prognosis of LN, but it's invasive and cannot be used for routine monitoring of disease activity and treatment responses. Because of this, several studies focusing on screening and identifying non-invasive biomarkers for the early diagnosis and monitoring of SLE and LN are emerging.



Because coagulation system disorders have been reported in SLE and lupus nephritis patients and the frequency of thrombotic events was documented to be higher in SLE patients than in the general population, Mohan's lab examined urinary proteins related to coagulation.

Finding elevations in both pro-thrombotic and thrombolytic proteins in the urine of patients with lupus nephritis was unexpected.

"When I first saw the presence of both I thought 'This can't be right, so let's look at this in more detail with more urine samples and better assays,'" said Mohan, who describes the presence of both proteins as "a raging war" within the kidneys. If one or the other predominates, he said, there are medicines that can regulate the clotting in balance, but when both processes are equally upregulated, balancing this biological process becomes clinically challenging.

Urine samples for this study were obtained from 113 patients with LN who had previously been recruited from the renal clinic at UT Southwestern Medical Center in Dallas between 2007 and 2011.

Collaborating with Mohan on the study are lead author, Qing Ling, a practicing nephrologist, Michelle A. Petri, director of the Hopkins Lupus Center at Johns Hopkins Medicine in Baltimore; and Ramesh Saxena, professor of internal medicine–nephrology at UT Southwestern Medical Center in Dallas.

BRAIN STIMULATION FOR PTSD PATIENTS

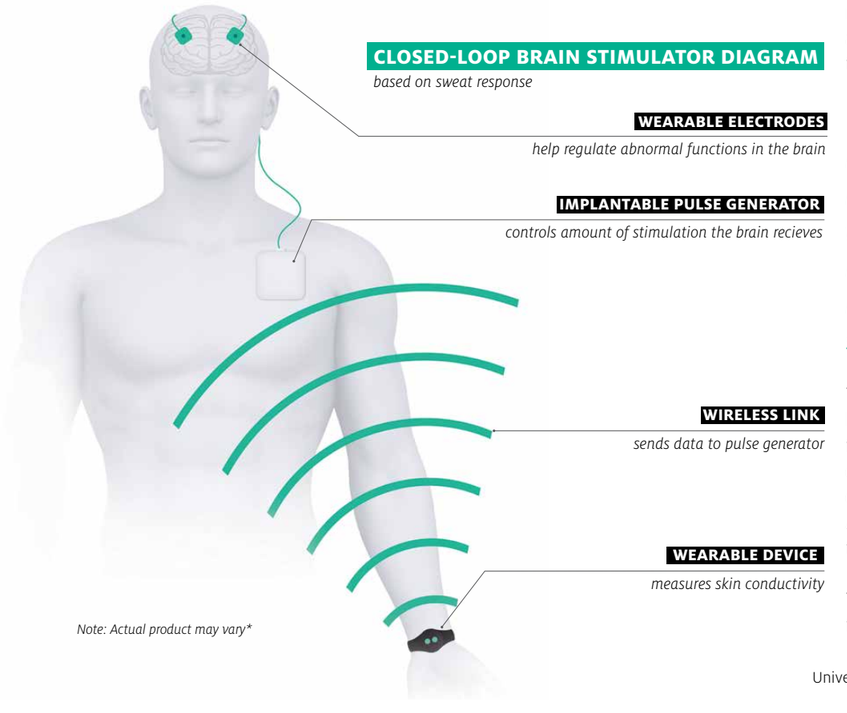
BY LAURIE FICKMAN

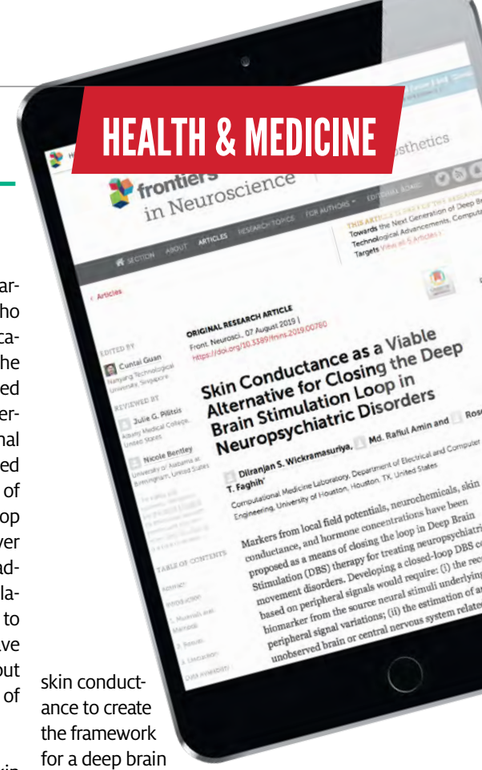
For 8 million adults who suffer from post-traumatic stress disorder in any given year, medication and cognitive therapy have been the treatment protocol. Now, University of Houston Assistant Professor of Electrical Engineering **Rose T. Faghih** is reporting in *Frontiers in Neuroscience* that a closed-loop brain stimulator, based on sweat response, can be developed not only for PTSD patients, but also for those who suffer an array of neuropsychiatric disorders.

"Sweat primarily helps maintain body temperature; however, tiny bursts of sweat are also released in response to psychologically arousing stimuli. Tracking the associated changes in the conductivity of the skin, which can be seamlessly measured using wearables in real-world settings, thus provides a window into a person's emotions," reports Faghih, who is part of the UH Cullen College of Engineering professoriate.

For people with movement disorders like Parkinson's disease and essential tremor, who have not responded to medication, application of high-frequency electric current to the brain, or deep brain stimulation, is regarded as most effective. Electrodes are placed in certain areas of the brain to regulate abnormal functions and a pacemaker-like device, placed in the upper chest, controls the amount of stimulation the brain receives. Open-loop stimulators, the most widely-used, deliver continuous stimulation until manually re-adjusted by a physician. Closed-loop stimulators, which provide stimulation in response to biomarkers of pathologic brain activity, have been developed for movement disorders, but are yet to be explored for the treatment of neuropsychiatric disorders.

Signaling the onset of a PTSD episode, skin develops the tiniest sheen of perspiration. That symptom of the body's fight or flight response signals a change in the skin's electrical conductivity and provides a window into the brain's state of emotional arousal. Using





skin conductance to create the framework for a deep brain stimulator seemed logical to Faghih after reviewing group studies of Vietnam combat veterans with PTSD. Among the findings, PTSD subjects had the largest skin conductance responses when confronted with combat-related words. In a similar study comparing Vietnam combat veterans with and without PTSD and non-combat controls, PTSD veterans had the highest baseline skin conductance levels.

*"**Skin conductance** additionally has the advantage of being easily measured with wearable devices that afford convenience, seamless integration into clothing and do not involve risk of surgically implanted sensors," said Faghih.*

The ultimate goal will be to develop closed-loop prototypes that can eventually be used for treating patients in a variety of neuropsychiatric disorders. Faghih's graduate researchers Dilranjan Wickramasuriya and Md. Rafiul Amin were first and second authors, respectively, of the article.

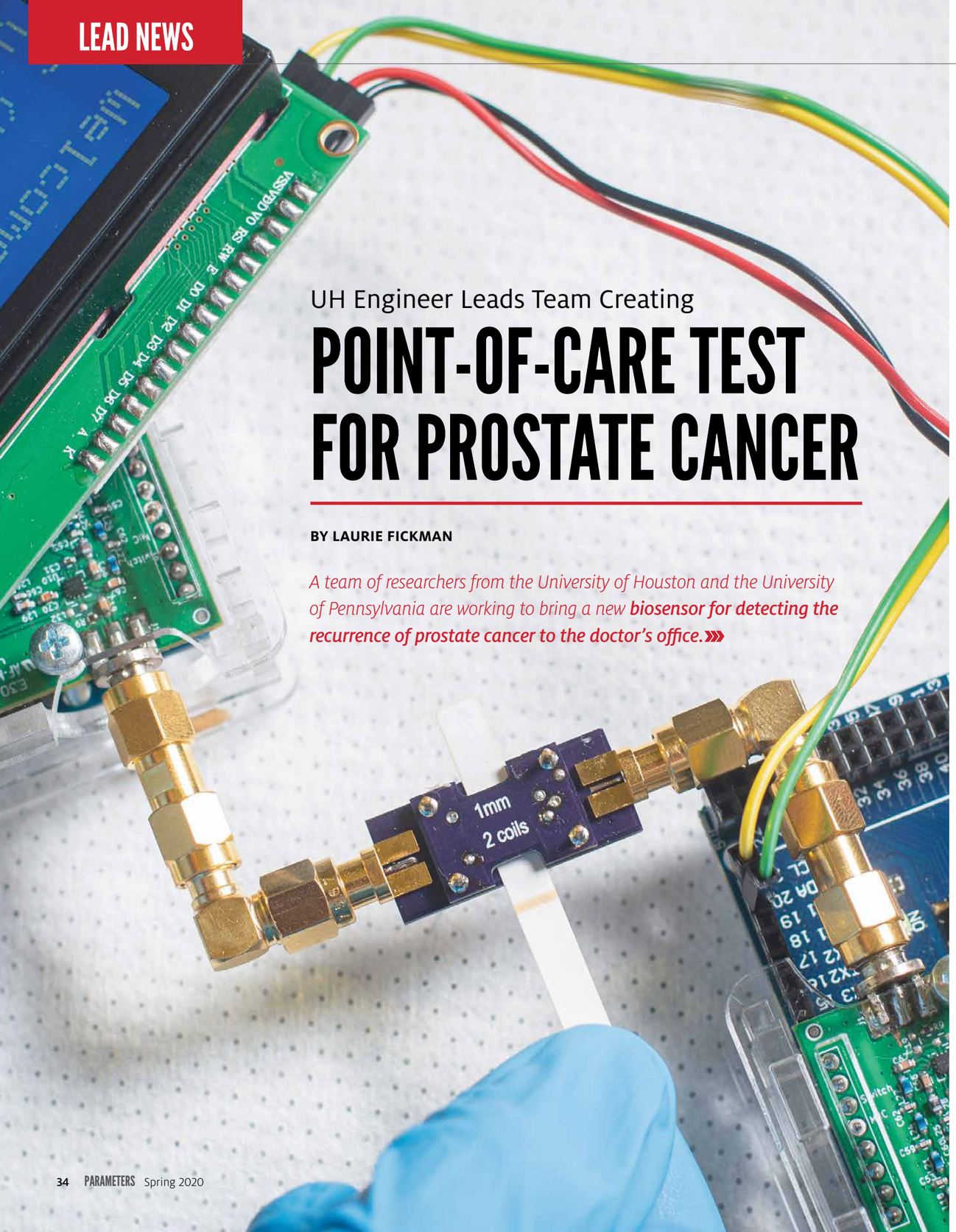
This project was supported, in part, by a grant from the National Science Foundation.

UH Engineer Leads Team Creating

POINT-OF-CARE TEST FOR PROSTATE CANCER

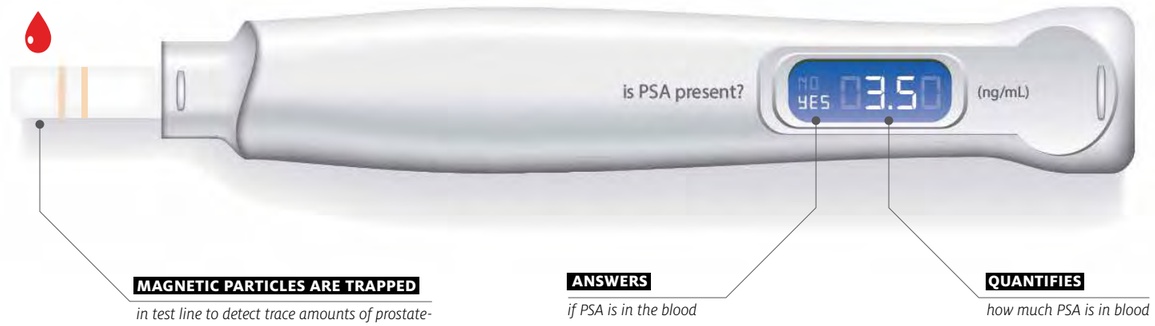
BY LAURIE FICKMAN

A team of researchers from the University of Houston and the University of Pennsylvania are working to bring a new ***biosensor for detecting the recurrence of prostate cancer to the doctor's office.***



LATERAL FLOW ASSAY TEST FOR PSA DIAGRAM

*Note: Actual product may vary**



"Such tests exist in clinical laboratories, but there remains a critical need for inexpensive, versatile and high-sensitivity diagnostic platforms which can bring the performance to the point of care or doctor's office," said **Dmitri Litvinov**, principal investigator and professor of electrical and computer engineering at the UH Cullen College of Engineering. The work is funded by a $399,988 grant from the National Science Foundation.

The population that would immediately benefit from such a point-of-care test are prostate cancer patients who have undergone radical prostatectomy but have positive surgical margins, with cancer cells detected at the edge of the removed tissue. These patients are at high risk for recurrence, and long-term ultrasensitive prostate specific antigen (PSA) monitoring is required.

"An effective point-of-care PSA biosensor would simplify post-surgery testing, improve patient compliance and alleviate anxiety to help ***improve long-term patient outcomes****," said Litvinov.*

The proposed biosensor platform will be based on an ultrahigh sensitivity magnetic nanoparticles detector and will look similar to a home pregnancy test with an electronic readout. As a bonus for healthcare providers and patients alike, it's expected to cost under $3 per test.

The sensor, like the pregnancy test stick, is a lateral flow assay test, which detects the presence of condition-specific biomolecules (biomarkers) using appropriately designed biochemistry to trap biomarkers. Unlike the pregnancy test, which uses the color change in the test line as a readout, the new tool will use ultrasensitive sensing of magnetic nanoparticles trapped in a test line to detect trace amounts of prostate-specific antigen (PSA) in a patient's blood.

"A pregnancy test is basically a 'yes or no' test. In our test, not only can we detect PSA at exceptionally small concentrations but we can also quantify how much PSA is present," said Litvinov.

Because the tool will provide immediate information and be easily accessible, Litvinov believes it will provide early and affordable detection of disease recurrence. Timely identification of the appropriate treatment options can improve long-term patient outcomes.

"Our technology has potential to help ***improve survival rates*** *with more accessible, affordable and easier testing," said Litvinov.*


DMITRI LITVINOV

CULLEN COLLEGE MECHANICAL ENGINEERING PROFESSORS EARN $867K IN NSF AWARDS

BY RASHDA KHAN

Three mechanical engineering professors at the UH Cullen College of Engineering won grants totaling $867,309 from the National Science Foundation (NSF). These funds enable professors to work on critical research on various topics that have the potential of impacting a broad range of industries – from aerospace to nanorobotics.

These three-year grants extend from 2019 to 2022. Here are the details of the award-winning projects:

Theocharis Baxevanis

ASSISTANT PROFESSOR

PROJECT TITLE: Collaborative Research: Fatigue Crack Formation and Growth in the Presence of Reversible Martensitic Transformation in High Temperature Shape Memory Alloys
AMOUNT: $245,693


THEOCHARIS BAXEVANIS

The idea is to eventually provide guidelines for the design of a HTSMA microstructure for optimum resistance to fatigue crack formation and early growth and in turn to prolonged service life. While HTSMAs will serve as model materials, the developed models and experimental findings will be directly transferable to other phase transforming materials.

- THEOCHARIS BAXEVANIS

Shape Memory Alloys, or SMAs, can recover their original shape upon heating after they have been heavily deformed at low temperatures. A reversible change of their crystal structure – a phase transformation – allows for the shape memory effect.

"Recently discovered SMAs that undergo phase transformation at high temperatures, named high-temperature shape memory alloys (HTSMAs), have inspired significant interest for innovative actuation applications in the aeronautics, energy conversion and transportation, and automotive industries," said **Theocharis Baxevanis**, assistant professor of mechanical engineering at the UH Cullen College of Engineering.

Actuators are devices that cause other devices or machines, such as a wing flap on an airplane, to operate or move.

"SMA actuators do not use motors or magnetic fields to generate force, are smaller and lighter than the conventional servo-hydraulic/electromagnetic actuators," Baxevanis added. "They can perform the functions of several materials and parts simultaneously, thus simplifying device design, resulting in fewer parts to break or wear down, and lower cost and maintenance."

However, repeated actuation fatigues in SMAs result in gradual accumulation of defects and degradation of its properties. Confidence on the fatigue response of SMAs is required before main stream applications become a reality.

The main goal of the project is to identify and examine the life-controlling microstructural fatigue mechanisms and mechanics for the fatigue reliability assessment of HTSMAs.

"The idea is to eventually provide guidelines for the design of a HTSMA microstructure for optimum resistance to fatigue crack formation and early growth and in turn to prolonged service life," Baxevanis said. "While HTSMAs will serve as model materials, the developed models and experimental findings will be directly transferable to other phase transforming materials."

Baxevanis is the principal investigator (PI) and UH is the lead institution. Co-principal investigator is Ibrahim Karaman from the Texas A&M Engineering Experiment Station.

The researchers hope the key outcomes of the proposed work will drive the fabrication and processing of HTSMAs will enable the development and design of innovative and reliable SMA actuators.

Baxevanis is already involved in a NASA funded project that aims to use HTSMA actuators for designing a commercially-viable supersonic aircraft that can change shape during flight to reduce noise and increase efficiency.

Shailendra Joshi

BILL D. COOK ASSISTANT PROFESSOR
PROJECT TITLE: Collaborative Research: Multiscale Modeling of Damage Tolerance in Hexagonal Materials
AMOUNT: $243,230

Hexagonal close-packed (HCP) materials are widely employed in industrial and biomedical sectors – as fuel rods in nuclear power plants (zirconium alloys); automotive components (magnesium alloys); medical stents and dental applications (titanium and magnesium alloys); compressor and turbine disks and blades in power generation systems and jet engines (titanium alloys); in cryogenic fuel tanks and space telescope mirrors (beryllium alloys) among other things.

HCP materials are strong candidates in an increasing number of applications that span a broad spectrum of engineering fields. For instance, magnesium alloys are perhaps the lightest structural metals that are promising candidates for use in the automotive industry. They are also biodegradable, which make them interesting for certain biomedical applications.

- SHAILENDRA JOSHI


SHAILENDRA JOSHI

"HCP materials are strong candidates in an increasing number of applications that span a broad spectrum of engineering fields. For instance, magnesium alloys are perhaps the lightest structural metals that are promising candidates for use in the automotive industry," said **Shailendra Joshi**, Bill D. Cook assistant professor in mechanical engineering at the Cullen College. "They are also biodegradable, which makes them interesting for certain biomedical applications."

In these, and similar applications, projections of strength and durability are critical in successful functionality. Yet, there are currently no material modeling frameworks to base robust engineering projections regarding their durability and damage tolerance.

"A clear scientific understanding of the underlying processes of strengthening and deformation is lacking, which stymies our ability to design HCP materials with the desired strength and damage tolerance that is needed," Joshi said.

The complex crystallography of these materials gives rise to intricate coupling between fine-scale mechanisms of plasticity that include slip and twinning modes of deformation. These mechanisms of plastic deformation are known to influence macroscopic damage and ultimate failure, but their precise roles are not understood, he explained.

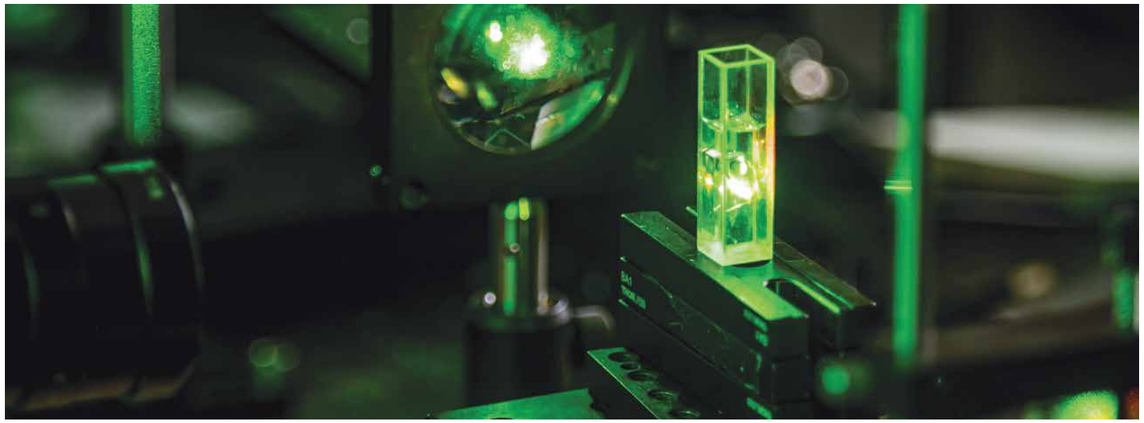
This project aims at predictive modeling of residual strength and ductility limits of HCP materials. If successful, the proposed research would advance the life assessment procedures and avoid material waste in processing and manufacturing operations.

Joshi is the principal investigator, and UH is the lead institution. He is joined by the co-principal investigator Ahmed- Amine Benzerga of the Texas A&M Engineering Experiment Station.

Dong Liu

ASSOCIATE PROFESSOR
PROJECT TITLE: Enabling Light-Driven Microfluidics with Laser Streaming
AMOUNT: $378,386

Microfluidics, which deals with both the science that studies the behavior of fluids through micro-channels, and the technology of manufacturing microminiaturized devices containing chambers and tunnels through which fluids flow or are confined, has led to significant advances in a few niche areas in applied science



and engineering. For lab-on-a-chip and point-of-care diagnostic applications alone, the global market will reach $8.78 billion in 2021.

At present, the manufacturing approach for microfluidics requires the performance factors, physical layout and fabrication processes to be considered simultaneously for all sensors and actuators integrated in a single chip. Modifying one portion of the device often entails redesigning the entire architecture. Consequently, most microfluidic devices are custom built and cannot be translated to low-cost scalable manufacturing.

> *"Light-driven microfluidics, where light serves as both sensor and actuator, promises a radical solution: it needs neither immobilized on-chip actuators nor physical connections to external electric/hydraulic peripherals and provides robustness and versatility that are unavailable in standard microfluidics."*
>
> - DONG LIU

"Light-driven microfluidics, where light serves as both sensor and actuator, promises a radical solution: it needs neither immobilized on-chip actuators nor physical connections to external electric/hydraulic peripherals and provides robustness and versatility that are unavailable in standard microfluidics," said **Dong Liu**, associate professor of mechanical engineering and principal investigator on the project.

"Moreover, light-driven devices can be reconfigured at will to adapt to changing operating conditions and new applications," he added.

Unfortunately, the photo-actuating mechanisms – driven by radiation pressure or light-induced capillary effects – demand the presence of refractive index inhomogeneities (such as local density fluctuations in colloids and phase-separated surfactant solutions) to scatter light or multiphasic interfaces (as in bubbles and droplets) to generate interfacial tension gradient, Liu said. This excludes the use of most common liquids, such as water and many organic solvents, as the working fluid.

As such, the "all-optical fluidic chip" concept envisioned more than a decade ago has yet to be materialized, he said.

This research project, which is built on Liu's previous work on laser streaming, aims to eradicate this fundamental limitation by establishing a new microfluidic principle.

"The proposed laser streaming will emancipate light-driven microfluidics from its fundamental constraints and open a new pathway enabling all-optical devices, in which the microfluidic functions are controlled by light stimulation and can be reconfigured dynamically for optimal performance," Liu said.

Laser streaming capitalizes on the synergy between laser-induced ultrasonic waves and acoustic streaming to convert the light energy into the mechanical momentum of a liquid stream, he explained. By modulating the laser beam, contactless and dynamic light actuation can be realized in a fully reconfigurable manner in terms of flow speed, spatial extension, time span, position and parallel multi-actuation.

Liu hopes his research will lay the scientific foundation for laser streaming by elucidating the underlying physics via experimental characterization and multiphysics modeling.

