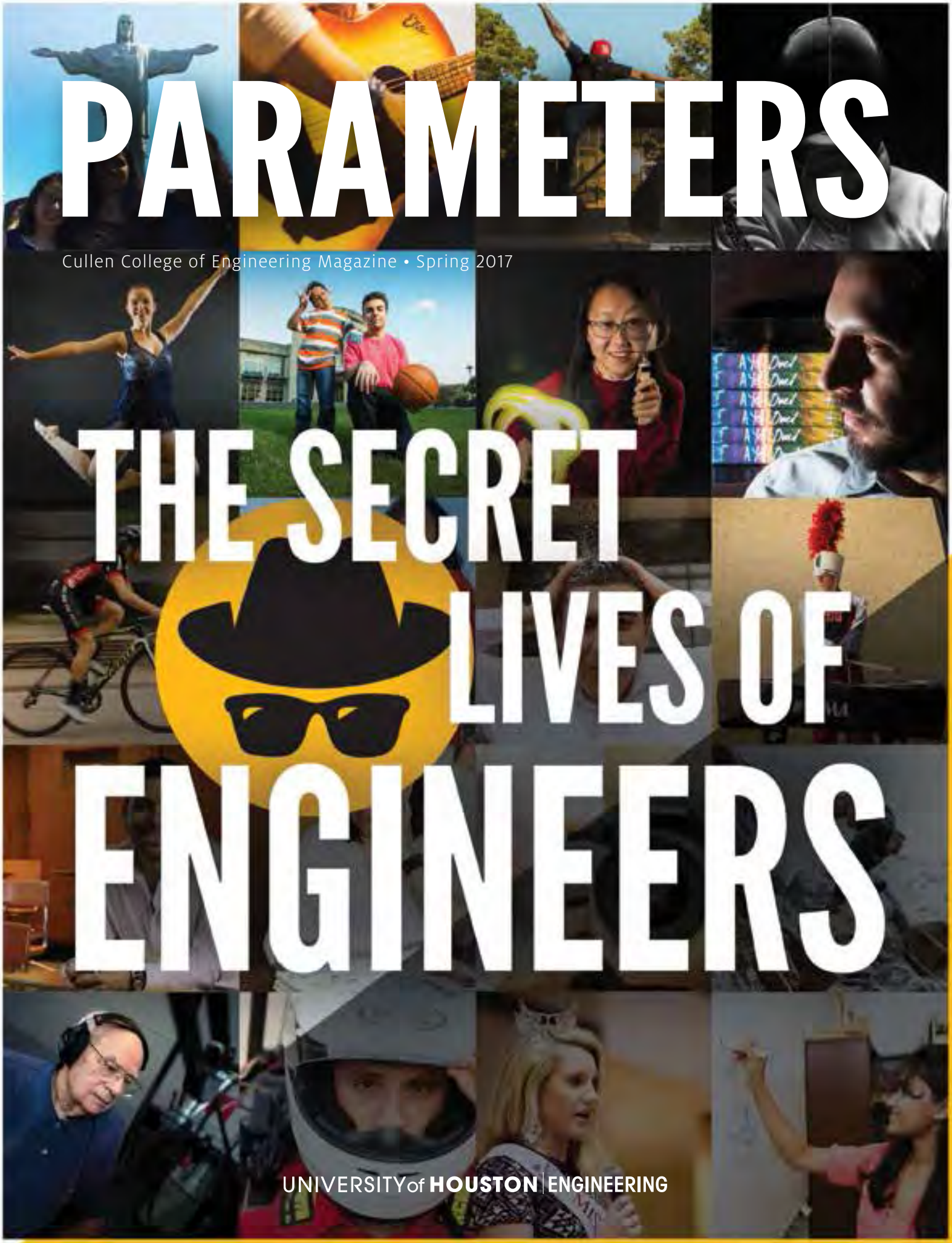


PARAMETERS

Cullen College of Engineering Magazine • Spring 2017

THE SECRET LIVES OF ENGINEERS

UNIVERSITY of HOUSTON | ENGINEERING

FLASHING LIGHTS

Mechanical engineering professor **Jae-Hyun Ryou** (pictured left) and doctoral student **Shahab Shervin** discovered a low-cost manufacturing process for flexible, color-changing LEDs.

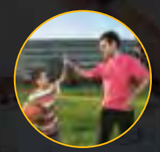
READ THE FULL STORY AT
www.egr.uh.edu/news/201604/uh-engineers-make-journal-cover-flexible-led-theoretical-study

THE SECRET LIVES OF ENGINEERS

by DAY

by NIGHT

JOHN LIENHARD
PG. 54



JALAL YAZJI
PG. 60

RYAN LINK
PG. 64

SNAPSHOTS

PG. 6

STUDENT SPOTLIGHT

PG. 84

IN EVERY ISSUE

Cullen College of Engineering

Dean
Joseph W. Tedesco

Associate Dean for Research & Facilities
Hanadi Rifai

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

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

Parameters

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

Communications Director
Audrey Grayson

Art Director/Graphic Designer
Rachel Knudsen

Senior Writer/Editor
Laurie Fickman

Photographer/Videographer
Carlos Landa

Contributing Writers
Jeannie Kever | John Lienhard
Natalie Thayer | Ashley Schwartz

Contact us:
University of Houston
Cullen College of Engineering
Office of Communications
Engineering Building 2
4722 Calhoun Road, Suite E311
Houston, Texas 77204-4009

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

Academic Departments

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

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

Petroleum Engineering
Chair: Mohamed Soliman
Web: www.petro.uh.edu
832-842-4848

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

Electrical & Computer Engineering
Chair: Badri Roysam
Web: www.ece.uh.edu
713-743-4400

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

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

Office of Advancement
Mail: University of Houston
Cullen College of Engineering
Engineering Building 2
4722 Calhoun Road, Suite E421
Houston, Texas 77204-4007
Web: advancement.egr.uh.edu

cullen college news
@uhengineering
uhengineering
UHCullenCollege
University of Houston Cullen College of Engineering

UNIVERSITY of HOUSTON
CULLEN COLLEGE of ENGINEERING

DEAN'S LETTER

It would be difficult to sum up an engineer with a singular definition. We are part scientist, part inventor, part dreamer and part realist, fully aware that our space in the world cannot be confined. You can observe these traits throughout each of the engineering disciplines – we toil in mechanics, chemicals, medicine, infrastructure and all places in between, sharing the ultimate goal of solving problems and making life a little better for humankind.

In that very space where engineers work to solve problems and design solutions, you see an important characteristic of an engineer's personality emerge: creativity. Successful engineers are highly creative, and I am proud to say we are surrounded by some of the most creative and multi-faceted engineers here at the Cullen College of Engineering.

Because of their imagination and creativity, engineers possess many talents. After hours, or in-between hours, engineers pursue a variety of fascinating hobbies, talents and interests. The Cullen College of Engineering has explored that in our engaging series, "The Secret Lives of Engineers."

In this issue of *Parameters*, we go a step further and introduce you to three great characters from the Cullen College – a student, alumnus and faculty member – with diverse personalities, interests and passions, who all found their second creative avocations through their first love of engineering.

You'll meet Jalal Yazji, a student who, merely as a hobby, builds prosthetics for those in need; Ryan Link, an author who writes of a futuristic world filled with scientific concepts he learned at UH; and John Lienhard, a professor whose long list of accomplishments could fill the entire magazine.

To borrow Lienhard's signature phrase on his "Engines of Our Ingenuity" syndicated radio series, "We're interested in how inventive minds work." After reading this edition of *Parameters*, maybe we'll be a little closer to finding out.

Warm regards,

Joseph W. Tedesco

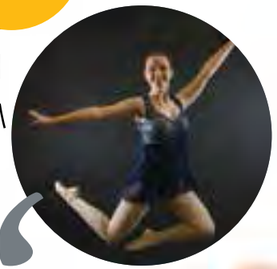
Joseph W. Tedesco, Ph.D., P.E.
Elizabeth D. Rockwell Dean and Professor

SNAPSHOTS

The Secret Lives of UH ENGINEERS

When asked to imagine a "typical" engineer, many people may find themselves conjuring images of sleep-deprived, math-obsessed or highly-analytical individuals. In reality, there is no one-size-fits-all stereotype for engineers – they come in all shapes and sizes and from all walks of life.

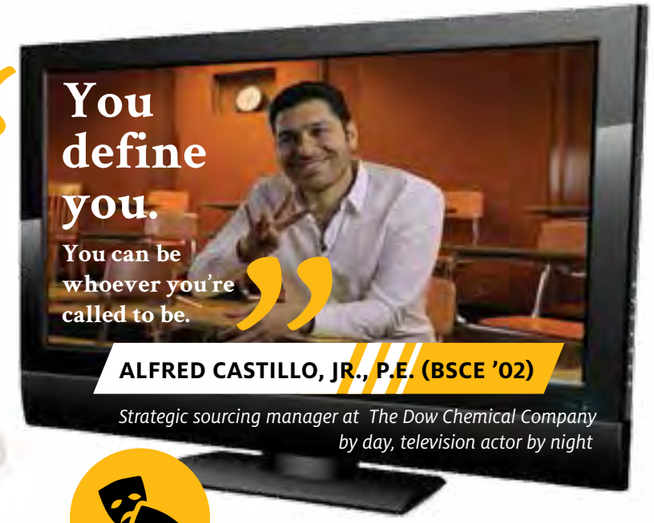
Here, we bring you the diverse talents, ambitions and passions our UH engineers bring to the table by day and by night!



"I love the order and the structure of ballet. It's actually a lot like math. People will often ask me if I'm choosing my head over my heart – engineering over dance – but for me, they're both heart."

JULIE ROGERS

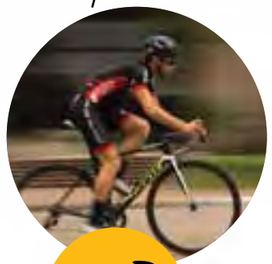
Mechanical engineering student by day, ballet dancer by night



ALFRED CASTILLO, JR., P.E. (BSCE '02)

Strategic sourcing manager at The Dow Chemical Company by day, television actor by night

"The endurance aspect of racing – being out there on your own and continuing to push yourself – and the training mindset have both definitely carried over into engineering."



MICHAEL PINCUS

Electrical and computer engineering student by day, professional cycling coach by night

"When I'm in a difficult class or working a complex problem, playing music can be an escape – something that relaxes me so I can clear my head and focus again."

AUSTIN METCALF

Mechanical engineering student by day, drummer in the tenor section of the UH drum line by night

Intelligence will never stop being beautiful.

— I want to be a role model for young girls in both the STEM and social media worlds.

CHRISTINA DILLON (BSME '16)

Mechanical engineer at Stinger Ghaffarian Technologies by day, Texas pageant queen by night

IN THE MEDIA SPOTLIGHT

KHOU11

Houston's CBS affiliate featured the selfless work of several UH Engineering students who make up the UH Chapter of eNABLE, a worldwide group providing free, 3D-printed prosthetics for children and adults.

WATCH THE HEARTFELT VIDEO AT

www.khou.com/features/boy-gets-new-hand-thanks-to-3-d-printer-uh-students/353926713

KHOU aired a story about UH engineer **Wei-Chuan Shih's** invention that turns smartphones into microscopes that can detect whether your pond water is healthy – and perhaps even diagnose diseases.

WATCH THE VIDEO AT

www.khou.com/tech/new-lens-turns-smartphones-into-microscopes-/352116602

HOUSTON CHRONICLE

The Houston Chronicle profiled three UH engineers who are changing the world and engineering the future:

Venkat Selvamanickam, who created high-temperature superconductors that can transport electricity with very little resistance.

Debora Rodrigues, who is improving global access to clean water with her nano-sized technology that can weed out metals and radioactive materials from drinking sources.

Jose Luis "Pepe" Contreras-Vidal, who is helping paraplegics walk again with mind-reading robotic exoskeletons.

MEET THE UH ENGINEERS WHO ARE CHANGING THE WORLD AT

www.egr.uh.edu/news/201610/houston-chronicle-profiles-uh-engineers-who-are-changing-world

CNN

CNN interviewed UH engineer **Andrew Boyd** to get the inside scoop on how airlines determine ticket prices. Boyd provided insights into the science of adjusting fares in real time so that airlines can maximize revenue.

WATCH THE VIDEO TO LEARN MORE AIRLINE PRICING SECRETS AT

www.cnn.com/2016/09/16/aviation/airline-pricing-secrets

Wired Magazine discussed the world's largest indoor waterfall with UH engineer **Arturo Leon**, an expert in hydraulic engineering. The waterfall, called the Rain Vortex, is scheduled to open inside of Singapore's Changi Airport in 2018.

Published in *WIRED Magazine's* September 2016 Issue

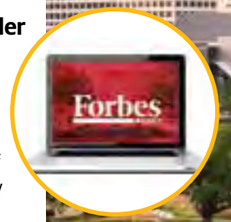
READ THE FULL WIRED MAGAZINE STORY AT

www.wired.com/2016/09/fit-worlds-biggest-indoor-waterfall-airport

TAKING HOUSTON TO THE NEXT LEVEL

WORD ON THE STREET

Forbes.com lauds University of Houston as leader in energy research and education



Forbes.com calls UH an epicenter of energy education and research, saying it is "increasingly a rival to places like MIT in advancing not just cleaner, safer and more efficient ways of extracting oil and gas from the earth, but also cleaner energy and zero-carbon energy."

READ THE FULL STORY AT
www.egr.uh.edu/news/201611/forbescom-lauds-university-houston-leader-engineering-research-and-education

UH ranks among best universities in the world for engineering and technology by CEOWorld Magazine

The University of Houston is one of the best universities in the world from which to earn an engineering degree, according to 2017 rankings released by *CEOWorld Magazine*. The UH Cullen College of Engineering was ranked No. 73 in the list of top destinations to receive an engineering or technology degree. *CEOWorld Magazine* ranked institutions based on academic reputation, admission requirements, job placement rate, recruiter feedback, specialization, global reputation and influence.