"The resulting light-driven microfluidic platforms will have unprecedented flexibility, robustness and parallelization," he said. "This will greatly influence various industries that have benefited from microfluidics — to name a few, from biology, medicine, space exploration to microelectronics cooling."

More remotely, laser streaming will also enrich the arsenals of pulse laser propulsion (PLP) in air and liquid and light-driven micro/nanorobotics, Liu added.

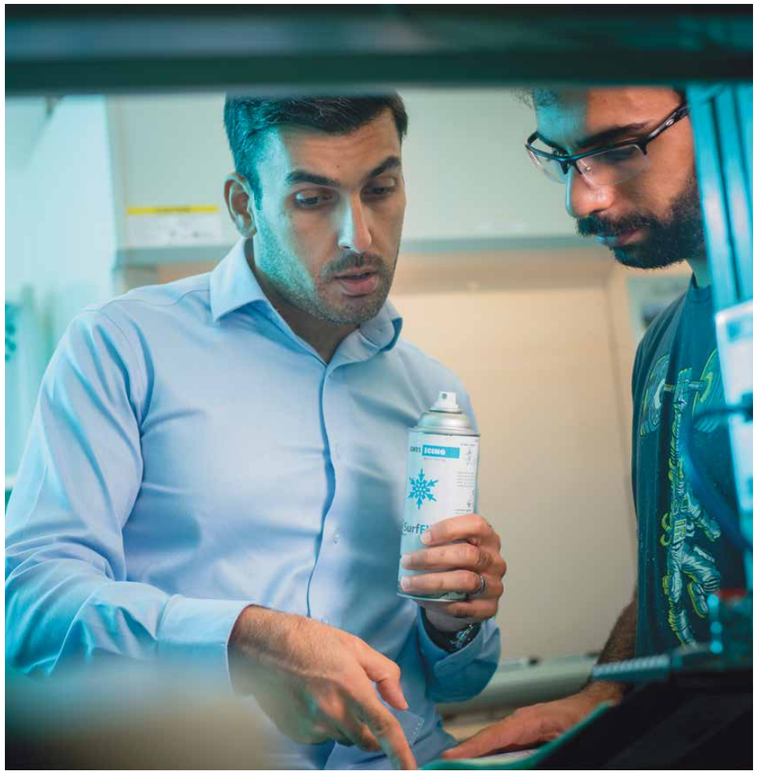
His co-princopal investigator on the project is **Jiming Bao**, associate professor of electrical and computer engineering at the Cullen College.

UH STARTUP SURFELLENT RAISES $470K IN FUNDING

BY RASHDA KHAN

SurfEllent, a UH startup which brings innovative and durable anti-icing coating technologies to the market, is hot, hot, hot after raising $470,000 in funding in 2019.

The company tasted success and started its financial windfall at the 2019 Texas A&M New Ventures Competition (TNVC). The first-time TNVC competitors won the second place award and its accompanying $35,000 check, as well as the Texas A&M Engineering Extension (TEEX) Product Development Center Prize of $10,000, walking away with a total of $45,000.



At the same competition, SurfEllent managed to snag the attention of several other interested parties, including the U.S. Department of Defense (DOD). Three months down the road and many discussions later, a private company, that wishes to remain anonymous, invested $350,000 in seed funding.

In addition, the DoD encouraged SurfEllent representatives to apply for federal grants. About the same time, an independent study out of the University of Iowa proved the efficacy of SurfEllent's current coating by trying it out on a jet engine.

As a result, SurfEllent was also awarded a $50,000 Small Business Innovation Research (SBIR) grant and a $24,999 Small Business Technology Transfer (STTR) grant.

Congress established the SBIR and STTR programs to support scientific excellence and technological innovation through the investment of federal research funds in critical American priorities to build a strong national economy.

"Ice is a problem that will exist as long as we live on the earth. It impacts a wide range of things, including aircraft wings and engines, automobiles, buildings and bridges, ships and vessels, and power transmission systems," said **Hadi Ghasemi**, Bill D. Cook associate professor of mechanical engineering at the UH Cullen College of Engineering and the brain behind SurfEllent.

The technology he nurtured into a product can be used to de-ice anything from cars to airplane engines.

"The end goal is to improve the quality of human life," Ghasemi said. "This recognition is another proof of the critical need for advanced anti-icing coating technologies and opens opportunities for collaboration with various industries and business partners."

The beginning

"I know firsthand the amount of problems icing can cause," said Ghasemi, who completed his Ph.D. and post-doctoral work in Canada and Boston. During this time, he experienced power outages as well as transportation and infrastructure issues.

"It's not only about the financial losses, but it also affects the quality of life for people," he added. "I myself have slipped on ice several times so I know that icing is not a good thing."

At University of Houston, Ghasemi has launched a research program focused on icing and developing durable anti-icing coatings. His research group based a new bio-inspired durable anti-icing coating on the North American wood frog, which can tolerate freezing of up to 65% of its total body water and still survive.

In 2017, NASA chose Ghasemi's project from entries submitted by more than 130 organizations across the U.S. for its potential to broadly impact human life on earth and the future of space travel.

Once Ghasemi had plenty proof of concept for his novel material, he partnered with his then student **Peyman Irajizad** (MSME '16, Ph.D. '18) and co-founded SurfEllent. A $50,000 grant from the University of Houston Technology Gap Fund, a program designed to support inventors as they move their technologies closer to commercial readiness, helped get the company off the ground.

The challenge

While the startup is about a year old, the research and development of its product took five long years.

"It was a few research assistants or interns, myself and my co-founder working on it in our spare time," Ghasemi said. It meant long hours, sacrificing weekends and balancing family and other responsibilities. "We didn't have dedicated time or resources to put towards the project like the big companies have."

The team members started with looking at the problem of icing and how it could be solved. They came up with different ideas, failed several times and had several breakthroughs. "One of these breakthroughs allowed us to develop this coating technology and it has performed really well," Ghasemi said.

However, the scientific challenges didn't faze the two co-founders as much as the business aspects of bringing their technology from concept to market.

"To make a business case from your technology, and then to convince people to invest in your technology – those were our major challenges," Ghasemi said. "But now I think we're in a good position to move forward into the next stage."

What's next?

SurfEllent is located at the UH Technology Bridge – a research park that offers 30,000 square feet of incubator space and 700,000 square feet for laboratories and light manufacturing. The company is expanding.

Plans are to move its manufacturing facility into a larger lab – about three times the size of the current one – at the UH Technology Bridge and increase market share, Ghasemi said. The company has also hired three additional employees, including a new chief executive officer.

Brian Huskinson as CEO will oversee SurfEllent's operations, including business development, marketing, financing and strategic partnerships. He earned his Ph.D. and master's degree in applied physics from Harvard University and has a B.S. in chemical engineering and political science from Yale University. Huskinson also has experience with ATP, a seed-stage venture capital firm; and McKinsey and Co., a well-established consulting firm serving a number of companies across multiple sectors including deep tech, chemicals, energy, aerospace and automotive.

Research and development is an ongoing process at the startup.

"We've worked with a wide-range of small customers, but now we're looking at B2B or selling business to business," Ghasemi said.

In other words, they're shifting gears and focusing on making sure the technology is ready for customers with larger-scale needs. Once that is validated, the SurfEllent team will begin considering options for scaling up production.

"It has been a long journey, both fruitful and challenging," Ghasemi said. "But we're pushing forward to further develop this technology's commercial potential and make new products available as soon as possible."

Actively working to take the technology from an idea to product form has been a rewarding experience for Ghasemi.

"As a scientist, one of my main goals and dreams was to develop a technology that I can commercialize," he said. "I wanted to commercialize my technology because you can directly see the impact of your innovation on people's lives."

Besides being useful on airplane wings and transmission lines, the products also have more everyday applications such as de-icing vehicles and porches.

MATERIALS

At University of Houston, Ghasemi has launched a research program focused on icing and developing durable anti-icing coatings. His research group based a new bio-inspired durable anti-icing coating based on the North American wood frogs, which can tolerate freezing of up to 65% of its total body water and still survive in the winter.

SurfEllent's products, available as aerosol sprays and paints, are available through the company's online shopping platform at **WWW.SURFELLENT.COM**.

NEW THINKING IN MATERIALS DEVELOPMENT

Could Affect Future Design and Fabrication

BY RASHDA KHAN

While most people consider cracking, peeling, stress and other similar factors to be negatives, a group of researchers see them as opportunities to improve the fabrication of innovative functional materials.

The researchers, representing the University of Houston, the University of Toledo, Virginia Commonwealth University and York University in Canada, recently published a paper discussing their groundbreaking approach in the Royal Society of Chemistry's journal, *Materials Horizon*.

"Most of the time we see defects as not good for the materials and something that should be avoided," said **Hadi Ghasemi**, Bill D. Cook associate professor of mechanical engineering at the UH Cullen College of Engineering. "But we have been able to demonstrate that a wide-range of functional materials can be developed using the failure mode in an organized way."

Parham Jafari, a UH doctoral student in mechanical engineering, worked with Ghasemi on the article and the research behind it.

"In this work, we developed a new ice-phobic material with ice adhesion using stress-localization, which was an order of magnitude lower than that of the current state-of-the-art materials," Jafari said. "The concept of stress-localization is far more effective than previously studied surface-modification methods."

*"From a design perspective, this approach promotes a **sustainable design philosophy** in materials science where 'one man's garbage' is another man's gold."*

- HADI GHASEMI

The eureka moment

Ghasemi and his UH research team, in the Nano Therm lab, are renowned for developing new materials that are anti-icing.

A lot of scientific research involves long hours, laborious work and results that don't always turn out as expected. The idea of using failure as a positive came about in just such a way.

Much of the team's research focuses on creating surfaces that repel solid objects. "We wanted the surfaces to remain free of any type of contaminant. It can be ice, biofouling, scaling, dust or anything," Ghasemi said. "The thought process we followed was, if anything undesired attaches to these surfaces, what mechanism would be needed to remove these contaminants?"

Ghasemi and his collaborators fixed on a simple answer: stress. They realized stress could be a good thing and it could be used to make materials behave in a certain way.

"It means you need to have some form of stress and failure at the interface of the surface and the contaminant," he explained. "When something, like ice or dust, comes into contact with those surfaces, those failures or defects occur at the interface and repel those foreign objects."

They successfully developed the idea and showed it to be effective for the anti-icing and anti-biofouling surfaces created in their lab. "We are now working to develop some other kinds of materials," Ghasemi said.

A Synergy of failures

Ghasemi and his team at the University of Houston weren't alone in making a negative work for them. Talking to other researchers in the field, they found that other teams at different universities were working on similar projects focused on other negatives.

The group of multi-university researchers ended up collaborating on the published article, titled "Advanced Functional Surfaces Through Controlled Damage And Instabilities."

BESIDES STRESS, IT IDENTIFIES THREE OTHER FAILURE-ORIENTED FABRICATION TECHNIQUES:

(1) CRACKING AND PEELING – Cracks on the surface of materials can create distinct, continuously repeating patterns on a surface. Research has shown that controlled cracking can be used to develop functional surfaces for ultra-mechnosensitive (highly sensitive) sensors and micro/nanomanufacturing, such as fabricating nanomolds or channels for nanowire manufacturing.

Peeling creates a roughness that can be used to develop superhydrophobic (water resistant) surfaces.

(2) SEVERE MATERIAL DAMAGE – Abrasions, cutting or tearing can also create a rough surface that can be useful for developing hydrophobic and non-slip resistant surfaces, such as that used in footwear. This affects wettability, or a liquids ability to maintain contact with a solid surface. It can also create a surface that helps toughen ceramics.

(3) INSTABILITY INDUCED PROCESSES – Bucking and swelling are usually considered a nuisance in design work, but researchers have recently used buckling-induced metamaterials for soft robotics and flexible electronics with applications in displays, sensors, energy harvesting systems, actuators, anti-icing surfaces and more.

Impact

"This is a new way of thinking about material development," Ghasemi said. "We offer a disruptive paradigm for material development that could potentially affect the future design and fabrication strategies."

Currently, much of these functional surfaces are developed through complex and costly manufacturing approaches, such as micro/nanofabrication or laser ablation. The failure approach could open up a new avenue for faster and lower cost materials development with applications in a wide-range of fields, he said.

"From a design perspective, this approach promotes a sustainable design philosophy in materials science where 'one man's garbage is another man's gold,'" Ghasemi added. "The studies presented in this article should inspire designers to include such damage and/or instability-based phenomena in materials development in an organized manner to create new design pathways in fabricating surfaces with unexpected value-added properties."

Ghasemi and his collaborators fixed on a simple answer: stress. They realized stress could be a good thing and it could be used to make materials behave in a certain way.

CUMARASWAMY VIPULANANDAN AND SAI ANUDEEP REDDY MADDI

UH STARTUP SENSYTEC

Builds a Foundation of Wins

BY RASHDA KHAN

Sensytec, a UH startup, was busy cementing its reputation with a pair of wins last fall.

On Sept. 5, it was chosen as one of three local winners of the inaugural Houston MassChallenge program. The Houston Angel Network – one of the oldest and most active group of angel investors in the area – also selected the company for its $40,000 investment prize at the same event.

The following week Sensytec was recognized as one of ten most promising companies by the Rice Allian-ce for Technology and Entrepreneurship. The award was presented Sept. 11 at the 17th annual Energy and Clean Technology Forum, which is the largest venture capital conference in the Southwest.

"We are proud to be a part of a grand vision to push boundaries, impact the community and embrace innovation," Sensytec's Twitter account posted after the wins.

Sensytec, established in 2015, is based on the groundbreaking research of **Cumaraswamy "Vipu" Vipulanandan**, professor of civil and environmental engineering at the UH Cullen College of Engineering and director of the Center for Innovative Grouting Materials and Technology (CIGMAT).

He invented "smart" cement, which is an innovative 3D highly sensing chemo-thermo-piezoresistive material used as an additive to cement or concrete that makes construction safer by enabling monitoring and real-time data collection. Less than eight ounces of the additive is needed to produce 1,000 pounds of smart cement, which can detect earthquakes, gas leaks, cracks and curing, among other things.

Vipulanandan also developed the real-time monitoring system for smart cement users.

Smart cement has broad applicability and can be used in oil, gas and water wells, pipelines, highways, bridges, buildings and more. The sensing ability lasts the lifetime of the structures.

"At the end of the day, we addressed a universal need," Vipulanandan said about his research team. "We figured out a way to make our research applicable to the real world."

Sensytec has brought to market both the smart cement and the monitoring system. The company is located at the UH Technology Bridge – a research park that offers 30,000 square feet of incubator space and 700,000 square feet for laboratories and light manufacturing.

While Vipulanandan serves as an advisor, the company is run by **Ody de La Paz**, a UH graduate with bachelor's degrees in accounting and entrepreneurship, and **Sai Anudeep Reddy Maddi**, who is working on his Ph.D in civil and environmental engineering at the Cullen College. Maddi earned his master's in structural engineering at UH in 2016.

Maddi said the wins mean more opportunities for Sensytec. "It was very exciting and a great honor to be recognized," he said. "The wins have elevated Sensytec's presence in the Houston community and beyond, and winning the investment prize took it to a whole different level."

The company, which has previously won funds from the National Science Foundation, the U.S. Department of Defense and the Techstars Accelerator, has also been selected to be part of the Smart Cities Ion Accelerator Program in partnership with Microsoft, Intel and the City of Houston. Sensytec tops the list of 10 companies accepted into the program.

To learn more about Sensytec, please visit: **WWW.SENSYTEC.COM**

Less than eight ounces of the additive is needed to produce 1,000 pounds of smart cement, which can detect earthquakes, gas leaks, cracks and curing, among other things.

PAPER ON MASS EVACUATION RECEIVES INTERNATIONAL RECOGNITION

BY RASHDA KHAN

GINO LIM

Industrial engineers make things and systems better for people. In the case of **Gino Lim**, it can involve reliable mass evacuation planning in situations of critical emergencies.

"A reliable evacuation plan is key to successful mass evacuation," said Lim, a professor and the chair of the industrial engineering department at the UH Cullen College of Engineering and Hari and Anjali Agrawal faculty fellow.

Houston has dealt with numerous disasters, including hurricanes and flooding, and knows well the value of emergency planning. Events such as Hurricane Katrina and Hurricane Rita in 2005, and Hurricane Harvey in 2017 made the international news and continue to haunt Houstonians. These disasters resulted in lost lives and billions of dollars in property damage.

*Sometimes, the **disaster can take the form of massive, grueling traffic congestion** as people attempt to flee an area under threat.*

Rita coming a few weeks behind Katrina resulted in 3.7 million people attempting to leave the Houston area – the largest evacuation in U.S. history according to PBS. The news reported jammed up traffic stretched for more than 100 miles, cars ran dry and abandoned vehicles littered shoulder lanes in 100-degree heat. Worse, dozens of people died from heat stroke, traffic accidents and a bus fire.

Lim, his doctoral student **Ayda Darvishan** and his former doctoral student **Mukesh Rungta** (MSEE '09, Ph.D. IE '12, and now with the international company AirLiquide), have been working with engineers at the City of Houston and Texas Transportation Institute to better understand traffic congestion triggered by mass evacuation in the Greater Houston Area.

Their work has resulted in a paper that was published by the Institute of Industrial and Systems Engineers (IISE) in two of its prestigious publications. It also appeared in the June 2019 issue of *IISE Transactions* and was also featured in the Research section of the institute's *Industrial and Systems Engineer* magazine.

"When an evacuation is called for, not all residents agree to evacuate for various reasons. Hence, evacuation demand estimates are usually based on expert judgment, which can lead to difficulties in forming a reliable estimate of the associated demand distribution, creating inconsistencies in estimation," said Lim, who has created efficient evacuation routes with Harris County and Houston Transtar.

The paper, titled "A Robust Chance Constraint Programming Approach for Evacuation Planning Under Uncertain Demand Distribution," the paper focuses on an evacuation planning problem where the number of actual evacuees (demand) is unknown. It then develops a comprehensive network flow-based evacuation planning approach to address demand uncertainty not only for the cases in which mean and variance of demand distribution are known, but also for the cases in which additional information – such as the demand uncertainty with symmetry and/or support information – are available.

Using this additional information, the authors prove that tighter bounds can be achieved on evacuation clearance time while providing an optimal evacuation plan with essential information like route selection, evacuation times, and how many cars each path should accommodate at each time interval during the course of evacuation.

> *"In an emergency situation, time is of the essence."*
> - GINO LIM

In the email notifying Lim and his co-authors about the acceptance of their work, *IISE Transactions*' Editor-in-Chief Jianjun Shi wrote: "The intent is to highlight your contribution and its potential impact on professional practice."

The IISE is the world's largest professional society dedicated solely to the support of the industrial engineering profession and individuals involved with improving quality and productivity. Founded in 1948, IISE is an international, nonprofit association that provides knowledge, training, networking opportunities and recognition to enhance the skills and effectiveness of its members, customers and the profession.

SYSTEMS & OPTIMIZATION

IMPROVING HEALTH CARE DELIVERY

BY RASHDA KHAN

Taewoo Lee, assistant professor of industrial engineering at the UH Cullen College of Engineering, was awarded two grants to address critical issues in health care by the National Science Foundation.

One focuses on making eye care more accessible to at-risk patients with diabetic complications and the other is looking to create smart incentives for organ transplant centers to work equitably with patient needs and government regulations.

"I'm very interested in using mathematical optimization and quantitative modeling skills for improving healthcare delivery and operational systems to ***help patients who otherwise would not receive good or equitable care****," Lee said.*

While pursuing his Ph.D. in operations research at the University of Toronto, Lee worked on optimizing treatment plans involving radiation therapy for cancer patients. This experience showed him the vital role operations research and industrial engineering can play in health care. It also spurred Lee's interest in broadening his experience involving different types of health issues.

Lee chose to do his postdoctoral work at Rice University because of its proximity to the Texas Medical Center, which happens to be the largest medical complex in the world.

"I found health-related problems in the underserved communities in the United States to be very eye-opening, because when I was in Canada I didn't see these problems," Lee said. "The disparities and lack of access for many of these patients, coupled with expensive medical care creates pressing situations that are important to address."

Lee's research interests include data-driven optimization and machine learning techniques with results being applicable to various areas of the healthcare industry – operations, medical decision making, cancer therapy, lifestyle management and more.

Here are the details of Lee's ***award-winning projects*** »»

“The idea is to see how we can make best use of teleretinal screening systems to really benefit the patients that are underserved and falling through the cracks.”

- TAEWOO LEE

PROJECT TITLE:

Collaborative Research: Optimal Design of a Teleretinal Screening Program for At-risk Patients.

AMOUNT:

The total is $254,672 with $169,792 going to Lee, who is the lead UH investigator.

Diabetic retinopathy (DR) is the most common diabetic eye disease in America and the leading cause of blindness in American adults, affecting more than 30 million diabetic patients.

“One of the biggest problems in diabetic complications is that so many of the diabetic patients are lacking access to eye care. It’s a question of time, expenses and not very convenient locations so a lot of people just skip going for eye care,” Lee said. “Timely treatment can prevent up to 98% of DR-related vision loss, but only 30% -60% of diabetic patients are screened by retina specialists annually.”

As a result, teleretinal screening has recently received increasing attention as an accessible screening technique, where patients first receive examinations at primary care offices or local health centers via non-dilated digital imaging and are referred to specialists if deemed to have threshold disease.

However, several challenges have undermined the effectiveness of teleretinal screening programs. First, little is known how such programs can be expanded and implemented in larger urban settings or rural areas and promote participation of patients with limited access.

Furthermore, there is a lack of quantitative understanding of the trade-offs between teleretinal and in-clinic screening exams for different patient subgroups and program structures and how a personalized screening policy can be developed and integrated with the current system based on the trade-offs.

The main goal of this project is to develop a comprehensive, quantitative modeling framework for an optimal design of a teleretinal screening program from both societal and individual patient's perspectives. Lee will use mathematical optimization, partially observable Markov decision processes in particular, to determine the optimal screening times for the patients, and game-theoretic approaches to integrate them with the societal perspectives.

“The idea is to see how we can make best use of teleretinal screening systems to really benefit the patients that are underserved and falling through the cracks,” Lee said.

The broader impact of this work is immense. The community's consensus is that disparities in access to care and low compliance are the most important issues in the management of DR today, Lee said.

*Lee hopes that the results of this research will provide insights into how clinical guidelines can adapt to advances in retinal imaging and how the **resources can be shifted to high-risk population** in the next-generation of DR screening systems.*

and often the only viable, therapy for end-stage organ failure. Unfortunately, the demand for organs greatly exceeds the supply,” Lee said. Add to that government regulations and compliance-based Medicare and Medicaid reimbursements involving the centers.

“The regulations sometimes backfire in the sense that the some of the centers can game the system to be compliant,” he added. “Some of the centers might become overly risk-averse because they don’t want to be penalized, which can lead to wasted organs and decreased transplantation volume.”

*With the aim to ensure transplant centers effectively use “these scarce organs, we will develop new transplant center evaluation criteria to incentivize transplant centers to **improve their post-transplant outcomes and maximize transplantation volume** at the same time,” he added.*

Other institutions involved in the project are Rice University and Houston Methodist Hospital.

The researchers hope to gain a deeper understanding of current pay-for-performance initiatives in the transplantation system and in other healthcare settings by examining the interplay between societal goals and provider incentives.

This research will build a bi-level optimization framework to model the interaction between the societal perspective and the goals of individual transplant centers to determine incentives that simultaneously maximize societal and center-level benefits. This framework (1) formulates the societal perspective (the leader) that quantifies the utility-adjusted, national benefit and determines societally optimal incentive parameters, and (2) models each transplant center's perspective (the followers) as a sequential, stochastic decision-making problem so as to maximize its transplant volume subject to the societal incentives.

“The motivation for both of the projects is how to connect these multiple stakeholders using the technologies and techniques that we have,” Lee said. “We want to align the different views and agendas, and smartly design systems to make the processes better, efficient and more consistent, which will definitely benefit the patients.”

“We have partnered with the Harris Health System to enable the implementation of the results of this study in the greater Houston area, and adopted an FDA-cleared automated diagnosis platform to enable the deployment of the devices at various accessible locations,” Lee said.

The other principal investigator on the project is Christina Y. Weng, of the Baylor College of Medicine.

PROJECT TITLE:

Collaborative Research: Performance Incentives for Organ Transplantation Centers

AMOUNT:

Total funding for the project is $386,251, of which $84,880 is allocated to Lee, who is the lead investigator.

This project goal is to ensure more effective use of donor transplant organs.

“Organ transplantation is the most effective,

A WEARABLE DEVICE SO THIN AND SOFT

You Won't Even Notice It

BY JEANNIE KEVER


CUNJIANG YU

Wearable human-machine interfaces – devices that can collect and store important health information about the wearer, among other uses – have benefited from advances in electronics, materials and mechanical designs. But current models still can be bulky and uncomfortable, and they can't always handle multiple functions at one time.

Researchers at UH, working with researchers in Colorado and China, recently reported the discovery of a multifunctional ultra-thin wearable electronic device that is imperceptible to the wearer.

The device allows the wearer to move naturally and is less noticeable than wearing a Band-Aid, said **Cunjiang Yu**, Bill D. Cook associate professor of mechanical engineering at the University of Houston Cullen College of Engineering. Yu is the lead author for the paper, titled "Metal Oxide Semiconductor Nanomembrane–Based Soft Unnoticeable Multifunctional Electronics for Wearable Human-Machine Interfaces," which was published as the cover story in the Aug. 2 issue of the.*Science Advances* journal.

"Everything is very thin, just a few microns thick," said Yu, who also is a principal investigator at the Texas Center for Superconductivity at UH. "You will not be able to feel it."

It has the potential to work as a prosthetic skin for a robotic hand or other robotic devices, with a robust human-machine interface that allows it to automatically collect information and relay it back to the wearer.

That has applications for health care. "What if when you shook hands with a robotic hand, it was able to instantly deduce physical condition?" Yu asked. Or if a robotic device could help deal with chemical spills, which are risky for humans but require human decision-making that is based on up-close gathering of information that is reported from the scene.

While current devices are gaining in popularity, the researchers said they can be bulky to wear, offer slow response times and suffer a drop in performance over time. More flexible versions are unable to provide multiple functions at once – sensing, switching, stimulation and data storage, for example – and are generally expensive and complicated to manufacture.

The device described in the paper, a metal oxide semiconductor on a polymer base, offers manufacturing advantages and can be processed at temperatures lower than 300 C.

"We report an ultrathin, mechanically imperceptible, and stretchable (human-machine interface) HMI device, which is worn on human skin to capture multiple physical data and also on a robot to offer intelligent feedback, forming a closed-loop HMI," the researchers wrote. "The multifunctional soft stretchy HMI device is based on a one-step formed, sol-gel-on-polymer-processed indium zinc oxide semiconductor nanomembrane electronics."

In addition to Yu, the paper's co-authors include first author Kyoseung Sim, Zhoulyu Rao, Faheem Ershad, Jianming Lei, Anish Thukral and Jie Chen, all of UH; Zhanan Zou and Jianliang Xiao, both of the University of Colorado; and Qing-An Huang of Southeast University in Nanjing, China.

*It has the potential to work as a **prosthetic skin** for a robotic hand or other robotic devices, with a robust human-machine interface that allows it to automatically collect information and relay it back to the wearer.*

RESEARCHERS BUILD A SOFT ROBOT WITH NEUROLOGIC CAPABILITIES

BY JEANNIE KEVER

In work that combines a deep understanding of the biology of soft-bodied animals such as earthworms with advances in materials and electronic technologies, researchers from the United States and China have developed a robotic device containing a stretchable transistor that allows neurological function.

Cunjiang Yu, Bill D. Cook associate professor of mechanical engineering at the UH Cullen College of Engineering, said the work represents a significant step toward the development of prosthetics that could directly connect with the peripheral nerves in biological tissues, offering neurological function to artificial limbs. It also can toward advances in soft neurorobots that are capable of thinking and making judgments. Yu is corresponding author for a paper describing the work that was published in *Science Advances*.

He is also a principal investigator with the Texas Center for Superconductivity at the University of Houston.

"When human skin is touched, you feel it," Yu said to describe the human capabilities the new device can mimic. "The feeling originates in your brain, through neural pathways from your skin to the brain."

The findings have implications for neuroprosthetics, as well as for neuromorphic computing, an emerging technology with the potential to allow high volume information processing using small amounts of energy through devices that mimic the electric behavior of neural networks.

Inspired by nature

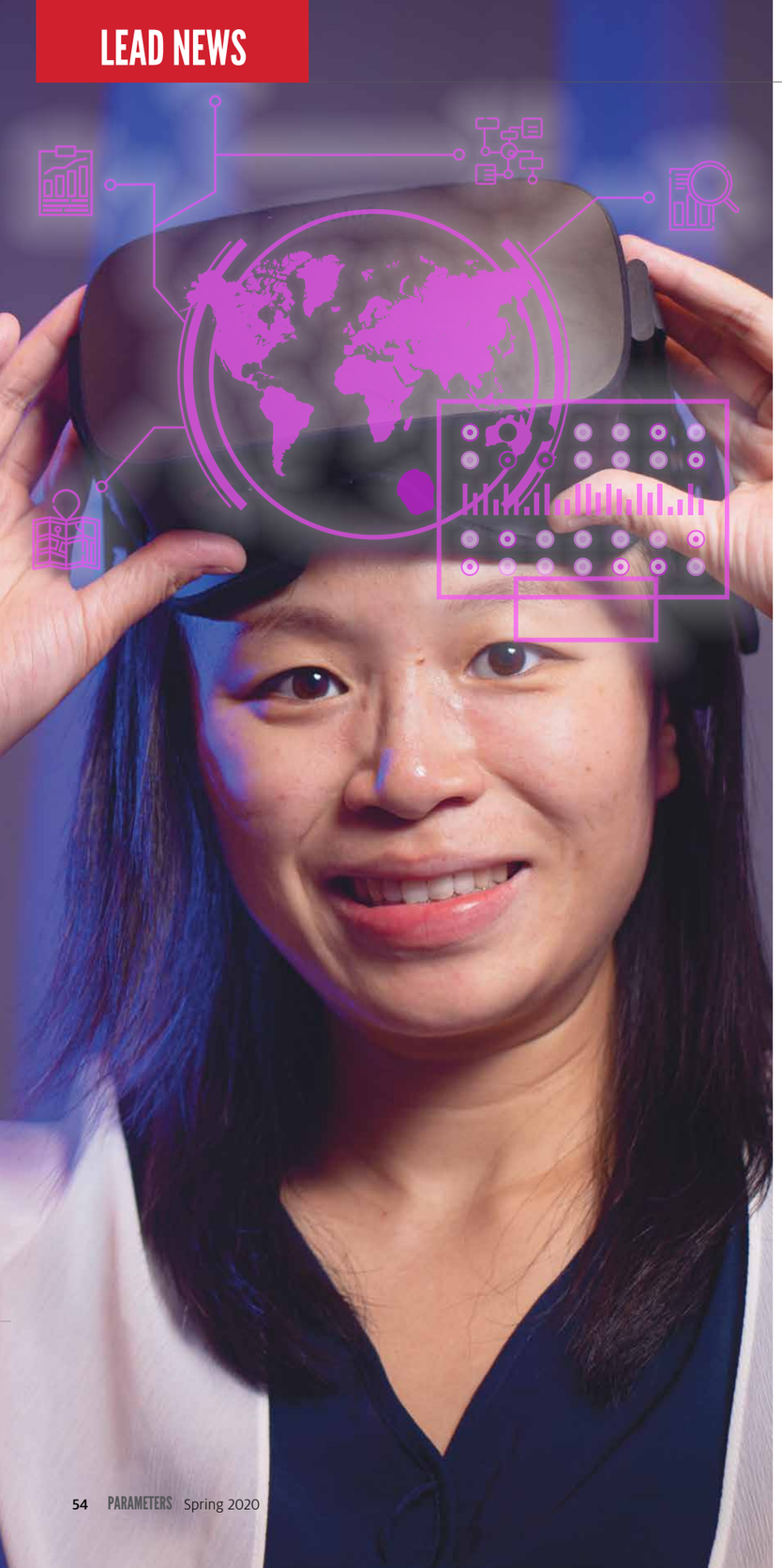
Inspired by nature, the researchers designed artificial synaptic transistors – that is, transistors that function similarly to neurons – which continue to work even after being stretched as much as 50%. While the resulting neurological function is less sophisticated than that exhibited by those of its living counterparts, they said it marks an important first step toward more powerful engineering systems in the future.

The transistor, described by researchers as having stretching characteristics similar to those in a rubber band, exhibited functions similar to those of biological synapses, including excitatory postsynaptic potential, current, facilitation, and short-term memory and long-term memory.

*The **soft neurorobot** was equipped with a neurologically integrated tactile sensory skin, allowing it to sense the interaction with the external environment and respond accordingly. "The neurorobot senses physical tapping and locomotes adaptively in a programmed manner through synapse memory encoded signals," the researchers wrote.*

In addition to Yu, the research team included Hyunseok Shim, Kyoseung Sim, Faheem Ershad, Pinyi Yang, Anish Thukral, Zhoulyu Rao, Hae-Jin Kim and Xu Wang, all affiliated with the University of Houston; Yanghui Liu and Yang Chai, both with Hong Kong Polytechnic University; Guoying Gu of Shanghai Jiao Tong University; Li Gao of Nanjing University of Posts and Telecommunications; and Xinran Wang of Nanjing University.


The soft neurorobot was equipped with a neurologically integrated tactile sensory skin, allowing it to sense the interaction with the external environment and respond accordingly.



UH Engineer Helps Improve MOBILE VIRTUAL REALITY/AUGMENTED REALITY USER EXPERIENCE

BY RASHDA KHAN

Virtual and augmented reality (VR/AR), once existing only in the realm of science fiction, are now a growing part of our daily lives. If you have ever used Snapchat face filters or played Pokémon GO, you have used AR technology right from your smartphone. The gaming industry pioneered the use of virtual reality technology for end users decades ago, and now many law enforcement organizations are using VR technology for training.

"Driven by the significant performance improvement of computing hardware and the revolution of graphics and display technologies, virtual reality (VR) and augmented reality (AR), which were invented back in 1990s, are now experiencing rapid growth and debuting into mainstream markets," said **Xin Fu**, associate professor of electrical and computer engineering at the UH Cullen College of Engineering.

"Both VR and AR are increasingly being adopted in smartphone apps for providing rich experience to mobile users," she said.

Retailers have noticed and are using VR/AR technologies to engage and enhance the customer experience. This has led to some innovative try-before-you-buy applications – such as virtual fitting rooms that let customers see images of themselves in new outfits without ever having to try anything on, as well as apps that show customers how potential purchases of furniture or decorative elements will look inside their own homes.

XIN FU AND HER STUDENTS

Mobile AR, which already has access to over a billion smartphone users, is expected to generate $3.4 billion by the end of 2019 and $9.6 billion by 2020, according to SuperData, a Nielsen company.

However, the limits of computing hardware in mobile devices make them hardly able to support the tremendous resource requirements by VR/AR and satisfy user demands for more seamless experiences.

The National Science Foundation awarded three universities a $450,000 grant to work on a project titled Enhancing Mobile VR/AR User Experience: An Integrated Architecture-System Approach. The University of Florida as the lead research institute. It is joined in the project by the University of Houston and Western New England University.

"Response time, battery life, and thermal challenges are the major obstacles to enabling the resource-intensive mobile VR/AR applications on compute, memory, and power-limited mobile devices," said Fu, who is the UH's principal investigator on the project. "The proposed research, which leverages the unique features of VR/AR to holistically and cooperatively tackle these challenges with integrated architecture and system support, will open the door for next generation mobile platforms that provide high-quality low-power VR/AR services to satisfy numerous mobile users."

THE COLLABORATIVE PROJECT HAS FOUR OBJECTIVES:

(1) Approximate computing to eliminate unnecessary workloads in mobile AR/VR to achieve benefits on performance, power and thermal issues without sacrificing image quality and output accuracy.

(2) Explore emerging technologies that can enable mobile VR/AR for performance/power optimization.

(3) Exploiting dynamic thermal energy harvesting to cool hotspots, prolong battery life and improve performance.

(4) Integrate key research innvations and cross-technology optimizations to maximize the performance, power and thermal enhancements.

Fu's collaborators are Tao Li from the University of Florida and Amer Qouneh from Western New England University.

The results of the research could impact VR/AR products and applications in a great number of fields, including education, medical and entertainment, Fu said.

"If successful, the proposed research will enable mobile devices to meet the increasing demands for excellent VR/AR user experience," she added. "It will also satisfy the desire for launching more innovative VR/AR applications into the mobile device market, making everyday living and working more convenient and efficient."

Research on Adaptive Machine Learning

WINS NSF AWARD

BY SARA STRONG AND RASHDA KHAN

Imagine cruising down a highway in your self-driving car. Its operating system relies on algorithms based on data collected during dry driving conditions. But what happens when the car has to navigate through high winds, hard rain and street flooding?

"This is a naturally occurring situation where the characteristics of the data will change," said **Hien Van Nguyen**, assistant professor of electrical and computer engineering at the UH Cullen College of Engineering. "So it's very likely that in those circumstances the machine learning models in place will fail."

In such situations, time is of the essence.

"You can't stop the self-driving car in the middle of the highway in a storm and say 'Hey, I'm going collect more data and retrain the machine," he said. "The car needs to adapt quickly. It's a safety issue."

Nguyen wants to advance machine learning algorithms to go beyond generalizations and respond appropriately when situations change.

The National Science Foundation awarded Nguyen a two-year, $225,000 grant for a related research project titled "Active and Rapid Domain Generalization."

"The main goal of this project is to develop technologies that will help machine learning models adapt to changes without having to collect a lot of data and without having to take the machine offline to retrain the models from the beginning," Nguyen said.

The need for adaptability exists across different fields – from the medical sector to offshore oil and gas operations.

"For example, with the current machine learning technology I can build a model to detect lesions on Caucasian skin," Nguyen said. But it wouldn't be useful in a large, multicultural metropolitan area like Houston. "If I try to use that same model on Asian, Latino or Black skin, it is likely to fail because there are subtle differences."

The offshore drilling industry, with its miles of submerged pipes that must be maintained, is another potential end user.

"Underwater robots could inspect pipelines for cracks and loose bolts so those problems could be fixed before there is the risk of damage to the ocean," Nguyen said. But the situation is often complicated by sea organisms that are naturally attracted to pipes.

A loose bolt can be detected by analyzing a tap-tap-tap sound made on a pipe; the sound will be clear if the pipe is fine or muffled by a recognizable vibration if a bolt is loose. But the sound will be altered in areas where seaweed or barnacles have grown around a pipe or bolt, which happens often.

"So we are addressing a very fundamental and annoying limitation of machine learning," said Nguyen, who is also director of the Houston Ubiquitous Learning Algorithms (HULA) Research Lab.

"If you don't have an algorithm that effectively detects and quickly adapts to changes in the data characteristics, machine learning would not be applicable or useful in many domains."

Nguyen's research aims to expand those capabilities and others. The NSF grant began on Aug. 1 and will continue through July 31, 2021.

Two Cullen College doctoral students, **Aryan Mobiny** and **Pengyu Yuan**, are assisting with the research and two more researchers are expected to join the team this spring.

The UH project is being conducted in collaboration with researchers at Johns Hopkins University, where a parallel project is led by Vishal M. Patel, assistant professor of electrical and computer engineering.

"I'm very excited to receive this award as visual domain adaptation is an important research topic and an area I have focused on for several years," Nguyen said. "This work has a lot of implications and applications in a number of different fields including medical imaging, computer vision, self-driving cars and speech recognition."

NEW HYBRID DEVICE CAN BOTH

Capture and Store Solar Energy

BY JEANNIE KEVER

The work combines molecular energy storage and latent heat storage to produce an integrated harvesting and storage device for potential 24/7 operation.

Researchers from the University of Houston have reported a new device that can both efficiently capture solar energy and store it until it is needed, offering promise for applications ranging from power generation to distillation and desalination.

Unlike solar panels and solar cells, which rely on photovoltaic technology for the direct generation of electricity, the hybrid device captures heat from the sun and stores it as thermal energy. It addresses some of the issues that have stalled wider-scale adoption of solar power, suggesting an avenue for using solar energy around-the-clock, despite limited sunlight hours, cloudy days and other constraints.

*The work, described in a paper published Wednesday in Joule, **combines molecular energy storage and latent heat storage** to produce an integrated harvesting and storage device for potential 24/7 operation. The researchers report a harvesting efficiency of 73% at small-scale operation and as high as 90% at large-scale operation.*

Up to 80% of stored energy was recovered at night, and the researchers said daytime recovery was even higher.

Hadi Ghasemi, Bill D. Cook associate professor of mechanical engineering at the UH Cullen College of Engineering and a corresponding author for the paper, said the high efficiency harvest is due, in part, to the ability of the device to capture the full spectrum of sunlight, harvesting it for immediate use and converting the excess into molecular energy storage.

The device was synthesized using norbornadiene-quadricyclane as the molecular storage material, an organic compound that the researchers said demonstrates high specific energy and exceptional heat release while remaining stable over extended storage times. Ghasemi said the same concept could be applied using different materials, allowing performance – including operating temperatures and efficiency – to be optimized.

T. Randall Lee, Cullen Distinguished University Chair professor of chemistry and a corresponding author, said the device offers improved efficiency in several ways: The solar energy is stored in molecular form rather than as heat, which dissipates over time, and the integrated system also reduces thermal losses because there is no need to transport the stored energy through piping lines.

"During the day, the solar thermal energy can be harvested at temperatures as high as 120 C (about 248 F)," said Lee, who also is a principle investigator for the Texas Center for Superconductivity at UH. "At night, when there is low or no solar irradiation, the stored energy is harvested by the molecular storage material, which can convert it from a lower energy molecule to a higher energy molecule."

That allows the stored energy to produce thermal energy at a higher temperature at night than during the day – boosting the amount of energy available even when the sun is not shining, he said.

In addition to Ghasemi and Lee, researchers with UH involved with the work include first author Varun Kashyap, Siwakorn Sakunkaewkasem, Parham Jafari, Masoumeh Nazari, Bahareh Eslami, Sina Nazifi, Peyman Irajizad and Maria D. Marquez, all with UH.

Researchers Report a

NEW WAY TO PRODUCE CURVY ELECTRONICS

BY JEANNIE KEVER

*Contact lenses that can **monitor your health as well as correct your eyesight** are not science fiction, but an efficient manufacturing method. But finding a way to produce the curved lenses with embedded electronics – has remained elusive.*

Until now. A team of researchers from the University of Houston and the University of Colorado Boulder reported developing a new manufacturing method, known as conformal additive stamp printing, or CAS printing, to produce the lenses, solar cells and other three-dimensional curvy electronics. The work, reported in the journal *Nature Electronics*, demonstrates the use of the manufacturing technique to produce a number of curvy devices not suited to current production methods. The work is also highlighted by the journal *Nature*.

"We tested a number of existing techniques to see if they were appropriate for manufacturing curvy electronics," said **Cunjiang Yu**, Bill D. Cook associate professor of mechanical engineering at the UH Cullen College of Engineering and corresponding author on the paper. "The answer is no. They all had limitations and problems."

Instead, Yu, who is also a principal investigator with the Texas Center for Superconductivity at UH, and his team devised a new method, which they report opens the door to the efficient production of a range of curvy electronic devices, from wearables to optoelectronics, telecommunications and biomedical applications.

"Electronic devices are typically manufactured in planar layouts, but many emerging applications, from optoelectronics to wearables, require three-dimensional curvy structures," the researchers wrote. "However, the fabrication of such structures has proved challenging due, in particular, to the lack of an effective manufacturing technology."

Existing manufacturing technologies, including microfabrication, don't work for curved, three-dimensional electronics because they are inherently designed to produce two-dimensional, flat electronic devices, Yu said. But increasingly, there is a need for electronic devices that require curvy, 3-D shapes, including smart contact lenses, curved imagers, electronic antennas and hemispherical solar cells, among other devices.

*These **devices are small** – ranging in size from millimeters to centimeters – with accuracy within a few microns.*

Recognizing that, Yu and the other researchers proposed the new fabrication method, conformal additive stamp printing, or CAS printing.

CAS printing works like an elastomeric, or stretchy, balloon that is inflated and coated with a sticky substance then used as a stamping medium. When the coated balloon is pressed against prefabricated electronic devices, it can pick up the devices' electronics; then it can print those electronics by being pressed against other surfaces, even if those surfaces have curves. In the paper, the researchers describe using the method to create a variety of curvy devices, including silicon pellets, photodetector arrays, small antennas, hemispherical solar cells and smart contact lenses.

The work was performed using a manual version of the CAS printer, although the researchers also designed an automated version. Yu said that will make it easy to scale up production.

In addition to Yu, co-authors include Kyoseung Sim, Song Chen, Zhoulyu Rao, Jingshen Liu, Yuntao Lu, Seonmin Jang, Faheem Ershad and Ji Chen, all with UH, as well as Zhengwei Li and Jianliang Xiao, both with the University of Colorado Boulder.

This work was supported by National Science Foundation.

Testing Biodegradable

SELF-GUIDED RECONNAISSANCE DEVICES

BY RASHDA KHAN

Discretion is an integral part of covert military reconnaissance missions. With that in mind, a team of UH Cullen College of Engineering researchers are working on a $1 million project to create self-guided biodegradable containers of sensors to map coastlines and the bottom of the ocean.

Imagine a swarm of water bottle-sized devices gathering information along coastlines as they float stealthily on the waves. Then once their mission is completed, they quietly dissolve without ever reaching the shore. In addition to military reconnaissance, these devices could potentially be used for law enforcement and environmental monitoring.

The UH project is led by **Craig Glennie**, associate professor of civil engineering and an investigator with the National Center for Airborne Laser Mapping, or NCALM. Other Cullen College researchers involved are **Megan Robertson**, associate professor of chemical and biomolecular engineering, and **Aaron Becker,** assistant professor of electrical and computer engineering.

These innovative, environmentally safe devices are now a step closer to reality.

Becker and his research assistants, along with Robertson and Glennie, recently spent three days testing prototypes in Gulfport, Mississippi, with the Commander U.S. Naval Meteorology and Oceanography Commands (CNMOC), which provides information to the oceans' extreme depths. They deployed three UH-made sensor nodes or drift nodes – each equipped with a camera, sonar, accelerometers, GPS, cellular connectivity and more. Once released, the nodes wirelessly sent measurements to a website during a five-hour exercise.

The team also participated in Industry Day, an event held by the Department of Defense, to present plans for current and future procurements to industry representatives. They did live demos of the biodegradable process for the packaging materials and the electronics included.

"Deploying the sensor nodes on the Navy's fast boat was a treat," Becker said. "We learned a lot about ocean-proofing our sensor nodes, and the industry teams shared some insight into electronics packages they use." The next step, after verifying that the sensor package works, the team will focus on integrating the biodegradable package and electronics into a unified device and then return for more testing.

Glennie, whose work with NCALM involves mapping with lasers and unmanned aerial vehicles, is responsible for the mapping capabilities. Robertson, who creates biodegradable plastics and other materials in her lab, is generating the materials for the devices. Becker, who works in swarm robotics and artificial intelligence, is focusing on deploying the sensors and working on a related project to develop a system to control a swarm of up to one million drones or other aerial reconnaissance vehicles in a way that appears to be unpredictable, thwarting an opponent's ability to track and target them.

The UH project is part of a larger effort, funded by Office of Naval Research and led by Northeastern University.