READ THE FULL STORY AT
www.egr.uh.edu/news/201702/uh-ranks-among-best-universities-engineering-and-technology-ceoworld-magazine

UH rated among best colleges for undergraduate education by Princeton Review

Princeton Review ranks UH among the nation's best institutions for undergraduate education in the 2017 edition of its flagship college guide, "The Best 381 Colleges," based, in part, on surveys from students. "Outstanding academics are the chief reason we chose UH for this book, and we strongly recommend it to applicants," said Robert Franek, *Princeton Review*'s editor-in-chief and author of "The Best 381 Colleges."

READ THE FULL STORY AT
www.egr.uh.edu/news/201609/uh-rated-among-best-colleges-undergraduate-education-princeton-review

UH among top U.S. universities for return on investment and upward mobility

Stellar academics, strong career prospects for graduates and affordability are among the reasons the University of Houston has been featured in the *Princeton Review*'s 2017 edition of "Colleges That Pay You Back: The 200 Schools That Give You the Best Bang for Your Tuition Buck." In addition, a recent study by the Equality of Opportunity Project shows UH is among the best universities in the U.S. at turning low-income students into top earners.

READ THE FULL STORY AT
www.egr.uh.edu/news/201702/uh-among-top-us-universities-return-investment-and-upward-mobility

UH chemical engineering undergraduate degree among best in nation

College Choice declares the UH Cullen College one of the top 25 places in the U.S. to pursue a chemical engineering degree. "Our students are exposed to a rigorous curriculum intended to train them to be effective chemical engineers upon graduating from the University of Houston. It's gratifying that others are acknowledging our undergraduate program," said M.D. Anderson Professor of Chemical and Biomolecular Engineering Michael Harold, chair of the department.

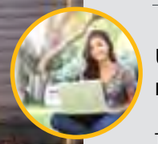
READ THE FULL STORY AT
www.egr.uh.edu/news/201612/uh-chemical-engineering-undergraduate-degree-among-best-nation

LATEST OFFERINGS

UH Engineering to offer data analytics certificate for energy industry

A new graduate certificate offered by the University of Houston Cullen College of Engineering focuses on helping oil and gas producers more efficiently use and maintain equipment by making better use of the terabytes of data streaming from monitoring sensors built into equipment. The certificate, titled Data Analytics for Condition and Performance Monitoring of Engineered Systems, will launch in fall 2017.

READ THE FULL STORY AT
www.egr.uh.edu/news/201701/uh-engineering-offer-data-analytics-certificate-energy-industry



University of Houston launches industry-relevant online engineering programs

The UH Cullen College launches flexible, online master's programs in civil, mechanical, subsea and industrial power systems engineering, tailored for working professionals. "It is critical that the Houston region and the U.S. has the engineering talent required to address the grand challenges in energy, infrastructure and the environment facing our society," said Joseph W. Tedesco, Elizabeth D. Rockwell Dean of the UH Cullen College of Engineering.

LEARN MORE AT
onlinelearning.egr.uh.edu

TAKING BETTER PICTURES

New Superconducting Coil Improves MRI Performance

BY JEANNIE KEVER

A multidisciplinary research team led by University of Houston scientist **Jarek Wosik** has developed a high-temperature superconducting coil that allows magnetic resonance imaging (MRI) scanners to produce higher resolution images or acquire images in a shorter time than when using conventional coils.

Wosik, a principal investigator at the Texas Center for Superconductivity at UH, said test results show the new technology can reveal brain structures that aren't easily visualized with conventional MRI coils. He also is a research professor in the Cullen College's department of electrical and computer engineering.

The cryo-coil works by boosting the signal-to-noise ratio (SNR) – a measure of the strength of signals carrying useful information – by a factor of two to three, compared with conventional coils. SNR is critical to the successful implementation of high resolution and fast imaging.

Wosik said the cryo-coil reveals more details than a conventional coil because of its enhanced SNR profile. Where a conventional coil does not have enough sensitivity to "see," a superconducting coil can still reveal details. These details will remain hidden to conventional coils even when image acquisition is repeated endlessly.

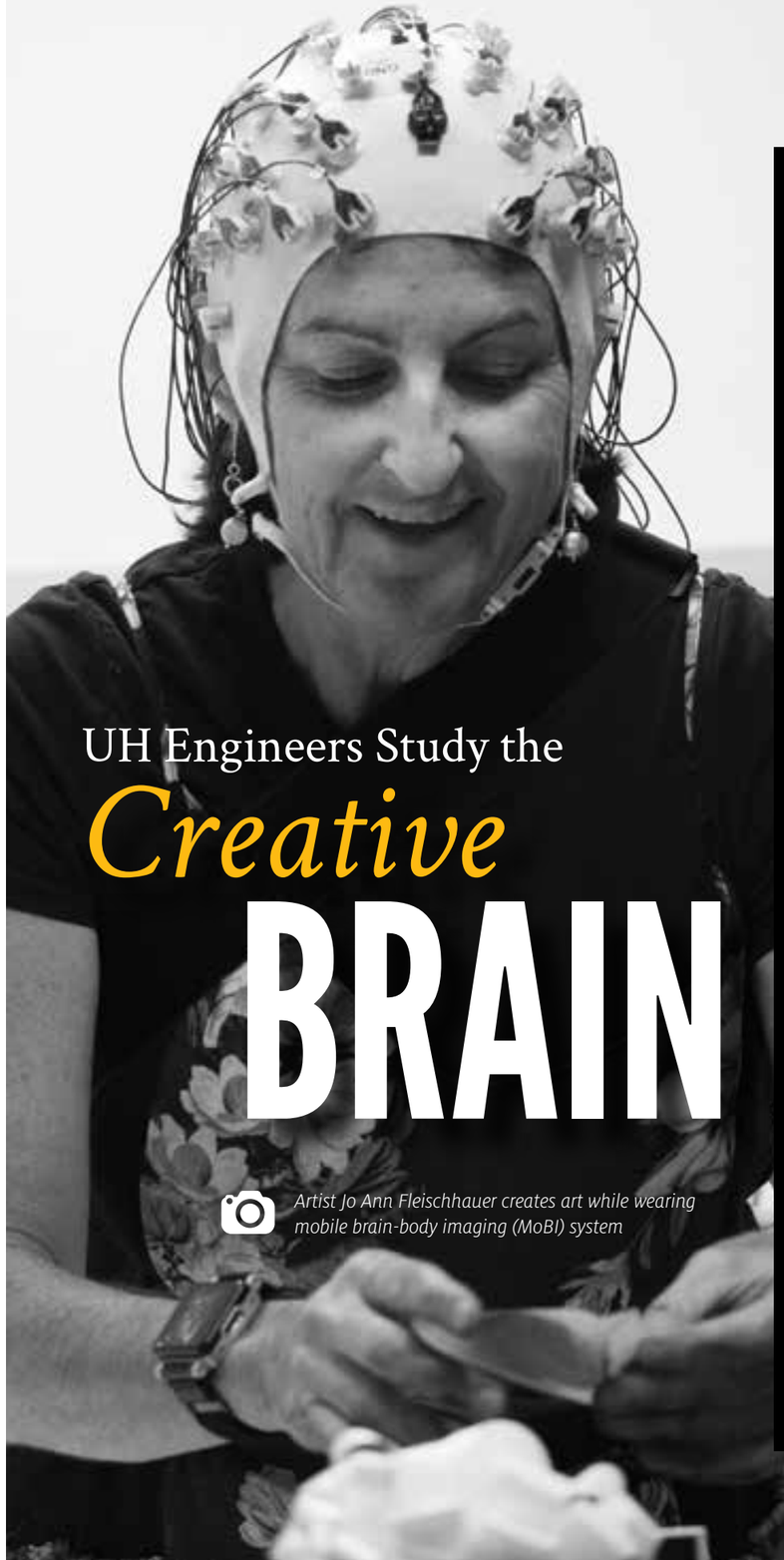
For the initial tests, the probe was optimized for rat brain imaging, useful for biomedical research involving neurological disorders. But it also has direct implications for human healthcare, Wosik said.

"Research in animal models yields critical information to improve diagnosis and treatment of human diseases and disorders," he said. "This work also has the potential to clearly benefit clinical MRI, both through high quality imaging and through shortening the time patients are in the scanner."

Results from preliminary testing of the 7 Tesla MRI Cryo-probe were presented at the International Symposium of Magnetic Resonance in Medicine annual meeting last May. The coil can be optimized for experiments on living animals or brain tissue samples, and researchers said they demonstrated an isotropic resolution of 34 micron in rat brain imaging. In addition to its use in MRI coils, superconductivity lies at the heart of MRI scanning systems, as most high-field magnets are based on superconducting wire.

In addition to Wosik, collaborators on the project include Ponnada A. Narayana, director of the Magnetic Resonance Imaging Center and a professor in the department of diagnostic and interventional imaging at the University of Texas Health Science Center at Houston; Kurt H. Bockhorst, senior research scientist at UT Houston; Kuang Qin, a graduate student working with Wosik; and I-Chih Tan, assistant professor in the department of neuroscience at Baylor College of Medicine.

"Compared to corresponding standard room temperature MRI coils, the performance of the cooled normal metal and/or the high-temperature superconducting receiver coils lead either to an increase in imaging resolution and its quality, or to a very significant reduction in total scan time," Wosik said.



UH Engineers Study the *Creative* BRAIN

Artist Jo Ann Fleischhauer creates art while wearing mobile brain-body imaging (MoBI) system

BY ASHLEY SCHWARTZ

In an innovative collaboration between scientists and artists, "Your Brain on Art" is a series of studies that seeks to understand what happens in the brain as people create and contemplate art.

To explore this mystery, **Jose 'Pepe' Luis Contreras-Vidal,** professor of electrical and computer engineering at UH and director of the University's Non-Invasive Brain Machine Interface Systems Laboratory, has teamed up with Houston-based sculpture installation artist **Jo Ann Fleischhauer** in an 18-month-long study on the creative process.

For the study, Fleischhauer wears a mobile brain-body imaging (MoBI) system, which is comprised of a portable electroencephalography (EEG) headset, motion sensors and a video camera, while researching and working on her current art project. She also wears the headset while conducting her daily activities, such as going to the gym and cleaning her house – activities that can sometimes lead to creative inspiration for Fleischhauer. The goal of the project is to create spatial and temporal maps of neural activity in Fleischhauer's brain linked to the aesthetic and creative experiences.

"This is the first experiment, at least to my knowledge, wherein researchers have been tracking EEG data for such a long period of time," said Ph.D. student and UH-Houston Methodist Fellow Jesus Cruz-Garza. "We are collecting data in a very unconstrained setting, which is not typical in neuroscience."

Contreras-Vidal is hopeful that the results of this study will further bridge the gap between art and science, and lead to broader impacts in science, technology, engineering, art and math (STEAM).

"We know that creativity is important in the arts. What we would like to say is that creativity is also important in engineering and science," he said.

WATCH OUR VIDEO ABOUT THIS RESEARCH AT
www.egr.uh.edu/creative-brain-video

HOW THE GRAY MATTERS:

Your Brain on Art Conference

BY ASHLEY SCHWARTZ

The human brain weighs only about 3 pounds, but inside that small compartment are 86 billion neurons – gray matter as they are known – ruling the entire universe of your body. One of the most curious studies of the brain delves into what happens inside it when you're thinking of art or creating it. That's how the "Your Brain on Art" research series got its name and why more than 100 engineers, scientists, artists and media representatives gathered for the 2016 International Conference of Mobile Brain-Body Imaging and the Neuroscience of Art, Innovation and Creativity ("Your Brain on Art" conference) in Cancun, Mexico.

The invitation-only conference was held in July and encouraged leaders in the science and art fields to collaborate and discuss the future of neuroaesthetics and neurocreativity, as well as the potential applications of this research in medicine, science, engineering, education and the creative arts.

"Your Brain on Art" is a partnership between the University of Houston's Non-Invasive Brain Machine Systems Laboratory and Blaffer Art Museum. **Jose Luis Contreras-Vidal,** Hugh Roy and Lillie Cranz Cullen University Professor of electrical and computer engineering, pioneered the "Your Brain on Art" partnership and served as chair of the conference. Klaus Gramann, professor of biological psychology and neuroergonomics at the Berlin Institute of Technology, served as the co-chair of the conference.

LEARN MORE ABOUT THE ANNUAL CONFERENCE AT
yourbrainonart2017.egr.uh.edu

WATCH OUR VIDEO OF THE 2016 YOUR BRAIN ON ART CONFERENCE AT
www.egr.uh.edu/yourbrainonart-2016-video

The discussion topics at the conference touched on five critical areas:

1. **Understanding** human responses to emotional stimuli such as the creative arts, our physical environments and our interactions with technology
2. **Finding** the best methods for reverse engineering the brain to understand aesthetic and creative experiences
3. **Identifying** the artistic, scientific and engineering challenges that affect collaboration and innovation
4. **Optimizing** and personalizing art as a form of therapy
5. **Designing** new tools for understanding and promoting creativity, health and wellness

View more photos from the UH Cullen College of Engineering on our Flickr page

www.flickr.com/photos/CullenCollege

"It was important that we brought together experts from a variety of disciplines to ensure that we had the most challenging and enriching discussions possible. Creativity and aesthetic experience are essential qualities in the arts, science, engineering and medicine, and thus it is important to understand, measure and promote neural activity associated with creativity."

- Jose Luis Contreras-Vidal

Professor Joe Francis' Mind is Teeming With Ways to

TEAM WITH ROBOTS

BY LAURIE FICKMAN

To the unfamiliar, it might seem a Jedi mind trick – the notion of controlling robots by simply thinking of what you wish for them to do.

If so, then **Joe Francis,** associate professor of biomedical engineering, is Obi-Wan Kenobi. The force, along with a grant from the National Science Foundation (NSF) for $308,077, is with him as he works to expand humans' ability to work with robots.