In a related project, Becker also is developing a system that tightly controls a swarm of up to 1 million aerial reconnaissance vehicles, such as drones, yet allows the movements to appear so random they thwart an opponent's ability to track and target.

MASTER'S STUDENT JARRETT LONSFORD WORKING ON THE ELECTRONICS FOR A SENSING DRIFT NODE

FOLLOW HER LEAD:

FAITH MALTON IS [RE] ENGINEERING A BETTER WORLD

FAITH AT HER INTERNSHIP: WALTER P. MOORE

»» UNIVERSITY OF HOUSTON STUDENT FAITH "FEFE" MALTON HAS A LIFETIME OF ENGINEERING EXPERIENCE.

FAITH AT UH CENTRAL CAMPUS

Born missing her right arm, shoulder and collarbone, she can't use prostheses of any sort. Malton grew up problem-solving, innovating and adapting the environment around her – learning everything from tying her shoelaces to driving a car with one hand.

A senior at the UH Cullen College of Engineering, the 23-year-old Malton has accomplished an impressive and unusual array of feats, from rappelling down a 21-story building to launching a popular YouTube channel devoted to showing how she navigates the world with one arm.

When Malton first mentioned engineering as a career, her mother, Melissa Edwards, was neither surprised nor worried. "I told her 'You're a natural-born engineer because you're always adjusting and making calculations'," Edwards said.

For instance, to go through a door Malton must think about the velocity and speed, how quickly the door will swing back, and her own responses. Should she jump through it? Prop it open? How would she carry groceries and other things inside?

"I knew you'd be fine because you think like an engineer all the time," Edwards said, looking at her daughter during the interview.

MALTON WILL GRADUATE IN MAY WITH A BACHELOR'S DEGREE IN CIVIL ENGINEERING AND A MINOR IN ENERGY AND SUSTAINABILITY. »»

IN THE BEGINNING

Her birth turned out to be a big surprise for many reasons. The pregnancy progressed normally and her parents expected a healthy baby boy. Instead, Edwards found herself cradling a beautiful, one-armed baby girl.

"The doctors at the time told me 'She's only as handicapped as you make her,' and that was the advice that has followed me throughout her life," Edwards said. "I really tried to reinforce that having one arm was a fact. That's a fact, and there's nothing you can do about it, but what you can do is decide how you want to go through life having one arm."

But putting that philosophy into practice wasn't always easy. One time, Malton had dragged out a lot of toys and spent hours playing. At the end, tired, she asked for help picking them up.

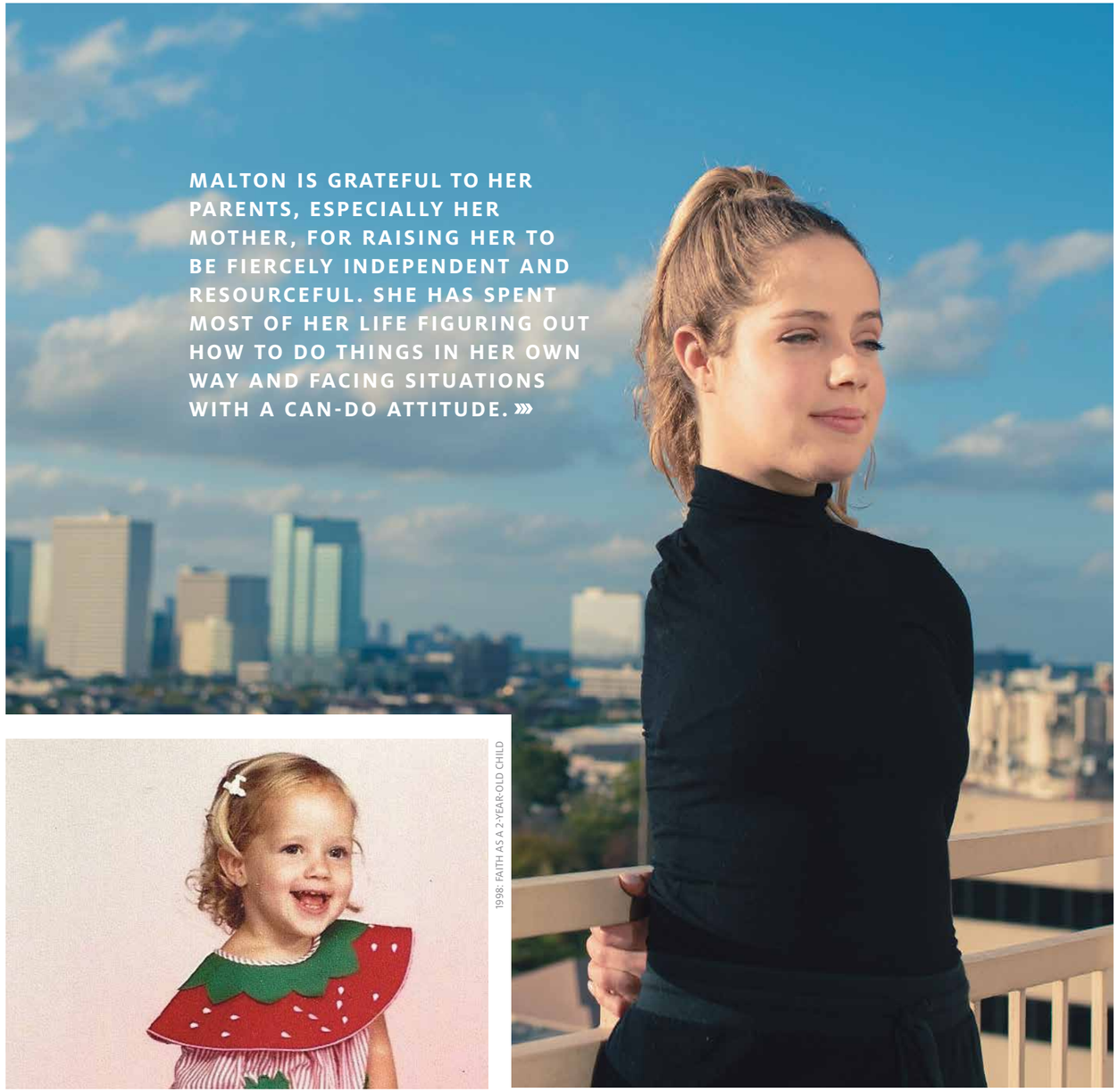
When Edwards replied that she'd pulled all the toys out so she could also pick them up, Malton answered that she had only one arm.

Edwards stood firm and told her daughter to do the job in two trips if needed.

"There are many moments that were, and are, hard," Edwards said. "But I knew that through the struggle, she'd figure it out."

FAITH AND HER MOTHER, MELISSA EDWARDS

"THE DOCTORS AT THE TIME TOLD ME 'SHE'S ONLY AS HANDICAPPED AS YOU MAKE HER,' AND THAT WAS THE ADVICE THAT HAS FOLLOWED ME THROUGHOUT HER LIFE," EDWARDS SAID.



FAITH AT HER APARTMENT IN HOUSTON, TX.

MALTON IS GRATEFUL TO HER PARENTS, ESPECIALLY HER MOTHER, FOR RAISING HER TO BE FIERCELY INDEPENDENT AND RESOURCEFUL. SHE HAS SPENT MOST OF HER LIFE FIGURING OUT HOW TO DO THINGS IN HER OWN WAY AND FACING SITUATIONS WITH A CAN-DO ATTITUDE. »»

1998: FAITH AS A 2-YEAR-OLD CHILD

LEADING A DARING LIFE

FAITH AT THE BLAFFER ART MUSEUM

Malton first realized she was different when she encountered the monkey bars at a Montessori preschool. Her father noticed she wasn't her usual bubbly self at pickup. "When he asked me what was wrong, I very matter-of-factly told him I couldn't do the monkey bars." »»

FAITH AT HOTEL ALESSANDRA IN HOUSTON, TX

FAITH ABROAD IN PERU

Back then, she hadn't been able to figure out the mechanics of making the monkey bars possible. What momentum would be needed so she could swing, let go of one bar and grab the next lightning fast? But she didn't let that stop her from going forward and on to new adventures.

Malton has traveled around the world since she was 8, starting with her first solo trip to visit her father, who lived in Hawaii at the time. Since then, she's traveled to far-flung places including Iceland and India.

She spent one summer in Tanzania on a National Geographic trip focused on wildlife conservation. In 2017, she traveled to Peru to learn about water resource management and sustainable practices, leading to her capstone project on aquaponics and hydroponic indoor farming. The year before, Malton was in Antarctica studying climate change and global sustainability.

"EVERY TIME I TRAVELED, I LEARNED SOMETHING ABOUT MYSELF, HUMANITY OR OUR PLACE IN THE UNIVERSE," SHE SAID. "I WAS AWAKENING WITH EVERY SINGLE TRIP THAT I TOOK."

When in Houston, Malton makes an effort to stay engaged and have new adventures. She volunteered with the Houston Museum of Natural Science and with the Houston Zoo for several years. At the zoo, she did everything from preparing food for the animals to taking care of rhinoceros, giraffes and ostriches.

In April 2019, Malton rappelled down 21 stories of the Hotel Alessandra in downtown Houston for a good cause. She was participating in Over the Edge, an annual fundraiser for Camp for All.

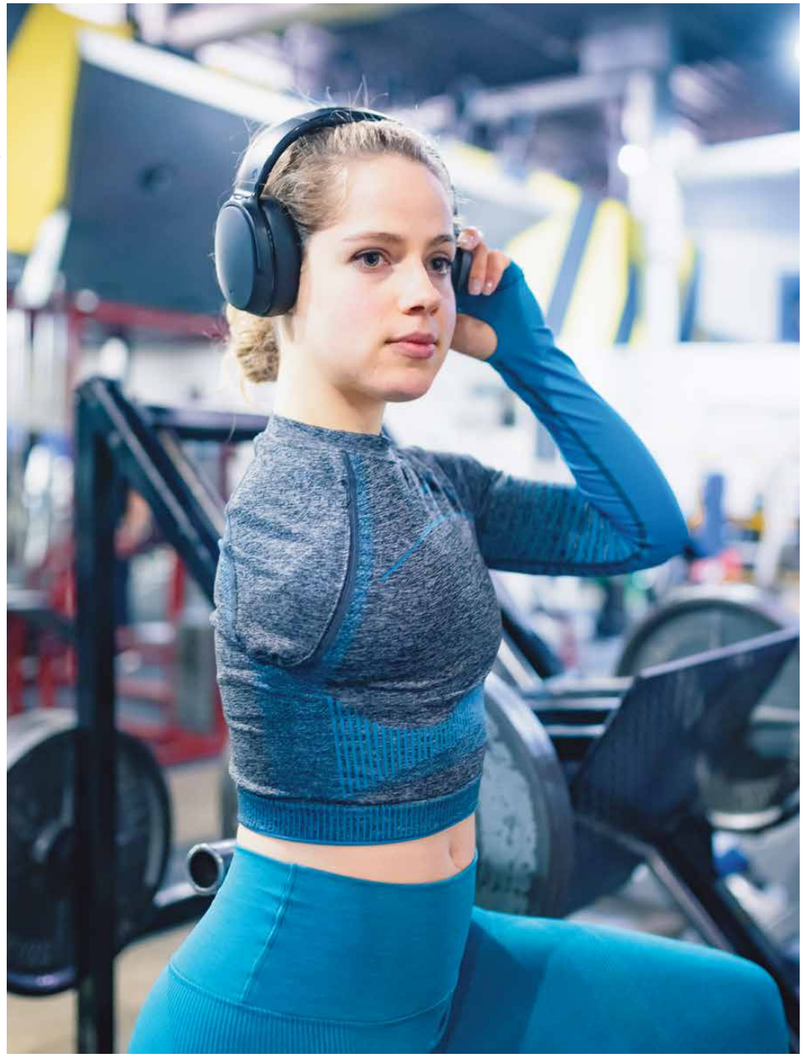
"It's an incredible organization. They believe in providing a barrier-free experience to all of their campers," she said. "Meaning that if you're in a wheelchair, if you have cerebral palsy or cancer, you can still do every camp activity without feeling 'Oh, I'm different, or there's something wrong with me.' That was a cause I could not pass up." Malton raised over $2,500 for Camp For All.

THE HARRIS COUNTY COMMISSIONERS COURT RECOGNIZED MALTON FOR HER EFFORTS.»»

FOLLOWING HER PASSIONS & STARRING IN HER OWN STORY

"I'M ALWAYS UPGRADING MYSELF PHYSICALLY, MENTALLY AND SPIRITUALLY," MALTON SAID. "ONE THING I HAVE FIGURED OUT IS THAT YOU CAN PROPEL YOURSELF IN WHATEVER DIRECTION YOU WANT, AND YOU CAN GO AS FAR AS YOU WANT, BUT YOU MUST DO THE WORK AND YOU HAVE TO BELIEVE IN YOURSELF FIRST AND FOREMOST." »»

FAITH AT HER LOCAL GYM IN HOUSTON, TX



Malton's interest in civil engineering is rooted in biomimicry and biomimetics, which is the imitation of natural biological designs or processes in engineering, scientific invention and architecture. She was inspired by a TED talk by architect Michael Pawlyn titled "Using Nature's Genius in Architecture."

While Pawlyn focused on individual architectural projects, Malton was thinking bigger.

"I thought, why not design our cities how nature would?" she said. "If you think of a city, it's a system. And so is a rain forest. You have your producers, your decomposers, your consumers … an entire ecosystem that works together. So why don't we mimic that same systemic philosophy into our own societies?"

That was a turning point for Malton and led her to civil engineering.

"I FIND CIVIL ENGINEERING IS THE DISCIPLINE THAT BUILDS WORLDS. WE DO EVERYTHING FROM DESIGNING FREEWAYS TO SKYSCRAPERS, WE DESIGN CIVILIZATIONS," SHE SAID. »»

»» "A BUILT ENVIRONMENT SHAPES THE WAY IN WHICH HUMANS EXPERIENCE THE WORLD. CIVIL ENGINEERS HAVE A HUGE RESPONSIBILITY TO DESIGN WORLDS THAT INSPIRE THE HUMAN SPIRIT, THAT ARE UNIVERSALLY ACCESSIBLE & ENHANCE THE EVERYDAY LIFE OF HUMAN BEINGS."

FAITH AT HER INTERNSHIP WALTER P. MOORE

To complement her studies, Malton is getting work experience. She is an infrastructure intern at Walter P. Moore Associates Inc., a Houston-based international engineering firm focused on designing "solutions that are cost and resource efficient, forward-thinking and help support and shape communities." She said she chose to work there because of the company's motto "Driven by the Challenge", its forwarding-thinking approach to solving problems and its openness to innovation – all major themes in her life.

Previously, she interned at Zarinkelk Engineering Services Inc. and worked on projects involving the Texas Department of Transportation, the City of Houston and METRO.

Malton hopes to one day design sustainable cities that take into account the psychological and biological needs of human beings as well as their culture, and to develop an urban ecosystem in sync with the natural environment.

"There's a ton of work to be done in the developed world, but I think there's a great opportunity in developing nations because they're a blank slate in many areas and they rely heavily on local resources," she said. "My dream is to develop sustainable cities in these areas that not only serve community and environmental needs, but breathe life and inspiration into people to encourage them to leave the planet better than they found it."

Her other passion involves health, fitness and biohacking. She explains that biohacking essentially means maximizing human potential by tapping into biological and psychological systems using training, nutrition and other different ways to influence cellular and neurological activity.

"I'm always upgrading myself physically, mentally and spiritually," Malton said. "One thing I have figured out is that you can propel yourself in whatever direction you want, and you can go as far as you want, but you must do the work and you have to believe in yourself first and foremost."

Her goal is to be "the superhero of my own story, to be the role model I needed as a kid" in every way possible.

To that end, she has set up the One-ArmWonder YouTube channel with videos that show how to accomplish different tasks one-handed, from tying shoelaces to working out with weights and machines at the gym. The channel is designed to provide inspiration, tutorials and tips for a healthy lifestyle, as it expands human consciousness at the macro level.

"I want the channel to exist for anyone who needs to hear my message," she said.

About one in four U.S. adults – 61 million Americans – live with a disability, according to the Centers for Disease Control and Prevention (CDC). Most people at some point in their lives will either have a disability or know someone with disabilities.

The response to the channel has been positive, with people thanking her for showing them how to do something because they recently broke an arm, or for sharing other useful pieces of information. "It's cool to be able to be productive in this way and help people I don't even know," Malton said.

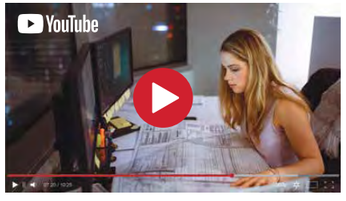
For 2020, her goal is to enter her first bodybuilding competition with the WBFF (World Beauty Fitness and Fashion, Inc.) event. She is competing to challenge conventional ideas of beauty, strength and body image, as well as challenging her own mental and physical limitations – ultimately showing people that barriers and obstacles can be overcome.

FAITH MALTON SHARES SOME ADVICE

My No. 1 advice to anybody is: Know thyself. I found that during my journey I often created my own suffering because I didn't know myself well enough. With knowing yourself, you can take better care of yourself and go after opportunities that truly bring you joy or satisfaction. Your body is the spaceship, you are the driver. Without knowledge of its mechanics, the driver cannot reasonably expect himself to get to his destination.

At the end of the day, you have to go to bed with yourself. And the resentment that you will ultimately build from repeatedly compromising yourself will ruin your life.

"FOR ME, OVERCOMING AN OBSTACLE IS NOT JUST ABOUT THE OBSTACLE, IT'S ALSO ABOUT EVOLVING DEEPLY IN MULTIPLE DIMENSIONS. AND I HAVE FOUND THAT AS I EVOLVE MYSELF, I'M ALSO ABLE TO HELP OTHERS EVOLVE," MALTON SAID. "I GO AFTER THOSE THINGS THAT ARE DIFFICULT TO SHOW PEOPLE WHAT CAN BE ACCOMPLISHED BECAUSE IT'S ABOUT EVOLVING THE HUMAN SPECIES."



WANT TO LEARN MORE ABOUT FAITH'S STORY? VISIT OUR YOUTUBE CHANNEL:
@UHEngineering

Jiming Bao

ELECTED FELLOW OF AMERICAN PHYSICAL SOCIETY

BY RASHDA KHAN

Jiming Bao, professor of electrical and computer engineering at the UH Cullen College of Engineering, is now a fellow of the American Physical Society (APS).

According to the APS notification letter, Bao was selected for his "discovery of photoacoustic laser streaming, contributions to the understanding of basic electronic and optical properties of nanostructured materials, and the development of new nanomaterials for applications in solar energy conversions and optoelectronic devices."

The number of APS fellows elected each year is limited to no more than one half of one percent of the membership.

"I'm honored by this recognition from my peers," said Bao, referring to his election as an important career milestone. "This makes me feel that I have made valuable contributions to the science of our community."

***Bao's research** focuses on new and novel materials, semiconductor nanowire optoelectronics, silicon photonics and metallic nanostructures for plasmonics, solar water-splitting, and fiber optic sensors.*

He was leading a UH research team studying the nonlinear transmission of light through an aqueous suspension of gold nanoparticles when they noticed something unexpected: A pulse laser appeared to have forced the movement of a stream of liquid in a glass laboratory cuvette. This observation led to a new optofluidics principle in 2017.

Earlier this year, Bao led a research team that developed a new laser-driven photoacoustic microfluidic pump, capable of moving fluids in any direction without moving parts or electrical contacts.

"Whenever I publish new findings or discoveries from my lab, I feel very happy," Bao said. "That's the most rewarding aspect of my career."

In 2018, Bao was elected a fellow of the Optical Society of America. In 2012, he won a National Science Foundation CAREER Award to study the optical properties of graphene. This year, he's won a Welch Award to continue studying cobalt oxides as viable catalysts for energy generation.

Bao earned both his bachelor's and master's degrees in physics from the Zhejiang University in Hangzhou, China. Then he went onto earn his Ph.D. in applied physics from the University of Michigan. He served as a postdoctoral fellow and a research associate on the research team of Federico Capasso at Harvard University from 2003 to 2008.

Founded in 1916, APS is a nonprofit organization working to advance and diffuse the knowledge of physics through its outstanding research journals and scientific meetings, as well as its education, outreach, advocacy and international activities. It represents over 55,000 members, including physicists in academia, national laboratories, and industry in the U.S. and throughout the world.

Cullen College Professor Wins

OUTSTANDING YOUNG ALUMNI AWARD

BY RASHDA KHAN

Jerrod Henderson, instructional associate professor at the UH Cullen College of Engineering, was among seven professors to be awarded the 2019 Outstanding Young Alumni Award from his alma mater, the College of Liberal Arts and Sciences at the University of Illinois.

*The LAS awards announcement described Henderson as a "**passionate educator** who has committed himself to increasing the number of underrepresented students obtaining degrees and pursuing careers in science, technology, engineering and mathematics."*

Henderson graduated in 2010 with a Ph.D. in chemical engineering and later served as a lecturer in the Department of Chemical and Biomolecular Engineering at Illinois. While there, he co-founded the St. Elmo Brady STEM Academy – an innovative after-school program aimed to introduce underrepresented minority boys in fourth- and fifth- grade to hands-on, inquiry-based STEM activities.

He joined the Cullen College in 2016 as an instructional assistant professor for the First Year Experience Program and expanded the St. Elmo Brady program to UH.

The UH St. Elmo Brady STEM Academy encompasses a partnership across disciplines and programs, allowing different skills, expertise and resources to work together for a common goal. It brings together the University of Houston's Cullen College of Engineering, the College of Education, the College of Natural Science and Mathematics, the Charter School and teachHouston, a program that prepares students to teach math and science.

Henderson is also director of the college's Program for Mastery in Engineering Studies or PROMES. The program was established at the University of Houston in 1974 for the recruitment, retention and academic development of Hispanic, African American and Native American students in the Cullen College of Engineering. Today PROMES is open to all students in the college, and its mission is to provide a positive learning environment that supportsthe needs of undergraduate students.

As part of PROMES, Henderson is pioneering engineering faculty-led study abroad experiences to far-flung places like Brazil and Ghana.

"There is significant research linking increased student success and retention to students who have a good support system and community, as well as diverse experiences such as learning abroad and undergraduate research," Henderson said. "I want to help provide as many opportunities to our students as possible."

Previously, PROMES garnered two consecutive awards from *INSIGHT Into Diversity*, the largest and oldest U.S.-based diversity and inclusion magazine and website in higher education. PROMES was recognized with a 2018 Inspiring Programs in STEM Award and Henderson was honored with a 2017 Inspiring Leader in STEM Award.

"Creating opportunities for our students to become successful and nurturing their success along the way is critical to the long-term outlook for our students, the Cullen College and the engineering ranks at-large," said **Joseph W. Tedesco**, Elizabeth D. Rockwell Dean of the Cullen College of Engineering. "Before we launch the next generation of great engineers, we foster their ability to learn, contribute and belong in our engineering community. These are lifelong skills they will take with them."

"I couldn't be prouder of Dr. Henderson for earning this tremendous and well-deserved honor," he added.

CULLEN COLLEGE RESEARCHERS A BIG PART OF EMBC 2019

BY RASHDA KHAN

Rose Faghih, assistant professor, and several other UH Cullen College of Engineering faculty and students were an integral part of the 2019 Engineering in Medicine and Biology Conference (EMBC) held in Berlin, Germany.

The yearly meeting, hosted by the Institute of Electrical and Electronics Engineers, is the premier global conference in biomedical engineering. It brings together industry and academic leaders as well as students who are interested in the role of engineering in medicine and biology. This year's theme was Biomedical Engineering Ranging From Wellness to Intensive Care.