To Francis, his project, "NRI: Collaborative Research: Multimodal Brain Computer Interface for Human-Robot Interaction," is all about teamwork. "We're teaming the human with the robotic systems," he said. "The robots can do certain things really well, but they're going to need some guidance, and rather than have the person guide them continuously with trying to inform them about everything, there's this interplay between the two systems."

The goal is to determine how well artificial agents and humans can work together instead of getting in each other's way.

It's personal

Once that teamwork is improved, Francis believes it and other research he is conducting will change people's lives by improving sensory prosthetics. His devotion to this belief is a deeply-felt cause, one he's probably had since first grade.

That was the year he lost the big toe on his left foot in a terrible accident, and he immediately found ways to overcome the loss, excelling at sports quickly and all the way through college. Sure enough, he helped himself profoundly with his determination. Now he's set his mind on doing the same for others.

"If somebody is blind, I want them to be able to see. If somebody can't hear, I want them to be able to hear. If they don't have an arm, I want to give them an arm and be able to control it naturally and I want them to feel it as if it was a part of them so they don't feel like they're using this tool, but they feel whole again," said Francis.

That's where focus shifts to the brain. Current human robot interaction (HRI) centers around video, keyboards and, plainly, just speaking to them – telling them what you want. The world Francis envisions makes robots part of everyday life and our communication with them second nature. That's also the idea of co-robotics, as expressed by the NSF, which acknowledges humans as part of a larger robotic control system.

Coordinating the team

Francis works to take information from humans and give it to robots so they can anticipate what humans want in the future. He does this by recording human brain waves through EEG and brain hemodynamics, or blood changes, through an imaging process called Functional Near-Infrared Spectroscopy (fNIRS).

"From that we can determine how active different brain regions are," said Francis. He also collects data by watching the eyes and recording them with high-speed cameras since pupils actually change size when certain rewarding or punishing events happen.

Unexpectedly, the researchers can also determine a reward/expectation signal from a person's brain.

"We can basically tell if they think something is leading to a reward or something good," said Francis.

Once that human data is collected, Francis takes it to improve the software for his robots and improve their learning agent.

He's robotic, too

In the old television series, "The Six Million Dollar Man," the lead character had robotic and bionic limbs. Francis doesn't have any of that, but you can call him the six million dollar man, too, because his robot research has brought in just about that amount of funding since arriving at the UH Cullen College of Engineering in March of 2016.

In the words of Obi-Wan, "I have the high ground."

POWERING the Air & Sea:

Haleh Ardebili Receives Two Grants to Store Energy

BY LAURIE FICKMAN

Imagine

a battery that doesn't fit neatly into its appointed slot, one that's neither cylindrical nor square shaped, but perhaps as thin as a business card and as stretchy as Play Dough.

If you can envision that, then you've jumped into the mind of **Haleh Ardebili,** Bill D. Cook Assistant Professor of mechanical engineering at the UH Cullen College of Engineering.

Ardebili is a bit of a juggler, with two new grants worth more than half a million dollars. What's more, her funding for energy storage research stretches – like her batteries – from the depths of the sea with an award from the Subsea Systems Institute, to the outer reaches of the atmosphere with money from the Air Force Office of Scientific Research (AFOSR).

Making smart uniforms even smarter

For the Air Force, Ardebili, principal investigator (PI) Jodie Lutkenhaus at Texas A&M University, and other co-PIs at A&M may just end up making smart uniforms last longer.

Textile manufacturers have been advancing smart materials that can communicate, store energy, regulate temperature and monitor health. But the batteries to power those kinds of fabrics have to be charged and integrated into the material so that those who wear them feel comfortable in their own skin.

"We're looking at how the fibers come together with the graphene," said Ardebili. "So we'll look at the electrochemical properties and mechanical properties, too." It's the kind of flexible battery that Ardebili makes in her lab. That's why she likes to bend it and have her students play with it. It's all research.

"Externally, if you bend it, what's going to happen with it?" she wonders. "And what happens internally when the lithium ions stress the electrode?" She conducts research on both levels.

That's what the research is focused on, technically known as aramid nanofiber-functionalized graphene electrode for structural energy storage, and it involves experiments and modeling for the design, testing and analysis of ANF/FG electrodes. The total award is approximately $1 million; the portion for UH is $260,000.

Powering down below the ocean

The Subsea Systems Institute Award for $300,000 is a collaboration between Ardebili and Jim Tour of Rice University. This research project is focused on the fabrication, testing and analysis of batteries and supercapacitors for subsea applications.

Whether on an oil rig or an autonomous underwater vehicle (AUV), batteries can supply the power that keeps them working – during an emergency power outage in an oil rig, or during normal AUV operation. Ardebili's goal is to make sure those batteries are as safe as possible.

To make safer batteries, she is replacing the flammable organic liquid electrolyte currently inside of traditional lithium-ion batteries with polymer electrolytes, which are not flammable.

"Safety is number one in my mind. The most compelling reason we would have a polymer electrolyte and not an organic liquid electrolyte is safety," said Ardebili.

Her next goals are to get the batteries to last longer while providing design flexibility (the bendable, stretchy batteries of which she's so proud).

"We're not bound to these rigid space requirements," said Ardebili. "You can bend it, it can conform to various shapes."

ENERGY

For subsea applications, the design is enhanced to make sure it isn't vulnerable to pressure and corrosion. Casings and boxes are built to protect the electronics inside, but instead of the battery getting bigger and bigger with each protective layer added, it is paper thin.

"Materials are very important, and if they are flexible and can conform to various spaces, at least you are opening up some design parameters that allow more space-efficient design, so hopefully you have more space for other requirements in those vehicles," she said.

Energy becomes her

Ardebili herself is filled with energy as she speaks about the world she envisions, where batteries are integrated into every aspect of our lives – walking on shoe-charging batteries, wearing clothes that are electronically integrated and, mostly, continuing to question what people think is normal about energy science.

"Just kind of flipping upside down the traditional understanding of how batteries are supposed to behave, I ask, 'Really? Do they have to?'" Ardebili says.

No, they don't. Not in Ardebili's world. And soon, because of her continuous questioning and research, not in ours, either.

UH Professors May Create Safe, Affordable Nuclear Energy,

CHANGING THE NATIONAL CONVERSATION

BY LAURIE FICKMAN

Research underway in a UH Cullen College of Engineering laboratory to make "heavy water" less expensively could soon make nuclear energy safer, eliminating real-life disasters like those that have occurred at the Fukushima and Chernobyl nuclear power plants.

It may seem impossible, but **Stanko Brankovic,** associate professor of electrical and computer engineering, **Lars Grabow,** assistant professor of chemical and biomolecular engineering and Ognjen Miljanic**,** associate professor of chemistry, have received a $400,000 grant from the National Science Foundation to make the impossible come true.

Their mission is to find a way to make heavy water, the coolant used in wet nuclear reactors, as accessible as, well, water.

Reactor safety: wet vs. dry

When it comes to nuclear energy and safety, it all boils down to the type of nuclear reactor that's powering the plant. In the cases of Fukushima, Chernobyl and 66 percent of all nuclear reactors in the world, the reactors are classified as light water, or dry reactors. They use weapons-grade enriched uranium or plutonium as fuel, and their primary coolant is water. They are hard to control and can go supercritical, which means the nuclear chain reaction cannot be stopped and the reactor core can melt down.

On the other hand, no nuclear spills or emissions involving heavy water reactors, also known as wet reactors, have ever occurred.

Heavy water nuclear reactors use either mildly-enriched uranium, which contains about 4 percent of the radioactive isotope, or natural uranium, which only has about 0.7 percent.

"The nuclear fuel used in a wet reactor cannot be used for a nuclear bomb, so proliferation of this technology to the world is a safe way of securing affordable energy for everybody," said Brankovic. "Wet reactors cannot go supercritical, and their operation and control involves less risk for nuclear pollutant emission."

The heavy water used as coolant in wet reactors is made with a heavy isotope of hydrogen; this kind of water is literally heavier than the H20 that runs out of our water faucets.

For every 10,000 molecules of regular water, only one molecule will actually contain an element known as deuterium which, with oxygen, makes D2O, or deuterium oxide. This is the heavy isotype of hydrogen, or the heavy water so in demand.

With something as rare as D2O, the cost to separate it far surpasses the cost of enriching the nuclear fuel or making plutonium. That's why the wet reactors are less popular, even though they are much safer.

> "SAFE NUCLEAR ENERGY IS ONE OF THE SOLUTIONS TO MANY OF THE WORLD'S PROBLEMS."
>
> - STANKO BRANKOVIC

"Therefore, making the heavy water more affordable will make safe nuclear energy more affordable and more widespread across the United States and world," said Brankovic.

Breaking up is hard to do

Separation of water molecules doesn't come cheaply. "But if we can have a catalyst that is more efficient in separating D2O from regular water, we're saving energy, which means the price of the heavy water will go down and wet reactors will be more financially beneficial," said Brankovic.

Brankovic is no stranger to the catalyst design business. In 2001, he was highly cited for his work on creating a catalyst for fuel cells, the kind that ultimately brought us the electric car.

The catalysts Brankovic, Grabow and Miljanic are making are special strained platinum and palladium monolayers that will increase the strength of the adsorbed hydrogen bond, leading to better isotope separation efficiency.

Nuclear safety and world peace?

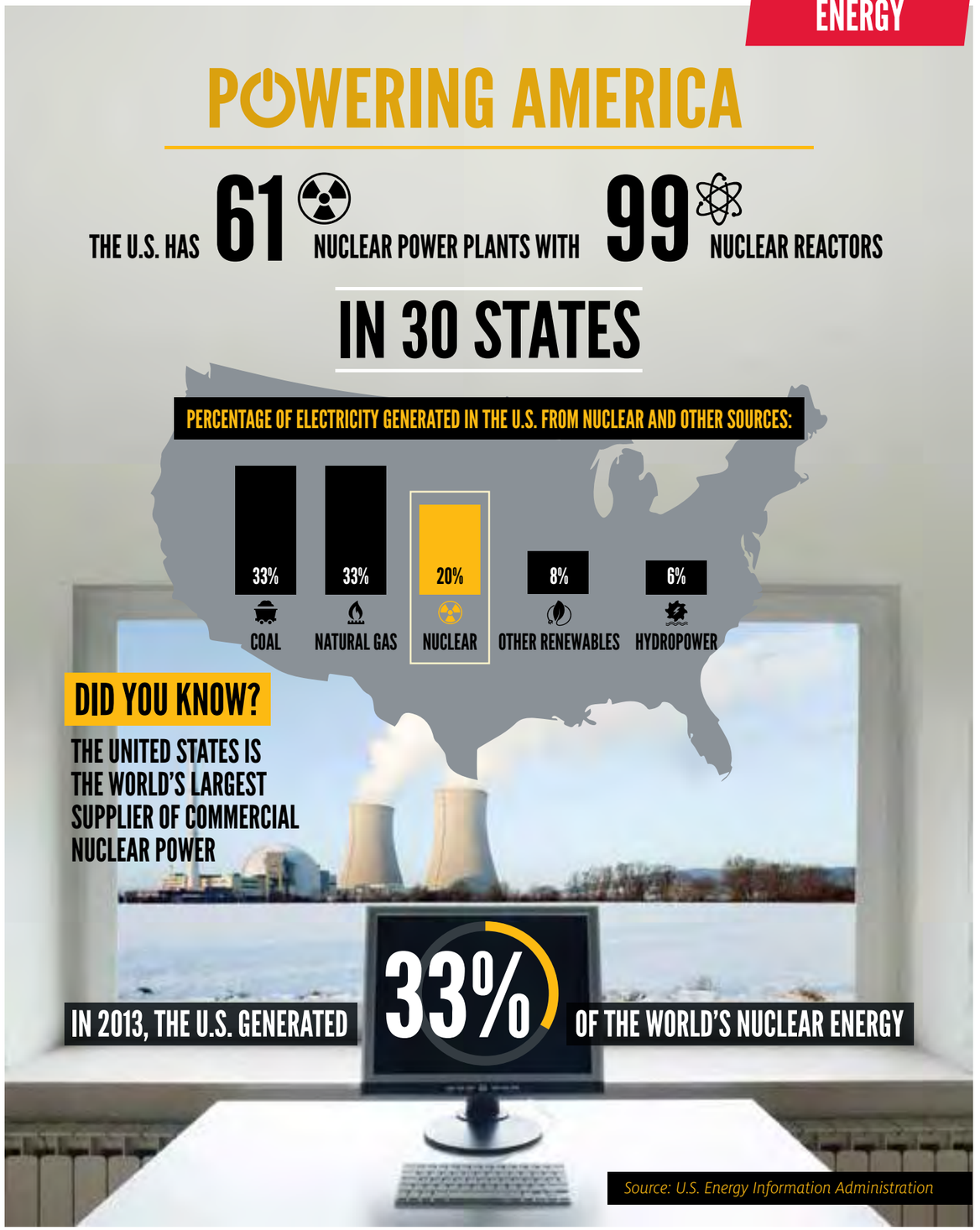
"Safe nuclear energy is one of the solutions to many of the world's problems," said Brankovic. He talks about a world where more wet nuclear reactors are online using the heavy water that he will create so inexpensively. Those reactors will also be using natural uranium.

"The whole problem now is that you don't know if anyone is enriching uranium for their reactors to produce electricity or because they want to make nuclear bombs," said Brankovic. "How do you police this?"

He thinks there is one certain way. By using heavy water reactors and providing methods to collect enough heavy water affordably. When heavy water is plentiful, dry reactors will no longer be needed and neither will the enriched uranium or plutonium used to make nuclear bombs.

"Ideally we can make the world a safer place," said Brankovic. That global safety may one day be traced back through Brankovic and his team to the UH Grants to Enhance and Advance Research (GEAR) program, which provided funding as they were preparing grant proposals.