"Although my training has all been in electrical engineering, I chose to perform research and apply my knowledge in the medical field to contribute to improving people's lives," Faghih said. "Every time I attend EMBC, I learn about different fascinating research in biomedical engineering around the globe. This is very inspiring and helps me shape new ideas and new research directions with the goal of making significant contributions to health care."

Faghih and Sabato Santaniello, assistant professor of biomedical engineering at the University of Connecticut, co-organized and co-chaired an invited session titled "Understanding the Link Between Brain Dynamics and Behavior." It featured three Cullen College speakers – **Jose Luis Contreras-Vidal, Joe Francis** and Faghih – in addition to speakers from the University of Connecticut, Johns Hopkins University and the University of Liège.

"We had over 80 attendants in our invited session and received exciting feedback from colleagues in the audience," Faghih said.

Faghih was also a featured leader at the "Lunch With Leaders," an event for students and young professionals at EMBC. In this role, she shared insights and advice about academia and career development.

Three Cullen College electrical engineering students, who are members of the UH Computational Medicine Lab (CML), also attended the conference.

The CML, led by Faghih, conducts research in the fields of biomedical and neural engineering with a particular emphasis on the design of different algorithms for the analysis of physiological signals. A major focus of the lab is to view the human body as a complex system whose disorders can be treated from a control-theoretic point of view.

The students are: **Dilranjan Wickramasuriya** and **Md. Rafiul Amin**, both pursuing Ph.D. degrees, as well as **Divesh Pednekar**, a master's student. Of these, Wickramsuriya and Amin attended the EMBC on a Cullen Graduate Fellowship Travel Grant – a competitive fellowship program that allows graduate students to showcase their research and scholarly work at conferences, meetings and exhibits – to attend EMBC in Berlin.

LAB MEMBERS PRESENTED 6 PAPERS

(five regular and one invited) at the 2019 EMBC. Below are samplings from the CML papers, which were based on research funded in part by the National Science Foundation:

*UH engineering professors **Jose Luis Contreras-Vidal**, **Joe Francis** and **Rose Faghih** and other featured speakers shared insights at the "Understanding the link between brain dynamics and behavior" invited session.*

DILRANJAN WICKRAMASURIYA, ROSE T. FAGHIH, "A CORTISOL-BASED ENERGY DECODER FOR INVESTIGATION OF FATIGUE IN HYPERCORTISOLISM."

Hormones play a crucial role in governing the body's internal environment. Cortisol, considered to be the body's main stress hormone, is one such example. Its primary task is to raise blood glucose levels in order to give the body more energy in response to external stressors. Disorders in cortisol secretion typically involve either too much or too little cortisol being secreted into the bloodstream.

Researchers at CML developed a method to extract an unobserved energy-state from the body based on simulated cortisol measurements. The method used the secretion timings of cortisol, and the upper and lower cortisol levels throughout the day to estimate energy. Data were simulated for a healthy subject and patients with Cushing's disease (a disorder with excess cortisol secretion) for estimating energy. The results showed almost random energy fluctuations throughout the day for the Cushing's patients, and provided insight into why these patients may experience daytime fatigue and nighttime sleep disturbances.

MD. RAFIUL AMIN, DILRANJAN WICKRAMASURIYA, ROSE T. FAGHIH, "WEARABLE-MACHINE INTERFACE ARCHITECTURES FOR MENTAL STRESS."

Mental stress causes variations to occur in the conductivity of the skin. These variations are caused by changes in the rate at which electrical impulses are sent to the nerves in the sweat glands. CML researchers developed a method to detect these electrical impulses to the sweat glands, and a second method to estimate stress from the rate at which they occur. Promising results were obtained on a publicly available dataset that examined the effect of different types of stress on various physiological signals. High stress was detected during cognitive tasks while low levels were detected during periods of relaxation.

DILRANJAN WICKRAMASURIYA, ROSE T. FAGHIH, "A NOVEL FILTER FOR TRACKING REAL-WORLD COGNITIVE STRESS USING MULTI-TIME-SCALE POINT PROCESS OBSERVATIONS."

Stress has been dubbed the "health epidemic of the 21st century" by the World Health Organization, and the workplace is one of the most stressful places for many people. In this project, CML researchers developed a method to estimate stress from skin conductance and electrocardiography (EKG) measurements.

The conductivity of the skin changes due to sweating. Sweat secretions primarily help maintain body temperature. However, tiny bursts of sweat are also released in response to psychologically arousing stimuli. The higher the arousal, the higher the rate at which these bursts of sweat are released. Heart rate speeds up with high levels of arousal as well. Both skin conductance and EKG can be converted to a series of binary observations (ones and zeroes) – skin conductance by identifying the locations of the bursts of sweat, and EKG by identifying the locations of the heartbeats.

By tracking the rates at which ones and zeroes occur in both sequences of binary data, it is possible to estimate a person's stress level. The results obtained by the researchers revealed that unfamiliarity with a task is

ROSE FAGHIH WITH HER STUDENTS AT THE 2019 EMBC IN GERMANY

one of the main causes of stress rather than distracting interruptions or time constraints.

MD. RAFIUL AMIN, ROSE T. FAGHIH, "TONIC AND PHASIC DECOMPOSITION OF SKIN CONDUCTANCE DATA: A GENERALIZED-CROSSVALIDATION-BASED BLOCK COORDINATE DESCENT APPROACH."

Variations in sweat secretions cause the conductivity of the skin to change. These changes in conductivity can easily be measured using electrodes placed on locations such as the palms or wrists.

A skin conductance signal comprises of two parts— a slow-varying baseline level known as the tonic component and a faster varying phasic component. The phasic component reflects changes in sweat secretions occurring as a result of psychological arousal.

This is partly due to the fact that sweat glands are innervated by nerves from the sympathetic branch of the nervous system, the branch that governs the body's "fight or flight" mechanism. Therefore, separating the phasic and tonic components in skin conductance signals is an important first step in automatically inferring emotions such as fear and stress from physiological data, Faghih said.

In this work, CML researchers developed an efficient algorithm to separate skin conductance into its constituent phasic and tonic parts.

HAMID FEKRI AZGOMI, DILRANJAN WICKRAMASURIYA, ROSE T. FAGHIH, "STATE-SPACE MODELING AND FUZZY FEEDBACK CONTROL OF COGNITIVE STRESS."

While many techniques exist for relieving stress, CML researchers sought to determine if it is possible to regulate stress by treating the brain and different physiological signal responses within a mathematical system-model framework.

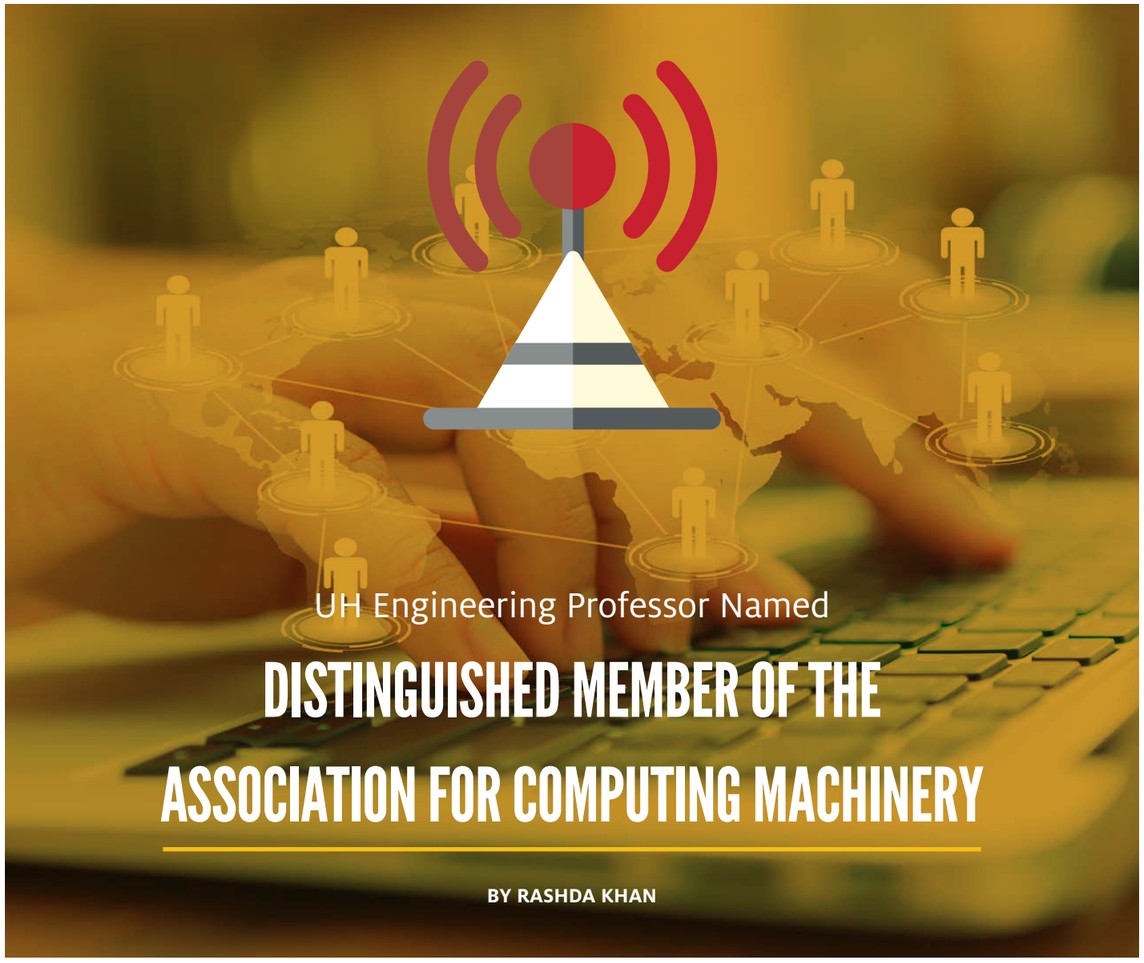
They developed a mathematical framework relating the brain's stress state to the rate at which tiny bursts of sweat are released by the skin. Promising preliminary results were obtained with simulated data both for decreasing stress and increasing stress. Future work in this area will involve exploring a realistic means of actuation such as music and light.

DIVESH DEEPAK PEDNEKAR, MD. RAFIUL AMIN, HAMID FEKRI AZGOMI, KIRSTIN ASCHBACHER, LESLIE J. CROFFORD, ROSE T. FAGHIH, "A SYSTEM THEORETIC INVESTIGATION OF CORTISOL DYSREGULATION IN FIBROMYALGIA PATIENTS WITH CHRONIC FATIGUE."

Fibromyalgia syndrome (FMS) affects approximately 150 million people worldwide. While the exact causes of FMS are currently not fully known, the condition is characterized using symptom-related guidelines, such as pain, fatigue, morning stiffness and a lack of sleep. This is inefficient as patients with chronic fatigue syndrome (a similar medical condition) also exhibit those symptoms.

In this work, CML researchers examined patterns in cortisol secretion in an attempt to characterize fibromyalgia. Results demonstrated a difference in cortisol secretion in the patients compared to healthy subjects. It is likely that these differences partly arise due to the inability of fibromyalgia patients to clear cortisol from their blood at the same rate that healthy subjects do, Faghih said.

"Our lab has been very productive and as a result we had a great showing at the conference," she added. "Colleagues from around the world were excited about our research and interested in collaborating with us."



UH Engineering Professor Named

DISTINGUISHED MEMBER OF THE ASSOCIATION FOR COMPUTING MACHINERY

BY RASHDA KHAN

Zhu Han, John and Rebecca Moores professor of electrical and computing engineering at the University of Houston, was named a 2019 distinguished member of the Association for Computing Machinery (ACM).

Renowned for his expertise in the field of computer science, Han was recognized by ACM for his outstanding scientific contributions to computing.

"Each year it is our honor to select a new class of Distinguished Members," said ACM President Cherri M. Pancake in a press release. "Our overarching goal is to build a community wherein computing professionals can grow professionally and, in turn, contribute to the field and the broader society.

Han joined the UH Cullen College of Engineering in 2008 and has gone on to earn a long list of accolades. He was named a fellow of the Institute for Electrical and Electronics Engineers (IEEE) in 2014 for his contributions to resource allocation and security in wireless communication; named IEEE Distinguished Lecturer in 2015; and received a National Science Foundation CAREER Award in 2009.

His research focus includes wireless resource allocation and management, wireless networking and communications, wireless multimedia, security and game theory.

All 62 of the 2019 ACM inductees are longstanding members of the organization and were selected by their peers for their significant accomplishments in the field of computing, computer science or information technology that have contributed to technologies that support how people live, work and play.

ACM is the world's largest educational and scientific computing society. It brings together computing educators, researchers and industry professionals to inspire dialogue and to share resources and challenges in the field.

UH Engineer Included Among

MEDICAL & BIOLOGICAL ENGINEERING ELITE

BY RASHDA KHAN

The American Institute of Medical and Biological Engineering (AIMBE) elected **Kirill Larin**, professor of biomedical engineering at the UH Cullen College of Engineering, to its prestigious College of Fellows.

Election to the AIMBE College of Fellows is among the highest professional distinctions accorded to an engineer working in the medical and biological engineering fields. AIMBE fellows comprise the top 2% of medical and biological engineers who have made "impactful contributions to biomedical engineering, research and innovation."

"As AIMBE's review and election process has become more rigorous, increasing numbers of very strong candidates are being nominated. It is a credit to the remarkable accomplishments of your candidate that they advanced from the specialty review subcommittee and received sufficient affirmative votes to be elected," wrote Milan Yager, executive director of AIMBE in his notification letter.

Larin's research interests include optics, diagnostic imaging, biosensing, microscopy and classification of tissues. He is best known for his contributions in biomedical optics and biophotonics and development and application of various optical methods for noninvasive and nondestructive imaging and diagnostics of tissues and cells.

He has used high-resolution optical coherence tomography (OCT) to study developmental biology as well as the heart's scar tissue to determine if the organ is responding to therapies.

"I find it very rewarding when an idea transforms into a useful technique or process that addresses specific biological questions or needs," Larin said. "This AIMBE recognition of my life's work is a great honor."

His previous accolades include the Yeltsin Presidential Award for Young Scientists, Wallace Coulter Young Investigator Translation Award, Office of Naval Research Young Investigator Award, Outstanding Young Investigator Award from the Houston Society for Engineers in Medicine and Biology, and the Herbert Allen Award from the American Society for Mechanical Engineers. He is also a fellow of SPIE (the international society for optics and photonics) and the Optical Society (OSA).

Larin earned a bachelor's degree in physics and a master's degree in laser physics and mathematics from Saratov State University in Russia. He also earned a master's degree in cellular physiology and molecular biophysics as well as a Ph.D. in biomedical sciences and biomedical engineering from the University of Texas Medical Branch in Galveston.

A formal induction ceremony took place for Larin and other members of the 2020 class of fellows at the AIMBE Annual Event in March 2020 at the National Academy of Sciences in Washington, D.C.

AIMBE is a non-profit, honorific society of the most accomplished individuals in the medical and biological engineering fields. Its mission is to advocate for biomedical engineering innovation through public policy initiatives.

UH ENGINEER ZHU HAN

Elected as AAAS Fellow

BY JEANNIE KEVER

An engineering professor from the University of Houston has been elected to the American Association for the Advancement of Science, joining a select group of researchers recognized by their peers as among the best in their fields.

Zhu Han, John and Rebecca Moores professor of electrical and computer engineering in the UH Cullen College of Engineering, is an expert in game theory, wireless networking and communications and big data.

AAAS is the world's largest general scientific society. Each year it elects members whose "efforts on behalf of the advancement of science or its applications are scientifically or socially distinguished."

Han was elected to the AAAS section on information, computing and communication for "distinguished contributions to the field of game theory, particularly by modeling analysis and algorithm design of new applications in communication networks."

"Dr. Han is a leader in game theory and wireless networks, and this recognition is richly deserved," said **Joseph W. Tedesco**, Elizabeth D. Rockwell Dean of the UH Cullen College of Engineering. "As the amount of data generated globally continues to grow exponentially, his work will help to ensure that engineers and society at large are able to benefit from the information being produced."

> *"Dr. Han is a leader in game theory and wireless networks, and this recognition is richly deserved."*
> - JOSEPH W. TEDESCO, ELIZABETH D. ROCKWELL DEAN

Han and the other new fellows were recognized at the association's annual meeting in Seattle. A candidate must be nominated by the steering group of the association's 24 sections or by three current AAAS fellows, or by the AAAS chief executive officer. Each steering group reviews nominations within its section, and a final list is forwarded to the AAAS Council, the policy-making body of the association, which votes on the list.

Last year Han was named a distinguished member of the Association for Computing Machinery. He has been included on the Clarivate Analytics list of highly cited researchers each year since 2017 and was named a fellow of the Institute for Electrical and Electronics Engineers (IEEE) in 2014.

His latest book, "Game Theory for Next-Generation Wireless and Communications Networks," was published last year by the prestigious Cambridge University Press.

Much of Han's earlier work involved the smart electric grid and machine learning, but he increasingly is focused on the application of game theory to engineering problems involving the use of massive amounts of data. "As more data is collected, you need new ways to handle it," he said.

While game theory originated in the social sciences, looking at mathematical models of negotiation, conflict and cooperation between people, organizations and governments, the issues that arise in engineering and computer networking are different, Han said.

"It must be revised to apply to the problems that engineers work with," he said.

Remembering UH Alumna and

LONGTIME EDUCATOR BETTY BARR

BY RASHDA KHAN

Betty J. Barr, University of Houston alumna and beloved longtime educator at the UH Cullen College of Engineering, died Nov. 1, 2019. She was 74.

Barr was a lifelong Cougar, earning her B.S., M.S. and Ph.D. degrees in mathematics from UH in 1967, 1969 and 1971, respectively. She joined the Cullen College in 1971 as a linear algebra instructor in the Department of Industrial Engineering, becoming one of the first female faculty at the college.

As a pioneer, Barr charted a career for herself and served as a mentor to other women who decided to pursue engineering.

"There was no women's bathroom in the building," she recalled in a previous article, noting that there were hideaway facilities for administrative staff. "We had to lobby to take one of the men's restrooms for ourselves." And she did.

Barr later moved to the Department of Electrical and Computer Engineering, where she helped build and modify the undergraduate curriculum. She also taught a large number of courses and advised generations of Cougar engineers during her 30-year tenure as the department's primary undergraduate advisor.

She was promoted to associate professor and named associate chair of the department in 2003.

"I enjoy working with students. I am a teacher," Barr shared in a previous article. "There's such joy at graduation, watching the students start as freshmen, struggle through and finally make it."

"Dr. Barr epitomized dedication to students, and her office...was chock full of files, with barely space for her desk. She was also a massive storehouse of departmental operational knowledge, and much of it was in her brain."

- BADRI ROYSAM, ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT CHAIRMAN

During her tenure at UH, Barr earned numerous awards for teaching and her commitment to students. She received a Teaching Excellence Award from the University in 2011, the George Magner Academic Advising Award in 1993 and was the first recipient of the of the University's Provost Faculty Advising Award in 2007. The Cullen College presented her with the Career Teaching Award twice.

In addition, she was honored by the Institute for Electrical and Electronics Engineers (IEEE) Region IV with an Outstanding Educator Award and by the UH Engineering Alumni Association with the Abraham Dukler Distinguished Engineering Faculty Award in 2005. UH engineering student organizations also recognized her with an Outstanding Faculty Advisor Award in 1993.

Over the years, she also served as the faculty advisor for the Society of Women Engineers and the Texas Epsilon Chapter of Tau Beta Pi. She also designed mathematical problems for her peers to solve in the slide rule competition at the annual IEEE Chili Cook Off.

"Dr. Barr epitomized dedication to students, and her office...was chock full of files, with barely space for her desk. She was also a massive storehouse of departmental operational knowledge, and much of it was in her brain," said **Badri Roysam**, Hugh and Lillie Cranz Cullen University professor and electrical and computer engineering department chairman. "I don't know what we're going to do without Betty Barr," Roysam said when Barr wrapped up her 40-year career by retiring in 2011.

"Our faculty, staff and students are deeply saddened by this news," said **Joseph W. Tedesco**, Elizabeth D. Rockwell Dean of the Cullen College. "We were blessed to have her share her extensive knowledge, unfailing dedication and expertise with our community. Our hearts go out to her family and loved ones at this very difficult time."

The UH Alumni Association flew the flag in front of the Alumni Center, 3204 Cullen Blvd., at half-staff from Friday, Nov. 8, to Monday, Nov. 11, in honor of Barr, who was a UHAA Life Member.

JEFFREY RIMER HONORED FOR

Work in Crystal Engineering

BY JEANNIE KEVER

An engineer from the University of Houston has received the state's top honor in engineering for his pioneering discoveries about how crystals form and how they can be dissolved.

Jeffrey Rimer, Abraham E. Dukler professor of chemical engineering at the UH Cullen College of Engineering, has received the 2020 Edith and Peter O'Donnell Award in Engineering from The Academy of Medicine, Engineering and Science of Texas, known as TAMEST.

Rimer was cited for his pioneering work in using crystals to improve treatments for malaria and kidney stones. This is just one outcome of his efforts to better understand the process of crystallization, which also is central to drug development, petrochemical processing, the design of new materials and other processes.

He likens the field of crystal engineering to solving a puzzle. "A lot of these systems are complex," he said. "There are a lot of ways that crystals grow, so we have to be creative in how we approach it. You never fully solve the puzzle, but you can fill in enough pieces to see the overall picture."

The O'Donnell Awards were established in 2005 to recognize Texas' most promising researchers, whose work is judged by professional performance, creativity and resourcefulness. They were formally presented Jan. 8 at the TAMEST 2020 conference in Dallas.

"Dr. Rimer is an internationally recognized expert in crystal engineering whose frontier research has produced drugs for treating kidney stones and malaria as well as uncovered chemical techniques in the petrochemical industry," said TAMEST Board President Amelie Ramirez.

Rimer reported in 2016 that a natural fruit extract can dissolve the most common component of human kidney stones, suggesting a major advance in drug development. Human clinical trials are underway and research to find new drug candidates ongoing.

He and collaborators more recently have discovered what happens at the molecular level when antimalarial drugs are combined, work which not only suggested the mechanisms by which the drugs interact but, more broadly, suggests a new platform that can more quickly screen molecules for their potential in drug development.

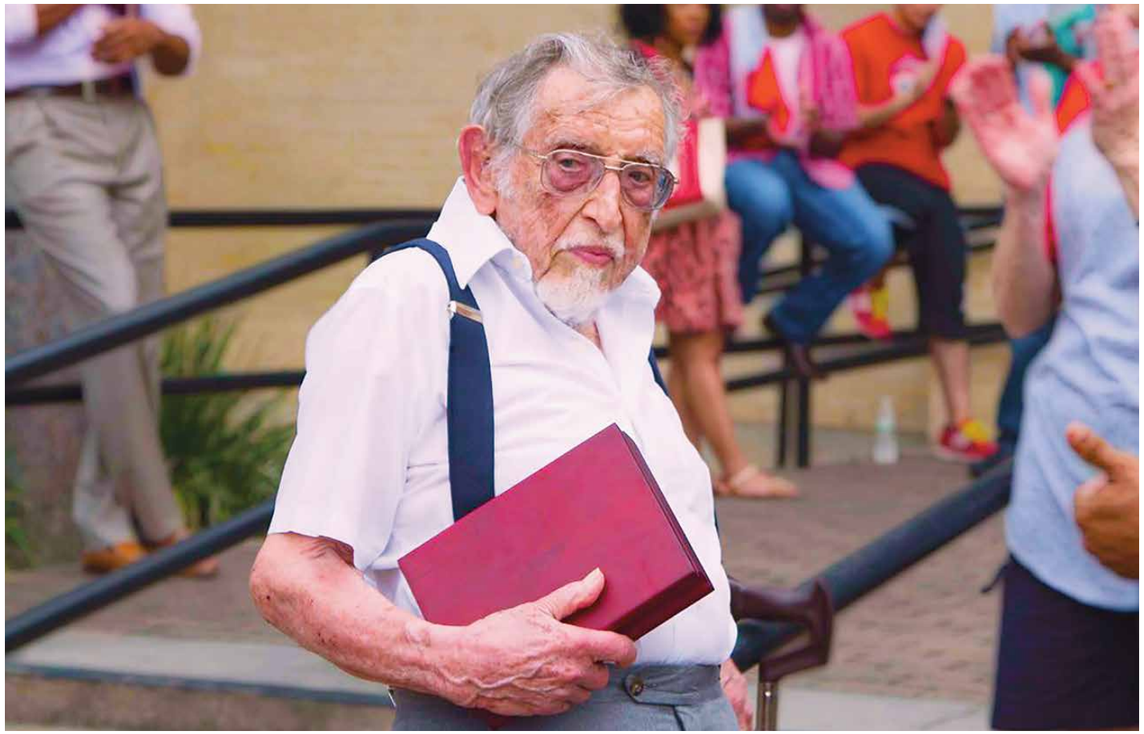
Joseph W. Tedesco, Elizabeth D. Rockwell Dean of the UH Cullen College of Engineering, said Rimer's work is an illustration of the creativity required for breakthroughs in engineering.