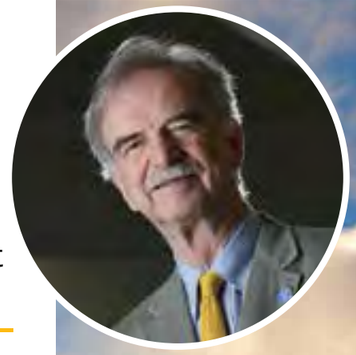
"This allowed my colleagues and I to create a competitive proposal that will lead to breakthrough research," said Brankovic.



$3 MILLION DOE PROJECT

to Evaluate Safety of Transporting Used Nuclear Fuel, Develop Methods to Monitor Fuel Stability During Transit

BY JEANNIE KEVER



Kaspar Willam is finding ways to safely transport used nuclear fuel

With more than 74,000 metric tons of used nuclear fuel stored at locations around the United States, ensuring the safety of moving it to more secure disposal sites is a top federal priority.

A University of Houston engineer will lead a $3 million, multi-institution effort to develop monitoring techniques to ensure the nuclear materials remain stable during transit under both normal conditions and in case of an accident.

The project, part of the U.S. Department of Energy's Nuclear Energy University Programs, will involve researchers from the University of Houston and five other organizations: the University of Illinois at Urbana-Champaign, the University of Southern California, the University of Minnesota, Pacific Northwest National Laboratory and Anatech Corporation.

The goal, said **Kaspar Willam,** Hugh Roy and Lillie Cranz Cullen Distinguished Professor of civil and environmental engineering, is to ensure spent nuclear fuel can be safely transported from temporary storage at nuclear plants around the country to interim storage sites that will be designated by the Energy Department, and eventually to permanent storage. No permanent disposal site has been approved.

Willam, principal investigator for the grant, said more used nuclear fuel, encased in high-performance steel casks, is expected to be moved to the interim storage sites once the safety of transporting the casks – huge enclosures, measuring as much as 25 feet in length, with the fuel rods held in place by a grid – has been established.

The spent fuel has been cooled at the nuclear power plants where it was used before being packed into the casks. "Under normal transport conditions, there will be no problem," Willam said.

He and other researchers will consider both what happens to the spent fuel in case of an accident – a train carrying the fuel casks derails, for example, or a cask falls from a truck – as well as during the routine jostling that occurs in the course of cross-country transport.

"The idea is to investigate the unexpected issues of transporting the nuclear casks," Willam said.

Each member institution will take on a different component.

Willam, a member of the National Academy of Engineering and an expert in infrastructure and structural integrity, will study structural issues, including the effect of unanticipated translateral movement. Nuclear engineers at the University of Illinois at Urbana-Champaign will perform risk analysis, including the risk of a temperature increase if the rods came into contact with one another. Other team members will explore new sensing techniques to detect changes in the internal composition of the rods and various uncertainty probabilities – what could happen, and how likely it is to happen.

Environmental Engineer

BOOSTS OIL PRODUCTION EFFICIENCY

with Department of Energy Grant

BY NATALIE THAYER

A researcher at the UH Cullen College of Engineering is collaborating with researchers from multiple universities and national labs on a major Department of Energy (DOE) project to tackle one of the biggest challenges in the energy industry –controlling mineral scaling to improve oil production efficiency.

Everyone with a water faucet knows the nuisance of limescale, the chalky deposits of minerals that tend to build up inside water heaters, pipes and pots. If left untreated, limescale can obstruct the flow of water through pipes and cause serious damage to various components of water lines and water heating systems.

Similarly, mineral scaling inside oil wells poses significant obstacles to efficiently extracting energy resources. Naturally-occurring minerals inside of oil wells can collect on the surface of rocks, equipment or pipes, forming a coating similar to limescale. This build up of mineral scale can drastically hinder the flow of oil out of the well and compromise the effectiveness of oil production equipment.

Yandi Hu, assistant professor of civil and environmental engineering, was awarded a three-year, $204,000 grant to study the growth of barium sulfate, a scale-forming mineral commonly found inside of oil wells and reservoirs. Hu serves as a co-principal investigator (PI) on the project, which is led by PI Andrew Stack of Oak Ridge National Laboratory. The goal of Hu's research group is to reveal the fundamentals of barium sulfate scale formation to better control mineral scaling in oil production processes and sites.

"We're looking at the nucleation and growth – the initial stages – to understand how barium sulfate starts to form on the surfaces of the rocks," she said.

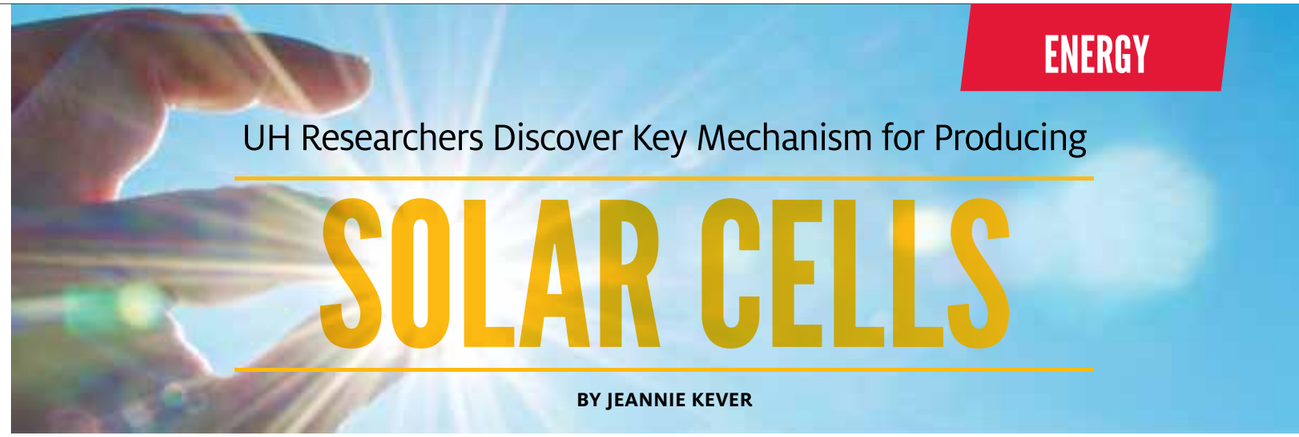
Barium sulfate scaling occurs inside an oil well when the mineral precipitates. In severe cases, the scaling can form solid mineral deposits on the surface of production equipment and inside of production piping, rendering the equipment ineffective and sometimes plugging the piping completely.

Even in milder cases, the precipitation of barium sulfate causes massive headaches for oil producers. In the hydraulic fracturing process, where liquid is injected at high pressure into shale – a thin layer of oil-rich rock – scaling can restrict or block the flow of oil through the rock's tight pores and cracks.

Although scale removal is common for oil well operation, current methods are costly and limited in effectiveness. Producers can add polymers to inhibit the production of barium sulfate, but the method is expensive and difficult to control, sometimes even leading to a permanent decrease in oil production in a reservoir.

Hu will conduct laboratory experiments on synthetic organic coatings on rock surfaces to understand the fundamental growth mechanisms of barium sulfate mineral scale formations in oil and gas reservoirs at the molecular level. Her experiments will take into account various conditions, such as the presence of impurity ions like strontium and radium, as well as the presence of inhibitors and other organic materials inside of the well that could impact scale formation.

"Once we have such fundamental understanding, we can better predict and control what's happening in the subsurface environment," she said. "With this data we can give some useful suggestions about the selection of the operation conditions and how industry can design the appropriate inhibitors. We are providing the basis for further applications."



ENERGY

UH Researchers Discover Key Mechanism for Producing

SOLAR CELLS

BY JEANNIE KEVER

Researchers from the University of Houston have reported the first explanation for how a class of materials changes during production to more efficiently absorb light, a critical step toward the large-scale manufacture of better and less-expensive solar panels.

The work, published in July as the cover story for *Nanoscale*, offers a mechanism study of how a perovskite thin film changes its microscopic structure upon gentle heating, said **Yan Yao,** assistant professor of electrical and computer engineering and lead author on the paper. This information is crucial for designing a manufacturing process that can consistently produce high-efficiency solar panels.

Last year Yao and other researchers identified the crystal structure of the non-stoichiometric intermediate phase as the key element for high-efficiency perovskite solar cells. But what happened during the later thermal annealing step remained unclear. The work is fundamental science, Yao said, but critical for processing more efficient solar cells.

"Otherwise, it's like a black box," he said. "We know certain processing conditions are important, but we don't know why."

Other researchers involved with the project include first author Yaoguang Rong, previously a postdoctoral fellow at UH and now associate professor at Huazhong University of Science and Technology in China; UH postdoctoral fellows Swaminathan Venkatesan and Yanan Wang; **Jiming Bao,** associate professor of electrical and computer engineering at UH; Rui Guo and Wenzhi Li of Florida International University, and Zhiyong Fan of Hong Kong University of Science and Technology.

Yao is also a principal investigator at the Texas Center for Superconductivity at UH, which provided funding for the work.

The work also yielded a surprise: the materials showed a peak efficiency – the rate at which the material converted light to electricity –

before the intermediate phase transformation was complete, suggesting a new way to produce the films to ensure maximum efficiency. Yao said researchers would have expected the highest efficiency to come after the material had been converted to 100 percent perovskite film. Instead, they discovered the best-performing solar devices were those for which conversion was stopped at 18 percent of the intermediate phase, before full conversion.

"We found that the phase composition and morphology of solvent engineered perovskite films are strongly dependent on the processing conditions and can significantly influence photovoltaic performance," the researchers wrote. "The strong dependence on processing conditions is attributed to the molecular exchange kinetics between organic halide molecules and DMSO (dimethyl sulfoxide) coordinated in the intermediate phase."

Perovskite compounds commonly are comprised of a hybrid organic-inorganic lead or tin halide-based material and have been pursued as potential materials for solar cells for several years. Yao said their advantages include the fact that the materials can work as very thin films – about 300 nanometers, compared with between 200 and 300 micrometers for silicon wafers, the most commonly used material for solar cells. Perovskite solar cells also can be produced by solution processing at temperatures below 150 degrees Centigrade (about 300 degrees Fahrenheit) making them relatively inexpensive to produce.

At their best, perovskite solar cells have an efficiency rate of about 22 percent, slightly lower than that of silicon (25 percent). But the cost of silicon solar cells is also dropping dramatically, and perovskite cells are unstable in air, quickly losing efficiency. They also usually contain lead, a toxin.

Still, Yao said, the materials hold great promise for the solar industry, even if they are unlikely to replace silicon entirely. Instead, he said, they could be used in conjunction with silicon, boosting efficiency to 30 percent or so.

UH Chemical Engineer Harnesses

HIGH PERFORMANCE COMPUTING POWER

to Design Improved Zeolite Catalysts

BY LAURIE FICKMAN

Jeremy Palmer, assistant professor in the Cullen College's chemical and biomolecular engineering department, was awarded the American Chemical Society Petroleum Research Fund's Doctoral New Investigator Grant. The prestigious award supports fundamental, high-caliber research in the petroleum field and promotes the careers of young engineers and scientists.

Palmer will use the two-year, $110,000 award to design improved zeolite catalysts using computational modeling techniques.

Zeolites are three-dimensional, crystalline minerals used in a wide variety of industrial processes and commercial products. They occur naturally, but can also be mass produced synthetically. The petrochemical industry commonly uses zeolites as catalysts because they efficiently speed up chemical reactions and can be produced relatively cheaply.

"Zeolites help make many chemical reactions economically feasible on an industrial scale," said Palmer.

Their topography, with thousands of tiny pores, makes them uber-effective as industrial catalysts. These tiny holes can temporarily trap individual molecules during a chemical reaction, thereby lowering the energy required to chemically-convert those molecules into more valuable compounds.

Compounds converted by zeolites are used in products ranging from fuels and plastics to value-added chemicals. Zeolites also help to make industrial processes more sustainable by minimizing the production of wasteful byproducts.

Palmer's work is inspired by experiments done at the Cullen College by Jeffrey Rimer, Ernest J. and Barbara M. Henley Associate Professor of chemical and biomolecular engineering. In Rimer's group, much has been discovered about the importance of the size and shape of zeolite crystals. Naturally-growing zeolites tend to form large crystals, but smaller crystals perform better as catalysts.

"Experimental work at UH has shown that smaller zeolite crystals last longer and give higher product yields. Both properties reduce waste and improve process sustainability," said Palmer.

To control crystal size and shape, Rimer and his collaborators introduced growth modifiers – chemicals like amino acids and alcohols – into the growth solutions used to synthesize zeolites. When these compounds are present during crystallization, zeolite growth is systematically altered to produce a desired size and shape. The crystals can be tuned to form thin platelets, for example, when normally they would grow into the shape of large cylinders.

While experimental techniques have primarily been used to search for effective growth modifiers, Palmer's work uses computer simulation to add predictive capability to the process.

"We want to identify classes of growth modifier compounds that are likely to work to get the desired crystal shape and size," said Palmer. "This is slow and expensive to do experimentally, so we are harnessing the power of molecular modeling and the supercomputing facilities at UH's Center for Advanced Computing & Data Systems to expedite the process."

After identifying the growth modifier compounds that are most likely to cause the desired changes in crystal shape and size, Palmer will build computational models of zeolites to study how the chemical compounds interact with the surface of the zeolites. When the surface interactions are understood, Palmer will know how the growth modifier compounds will alter the crystal's shape and size.

It seems the smaller the zeolite, the larger the potential for impact on the oil and gas industry and the world around us. Looking to the future, small zeolites may help convert natural gas into products like polyethylene that have traditionally been derived from petroleum. Palmer said he hopes his team will help to realize that potential using his computer models.

NEW BOOK

Offers Comprehensive Look at Fracturing Horizontal Wells

BY JEANNIE KEVER

Fracturing horizontal wells has had a profound impact on the U.S. oil and gas industry over the past 25 years, allowing production from fields once considered too marginal to produce. A new book, "Fracturing Horizontal Wells," translates that history and the lessons learned into a comprehensive look at the process, from planning to production.

Mohamed Soliman, chairman of the department of petroleum engineering, co-wrote the book with Ron Dusterhoft, technology fellow for Halliburton Energy Services.

"We look at the issues people worry about in fracturing and completion of horizontal wells," said Soliman, who joined UH last summer. "At the end, we address environmental issues, which have become very important, especially in areas plagued by drought."

Environmental issues weren't a factor when the first well was fractured in 1947. That was a vertical well, and the technique enjoyed a burst of popularity in the 1970s. But Soliman, who spent more than 30 years at Halliburton before entering academia in 2011, said even fractured vertical wells were unable to economically produce hydrocarbons from shale fields.

As chief reservoir engineer at Halliburton, Soliman was involved in the first fractured horizontal well, an experiment in the late 1980s that was funded by a number of oil companies interested in the research it yielded on drilling, logging, fracturing, cementing and other procedures. Soliman later published and presented the results at conferences around the world.

Oilman George Mitchell is credited with popularizing the technique in the Barnett Shale in North Texas several years later.

"Fracturing Horizontal Wells," published by McGraw Hill, is aimed at an industry audience, although Soliman said it is suitable for graduate petroleum engineering students who already have some knowledge of the technique. Among the topics covered are: fracture stimulation of horizontal wells, transitioning from vertical to horizontal wellbores, proppant and proppant transport, interval isolation, and horizontal completion fracturing methods and techniques.

Soliman, who holds 29 U.S. patents, has written a chapter in the textbook "Well Construction," chapters in World Oil's "Handbook of Horizontal Drilling and Completion Technology" and the Society of Petroleum Engineers monograph "Well Test Analysis of Hydraulically Fractured Wells," as well as serving as author or co-author of more than 200 papers.

Mohamed Soliman literally wrote the book on fracturing horizontal wells

PEOPLE POWER

Technology Allows Smartphone-based Water Testing

BY JEANNIE KEVER

Ever wondered what's in the neighborhood pond? Technology developed by engineers at the University of Houston will allow you to test for waterborne pathogens by using your smartphone.

"The goal is to have citizens help to investigate and monitor water quality near where they live, while educating people about potential threats in environmental or drinking water," said **Wei-Chuan Shih,** associate professor of electrical and computer engineering at UH. "This type of citizen science is a priority for the National Science Foundation (NSF), to increase awareness of science and technology through individual participation."

Shih received a $100,000 grant from the NSF citizen science initiative to develop the technology, which builds upon an inexpensive lens his lab created last year, allowing people to turn their smartphones into microscopes.

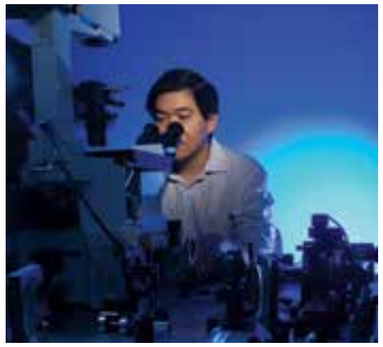
"Almost everyone has a smartphone," he said. "Our goal is simple components that work with commercially available test kits, so people can order what they need to engage in this activity."

He and members of his lab created DotLens to produce and distribute the inkjet printed lenses, which attach directly to a smartphone camera lens. The researchers now are using 3D printing to create an attachment that provides a narrow-band light source, which will allow people using commercial water testing kits to see and identify waterborne pathogens.

The attachment allows the user to control the light spectrum emitted, fine-tuning it to make different pathogens visible under magnification, said Yulung Sung, a doctoral candidate working in Shih's lab.

Shih said the system initially will test for two types of pathogens: Giardia lamblia and Cryptosporidium parvum, both of which can enter the body through the nose and mouth and cause intestinal infection. They can be serious – a 1993 outbreak of Cryptosporidium parvum in Milwaukee affected more than 400,000 people, according to a study by the U.S. Centers for Disease Control and Prevention.

Test kits are already available to allow people to detect pathogens in water, but without fluorescent microscopy – a microscopic technique that employs a narrow spectrum of light – those pathogens aren't visible, even



Wei-Chuan Shih is turning citizens into scientists with his latest invention

under magnification. The kits target specific pathogens, and if those pathogens are present when exposed to the light, they become visible. If there are no pathogens in the water sample, there's nothing to see.

But most people don't have access to fluorescent microscopy. The DotLens and Shih's attachment serve as a low-cost alternative. The lenses sell for $12.99 and up; a price for the light source hasn't been set.

By changing the light spectrum, researchers – and nonscientists armed with the attachment and a smartphone – could use the same system for other water contaminants, including lead, Shih said.

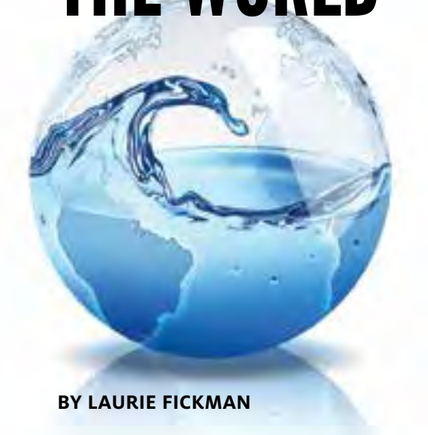
Sung and Hoang Nguyen, who also is a Ph.D. student working in Shih's lab, are currently testing the device on water samples collected from around the region in order to refine its performance and record what they find. She said that two undergraduates, Fernando Campa from the University of Texas at Arlington and Kelly O'Shaughnessy from the University of Cincinnati, worked as the lab's first "citizen-scientists" over the summer under a NSF Research Experiences for Undergraduates grant.

Ultimately, Shih said he envisions an online map to be drawn collaboratively with citizen scientists, posting and sharing their findings.

"This is like completing a puzzle with a community of citizen scientists who share similar interests," he said.

UH Engineer Dives in to Determine

HOW MUCH WATER EXISTS IN THE WORLD



BY LAURIE FICKMAN

Hyongki Lee, assistant professor of civil and environmental engineering at the Cullen College, is making quite a splash. Lee has accomplished so much in the field of water you could say he's all over the map, and soon his work will be high above the map, too. He's helped Pakistani officials manage water resources and was selected by NASA to do the same in Indochina. Now NASA has come calling again, making Lee part of the prelaunch team for their Surface Water & Ocean Topography (SWOT) satellite mission – set to go airborne in 2020 – to conduct the first global survey of Earth's surface water.

No satellite mission has ever been designed to specifically examine surface water – SWOT is the first of its kind. In 2007, the National Research Council Decadal Survey of Earth Science selected it as one of the missions that NASA should implement in the next decade.

According to NASA, the SWOT mission, which is a joint venture with CNES, the French space agency, "will provide the very first comprehensive view of Earth's freshwater bodies from space and will allow scientists to determine the height and area of fresh water across the globe at an unprecedented resolution."

Maybe it's time

The truth is no one really knows how much water we have on Earth or understands much about its movement. "We don't have much clue," said Lee.

Come 2020, after the SWOT satellite mission gathers its data of freshwater storage changes in global lakes, he hopes to have more than just a clue – especially about the Mississippi Basin, which is the portion of the mission he is examining.

"How much water we have in the world is a fundamental question and mystery of science," said Lee. "We need to first have a holistic picture of where water is and how much there is. Those are the questions we need to answer to have proper resource management."

To help find the answers, NASA will give Lee $80,000 over the next four years. The principal investigator (PI) is Edward Beighley of Northeastern University and two other co-PIs come from Ohio State University and the Jet Propulsion Laboratory.

But first, math and computer science

The very trajectory of the satellite, or orbital design, is something Lee has had a hand in developing. In 2010 he helped determine which way the SWOT satellite must travel to get that holistic look at the world's terrestrial surface waters.

Now Lee has switched his own trajectory, concentrating on developing the scientific algorithm that will determine water discharge amounts. The satellite will gather the data and then go through the formula being developed by Lee and his colleagues.

"The algorithm will make the information readily accessible and usable," said Lee.

To create the algorithm, Lee and his colleagues will use SWOT-like data, simulating and predicting the information SWOT will eventually deliver. To develop the SWOT-like data, the team will use existing satellite measurements including lake storage changes, river level elevation data, precipitation data and a hydrology model.

"Once we have all this we can think about what kind of algorithms to use to calculate the river discharge from the real SWOT data," said Lee.

An international mix from above

When the math is delivered, NASA will use it to continue planning the mission. Then, in 2020, high above our heads, SWOT's eyes in the sky will observe the details of our surface water and measure how all the bodies of water change with time.

Those details will be delivered to the mission alliance, comprised of U.S. and French oceanographers, hydrologists and other international partners who have been with the project since the concept was first developed in the early 2000s.

If measured in time, the project has taken a good bit, but in this water-thirsty world the need for basic information about this precious natural resource is incalculable.

"Using data from the SWOT satellite mission, our expectation is to have a more complete understanding of surface water distribution and volume changes," said Lee.

UH Biomedical Engineer Pursues

NERVE REGENERATION

BY JEANNIE KEVER

A biomedical engineer from the University of Houston will use a $1.2 million grant from the National Institutes of Health to determine how best to spur nerve regeneration in the nervous system.

The nervous system functions as the body's electrical system, a collection of specialized cells that transmit signals between different parts of the body. But injuries and certain degenerative diseases – including Parkinson's disease, amyotrophic lateral sclerosis and multiple sclerosis – can interrupt that communication, posing a challenge for scientists seeking ways to return the body's nervous system to healthy function.

Mohammad Reza Abidian, associate professor of biomedical engineering, said surgical repairs can sometimes bridge small gaps between damaged nerves – typically gaps of less than one centimeter – but that isn't an option for more severely damaged nerves. Instead, scientists are seeking to spur nerve regeneration in ways that can mend the breach.

"Nature can regulate nerve regeneration, but fully functional recovery may require additional steps," he said. "We want to provide cues for the axons to regenerate along specific pathways."

The nervous system is made up of the central nervous system – the brain and spinal cord – and the peripheral nervous system, which communicates with the central nervous system through axons, transmitting instructions from the brain to the arms and legs, for example. Abidian's work under this grant will focus on directing axons to regenerate along specific pathways.

Axons search out signals from their physiological environment to determine which direction to grow, and Abidian said scientists know that those signals can be disrupted by illness or injury. To overcome that disruption, researchers need to understand how shifts in the concentration of chemicals or other physical factors, known as the gradient, affect axonal growth, as well as how that gradient should be shaped. Abidian and his lab will develop a technology platform that will allow them to test various gradient shapes, individually and in combination, and then do testing in the lab and in animal studies to determine how those changes affect axonal regeneration.

The work is a continuation of research he began in graduate school; he started working with the peripheral nervous system during a postdoctoral fellowship at the University of Michigan.

His expertise includes developing implantable micro and nanodevices that can safely interact with the nervous system, and while his research group doesn't target specific diseases, researchers there create materials and devices to solve specific neurological problems.

Abidian said the work in axonal regeneration would be useful for repairing the damage caused by neurodegenerative diseases or injuries, but it also has applications for the field of neural prosthetics, devices that can artificially restore lost function.

TARGETED TREATMENT

Possible With UH Engineer's Discovery

BY LAURIE FICKMAN

The same technology that powers MRI scanners to see inside your body may soon be used to deliver targeted treatments for a variety of diseases and conditions. Electrical and computer engineering Assistant Professor **Aaron Becker's** research, published in *Scientific Reports*, uses magnetic fields to move tiny magnetic particles around to deliver chemotherapy to the precise locations of tumors seen in MRI images.

"One challenge is that the MRI is using the magnetic coils to take images, so using the coils to push particles around prevents you from doing imaging – you can either see or move, but not both at once. This slows down both movement and the imaging process," said Becker.

His team's breakthrough came when they realized that they could change some variables in a normal imaging sequence to make the imaging sequence apply forces precisely in the directions he wanted.

"By cleverly modeling the response of these inputs, we can shift imaging parameters and move the magnetic particle at blazingly fast speeds," said Becker.

In a video accompanying Becker's research, he steers a particle through a 3D printed maze inside of a clinical MRI scanner. He compares it to a game, although the stakes are a bit higher.

"Much like the game five-finger fillet, where one places the palm of their hand on a table and stabs a knife back and forth between the fingers without touching the fingers, we can quickly move the magnetic particle through the vascular maze," he said. This medical version of the game has no known risk.

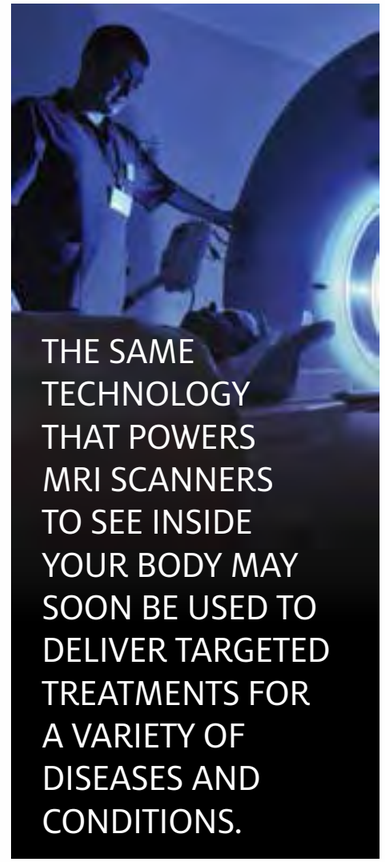
Targeting trouble

Becker says that while significant progress has been made in developing cellular medicines and therapeutic drugs, techniques for targeted delivery have not proceeded apace.

"While localized delivery is sometimes possible, systemic injection remains the best option for deep-seated targets or for multiple targets dispersed through the body," said Becker.

With systemic injection of chemotherapy agents, anti-cancer drugs are either injected into the vein or taken by mouth in pill-form. The drugs then travel through the bloodstream, subjecting healthy tissues throughout the body to the toxic effects of the chemotherapy cocktail.

In addition to causing debilitating side effects in patients, systemic administration of cancer drugs carries other important drawbacks. For one, delivering the drugs to a desired location inside of the body, such as the site of a tumor, is nearly impossible. Moreover, the drugs have only a limited circulation time in the body due to the filtering of the blood by the lungs, spleen and kidneys.