"Dr. Rimer's work in crystal engineering, whether it is applied to the discovery of new drugs or to improve the efficiency and safety of petrochemical processes, has pushed the envelope in terms of what we know about crystal formation and dissolution," he said. "He is answering fundamental engineering questions but finding very real solutions to modern problems."

Rimer received the 2018 Norman Hackerman Award in Chemical Research, given by the Welch Foundation to chemical scientists working in Texas and designed to encourage the fundamental understanding of chemistry. He also received the 2016 Owens Corning Early Career Award and 2017 FRI/John G. Kunesh Award from the American Institute of Chemical Engineers, as well as multiple teaching and research excellence awards from UH.

His research is recognized for its focus at the nexus of fundamental and applied science.

"We're right at the boundary," he said. "Often when you do fundamental work, it never sees the light of day, and that's fine, because your discoveries can move the field forward. But when that work can be translated into a new drug, you realize what you do can have a benefit to society. It is a very humbling feeling."



UH Engineering Mourns Loss of

GERHARD F. PASKUSZ, PROMES FOUNDER AND ACADEMIC VISIONARY

BY RASHDA KHAN

Gerhard "Gerry" F. Paskusz, professor emeritus of electrical engineering at the University of Houston Cullen College of Engineering and founder of its award-winning Program for Mastery in Engineering Studies (PROMES), died Nov. 23, 2019, in California. He was 97.

"Dr. Paskusz transformed engineering education at the UH Cullen College and helped shape continuing generations of successful engineers," said **Joseph W. Tedesco**, Elizabeth D. Rockwell Dean of the Cullen College. "We were blessed to have him as part of our community. Our hearts go out to his family and loved ones at this very difficult time."

The author of several books and articles on electrical engineering education, minority education programs and teaching innovations, Paskusz was born Jan. 21, 1922, in Austria. He earned his bachelor's degree in engineering in 1949 and his Ph.D. in engineering in 1961 from the University of California, Los Angeles.

After teaching at UCLA while getting his doctorate, he joined the University of Houston faculty in 1961 as an associate professor. He was promoted to professor in 1968 and served as associate dean for undergraduate studies from 1968 to 1976.

A legacy of a lifetime

Before turning his focus to undergraduate studies, Paskusz played a key role in building and launching the graduate programs in the Department of Electrical Engineering, which was later renamed the Department of Electrical and Computer Engineering (ECE).

He built the university's first ruby laser, a solid-state laser using a synthetic ruby crystal as its laser medium.

*In addition, Paskusz **helped pioneer a team-based approach** in teaching that places the student in the roll of the teacher, a method that has been shown to boost grades and graduation rates for students.*

"It's almost axiomatic that students can communicate with their peers better than the instructor can," Paskusz said in a 2003 interview.

The state-funded "Redshirt Camp" program currently used by ECE to help boost passing rates for difficult sophomore-level courses is based on Paskusz's methods.

"We wanted to make sure the students were working together, helping each other and competing with each other. That, from the very beginning, has been our aim."

- GERHARD F. PASKUSZ

The birth of PROMES

He established PROMES – pronounced "promise" – in 1974 for the recruitment, retention and academic development of Hispanic, African American and Native American engineering students.

Paskusz credited a speech by Reginald H. Jones, who led General Electric from 1972 to 1981 and advised three U.S. presidents on economic policy, for the impetus. In that speech, Jones said that if America wanted to improve the economic future for minority students, getting them into engineering was key.

PROMES, which was originally known as the Program for Minority Engineering Students, started with eight students and a $5,000 grant from Dupont.

"We got to know them [the students], they got to know us, they got to know each other," said Paskusz in a 2002 interview. "We wanted to make sure the students were working together, helping each other and competing with each other. That, from the very beginning, has been our aim."

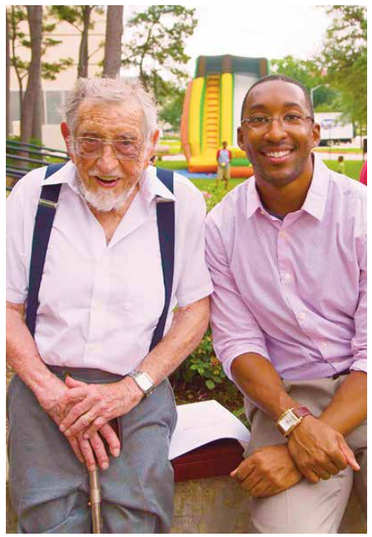
Paskusz, who served as the first director, retired from the program in August 2005 after 31 years.

Today PROMES is open to all students in the college, and its mission is to provide a positive learning environment that supports the needs of undergraduate engineering students. It supports student success through academic advising, workshops, scholarships, community and other professional and personal development opportunities. About 5,000 students have come through PROMES since fall 1998, and there are currently 415 PROMES scholars enrolled.

The program won two consecutive awards from *INSIGHT Into Diversity*, the largest and oldest U.S.-based diversity and inclusion magazine and website in higher education. It received a 2018 Inspiring Programs in STEM Award and **Jerrod Henderson**, the current director of PROMES, was honored with a 2017 Inspiring Leader in STEM Award. The UH System Board of Regents also recognized PROMES with the Regents' Academic Excellence Award in 2018.

Paskusz garnered several accolades for his work. He was elected as a fellow of the American Society for Engineering Education (ASEE) in 2003 and received the Dupont Minorities in Engineering Award from the organization in 2007.

"The PROMES community – staff, advisory board, and PROMES Scholars, those who met Dr. Paskusz and those who have not – mourns the loss of such a giant in higher education," said Henderson. "As we chart the course for diversity, inclusion, recruitment and retention, Dr. Paskusz's legacy of being a trailblazer lives on in PROMES. We are inspired by his life and seek to continue to build upon the foundation that he established."



UH Engineering Student Wins

PRESTIGIOUS DEPARTMENT OF DEFENSE GRADUATE FELLOWSHIP

BY RASHDA KHAN

*University of Houston doctoral student **Adesola Saba** won a highly competitive 2019 National Defense Science and Engineering Graduate (NDSEG) Fellowship. Saba is pursuing a Ph.D. in chemical and biomolecular engineering at the UH Cullen College of Engineering.* »»

He is the second NDSEG fellow in the history of UH. The 2018 winner was Andrea Albright, a doctoral student in the Cullen College's geosensing systems engineering and sciences program.

The fellowship, which is the highest honor awarded to graduate students by the U.S. Department of Defense, covers full tuition, research expenses and mandatory fees for three years. Fellows receive a monthly stipend of $3,200, up to $1,200 annually for health insurance coverage, and up to two all-expense paid trips – based on the government travel policy – per year for training and/or conferences that support their educational initiatives.

"Sola, without a doubt, is one of my top Ph.D. students and highly deserving of this prestigious award," said **Mehmet Orman**, assistant professor of chemical and biomolecular engineering. "He is extremely smart, hard-working, determined and has shown superior performance in his research."

The research

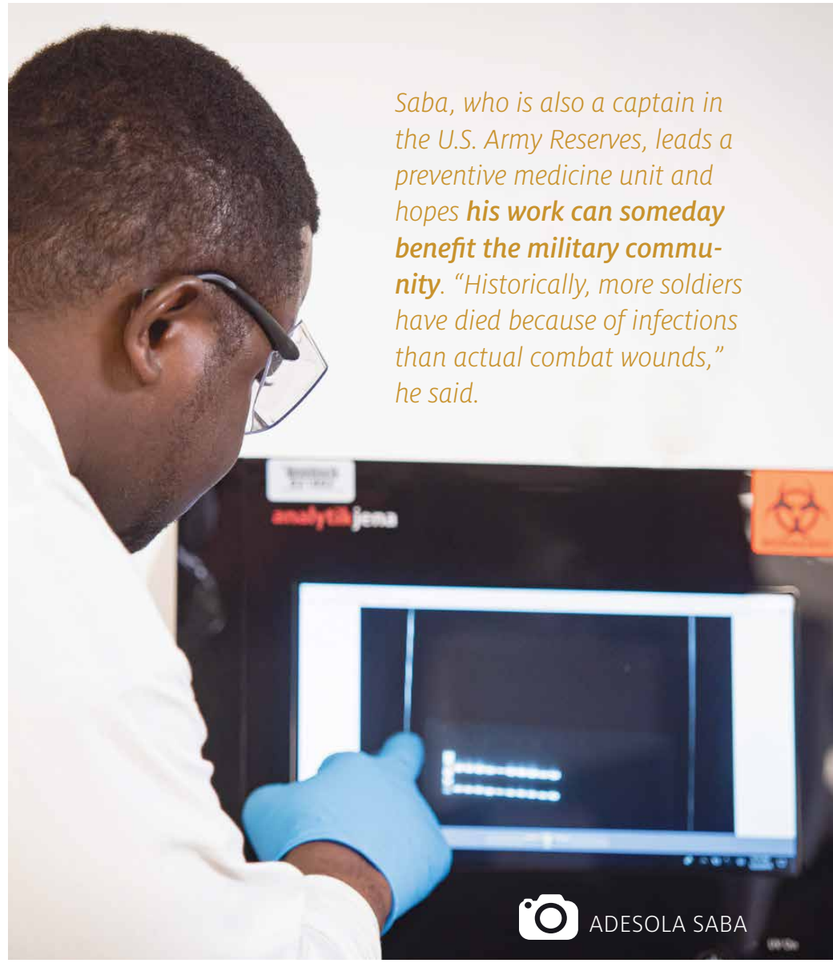
Saba's research uses metabolomics and several genetic engineering tools to investigate why certain bacterial cells play dead when treated with antibiotics, and later wake up when conditions are more favorable. This phenomenon is known as persistence.

"The economic burden of persistence is undeniable, not to mention the countless lives lost to persistence-related infection," said Saba, whose interest include bacterial persistence, omics and genetic engineering. He is a member of the Orman Lab at UH.

"I go inside the E. coli DNA and turn off their genes one by one, all 4,000 of them, until I find the ones that control their ability to play dead," he said.

Why it matters

Persistence is one of the reasons why bacterial infections such as cystic fibriosis, tuberculosis and urinary tract infection are difficult to treat. "E. coli, for instance, doubles every 22 minutes. So let's say you took this amazing antibiotic that killed 99.999% of the bacteria. If even one cell survives the drug treatment, just wait 22 minutes and now you have two, then four, eight, sixteen, and so on," Saba said. "After 12 hours, there is literally a billion of them, so you are right back where you started."



ADESOLA SABA

*Saba, who is also a captain in the U.S. Army Reserves, leads a preventive medicine unit and hopes **his work can someday benefit the military community**. "Historically, more soldiers have died because of infections than actual combat wounds," he said.*

What's next?

The Orman Lab members have identified some new genes responsible for persistence and are working to find more. In the near future, they hope to establish collaborative partnerships with Houston's medical community and the Texas Medical Center.

For right now, Saba is thrilled about winning the fellowship. "A large number of the awards this year went to students from places like MIT, Harvard and Stanford, so I feel very honored and excited to get one for UH," Saba said. "Obviously this would not be possible without the mentorship I got from Dr. Orman, **Dr. (Muayyad) Al-Ubaidi** at UH and Colonel Gabriel."

Begun in 1989, NDSEG has awarded nearly 3,600 fellowships to U.S. citizens and nationals who pursue a doctoral degree in one of 15 supported disciplines at a U.S. institution. The NDSEG fellowship is sponsored by the Air Force Office of Scientific Research, the Army Research Office, and the Office of Naval Research under the Office of the Assistant Secretary of Defense for Research and Engineering.

Cullen College Students Shine in

UH GRADUATE RESEARCH SHOWCASE

BY RASHDA KHAN

DALIA LEZZAR AND MADELEINE LU

Graduate students representing the UH Cullen College of Engineering shone bright in the university-wide Graduate Research Showcase hosted Nov. 1, 2019 by the UH Graduate School and the Office of the Provost. Students pursuing master's degrees and Ph.D.s across all disciplines ***exhibited their research projects, networked with peers and competed to receive awards and scholarships*** *for their work.*

"The Graduate Research Showcase provides students with a valuable opportunity to present their research and to hone their communication skills," said **Sarah C. Larsen**, vice provost and dean of the University of Houston Graduate School. "It is so impressive to see the breadth of exciting research being conducted by UH graduate students."

Sharing research accomplishments serves as inspiration for more. "Students have commented that they benefit not only from presenting their research but from hearing about other student's research projects," Larsen added.

Several of the top prizes went to engineering graduate students and the Cullen College's Department of Biomedical Engineering had an especially good showing.

3MT awards

In the Three Minute Thesis (3MT) competition, **Dalia Lezzar** won first place and $1,000 with her presentation titled "Out with Bad Cells, in With the Good;" and **Madeleine Lu** tied for third place with a student from the School of Social Work and won $500 with her entry titled "Tools for Sticky Situations: Developing Tools for Monitoring Patients with Blood Disorders."

Both Lezzar and Lu are pursuing their Ph.D.s in biomedical engineering and work in the UH Blood Microfluidics Laboratory. Their advisor is **Sergey Shevkoplyas**, professor of biomedical engineering.

In addition, **Musa Ozturk** and **Faheem Ershad**, both doctoral candidates in biomedical engineering, as well as **Adesola Saba**, a doctoral candidate in chemical engineering, each won $250 as finalists.

The 3MT is a competition where graduate students try to condense their thesis into an engaging three-minute presentation.

Poster session awards

In the Poster session, **Justin Brantley** took the $1000 top prize, **Faheem Ershad** won second place and $750 and **Dilranjan Wickramsuriya** won $250 as a finalist.

Both Brantley and Wickramsuriya are pursuing Ph.D.s in electrical and computer engineering.

Brantley presented a poster titled "A Neural-Machine Interface for Control a Lower Limb Prosthesis." The poster presented his research where neural information from the brain (measured by electroencephalography or EEG) and muscles (measured using electromyography or EMG) are fused together to create a multimodal neural-machine interface that allows users to actively control a powered lower limb prosthesis. He works with Jose **Luis Contreras-Vidal**, Cullen Disinguished professor of electrical and computer engineering and one of the world's leading researchers in the field of noninvasive brain-machine interfaces.

The researchers used non-invasive mobile brain-body imaging to understand the brand, muscles and joint kinematics of able-bodied individuals and that of amputees collected during unconstrained walking on various terrains. They used this information to understand if and how the representation of the lower limb in the brain is changed after the loss of a limb. These findings are being used to develop a framework for controlling an artificial lower limp using brain and muscle signaling.

Ershad's poster, titled "Drawn electronic Tattoos: A Simple and Customizable Platform for Improved Medical Sensing and Treatment," was focused on an innovative new technological development – a wearable sensor in the form of a temporary electronic tattoo that can be used to detect biological signals, such as heart activity, temperature and/or sweating. He works with **Cunjiang Yu**, Bill D. Cook associate professor of mechanical engineering.

The technology has a potential to be very useful in low-resource areas, such as a battlefield or disaster zone. The researchers' experiments indicated that customizing these electronic tattoos – which are directly drawn on skin – to the size of a wound and applying electrical stimulation through them could lead to a faster rate of healing.

"This highlights the excellent work being done by the Cullen College of Engineering graduate students in terms of their own research, and the research mission of the college and the University," said **Joseph W. Tedesco**, Elizabeth D. Rockwell Dean of the Cullen College. "I'm justifiably very proud of our students."

NAOMI NUBEN, FAHEEM ERSHED, AND JUSTIN BRANTLEY

Outstanding Junior

BENJAMIN DIAZ VILLA

For Benjamin Diaz Villa, the decision to study engineering was a no-brainer. Born in Colombia, Diaz Villa moved to the United States with his family as a child. Not yet fluent in English, he was immediately drawn to math and science since both are universal languages.

As a teenager, Diaz Villa attended the Michael E. DeBakey High School for Health Professions, which is a Houston Independent School District total magnet school. His studies there affirmed his interests in engineering, and Diaz Villa joined the UH mechanical engineering department in 2017 as a freshman.

Since that time, Diaz Villa has interned at Technip FMC, worked as a research assistant in Dr. Ralph Metcalfe's computational fluid dynamics lab, and received numerous scholarships and awards, including an award for being an Outstanding Honors First-Year Student in 2018.

As for what comes next, Diaz Villa already has that figured out. He is making plans to pursue a Ph.D. in aerospace engineering after he graduates.

Diaz Villa attributes his success to the support of his family, along with being well-rounded. He remarked that being involved in activities outside of his academics actually helped him with budgeting his time.

"If you only have your classes and nothing else, you'll find that you are wasting so much of your free time on pointless things like playing on your phone or watching TV. But if you are involved in things outside of school, be it your church, a service project, or sports, you will feel more inclined to allocate your resources better and dedicate a certain amount of time for your studies," he said. But Diaz Villa cautions not to overdo it, remarking that work-life balance is very important.

In his spare time, Diaz Villa is very active in his church and participates in the musical ensemble, named M4Es (Music for Engineers) at the college. The group gives a public performance on campus at the end of each semester.

Diaz Villa also credits the support he has received from his professors. "The professors here are very open about what they do, their research, their industry connections. It makes being a student here a great experience."

Outstanding Senior

LAURA MALCOTTI-SANCHEZ

Being an outstanding student is familiar territory for Laura Malcotti-Sanchez. She was named the Outstanding Junior in 2019, and for good reason. She has an impressive list of accomplishments from her time at the Cullen College, ranging from interning at Hewlett Packard Enterprise (HPE) to serving as a mentor in both the American Society of Mechanical Engineers and the Society of Women Engineers (SWE) Pros Mentorship programs.

Malcotti-Sanchez describes her internship at HPE as a turning point in her academic career. Initially unsure of what role a mechanical engineer would play at HPE, the experience introduced her to the field of thermal engineering. "It turned out there was this huge world that I didn't even know about that's dedicated to keeping computers cool and from overheating. It's a huge challenge," she explained. "After I finish my bachelor's, I'm going to enter the accelerated master's program here with a focus on thermal engineering. That's where my passion is at right now."

In addition, Malcotti-Sanchez was selected to be the recipient of the Cynthia Oliver Coleman P.E. ('71) Rising Star Award. Malcotti-Sanchez received the award at the Women in Engineering Celebration. The opportunity to meet Coleman, for whom the award is named, was an exciting experience. Coleman, who is an active supporter and alumna of the Cullen College, serves as a sponsor of the SWE Mentorship program. "She's an inspiration. It's really great when alumni come to the college and give back."

When reflecting on her time at UH, Malcotti-Sanchez feels that the positive environment is what stands out from her experiences. "I originally chose to come to UH Engineering because I had this overwhelming feeling that everyone here genuinely wants you to be successful. I wanted to be in an environment like that."

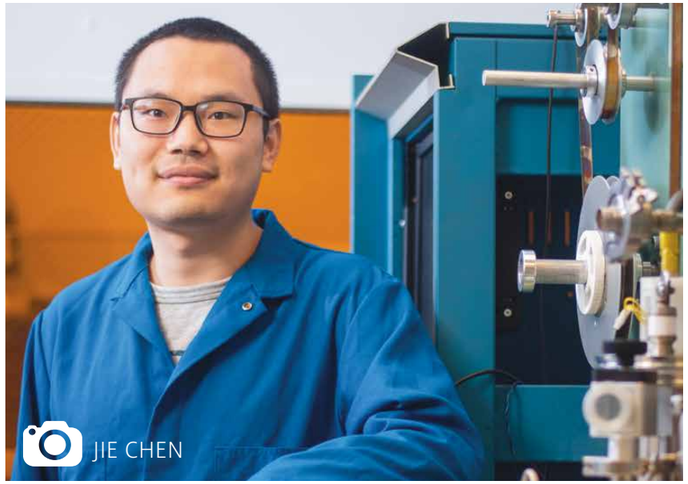
According to Malcotti-Sanchez, the support she has received from her professors has also been a huge perk. "The professors here are so compassionate, and they go out of their way to make sure you are successful," she explained. "The professors are hands down the best part of being a student here because they care. And that makes a huge difference."

When asked if she had any advice to give to other students, Malcotti-Sanchez had some wise words to share. "Pursue knowledge not for the sake of getting an 'A', but for the purpose of being a good engineer. Right now, there is no consequence if you mess up or do something wrong, so this is the time to try things and learn."

FLEXIBLE

PULSE SENSORS

BY RASHDA KHAN


JIE CHEN

Wearable electronics – from smartwatches to fitness trackers – are experiencing rapid growth in recent years. New technological advances are prioritizing even more health-related functionality, such as using wearable devices for non-invasive tracking of vital signs with the aim of preventing common health problems. Designed to be worn close to the human body, at times even attached to the skin, these devices need to be flexible.

Jie Chen, a doctoral candidate in materials science and engineering at the UH Cullen College of Engineering and the Ryou Group recently developed a flexible biocompatible pulse sensor, which could help diagnose cardiovascular diseases.

According to the World Health Organization, cardiovascular diseases are the leading cause of death for men and women around the globe. An estimated 17.9 million people died from cardiovascular diseases in 2016. Of these, 85 percent were attributable to heart attacks and strokes.

The good news is that most cardiovascular diseases can be prevented or managed by addressing risk factors like tobacco use, bad diets, alcohol intake and physical inactivity.

*"I found myself wondering if there is a **simple way to help detect cardiovascular health on a daily basis** so that patients can pay attention and receive timely therapy," Chen said. "This research could vastly improve the quality of life and the health of human beings."*

Chen recently discussed the team's research findings in an article titled "High Durable, Biocompatible, and Flexible Piezoelectric Pulse Sensor using Single-Crystalline III-N Thin Film." It was published in the prestigious journal *Advanced Functional Materials* as a featured back cover article.

The team is focusing on flexible pulse sensors that can detect subtle skin surface deformation caused by arterial pulses – specifically piezoelectric pulse sensors. The piezoelectric sensors offer to be a promising option with their relatively high sensitivity and stability as well as low power consumption, when compared with conventional active pulse sensors.

However, the reported high performance PPSs contain toxic lead, which is of concern and limits their practical applications.

"Group III-nitride thin film-based piezoelectric generator developed in our research overcomes most of these drawbacks and could make the self-powered electronics one step closer to reality," Chen said.

In this study, a highly sensitive and flexible PPS that detects surface deflections on the micrometer scale is fabricated with single-crystalline group III-nitride thin film. This biocompatible flexible PPS is sensitive enough to detect pulse waveform with detailed characteristic peaks from most arterial pulse sites when attached to the skin surface without applying external pressure. Useful physiological parameters such as the pulse rate, artery augmentation index and pulse wave velocity can be drawn from the as-acquired pulse waveforms. It can also be used to continuously monitor the arterial pulse waveform.