In Becker's method, the same MRI used to detect the tumor will steer the magnetized medicine to the desired point, representing a promising approach to take on the challenges.

Like the breakthrough itself, Becker's work both propels treatment options and mirrors a great future in treating tumors.

Aaron Becker's discovery could revolutionize targeted treatments for diseases like cancer

UH Engineers Invent

GLUCOSE-SENSING CONTACT LENS

BY JEANNIE KEVER

Blood testing is the standard option for checking glucose levels, but a new technology could allow non-invasive testing via a contact lens that samples glucose levels in tears.

"There's no noninvasive method to do this," said **Wei-Chuan Shih,** associate professor of electrical and computer engineering at the Cullen College who worked with colleagues at UH and in Korea to develop the project, described in the high-impact journal *Advanced Materials*. "It always requires a blood draw. This is unfortunately the state of the art."

But glucose is a good target for optical sensing, and especially for what is known as surface-enhanced Raman scattering spectroscopy, said Shih, whose lab, the NanoBio-Photonics Group, works on optical biosensing enabled by nanoplasmonics.

This is an alternative approach, in contrast to a Raman spectroscopy-based noninvasive glucose sensor Shih developed as a Ph.D. student at the Massachusetts Institute of Technology. He holds two patents for technologies related to directly probing skin tissue using laser light to extract information about glucose concentrations.

The paper describes the development of a tiny device, built from multiple layers of gold nanowires stacked on top of a gold film and produced using solvent-assisted nanotransfer printing, which optimized the use of surface-enhanced Raman scattering to take advantage of the technique's ability to detect small molecular samples.

Surface-enhanced Raman scattering – named for Indian physicist C.V. Raman, who discovered the effect in 1928 – uses information about how light interacts with a material to determine properties of the molecules that make up the material.

The device enhances the sensing properties of the technique by creating "hot spots," or narrow gaps within the nanostructure which intensified the Raman signal, the researchers said.

Researchers created the glucose sensing contact lens to demonstrate the versatility of the technology. The contact lens concept isn't unheard of – Google has submitted a patent for a multi-sensor contact lens, which the company says can also detect glucose levels in tears – but the researchers say this technology would also have a number of other applications.

"It should be noted that glucose is present not only in the blood but also in tears, and thus accurate monitoring of the glucose level in human tears by employing a contact-lens-type sensor can be an alternative approach for noninvasive glucose monitoring," the researchers wrote.

"Everyone knows tears have a lot to mine," Shih said. "The question is, whether you have a detector that is capable of mining it, and how significant is it for real diagnostics."

In addition to Shih, authors on the paper include Yeon Sik Jung, Jae Won Jeong and Kwang-Min Baek, all with the Korea Advanced Institute of Science and Technology; Seung Yong Lee of the Korea Institute of Science and Technology; and Md Masud Parvez Arnob of UH.

Although non-invasive glucose sensing is just one potential application of the technology, Shih said it provided a good way to prove the technology. "It's one of the grand challenges to be solved," he said. "It's a needle in a haystack challenge."

Scientists know that glucose is present in tears, but Shih said how tear glucose levels correlate with blood glucose levels hasn't been established. The more important finding, he said, is that the structure is an effective mechanism for using surface-enhanced Raman scattering spectroscopy.

Although traditional nanofabrication techniques rely on a hard substrate – usually glass or a silicon wafer – Shih said researchers wanted a flexible nanostructure, which would be more suited to wearable electronics. The layered nanoarray was produced on a hard substrate but lifted off and printed onto a soft contact, he said.

UH Cullen College Professor has the Right Prescription for

MOBILE HEALTHCARE

BY LAURIE FICKMAN

The National Science Foundation (NSF) isn't asking too much – just present potentially transformative research that might improve people's lives and they might be eager to give you money through their Early-concept Grant for Exploratory Research (EAGER) program.

As luck would have it, **Jiming Peng**, UH Cullen College associate professor of industrial engineering, has such a plan. It's called "Increasing Healthcare Access to At-Risk-Populations in Smart Communities: Optimal Deployment of Mobile Health Clinics," a joint project with colleagues from the UT School of Public Health in Houston. The idea is to expand mobile clinics in underserved areas, which could definitely change lives for the better in Houston, where mobile clinics figure prominently in delivering healthcare to at-risk populations. In Houston, about 30 mobile clinics currently offer care ranging from routine and cancer screenings to dental work for over 1 million people.

Seeing the value and need, the NSF awarded Peng $125,000 for two years of research beginning last September. But if this was a ballgame, Peng's research would already be on third base. In January of 2016, the Texas Medical Center awarded Peng and his colleagues a budget of $150,000 for a pilot project to improve the lives of Texans by coming up with research-based policies for mobile health clinics.

"I'm an optimization guy."

Peng's expertise as an optimization expert, maximizing the revenue or minimizing the loss under certain operational and budgetary constraints, makes him a perfect fit for this project. Peng is pouring over demographic data to optimize and deploy mobile health clinics to better serve the needs of Houstonians.

He's already discovered that one problem with mobile clinics in Houston is the lack of coordination in scheduling. Preliminary study in the pilot project shows him there's a better way.

"Every major hospital has a mobile clinic, but there's not enough coordination among them," said Peng. "Sometimes they have to travel too far. For example, every time the UTMB mobile clinic, located in Galveston, is scheduled to [visit] the very north part of Houston, it has to travel two-to-three hours."

That's lost time that could be spent treating patients. The next task is to make sure the mobile clinics are servicing the correct areas.

"Some of Houston's service spots are not carefully selected," said Peng. He said sometimes that's based on the relationships of certain neighborhoods and hospitals, and he believes his research will help change that.

"Once we identify the needs in the greater Houston area we can assign and coordinate between the program providers and the local communities," he said.

Altogether, Peng says his plan to strategically re-route and locate the clinics will allow them to serve 20-30 percent more people while keeping the costs exactly the same.

Stage two

For the NSF grant, Peng will try to predict what the future healthcare demands will be in Houston. He will develop optimization models and resolution techniques that use geographic information systems (GIS), demographic and economic population data to identify systematic, technology-based deployment of mobile health clinics as well as optimal strategies to expand the mobile clinic service to meet the future demand. That kind of future-casting puts the "smart" in smart communities from the research title.

Jiming Peng delivers mobile healthcare to more people across Houston

> "EVERY MAJOR HOSPITAL HAS A MOBILE CLINIC, BUT THERE'S NOT ENOUGH COORDINATION AMONG THEM."
> - JIMING PENG

"Based on our research we can predict the demand for this kind of service in the future," said Peng.

It looks like Houston is going to need it. According to Peng, moderate estimates in a recent study indicate the population in the metropolitan Houston area will be over 8 million in 2030 and over 10 million by 2050.

That's a lot of healthcare needed, but with Peng on the job, the solutions will no doubt be optimized.

Researchers Propose New Treatment to

PREVENT KIDNEY STONES

BY JEANNIE KEVER

Jeffrey Rimer and Jihae Chung are using fruit to fight kidney stones

Researchers have found evidence that a natural fruit extract is capable of dissolving calcium oxalate crystals, the most common component of human kidney stones. This finding could lead to the first advance in the treatment of calcium oxalate stones in 30 years.

Jeffrey Rimer, associate professor of chemical engineering at the University of Houston, was lead author of the study, published last August in the online edition of *Nature*, one of the world's most prestigious scientific magazines. The work offers the first evidence that the compound hydroxycitrate (HCA) is an effective inhibitor of calcium oxalate crystal growth that, under certain conditions, is actually able to dissolve these crystals. Researchers also explain how it works.

The findings are the result of a combination of experimental studies, computational studies and human studies, Rimer said.

Kidney stones are small, hard mineral deposits that form inside the kidneys, affecting up to 12 percent of men and 7 percent of women. High blood pressure, diabetes and obesity can increase the risk, and the reported incidence is on the rise.

Preventive treatment has not changed much over the last three decades. Doctors tell patients who are at risk of developing stones to drink lots of water and avoid foods rich in oxalate, such as rhubarb, okra, spinach and almonds. They often recommend taking citrate (CA), in the form of potassium citrate, a supplement that can slow crystal growth, but some people are unable to tolerate the side effects.

The project grew out of preliminary work done by collaborator John Asplin, a nephrologist at Litholink Corporation, who suggested HCA as a possible treatment. HCA is chemically similar to CA and is also available as a dietary supplement.

"HCA shows promise as a potential therapy to prevent kidney stones," the researchers wrote. "HCA may be preferred as a therapy over CA (potassium citrate)."

In addition to Rimer and Asplin, authors on the paper include Giannis Mpourmpakis and his graduate student, Michael G. Taylor, of the University of Pittsburgh; Ignacio Granja of Litholink Corporation; and Jihae Chung, a UH graduate student working in Rimer's lab.

The head-to-head studies of CA and HCA determined that while both compounds inhibit the growth of calcium oxalate crystals, HCA was more potent and displayed unique qualities that are advantageous for the development of new therapies.

The team of researchers then used atomic force microscopy, or AFM, to study interactions between the crystals, CA and HCA, under realistic growth conditions. According to Rimer, the technique allowed them to record crystal growth in real time with near-molecular resolution.

Chung noted that the AFM images recorded the crystal actually shrinking when exposed to specific concentrations of HCA. Rimer suspected the initial finding was an abnormality, as it is rare to see a crystal actually dissolve in highly supersaturated growth solutions. The most effective inhibitors reported in the literature simply stop the crystal from growing.

It turned out that Chung's initial finding was correct. Once they confirmed it is possible to dissolve crystals in supersaturated solutions, researchers then looked at reasons to explain why that happened.

Mpourmpakis and Taylor applied density functional theory (DFT) – a highly accurate computational method used to study the structure and properties of materials – to address how HCA and CA bind to calcium and to calcium oxalate crystals. They discovered HCA formed a stronger bond with crystal surfaces, inducing a strain that is seemingly relieved by the release of calcium and oxalate, leading to crystal dissolution.

HCA was also tested in human subjects, as seven people took the supplement for three days, allowing researchers to determine that HCA is excreted through urine, a requirement for the supplement to work as a treatment.

While Rimer said the research established the groundwork to design an effective drug, questions remain. Long-term safety, dosage and additional human trials are needed, he said.

"But our initial findings are very promising," he said. "If it works in vivo, similar to our trials in the laboratory, HCA has the potential to reduce the incidence rate of people with chronic kidney stone disease."

RESTORING THE SENSE OF TOUCH

Makes Professor Joe Francis

SENSE-SATIONAL

BY LAURIE FICKMAN

If it has to do with the brain, Associate Professor of biomedical engineering **Joe Francis'** neurons are crackling. While he continues teaching robots to sense what humans want through brain research, he's published a paper in the *Journal of Neural Engineering* where he shares his ideas to restore the lost sense of touch by electrical stimulation of the central nervous system.

"We want people to feel whole whether or not they have their limbs," said Francis. "If you're paralyzed, your limb being there doesn't mean that much to you. It's just something that needs to be moved along with you. Whereas, if we can let your brain control it again and let you feel it again, just making the person whole is really what it's all about."

Amazingly, he knows how it can be done.

His study of touch and brain waves has proved that he can stimulate the brain and imitate the sense of touch, opening the door for a new era in prosthetic integration. He and several colleagues wrote an article, "Eliciting naturalistic cortical responses with a sensory prosthesis via optimized microstimulation," published in the July 2016 edition of the *Journal of Neural Engineering*.

It's the first time this kind of work has been done, where the electrical stimulation is optimized to generate brain responses as close to natural as possible. What also sets the work apart is that it assumes little, other than the concept that what we feel is based on what our brain activity looks like. Similar sensory research has involved measuring walking and the sensory nerve's responses, taking that activity pattern and assuming the stimulation pattern to the same nerve will evoke the same response, "which just isn't true," said Francis.

> "MAKING THE PERSON [FEEL] WHOLE IS REALLY WHAT IT'S ALL ABOUT."
>
> - JOE FRANCIS

Francis and his team took a much different approach. They undertook brain mapping and began touching different parts of subjects' hands. If a certain part of a finger is touched, it connects to a certain part of the brain's thalamus and that information flows up to the brain's cortex. If a different part of the digit is touched, the sensation moves up to a different spot.

"We put electrodes in the thalamus and cortex and touched the hand to see how the activity flows through the thalamus and to the cortex," said Francis. "Then we stimulated the thalamic electrodes randomly and formed a mathematical model to predict the downstream cortical responses."

Next, after completing what Francis calls "a bunch of mathematical magic," his team electrically stimulates the brain to recreate responses that look the same as touch.

When the research plays itself out, Francis envisions sensors inside either people's limbs or prosthetic limbs so that when a patient touches an object, sensory information will be transmitted directly to the user's brain as if they were feeling something with their own hand.

But wait, there's more

A lot more. Francis' research in understanding the inner workings of the brain has led him to bypassing broken brain regions. That could be groundbreaking for stroke victims.

"The person will have to relearn to some extent, but this should be a huge advance in being able to input information into the nervous system," said Francis.

For instance, the brain of a stroke victim unable to use his hand could be bypassed one day, and his hand could become usable by reconnecting the brain to another area. He's published that work, too.

Even though he says it's a coincidence, it's no wonder Francis' office is on the fourth floor of the University Eye Institute at UH. One day he'd like to restore vision to those who cannot see. In his world, sensory brain research is a generalized way of controlling the nervous system. "If you know what you want that response to be and you can give us input to that region, we should be able to make it happen," he said.

The world of restoring the sense of touch and other human senses is the world that makes sense to Joe Francis.

THE CLOT THICKENS:

UH Engineer's New Method to Help Keep Donated Blood Supply Safe

BY LAURIE FICKMAN

Every two seconds someone in the United States needs blood, according to America's Blood Centers, generating a fundamental need to keep the blood supply healthy. A significant part of that process is to remove the white cells (leukocytes) from donated blood. **Sergey Shevkoplyas,** associate professor in the Cullen College department of biomedical engineering, along with his research team, have created a new, advanced system to do just that, ideally leading to a healthier blood supply, while also creating an innovative way to isolate white cells for research.

"Prior systems to separate cells have been very crude, but here we have something completely new – no one has ever done this before," said Shevkoplyas. He and his team have written an article published in the journal *Scientific Reports* that outlines their newly-developed system that will gently isolate platelets and plasma from white blood cells, potentially leading to healthier platelets for transfusion. "Cancer patients need frequent platelet transfusions, so delivering a high-quality blood product is essential for these already immunosuppressed patients," Shevkoplyas added.

The system, called Controlled Incremental Filtration (CIF), is small, yet fast. The patent-pending technology was developed in conjunction with Halcyon Biomedical, a start-up company Shevkoplyas founded with Sean Gifford, a co-author of the article.

For the field of microfluidics, which is the study of processing small volumes of fluids, Shevkoplyas said their system represents "a complete revolution" in how quickly samples can be processed. "For the first time, microfluidics can be used to process blood products in a timeframe that makes the process not only feasible, but an attractive alternative to conventional large-scale filters," said Shevkoplyas.

Separating white cells

In blood donation, great care is taken to isolate the red cells, platelets and plasma (the transfusable components) from the leukocytes. Leukocytes are extremely valuable inside your body, but they can wreak havoc inside someone else's.

Sergey Shevkoplyas (center) with Briony Strachan and Hui Xia, know bloody well how to keep the blood supply safe

"Leukocytes are your immune system," said Shevkoplyas. "They literally contain information about all infections you've ever had and they can produce antibodies against those infections. Also, some of those white cells are basically designed to kill things. They go and actively eat all of those infections."

They are hard workers, these little white cells that keep us healthy. So why not have them in the blood supply?

"I don't want yours! Mine will look at yours and kill them, because of the different genetics," said Shevkoplyas. It can be a process like organ rejection, in which the body might start attacking everything in the bloodstream, similar to an autoimmune reaction.

Dead-end filtration

Current protocol calls for donated blood to be spun in a centrifuge to separate the components. This results in the platelets being suspended in plasma – however, leukocytes still remain. Then the process to remove the white cells is called dead-end filtration, which is similar to how coffee is filtered. In this instance, however, it's the leukocytes that are collected in the filter while the to-be-transfused plasma and platelets pass through as the filtration process continues.

"What our device allows is to not filter leukocytes out, but isolate them, in a very gentle manner, from the blood product," said Hui Xia, Shevkoplyas's postdoctoral fellow and lead author of the article.

This way, the leukocytes don't continue to be trapped and possibly release toxins into the purified platelets and plasma. Instead, they are separated gently from the blood product where they can be collected for later use. Because of that, CIF not only provides a well-filtered blood supply with potentially healthier platelets for transfusion, but also finds its secondary benefit: A new stream of white cells for researchers.

"The white cells could actually be a cure for cancer," Shevkoplyas casually drops into the conversation. "Some of these cells are T cells, the lymphocytes that contain your immunity, and T cell-derived therapies, like immunotherapy, are all the rage right now for treating cancers."

"It's an incredibly efficient improvement," says Briony Strachan, Shevkoplyas's postdoctoral fellow, and another author of the article. "You get the white cells as a byproduct of doing what needs to be done anyway."

As Strachan, who's from the United Kingdom, might say: "That's bloody brilliant."

How the Guardian of Our DNA Gets its

DONUT-LIKE STRUCTURE

BY LAURIE FICKMAN

Deep within your body there exists donut-shaped objects – many of them, in fact.

No, these donuts aren't from the box of Shipley's that mysteriously disappeared, despite the fact your diet had just started. These particular donuts are the membranes of the nuclear envelope, which surround and protect the cell's nucleus, where the all-important genetic material, or DNA, is stored. Why they are shaped like donuts has been one of biology's great mysteries, but now a University of Houston Cullen College of Engineering professor may have found the recipe for one of the most fascinating structures inside a human cell.

In the *Proceedings of the National Academies of Sciences* (*PNAS*), **Ashutosh Agrawal,** assistant professor of mechanical engineering, explores the junk-food-shaped design in his article "Ultradonut topology of the nuclear envelope," and concludes that mechanical forces play a critical role in shaping the nucleus, a finding that provides a fresh perspective into the design of the command centers of cells.

"The mechanics of the nucleus have not been explored much, even though the nucleus has our important genetic material," said Agrawal. "This work should provide impetus to more biophysical studies to investigate the effect of forces on the workings of our nuclei. This is just the beginning of a less-explored area."

Facing down your donut

The donut structure of the nuclear envelope is formed by two concentric membrane shells fused at numerous sites. Interestingly, not many scientists have delved into how the membranes achieve and keep such a unique shape.

Agrawal studied the donuts very carefully, investigating their geometry and the stability of the membranes in the presence of mechanical forces. He and his team, graduate student Mehdi Torbati and collaborator Tanmay Lele, engineering professor at the University of Florida in Gainesville, used nonlinear computer modeling to discover instabilities that lead to new sites for fusion between the layers.

They determined that buckling potentially occurs during the growth process, when the nucleus is growing and more membrane is being recruited. The recruitment of membrane can generate compressive forces that can destabilize membranes and set the stage for the formation of new pores (or holes).

> *"[This has] been a question that excited the scientific community for a long time, and now people can relate the shape of the red blood cell to its health."*
>
> - ASHUTOSH AGRAWAL

"When a membrane buckles, it deforms to meet the other membrane, allowing the proteins to fuse them to create a new pore," said Agrawal.

How many holes in your donut?

Topology of the nuclear envelope is defined by how many holes it has. Cell nuclei typically have a few thousand holes that are intriguingly present in a more or less uniform density. But why? Why don't nuclei have 10 holes or a million holes for that matter, and why is the density fairly uniform?

Agrawal found that spacing larger than 500 nanometers (nm) basically does not exist because as the size of the membrane increases it becomes more unstable.

"Once it reaches the 500 nm size, very small compression can buckle it – the nuclear membrane becomes very unstable, and that's why sizes beyond 500 nm will not be seen," said Agrawal.

Now that Agrawal has discovered the impacts of mechanical forces and the reason for the observed topology, Lele will test these ideas in future experimental studies.

"He will do the experiments to test the impact of mechanical forces on the architecture of the membrane," said Agrawal.

Agrawal compares his exploration of the nuclear envelope's shape to the early stages of research done on red blood cells, before scientists understood why they were shaped like a concave disc.

"That had been a question that excited the scientific community for a long time, and now people can relate the shape of the red blood cell to its health," said Agrawal.

One day he hopes that the doors he's opened to the ultradonut-shaped world will swing wide with the answers to how all those donuts really affect our health.

Membranes of the nuclear envelope look like this donut baked by Agrawal's students

DESIGNING SAFETY:

Cullen College and Taipei Center Renew Agreement to Improve Seismic Performance of Infrastructures

BY LAURIE FICKMAN

Continuing a successful 15-year-long partnership, the UH Cullen College's department of civil and environmental engineering (CEE) has renewed its collaborative agreement with the National Center for Research on Earthquake Engineering (NCREE) in Taipei, Taiwan for another five years.

Recognized as one of the best earthquake research centers in the world, NCREE is home to two of the largest tri-axial shake tables, used to simulate the response of structures to earthquakes. Shake table experiments provide data that is crucial for assessing the seismic performance of infrastructure components and for improving design procedures.

"What do they bring to the table? They bring the table!" said **Roberto Ballarini,** Thomas and Laura Hsu Professor and chairman of civil and environmental engineering.

But that's not all they boast.

"Unlike in the United States, where the experimental structures are most often built and tested by graduate students, NCREE employs professional engineers and technicians to do the work," said Ballarini.

The synergistic relationship between CEE and NCREE is the result of the efforts of **Thomas Hsu,** Moores Professor of CEE and **Yi-Lung Mo,** who helped found NCREE in 1991, and joined UH as professor of civil and environmental engineering in 2000. Both are internationally recognized experts in structural engineering. In fact Hsu's past research formed the basis for the shear and torsion design provisions in the American Concrete Institute Building Code.

Mo and Hsu travel to Taiwan two-to-three times a year to collaborate with the center's researchers and graduate students. The many fruits of the collaboration include the UH-developed analytical models for predicting the mechanical behavior of infrastructure elements that have been implemented in the finite element analysis program, Simulation of Concrete Structures (SCS). The models were verified by a series of large scale tests conducted at NCREE. Currently SCS can be used to perform seismic design and evaluation of engineering structures such as high-rise buildings, cable-stayed bridges, off-shore platforms and nuclear containments.

The expertise brought to NCREE by UH faculty enables NCREE to fulfill its mission to improve the reliability and reduce the cost of concrete structures, building materials and designs of structures subjected to earthquakes. Mo's seen the process work, pointing to the 1999 Jiji earthquake in Taiwan, which took more than 2,400 lives and destroyed 51,711 buildings. Following that catastrophe, Mo led a team of 20 researchers and engineers in redesigning Taiwan's seismic design code.

Flash forward to 2016 when a similar earthquake hit the area and the buildings that adhered to the recommended retrofits in the improved code book stood stock still, undamaged.

The partnership between the Cullen College and NCREE benefits UH students, who also travel to Taipei to work with professionals at the center.

Together, Ballarini says, UH and the center develop high quality research and design safer structures.

That's a partnership built to last.

Cullen College Engineers Bring TxDOT Bridge Ratings

UP TO DATE

BY LAURIE FICKMAN

Take a car trip from Houston and you'll likely drive over one of the 50,000 bridges that span the great state of Texas. During your drive you probably never wondered if the weight limits on the bridges were accurate. But then, that's why we have **Mina Dawood,** associate professor of civil and environmental engineering in the Cullen College.

That's the way he thinks, and the Texas Department of Transportation (TxDOT) has taken notice, awarding him and two colleagues $260,000 over two years to assess bridges and bring them accurate load information. His co-principal investigators are **Abdeldjelil Belarbi,** professor of civil and environmental engineering, and **Qianmei (May) Feng,** associate professor of industrial engineering and Brij and Sunita Agrawal Faculty Fellow.

"TxDOT is by nature conservative," said Dawood. "What we're trying to do is allow them to safely increase the loads being carried by bridges and hopefully, in some cases, not need to post loads on bridges that are being load posted now."

TxDOT regularly assesses its bridge inventory for safety and posts the safe load weight on older bridges that were built before the days of 18-wheelers and heavy intrastate traffic.

Historically conservative

When analyzing a bridge that was built almost a century ago, there's a good chance the details of the material tests that were performed decades ago aren't available, so engineers depend on guidelines set in the American Association of State Highway and Transportation Officials (AASHTO) Manual for Bridge Engineering (MBE).

Left to right: May Feng, Abdeldjelil Belarbi and Mina Dawood hold tension coupons, which help determine load on Texas bridges

"We believe AASHTO provides conservative guidance on material strength and, in reality, actual materials may have strengths measurably greater than the MBE guidance or what was specified in the original plans," said Dawood. "If you have more accurate data about the strength of the materials in a bridge you would calculate more accurately the capacity of the bridge."

While Dawood anticipates most load-posted bridges can take more weight, some bridges in Texas were built before World War II and environmental conditions may have hastened aging.

"On the one hand, the bridges are deteriorating, and on the other hand, we need to apply more load to the bridges on a day-to-day basis," said Dawood.

Bridging the data gap

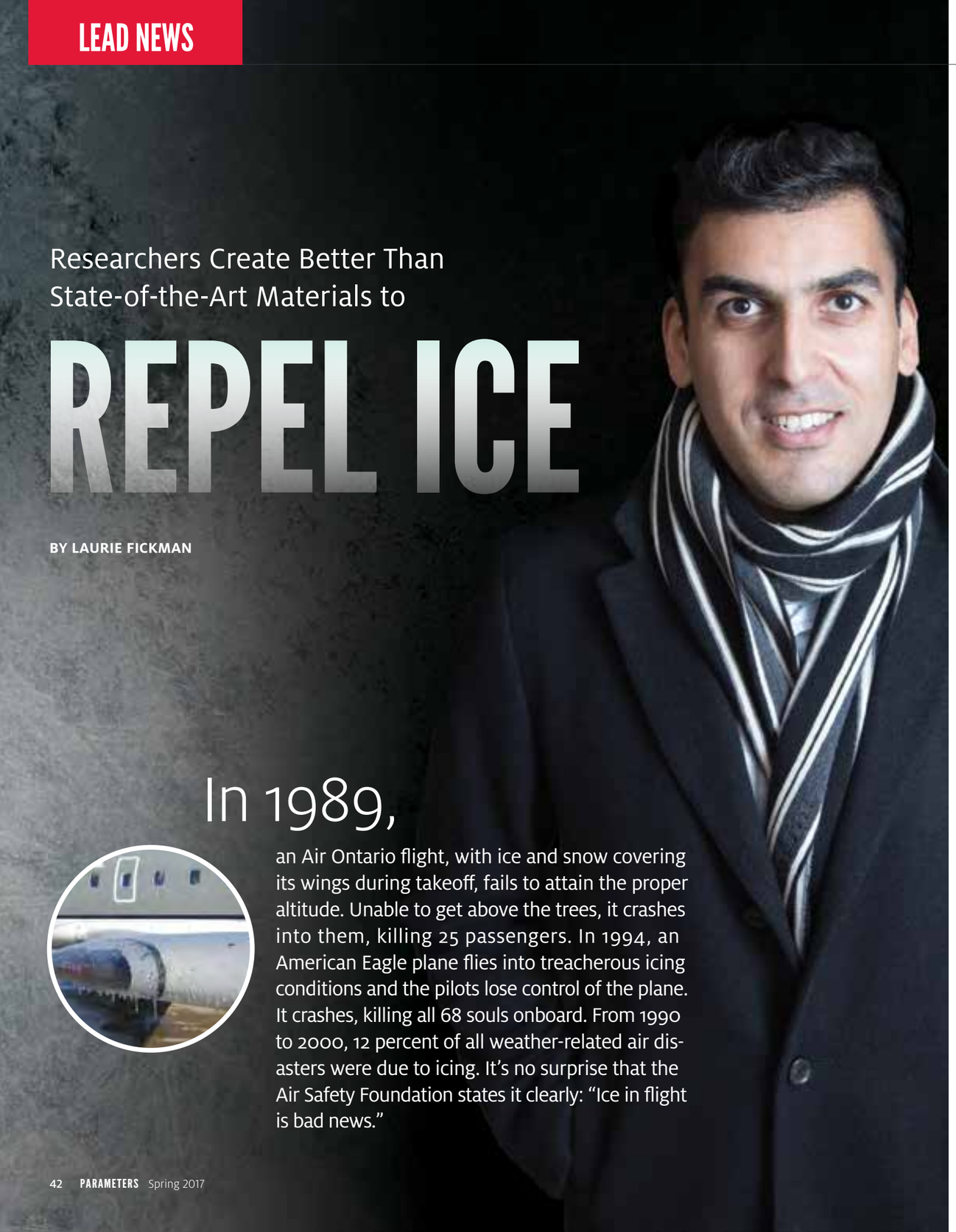
With TxDOT the UH group will visit different historical bridges being decommissioned to gather test samples. The samples may be collected from girders, braces, gusset plates, reinforcing bars in concrete, bolts or rivets – any steel part in the structure. Back at the Structural Research Laboratory, machinists will take the test samples and create pieces small enough to hold in your hand (called tension coupons) and stress testing on those pieces will begin. Machines will actually pull apart a tension coupon to note the exact load at which it ruptures.