Chen is the lead author on the article. **Jae-Hyun Ryou**, associate professor of mechanical engineering, team leader of the Ryou Group and Chen's faculty advisor, is the corresponding author. Other UH co-authors include **Noor Nabulsi**, a UH mechanical engineering senior and an undergraduate research assistant, and **Weijie Wang**, a UH doctoral candidate in mechanical engineering.

Non-UH co-authors on the paper are: Haoran Liu with the Houston Methodist Research Institute; Wenbo Zhao with the Capital Medical University in Beijing, China; Ja Yeon Kim with the Korea Photonics Technology Institute; and Min-Ki Kwon with the Chosun University in South Korea.

RECORD NUMBER OF STUDENTS ATTEND

Forbes UNDER 30 SUMMIT

BY RASHDA KHAN

***Seven Cullen College of Engineering students** joined other technology and business students from the U.S. and Canada as scholarship winners of the **2019 Forbes Under 30 Summit**.*

In support of the summit's focus on diversity and inclusion, Forbes Under 30 scholars were chosen among students of underrepresented backgrounds. As scholarship winners, they enjoyed full access to the high-profile annual event, which drew 9,272 young attendees to Detroit from Oct 27-31.

The summit's website promised to "future captains of technology, entrepreneur, finances, fashion, food and philanthropy" a chance to learn during "a life-changing four days of connecting, learning, teaching and building." The annual event brought together A-list speakers, investor speed-pitches, an Opportunities Hub recruitment fair – and a legendary pub crawl. Tennis great Serena Williams was among popular speakers at the event. In addition to being one of the world's greatest athletes, she also is CEO of Serena Ventures, which comprises her fashion and venture capitalist interests.

Artificial intelligence expert Tomas Pfister was another featured speaker. He is now head of research for Google Cloud AI and previously was co-founder of Apple's central research group for Artificial Intelligence. Also among the impressive list of speakers was automotive engineer Keysha Camps, the program manager for General Motors Autonomous Vehicle Group.

MEET THE CULLEN COLLEGE'S 2019 FORBES SCHOLARS:

RUKAIYA BATLIWALA

Mechanical engineering junior Rukaiya Batliwala is a provost undergraduate research fellow at the UH Center for Neuro-Engineering and Cognitive Science, where she assists in research to identify correlations between human eye movement and information processing by the brain. As an undergraduate teaching assistant, she helps engineering students learn MATLAB, Python and other programming languages. She has a Lean Six Sigma white belt certification.

Batliwala is the projects chairwoman with the UH chapter of e-NABLE, a global community of volunteers who use 3D printers to make free and low-cost upper-limb prosthetic devices for children and adults. She serves as an ambassador for the UH Program for Mastery in Engineering Studies (PROMES). And she was the outreach chairwoman for the UH student chapter of the American Society of Mechanical Engineers (ASME).

MARCO ESPINOSA

Mechanical engineering senior Marco Espinosa supplements his education with plenty of work experience. He served as a data engineering intern with Proctor & Gamble, a mechanical engineering intern with Covestro LLC, and a structural engineering research intern with the Thomas T.C. Hsu Laboratory at UH. Through a co-op program, Espinosa also worked at ExxonMobil as a fixed equipment engineer.

He is also very active on campus. Espinosa is the founder and director of Enabling Entrepreneurship in Engineering (E3), which encourages entrepreneurship among members of engineering honor society Tau Beta Pi, of which he is chapter president.

Espinosa earned certification in the Economics for Managers program when he attended the Summer Venture in Management Program at Harvard Business School.

TAHA SHAFQUAT

Mechanical engineering master's student Taha Shafquat (BSME '18) is a teaching assistant at the college.

He worked as an engineering intern at SNM2R, a woman-owned civil and environmental engineering consulting firm providing sustainable and responsive engineering solutions. In 2016, he won a summer undergraduate research fellowship and participated in research about ferrofluids (liquids that become strongly magnetized in the presence of a magnetic field).

He is involved with Tau Beta Pi, American Society of Mechanical Engineers, Society of Asian Scientists and Engineers, National Society of Collegiate Scholars and the National Society of Black Engineers.

BRANDON SANTOS

Mechanical engineering senior Brandon Santos is a first generation college student from the Pacific Islands. He is a drilling and completions intern with ExxonMobil's upstream integrated solutions unit.

Previously, Santos worked as a drilling and completions intern with Chevron, a service engineering intern in heavy base maintenance with United Airlines, and in various intern positions with TechnipFMC.

He is active with the Society of Hispanic Professional Engineers (SHPE) at UH and served as a workshop assistant facilitator with PROMES. He has met all requirements for the UH Global Citizens Credential and will graduate with the certification this year.

RONY HERNANDEZ

Chemical engineering senior Rony Hernandez has a long list of internships. He served as a process control technology intern and a process engineering intern at Covestro during two different stints and as a product development engineering intern at ExxonMobil Chemical. He also worked as a chemical processes workshop assistant facilitator and as a research assistant at UH.

He is also the communications chairman for UH chapter of the engineering honor society Tau Beta Pi and is the mentor manager for Harmony Science Academy.

MOHAMMAD ANSAB KHAN

Biomedical engineering senior Mohammad Khan is a research assistant in the UH REIGN Lab, which focuses on developing novel rehabilitation engineering applications and therapeutic strategies to help improve motor functions in individuals with neurological impairments. He also served as a research assistant with the Baylor College of Medicine where he conducted an introductory analysis of molecular data using a genetic sequencing program.

Khan is minoring in business administration and hopes to contribute to innovations in the medical field.

FRAN TUMAJAN

Chemical engineering senior Fran Tumajan served as a workshop facilitator for chemical processes and an undergraduate researcher with the college. He worked as a process engineering intern with Kaneka North America, as well as a research and development intern with Flotek Industries Inc.

He has a Lean Six Sigma white belt certification from the U.S. Navy and also participated in the Harvard Business School's MBA Program Peek Weekend this year. Tumajan is the industry relations chairman for Tau Beta Pi and is the conference coordinator for the Model of United Nations Club at UH.

Networking

These seven UH students joined 7,000 other attendees from the U.S. and Canada at the Forbes Under 30 Summit, enjoying the exceptional opportunity to connect with fellow students and others at the event.

"I believe that great ideas are born out of conversations among curious and innovative people," Batliwala said. The Forbes Under 30 Summit will allow me to be a part of some of these important conversations. Surrounding myself with thousands of great minds and driven young people is exactly what I believe is necessary to further cultivate and expand some of my own ideas."

This year's summit

Forbes returns to Detroit, Oct. 18-21, for its 2020 Forbes Under 30 Summit. For information about attending this year's event visit www.live.forbes.com/under30.

The event is sponsored by Forbes Media, a global media, branding and technology company. Among the company's widespread publishing empire are Forbes and Forbes Asia magazines, as well as the Forbes.com site. It also is well known for its annual Forbes Best annual lists, which cover a wide variety of interests.

UNDER 30 SUMMIT BY THE NUMBERS:

SOURCE: "2020 FORBES UNDER 30 SUMMIT | DETROIT, OCTOBER 4 - 7, 2020." FORBES, FORBES MAGAZINE, LIVE.FORBES.COM/UNDER30.

200+
World-Class Speakers

9K+
Global Attendees

500+
Top Investors

2.3 B
Social Reach

20+
Focused Tracks

175+
Journalists

ENGINEERING

CONFERENCE CIRCUIT

BY RASHDA KHAN

UNITED STATES OF AMERICA

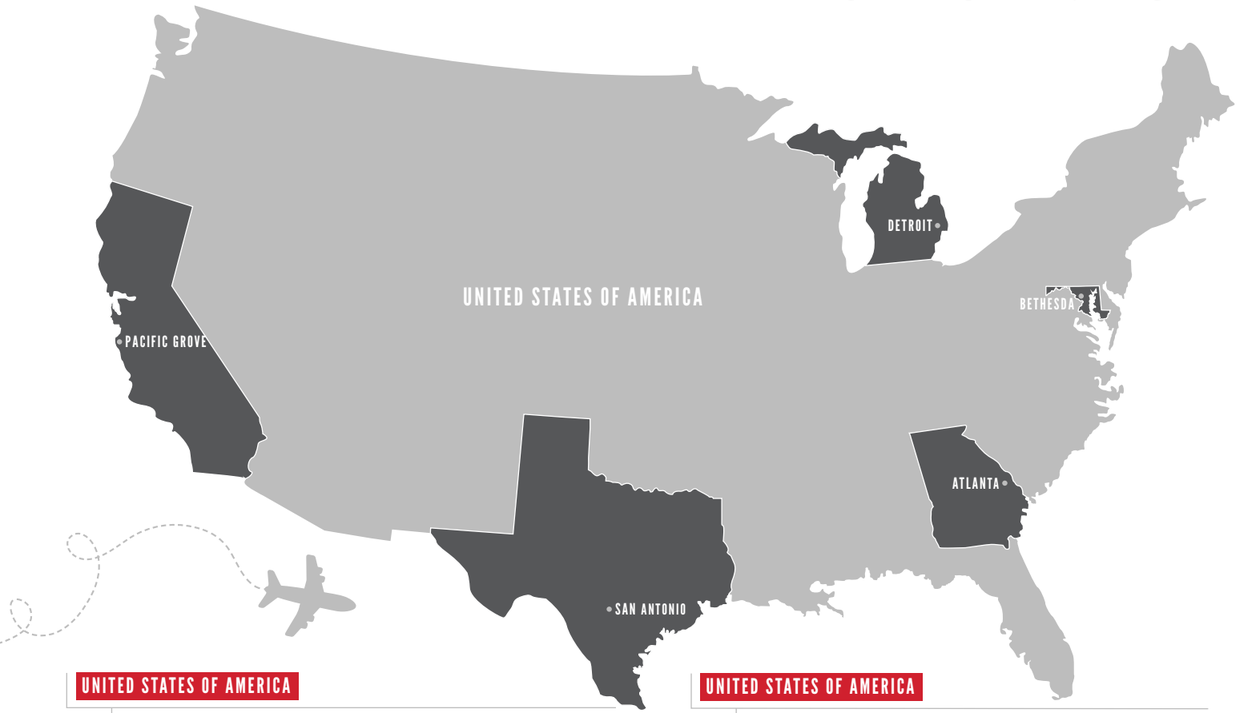
PACIFIC GROVE, CALIFORNIA

Hamid Fekri Azgomi, an electrical engineering doctoral student, won a Cullen Travel Fellowship Grant and traveled to California to present several papers at the 53rd IEEE Asilomar Conference on Signals, Systems and Computers in California. The papers were titled "Real-Time Seizure State Tracking Using Two Channels: A Mixed-Filter Approach," and "Wearable Brain Machine Interface Architecture for Regulation of Energy in Hypercortisolism."

UNITED STATES OF AMERICA

BETHESDA, MARYLAND

Electrical engineering Ph.D. student **Ali Slim** presented two papers at the IEEE-EMB Special Topics Conference on Healthcare Innovations and Point-of-Care Technologies (HI-POCT) held this year at the National Institutes of Health (NIH) in Bethesda, Maryland. The papers were titled "Emotion Recognition by Point Process Characterization of Heartbeat Dynamics" and "Facial Expression-Based Emotion Classification Using Electrocardiogram and Respiration Signals."



UNITED STATES OF AMERICA

SAN ANTONIO, TEXAS

Natalia Villarreal, a student in the UH Biomedical Engineering Department, recently won the Outstanding Abstract Award for Trainees from the AABB. She was presented the award at the 2019 AABB Annual Meeting in San Antonio, which took place from October 19 – 22. The Outstanding Abstract for Trainee Award recognizes 10 outstanding abstracts in the categories of Undergraduate/Nursing/MLS students, SBB students, Medical/Graduate students, Residents and Fellow/Post-Doctoral students.

UNITED STATES OF AMERICA

ATLANTA, GEORGIA

Daniel Ajuzie, a biomedical engineering doctoral student, presented a poster at the American Institute of Chemical Engineers' inaugural AfroBiotech Conference 2019, held in Atlanta, Georgia. He won a National Science Foundation award to cover the conference registration. Ajuzie's poster was titled "Quantifying the Effects of Hydrogen Peroxide-induced Oxidative Stress and Iron Stress on Escherichia coli Growth and Persistence."

GERMANY

BERLIN, GERMANY

Dilranjan Wickramasuriya and **Md. Rafiul Amin**, both electrical engineering Ph.D. students as well as **Divesh Pednekar**, an electrical engineering master's student, attended the 2019 IEEE Engineering in Medicine and Biology Conference held in Berlin, Germany. Wickramsuriya and Amin each won a Cullen Graduate Fellowship Travel Grant – a competitive fellowship program that allows graduate students to showcase their research and scholarly work at conferences, meetings and exhibits. Lab members presented six papers (five regular and one invited) at the 2019 EMBC. The theme of the conference was "Biomedical Engineering Ranging From Wellness to Intensive Care."

UNITED STATES OF AMERICA

DETROIT, MICHIGAN

Rukaiya Batliwala, a mechanical engineering junior; **Marco Espinosa**, a mechanical engineering senior; **Rony Hernandez**, a chemical engineering senior; **Mohammad Khan**, a biomedical engineering senior; **Brandon Santos**, a mechanical engineering senior; **Taha Shafquat** (BSME '18) a mechanical engineering master's student; and **Fran Tumajan**, a chemical engineering senior, were selected as 2019 Forbes 'Under 30 Scholars' and attended the Forbes Under 30 Summit in Detroit as honorees. Forbes reported it was the largest summit yet that brought together 9,272 attendees from nearly 60 countries for an immersive experience featuring more than 200 world-class speakers including investors, celebrities, musicians, sports stars, cultural icons, as well as political and business leaders.

KINGDOM OF SAUDI ARABIA

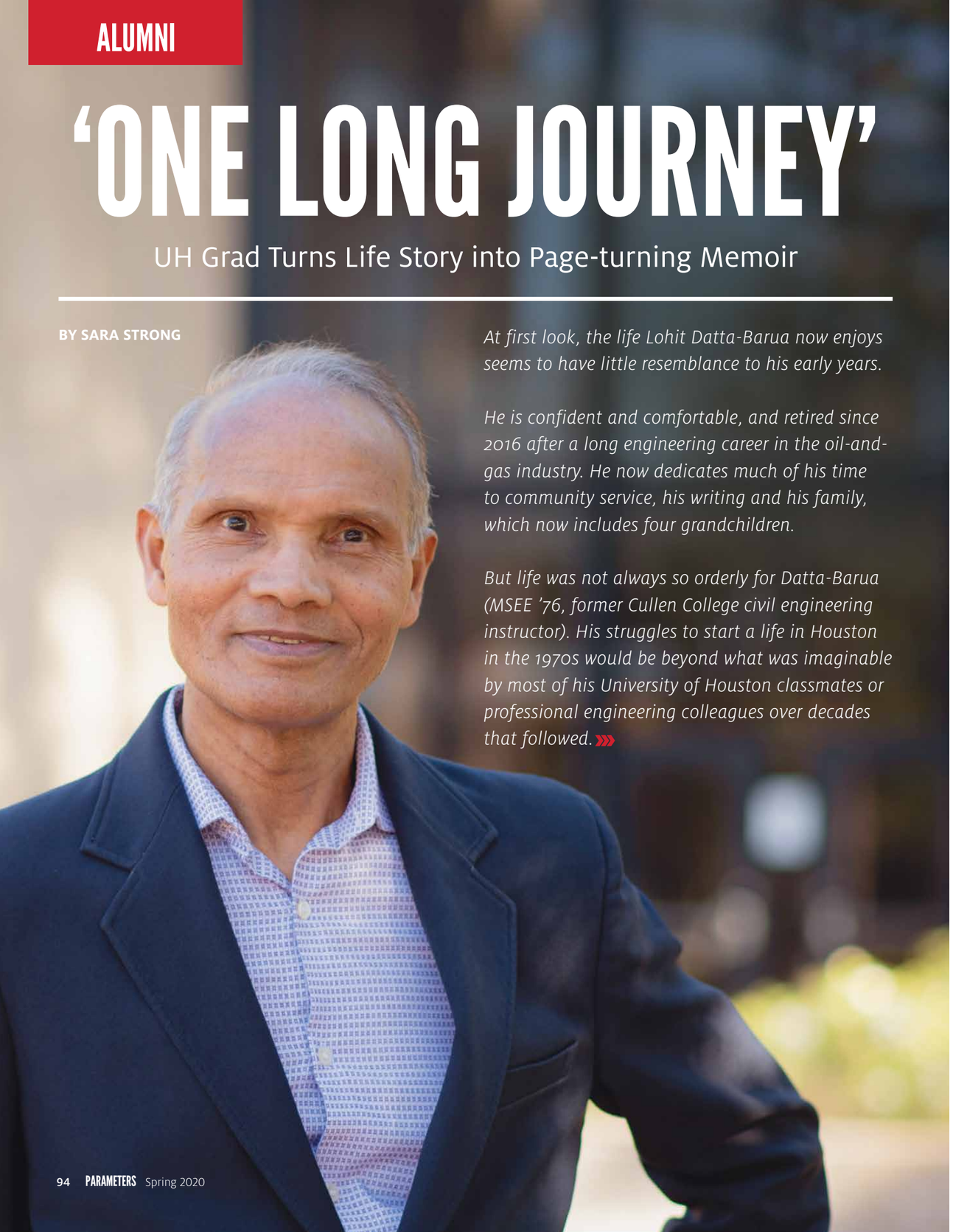
KINGDOM OF SAUDI ARABIA

Nhung Nguyen, a junior majoring in petroleum engineering, was one of 100 students chosen from around the world to attend the Education Week program of the 2020 International Petroleum Technology Conference (IPTC) held January 11-15, 2020, in Saudi Arabia. Education Week is designed to provide college juniors and seniors insight into the petroleum industry, as well as the opportunity to work together on a joint assignment, go on field trips and network with major industry employers. IPTC covered travel and accommodation expenses for the selected students.

‘ONE LONG JOURNEY’

UH Grad Turns Life Story into Page-turning Memoir

BY SARA STRONG



At first look, the life Lohit Datta-Barua now enjoys seems to have little resemblance to his early years.

He is confident and comfortable, and retired since 2016 after a long engineering career in the oil-and-gas industry. He now dedicates much of his time to community service, his writing and his family, which now includes four grandchildren.

But life was not always so orderly for Datta-Barua (MSEE ’76, former Cullen College civil engineering instructor). His struggles to start a life in Houston in the 1970s would be beyond what was imaginable by most of his University of Houston classmates or professional engineering colleagues over decades that followed. »»

“Poverty is a fatal disease. You can die from it. But wealth can be a fatal disease, too,” he said.

Datta-Barua was born into deep poverty in India’s remote northeast. Every morning, his mother swept and washed the uneven dirt floors of the family home. At sunset, his daily chore was to gather the family’s few cows, which had a habit of wandering either the slum where the town’s beggars and lepers lived or a flea market where they incurred vendors’ wraths by helping themselves to produce in the stalls.

In the evening he studied by light of a kerosene lamp. Later, in the darkness, he gazed through holes in the roof to count stars in the sky. When the days permitted, he climbed atop a large rock on the south bank of the mighty Brahmaputra River, near his home. Perched there, he pondered life’s biggest questions. Then he listened to hear answers in the flowing waters.

In many ways, the important things in his life never changed.

The shy young Lohit from far away and the well-spoken Dr. Datta-Barua of today remain aligned in personal values. Each possesses the soul of a poet and the heart of a campaigner for social justice, especially on issues of poverty, education and women’s rights. And each is ready to tackle lofty goals one step at a time, even when odds pile up.

Datta-Barua’s newly released memoir, titled “One Long Journey,” examines his life story from the beginning to the current time. Its early tales relate the deaths of family and friends he held dear, the banishment of a beloved brother, and a young heart broken by the sharp divides of India’s caste divisions.

The stories tell of a gamble of a lifetime, recurring medical crises and, most riveting of all, a family secret so profound that its unraveling would shake his own sense of where he stood in the world.

The book reads like a page-turner of a novel, but it is the story of his life.

Datta-Barua’s first memories are of a father and a mother, five older brothers and two older sisters. They lived in the town of Guwahati in northeast India’s state of Assam, famous for its tea-growing plantations. Assam is also known for violent clashes with invaders, strife among separatist factions within, even defiance of national troops over handling of the region’s oil deposits.

Assam was an independent country until an 1826 treaty with Great Britain merged it into its colony of India. The political decision formed the famous “jewel in the crown” for the British Empire. For India, it imposed a new upper class at the very top of already strictly-divided social structure. The British left in 1947, but many of their social norms lingered.

Violence would return to Assam during Datta-Barua’s youth when China invaded India in 1962. Officially it was a border dispute, but most Indians saw it as vengeance for India providing sanctuary in recent years to Tibetan refugees, including the Dalai Lama and his followers.

With China’s People’s Liberation Army getting a foothold nearby, Datta-Barua and his young classmates received rifle training in the mornings. Afternoons, they helped evacuees temporarily housed in their school. Their own classes came later in the day in makeshift classrooms.

He worked diligently at his studies, always holding tightly to the promise that education would be his ticket out of Guwahati to a prosperous, more egalitarian life somewhere else.

By the time he graduated from the local school, a scholarship with a small stipend waited at a five-year engineering program at Birla Institute of Technology and Science, located in the town of Pilani in northwestern India.

The opportunity was excellent, but Pilani is almost 1,000 miles away from his family and his cherished Brahmaputra River, where he had listened for wisdom in his early years.

Settling into working hard in his studies at Pilani, he adapted to the distance and even grew to appreciate the desert sand of northwestern India almost as much as his beloved River back home. (The capitalization reflects Datta-Barua’s preference. In “One Long Journey,” he writes: “I don’t recall and can’t imagine my life without the River. I claim him as my River and honor him with a capital ‘R.’”)

When he earned a bachelor’s degree in electronics engineering in 1970, a professor urged him to immediately undertake Ph.D. studies in the United States, a suggestion so far-fetched it sounded like he was being told to relocate to the moon. Desperate for income, he accepted his first job offer instead.

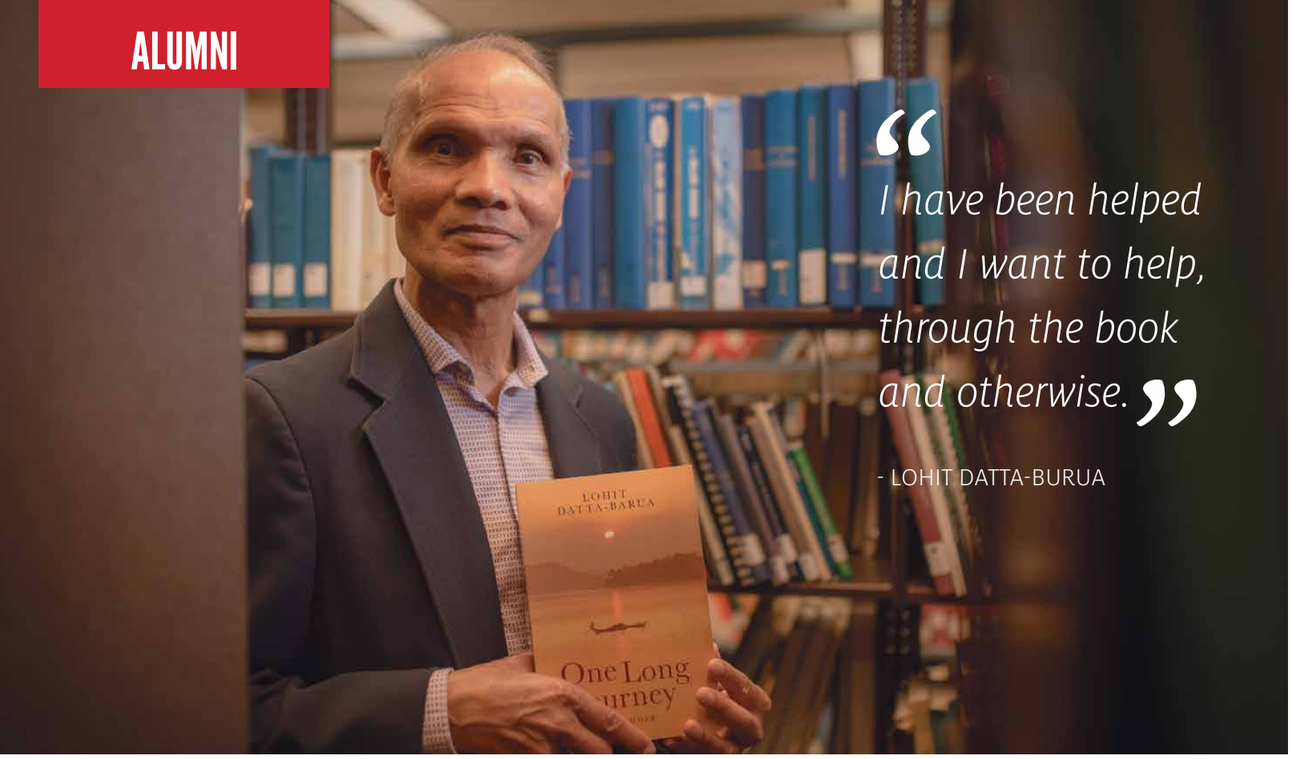
For 300 rupees a month, he went to work for Bhava Atomic Research Center (BARC), and moved into the company’s dormitory-style housing in Mumbai (known then as Bombay to many English speakers). Officially, the project was for building nuclear power plants, but silently it also was part of India’s plan to develop nuclear weapons.

The cacophony of Mumbai, India’s second largest city, was worlds away from the lush tea fields of Assam and the quiet desert of Pilani. In his book, Datta-Barua writes:

“The densely populated city of Bombay was home to dreams ending in disappointment or worse, as well as dreams realized. Some people followed their dreams and came to be movie stars. Others never found work. Lured by the city lights, many ended up in the slums sharing space with street dogs and open drains. Then there were others who lived in Malabar Hills or Marine Drive, driving imported cars and drinking Scotch whiskey. Some, like me, were lucky to find a job to barely make a living in an expensive city.”

After just three months, a rescue came in the form of a job offer near Guwahati, his hometown, from the Pipeline Division of Oil India Ltd. (OIL). He would work with remote control, communication, automation, instrumentation, and radio/telemetry, even though he knew many of these systems only in theory.

His salary almost doubled. But far better, the move brought him »»



> *"I have been helped and I want to help, through the book and otherwise."*
>
> - LOHIT DATTA-BURUA

near his widowed mother and siblings.

He was assigned to share a house with Dilip Deka, another new hire and an instant friend. Air conditioning and hired help for cooking, cleaning and gardening were unimaginable luxuries for both. Datta-Barua kept a used record player, received from an older brother, spinning with country-western music and Jim Reeves albums. And he struggled to settle into the company's highly stratified society, all too reminiscent of the British colonial times.

The housing they were assigned – a Type D house design – sent a silent signal to everyone who worked and lived inside the company's fenced-in compound: "We were officers of the most junior rank. Our immediate supervisors lived in Type D, E or F bungalows, depending on their job," he said.

Top company officers were also granted Type F houses. Non-officer workers lived smaller, more sparse Type A, B or C homes.

One social club served only officers. Another was meant strictly for lower ranks. These invisible barriers were rarely crossed, at least not openly.

The job was enjoyable at first. At the Western-style Christmas, Santa Claus was helicoptered in. On New Year's Eve, officers danced to Western music and enjoyed Western food. But for Datta-Barua, the glitter was quickly tarnishing.

A breaking point came in the fall, when the company's annual sports event gathered employees from all nearby facilities. After the closing awards ceremony, the large crowd of participants and guests were treated to a poolside barbecue dinner. As grilled chicken burgers were handed out amid the laughter and music around the swimming pool, Datta-Barua happened to glance around the perimeter.

Just beyond, groups of children – in torn, dirty clothes and looking hungry – peered silently at the celebration through the tall chain-link fence.

"That could have been me. Not so many years before, I had been a poor boy with ragged clothes," he said. "If I did not leave this job, I would become like the other officers, oblivious to the struggles of the people looking in from the outside."

In his memoir, Datta-Barua writes: "I felt awful. I realized that I was getting sucked into a pseudo society while the real world lived outside the fence. In that instant I knew that I must get out before I got trapped."

His ambition soon clarified. He would earn a master's degree – not in India, but at a leading engineering program at a U.S. university.

But how? His father died when he was still a teen, leaving struggles for his widowed mother. There was no family savings and no collateral to secure a loan. His siblings were stretching their funds to provide for their young families.

Besides, he said, few Assamese Indians moved to the U.S. in those days. "Coming to America was beyond most people's imagination, let alone coming here to go to school."

His friend Dilip Deka was among those who did. Having left OIL and India, he was attending college in St. Louis, Mo. He offered advice: Look at state-funded schools for lower tuition, especially those in Texas.

After researching in the American Corner of the district library, Datta-Barua narrowed his choice to three. Austin, College Station – he had never heard of those cities. But Houston? Everyone recognized the message "Houston, the Eagle has landed."

So the decision was made: He would study engineering at the University of Houston. But there were immediate problems.

"The UH application fee was $15, which I did not have. I wrote to my friend in St. Louis, asking him to pay the fee for me. In exchange, I would pay his father the equivalent amount in Indian rupees, which I did later," he said. That left the larger challenges of getting accepted into the Cullen College plus raising the first semester's tuition, travel costs from Guwahati to Houston, and living expenses until he could get a job.

"I begged any close friends and family to loan me money, whether it was 300 rupees or 500 rupees, or whatever they could provide," he said. (In the early 1970s, $1 was equivalent to 7 rupees.)

After much effort, he finally landed in Houston with $7 in his pocket and a bank draft for one semester's tuition. Two years later he returned home to see his ailing mother and to see his love of many years. He was heartbroken when his love was rejected because of caste difference.

But new and risky adventures brought happiness, such as his arranged marriage in July 1975 to Manjula (MSEE '79), a beauty who valued education as he did. Her father introduced the couple just three days before the wedding and they agreed to marry, perhaps the biggest gamble of their lives.

"I came back to Houston with a stranger," he said. "And I love her very much." Now married 44 years, they would work as their family and careers prospered. Through the years, they would travel much of the world with the two daughters they raised in north Houston.

In their early time together, they fulfilled a promise to her father that Manjula would continue her education beyond the bachelor's degree in physics she earned in India. In 1979, she graduated with her own electrical engineering master's degree from the University of Houston and soon began her long career in the electric power industry.

Other experiences were harsh. Work hours were long, especially in the beginning. Income was minimal, and prejudice and frustrating bureaucracy were inescapable.

There was tragedy, too. Datta-Barua was behind the wheel on March 27, 1977, when a predawn accident took the life of friend, boss and academic mentor Dr. Randolph Blumberg (UH assistant professor of civil engineering). They had been on their way to an offshore drilling site in Louisiana.

"I didn't care for anything anymore," he said. "My wife and our friends stood by me."

Datta-Barua eventually would regain his strength with their support and progress through an impressive engineering career in the oil-and-gas industry.

He finds time for helping the community, too, by volunteering in his neighborhood elementary school, and he has helped the End Hunger Network. In India, he is trying to set up a solar power system that will save ongoing high costs of electricity at a girls orphanage, Assam Sishu Kalyan Sadan (Assam Child Welfare House). He has participated in the MS 150 biking fundraiser and climbed Mount Kilimanjaro in support of charity.

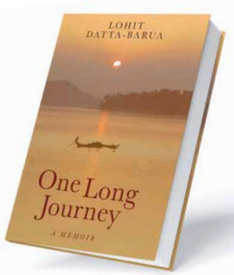
"I have been helped and I want to help, through the book and otherwise," he said.

Back in Assam, just as the waters of his River keep on flowing, so too has his family's story. His beloved mother died in 1975; other family members have passed, too. Nieces and nephews were born, and many would pursue ambitious goals of their own.

Eventually, Datta-Barua would come to embrace a central truth of his survival, thanks in part to an unexpected message of hope and desperation that came to him through the generations. In childhood, he had mistaken it as merely a signature and notes left by a stranger inside a book that was among items his mother cherished for reasons unspoken. As an adult, he came to know those things were part of his own story, too.

Like the stranger, Datta-Barua would position education as the keystone in his life but sometimes would find himself battered by forces he could not control. Each would hold loved ones close, and each would turn to the power within waters of the mighty Brahmaputra.

Datta-Barua ultimately triumphed, perhaps helped on the journey by wisdom gained from the generation before. His search, in the end, carried him onward to a place of safety and peace – just like his River, which always flows forward.



Datta-Barua's memoir, "One Long Journey," is available worldwide from Amazon and from distributor IngramSpark. All proceeds from its sales help fund welfare projects for orphans.

Among his 11 books are two others for general audiences: "A View Through My Window," inspired by his travels, and "Color of Life," a collection of short stories. His writings for technical readers include "Natural Gas Measurement & Control," and "Digital Computers: Repair & Maintenance."

He has also published five works in the Assamese language.

LIENHARD'S LENS

BY JOHN LIENHARD

WHALE SKELETONS: SPERM WHALE SKELETON, NEW BEDFORD WHALING MUSEUM

SPERMICETI: BOTTLES OF OIL SEPARATED FROM THE SPERMACETI OF A SPERM WHALE, NEW BEDFORD WHALING MUSEUM.

View more photos at:
enginespics.smugmug.com

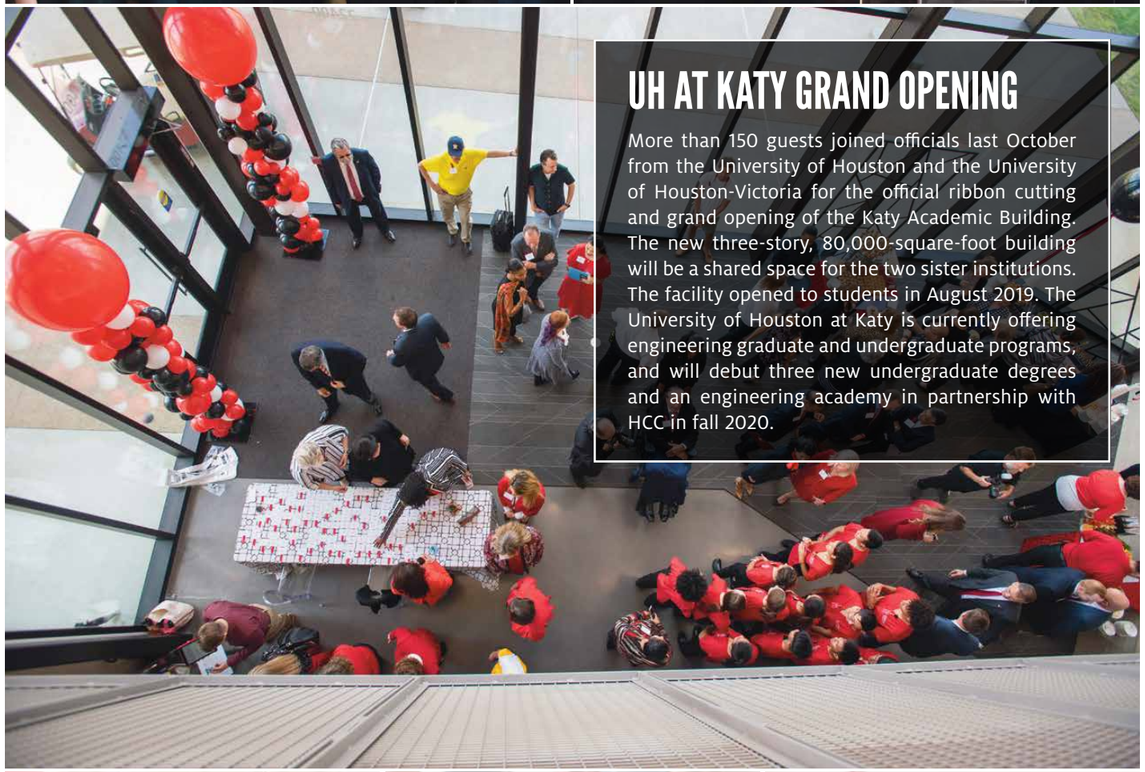
We lit lamps with oil in antiquity. And we kept doing so until we had electricity. But what oil did we use? Petroleum found wide use only after the Civil War. Most lamp oils had come from vegetables or animal fat before that. So where did whale oil fit in? Well, it was America's most desired oil during the early 19th century. It had made whaling into a major American industry by 1820.

That brings us to the ***Whale Oil Myth***. That's the idea that petroleum oil, and the free market, saved the whales. Whales had come under a serious threat of extinction by 1860. And petroleum oil did fuel most lamps in the latter 19th century. So what really happened?

The cost of whale oil had risen as we killed off whales. It had always been too costly for most ordinary users. And only the wealthy could afford it by the end of the Civil War. We lit most lamps with far cheaper oils – oils derived from coal, as well as from plants and land animals. We lit lamps with turpentine, lard, or alcohol. Then camphine became popular during the Civil War. That much-used witch's brew was a mixture of camphor oil and a turpentine derivative.

So the market ended whale oil use before petroleum oil became important. Petroleum oil first arrived in the form of kerosene, just before the Civil War. Then, during the War, we taxed kerosene at 10 cents a gallon. But the tax on the alcohol in camphine rose to as high as $2 per gallon. Early petroleum derivatives suddenly enjoyed a huge government price advantage. And that advantage was over camphine. Whale oil no longer mattered.

So whale oil never was competitive. Using it was always a bit like killing elephants so the wealthy could have costly carved ivory. As for lamps, government-supported petroleum was just a stopgap until Thomas Edison began building public electric lighting systems in 1882. Of course, petroleum really came into its own with the automobiles of the 20th century. Its use in lighting our lamps had been only a way-station in its history.



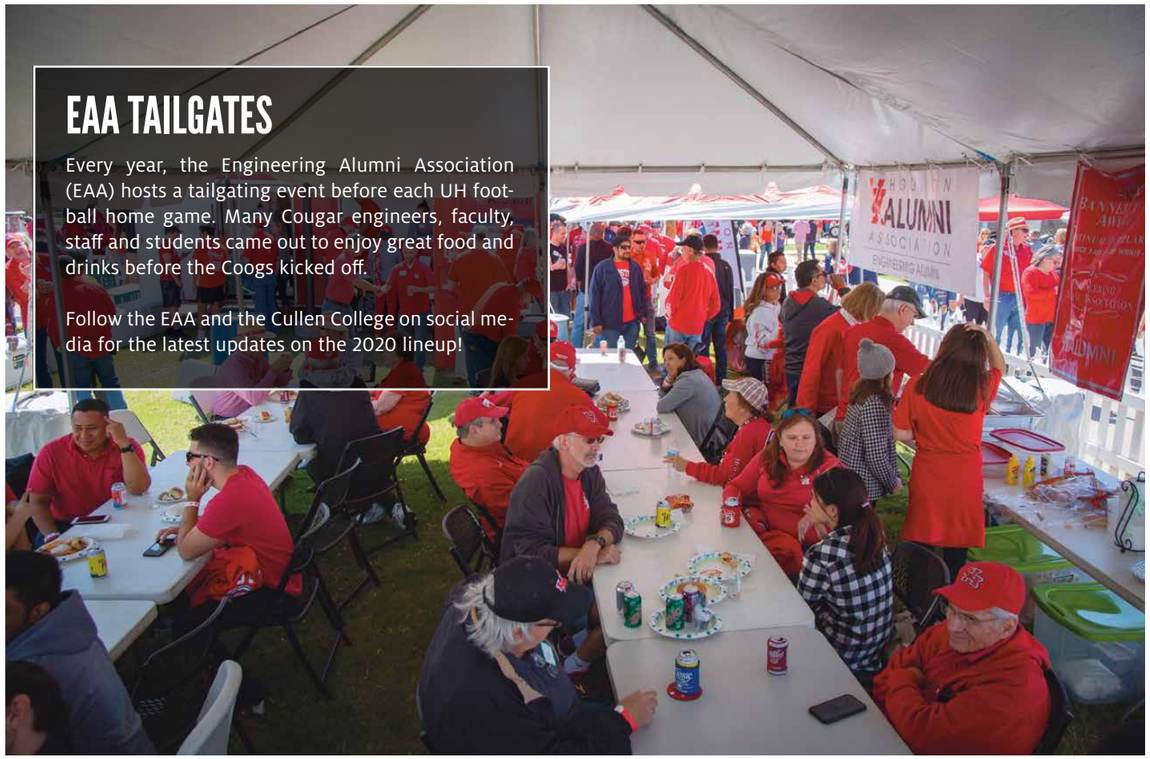
UH AT KATY GRAND OPENING

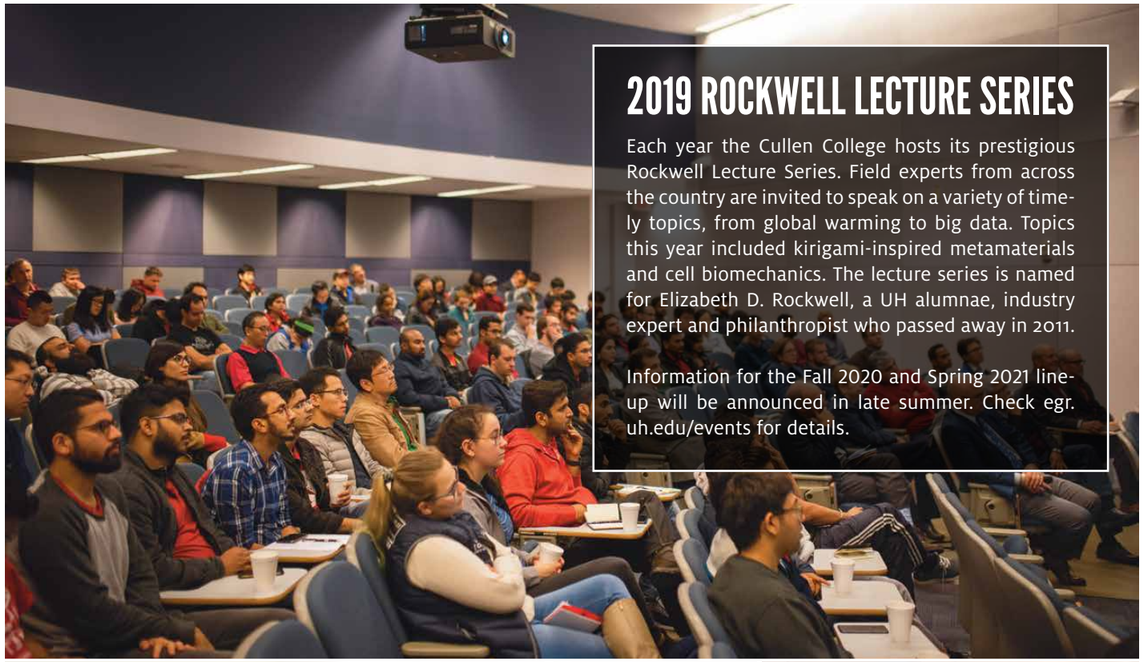
More than 150 guests joined officials last October from the University of Houston and the University of Houston-Victoria for the official ribbon cutting and grand opening of the Katy Academic Building. The new three-story, 80,000-square-foot building will be a shared space for the two sister institutions. The facility opened to students in August 2019. The University of Houston at Katy is currently offering engineering graduate and undergraduate programs, and will debut three new undergraduate degrees and an engineering academy in partnership with HCC in fall 2020.

EAA TAILGATES

Every year, the Engineering Alumni Association (EAA) hosts a tailgating event before each UH football home game. Many Cougar engineers, faculty, staff and students came out to enjoy great food and drinks before the Coogs kicked off.

Follow the EAA and the Cullen College on social media for the latest updates on the 2020 lineup!





2019 ROCKWELL LECTURE SERIES

Each year the Cullen College hosts its prestigious Rockwell Lecture Series. Field experts from across the country are invited to speak on a variety of timely topics, from global warming to big data. Topics this year included kirigami-inspired metamaterials and cell biomechanics. The lecture series is named for Elizabeth D. Rockwell, a UH alumnae, industry expert and philanthropist who passed away in 2011.

Information for the Fall 2020 and Spring 2021 lineup will be announced in late summer. Check egr.uh.edu/events for details.

ASSOCIATION OF SPACE EXPLORERS VISITS UH

UH Cullen College of Engineering faculty and students celebrated the Association of Space Explorers (ASE) Symposium Community day on Wednesday, October 16. The day-long event featured discussions and class visits with astronauts, who shared their passions for space exploration, and described the opportunities and challenges of returning to the moon and traveling on to Mars. The space explorers also participated in a STEM panel discussion led by Olga Bannova, director of the space architecture program at UH, and visited the Sasakawa International Center for Space Architecture (SICSA) department. The goal of this community event is to generate public awareness about human space exploration and to inspire students in STEM.

To learn more about events and outreach at the Cullen College,

visit **www.egr.uh.edu/events** or follow us on social media!

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View more photos online at

www.flickr.com/photos/cullencollege/albums

ENGINES OF OUR INGENUITY

Episode No. 2704

MUSCLE MEMORY

I think a lot about muscle memory as I grow older— our wonderful ability to do complex tasks unconsciously— the fine motions of bike riding, piano playing, shaving, of walking. Debate goes on over just how the brain does that. So I won't go there. Rather, let's think about muscle memory and engineering design.

Take typing. We're stuck with our QWERTY keyboard layout because it was designed before people realized they could touch type. So we type on QWERTY keyboards without looking. Our brain says G and our finger unconsciously goes to that key. Our muscle memory is wed to QWERTY; and now we won't accept a better layout.

Or think about muscle memory and perfect pitch. The rare person who has it can sing, say, an E-flat with no context. Here in America just a few out of every 10,000 people have perfect pitch. (In China, with its pitch-inflected language, the number is higher. Chinese children are attuned to pitches from the cradle.)

But ask an average citizen on the street to sing the first line of some popular tune. More often than not, she'll do it in the key she's been singing along with her radio. That's not perfect pitch, it's vocal cord muscle memory.

Singing from printed music is a lot like typing. The muscles that tense our vocal cords react to a written E-flat much as our typing finger reacts when our brain says the letter E. So what happens if we're asked to sing a piece in a key other than the one where it's written? Now that E-flat has to be sung as, say, a G.

Without perfect pitch, we don't know that we're being started out in the wrong place. But think about typing. We've all had the experience of trying to type on a keyboard unfamiliar to us. Our touch-typing deteriorates. Same thing with singers: Each time we try to sound a note, our muscles are doing something inconsistent with our muscle memory of that printed note.

I meet people who think they can play a hymn in a key other than the one it's written in. Of course the result is the same as giving a typist a strange keyboard. Things go wrong. Notes come out flat or sharp— like the typist reaching for W and typing E.

This is an ongoing problem in engineering design. Any machine— automobile, cell phone, piano— has to interface with a human being. And we engineers are constantly tempted to decide what should work when we create something new. The result might be a highway with an awkward intersection. Or a copy machine with an array of buttons that give it vast, but incomprehensible, flexibility. Which of us has not been flummoxed by a new point-and-shoot camera with too many obscure switches in illogical places?

It's a hard-learned lesson in humility. But, if we try to design without keeping our users' muscle memory clearly in mind, the result will be ... Well, the machine we build will simply be out of tune.

I'm John Lienhard at the University of Houston, where we're interested in the way inventive minds work.

John Lienhard

The Engines of Our Ingenuity is a nationally recognized radio program authored and voiced by John Lienhard, professor emeritus of mechanical engineering and history at the University of Houston and a member of the National Academy of Engineering. The program first aired in 1988, and since then more than 2,800 episodes have been broadcast. For more information about the program, visit www.uh.edu/engines.

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Pictured: UH Engineering's Dr. Aaron Becker and his research group celebrate their $500K grant award with an apple cider toast.