Aside from test samples, the group will pull information from the TxDOT historical archives and explore existing literature. And then, Feng will take all the pieces of information to make sense of it.

"I will look at the strength of the materials versus the stress or loads, to see how much stress the bridge can take based on the material strength," said Feng.

"We definitely need Dr. Feng's expertise with statistics," said Dawood. Out of a thousand or more pieces of data, she will conduct a statistical analysis and identify the appropriate material strengths to be used for load ratings based on the desired reliability of bridges.

Once the work is completed and delivered to TxDOT, there's a good chance that state officials will have their hands full traveling Texas, changing signs and bringing load posts up to date, the way Cullen College engineers determine appropriate.



Researchers Create Better Than State-of-the-Art Materials to

REPEL ICE

BY LAURIE FICKMAN

In 1989,

an Air Ontario flight, with ice and snow covering its wings during takeoff, fails to attain the proper altitude. Unable to get above the trees, it crashes into them, killing 25 passengers. In 1994, an American Eagle plane flies into treacherous icing conditions and the pilots lose control of the plane. It crashes, killing all 68 souls onboard. From 1990 to 2000, 12 percent of all weather-related air disasters were due to icing. It's no surprise that the Air Safety Foundation states it clearly: "Ice in flight is bad news."

Enter **Hadi Ghasemi,** Bill D. Cook Assistant Professor of mechanical engineering at the UH Cullen College, who has invented a material that can be applied to any surface to repel ice. It's called a magnetic slippery surface (MAGSS) and it outperforms all other icephobic surfaces in use. Icephobicity is one of those words that make pretty good sense: It means the ability of a surface to repel – or become almost phobic about – ice. His work is described in the November 2016 issue of the journal *Nature Communications*.

"These new surfaces provide the path to tackle the challenge of icing in systems, thereby improving the quality of human life," said Ghasemi.

Icephobic surfaces play critical roles in industries ranging from transportation to power transmission. For scientists it's been somewhat of a slippery subject – designing surfaces that are icephobic.

Widespread impact and improvement

In the aircraft industry, planes intercept supercooled water droplets as they fly through clouds or encounter freezing rain. The droplets freeze rapidly on the surface, leading to ice accretion, or buildup. This ice accretion results in increased drag and may lead to loss of lift force and potentially catastrophic events.

In the power industry, icing in transmission systems can lead to collapse of poles and towers, rupture of conductors and flashover of insulators. At your house, a buildup of ice on your air conditioner can cause it to freeze, which will increase your bills or break the A/C unit completely.

The industrial and consumer applications are widespread for Ghasemi's newly created MAGSS. He has a patent pending on it.

How it repels

Ghasemi's material can be applied to any surface – ceramic, polymers or metals.

"We coat a magnetic material on one side of the surface and on the other side we deposit a thin layer of magnetic fluid called ferrofluid," said Ghasemi. The ferrofluid is a mixture of fluid and iron oxide nanoparticles.

The side with the ferrofluid faces outside. When a droplet of water hits the surface of the ferrofluid, this magnetic fluid acts as a barrier and doesn't allow the droplet to interact with the solid.

"There's no adhesion of the ice to the solid surface, so it basically slides off the surface," said Ghasemi.

Why it's better

Today's icing systems seem frozen in time compared to Ghasemi's. Case in point: The strength needed to remove ice. It's measured in Pascals (Pa). Current systems use force measured at 100,000 Pa to remove ice. Ghasemi's uses 2 Pascals. Two. Just two.

"This is so small that even by tilting the surface, ice is going to be removed," said Ghasemi.

Ghasemi's material also lowered the freezing threshold. With the best icephobic technology available today, water will freeze at minus 13 degrees Fahrenheit. If, however, a surface is coated with Ghasemi's material, water would not freeze until it reached minus 29 degrees Fahrenheit.

What's more, Ghasemi's ferrofluids can regenerate themselves – or "self-heal," as he calls it – and they are inexpensive.

Not out in the cold

Four of Ghasemi's mechanical engineering students participate in the creation of the MAGSS and are listed as co-authors of the *Nature Communications* article. Peyman Irajizad and Nazanin Farokhnia are seeking Ph.D. degrees, Seyed Mohammad Sajadi is studying for his master's and Munib Hasnain is an undergraduate.

Now that Ghasemi and his team have proved their concept, their next step is to get more money to create the new icephobic surfaces and move toward large-scale implementation of the material. The ultimate goal is to develop the coating as a spray that can be applied to any surface.

Ghasemi is a pretty cool character when it comes to explaining how he created this ice-repelling material that might well change the flight plan for so many industries.

"It just came to me," he said.

That's pretty chill.

Left: Hadi Ghasemi shows how easily a drop of water rolls off his newly-invented icephobic surface
Above: Ghasemi (far left) joined by students Seyed Mohammad Sajadi, Peyman Irajizad and Nazanin Farokhnia

CUTTING DOWN TIME

to Speed Progress in the Aerospace Industry

BY LAURIE FICKMAN

Deep within a UH computer, models being built by **Theocharis Baxevanis,** assistant professor of mechanical engineering, just may cause a sea of change in the aerospace industry. The hydro-mechanical system actuator, like an on/off switch, that controls wing flaps (you see them coming up as a plane is landing) could be replaced with a new solid-state actuator made of a new High Temperature Shape Memory Alloy (HTSMA) that is lighter and more cost efficient.

"I'm trying to design the material that will make this new technology available for the aerospace industry as soon as possible," said Baxevanis.

The National Science Foundation (NSF) awarded him and his co-PIs at Texas A&M University $1.5 million to carry out the work. The grant comes through the NSF's Designing Materials to Revolutionize and Engineer our Future (DMREF) program, in support of the multi-agency federal Materials Genome Initiative (MGI), seeking to target one of the primary MGI goals: to halve the current time and cost for transitioning breakthroughs from the laboratory to the marketplace – a process that can take as long as two decades.

New to the UH Cullen College, Baxevanis brought his portion of the grant, "Accelerating the Development of Phase Transforming Heterogeneous Materials: Application to High Temperature Shape Memory Alloys," to Houston.

Back to those wing flaps

Baxevanis concentrates on HTSMAs, which are alloys (a mixture of metals) that can change shape and operate at high temperatures, providing high power density.

Currently in the aerospace industry, conventional actuators control the wing flaps in planes. Though perfectly safe, the wing weight could be lightened if the actuators are made out of new HTSMA materials, and Baxevanis is set on designing the HTSMA to do just that.

"We would like to replace the conventional actuators in the aerospace industry with single-piece, compact actuators from high temperature shape memory alloys," said Baxevanis. "They perform the functions of several materials and parts simultaneously, thus simplifying the device design, having fewer parts to break or wear down during the service of the plane, so they will save the industry money and decrease the overall weight of the plane and the drag on it."

Putting the pedal to the metal

But 20 years is too much time for the entire process of bringing the lightweight actuator to market. The project attempts to accelerate the development and application of HTSMA–actuators by combining ideas from informatics and design with experimental and computational materials science.

"The basic idea is to develop a framework that will allow the design of a material equipped with tailored properties by conducting an optimum number of physical experiments, which are costly and time consuming," said Baxevanis. To narrow down the required number of physical experiments to actually take to the lab, he conducts numerical experiments – or "fictitious experiments," as he calls them.

"We test hypothetical materials with computer models," he said. "The simulations guide targeted physical experiments that in turn allow for the refinement of the models and point us towards where we should look next,

It all starts here: at the computer Theocharis Baxevanis creates new technology for the aerospace industry

effectively reducing the required number of physical experiments before coming up with the material that we are looking for."

Research taking flight

Once the work is completed, Baxevanis and his collaborators would like anyone in the world to be able to pick up on their research and continue creating new phase transforming materials quicker by learning from their experience.

"We want to create a database and a framework available for other researchers designing phase transforming materials for specific application requirements," he said.

That way, when Baxevanis flies on from this project to the next, his research will continue to soar.

MAKING THEM DANCE

Jiming Bao Discovers how to Rotate and Align Graphene Flakes, Opening the Door for a *FASTER WORLD*

BY LAURIE FICKMAN

In 2010 graphene took center stage when the Nobel Prize in physics was awarded to two scientists in the UK "for groundbreaking experiments regarding the two-dimensional material graphene." At the UH Cullen College of Engineering, that same passion over pencil lead is shared by **Jiming Bao,** associate professor of electrical and computer engineering, but he's taken it to a whole new dimension, with a patent filed on his process to rotate and align graphene flakes in 3D by using a magnetic field. You can read about it in the January 2017 issue of the journal *Advanced Materials*.

"It's a breakthrough," said Bao. "No one has ever thought to rotate and align graphene or the magnetic properties of graphene. It's so strong. No one thought it could be rotated by a tiny magnet."

Editors at *Advanced Materials* must have agreed, Bao said, noting the unusually short time it took for his article to be accepted for publication.

"Sometimes it takes six months to get an article published. They accepted this one in two weeks," Bao said.

For the uninitiated, graphene is made of carbon, just like graphite (the lead in pencils) and diamonds (the beautiful treasures that sparkle in your jewelry). Though all are made of the same stuff, the atoms are arranged differently in each.

Scientists seem to gush over graphene, touting it as one of the lightest, strongest conductors of heat and electricity. According to Bao, it could make computers faster, microwave ovens safer and everything much cheaper.

"It's much cheaper than metal to produce and opens enormous application possibilities,"

Jiming Bao discovered that magnets rotate and align graphene flakes Below: Even magnets and rotated graphene are UH proud

said Bao. "Graphene is very conductive, even more conductive than copper." It can replace copper wire or the magnetic shield in front of the microwave. It can also dissipate heat much faster than the commonly-used materials of today. It is a diamagnetic material, meaning it can create a magnetic field and, at the same time, oppose one.

If you're keeping score, that means graphene will be another material (like a superconductor) that will make things, like trains, levitate. At extremely low temperatures, superconductors allow current to flow without resistance and repel a magnet, but with more strength, a superconductor and magnet will repel against gravity, causing stable magnetic levitation.

In Bao's experiments he found that aligning the graphene flakes makes them powerful. "When graphene flakes are assembled in the same planar direction, they show excellent thermal, optical, electrical and electromagnetic shielding properties," said Bao.

Another example of the powers of graphene involves lithium-ion batteries, the kind that power electronic cars. Currently the graphite used in those batteries is not aligned.

"Once we align it, this battery can last longer, have higher capacity and charge faster," said Bao.

It's no wonder the Nobel Prize Committee believes it can change the world.

For Bao's part, he'd like to see graphene in a science museum one day. "Instead of using iron filings to play with magnets they will be using graphene. I'd like to see it become that important and historic," said Bao.

DOE Awards $4.5M to UH Engineer to Speed Manufacturing of Superconductor Wires for

NEXT-GENERATION MACHINES

BY JEANNIE KEVER

With their potential for big savings through increased energy efficiency and reduced greenhouse gas emissions, interest in improving the manufacturing of superconductor wire is at an all-time high.

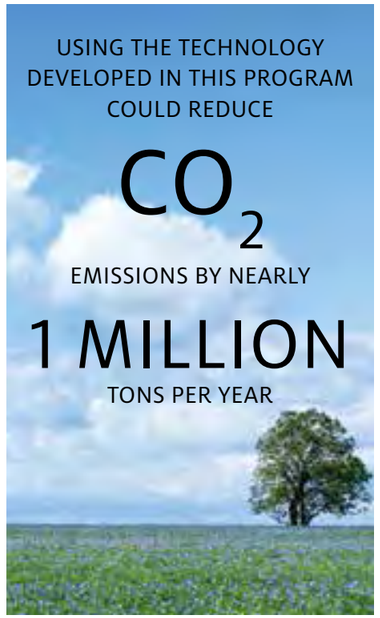
The U.S. Department of Energy announced a $4.5 million grant to **Venkat Selvamanickam,** MD Anderson Chair Professor of mechanical engineering at the University of Houston, to boost the advanced manufacturing of high-performance superconductor wires for next generation electric machines.

The award is one of 13 projects funded to advance technologies for energy efficient electric motors through applied research and development.

"Advancing these enabling technologies has the potential to boost the competitiveness of American manufacturers and take the development of more efficient electric machines a giant step further," Mark Johnson, director of DOE's Office of Energy Efficiency and Renewable Energy, said of the nearly $25 million in grant awards. "These technology R&D projects aim to significantly improve industrial motors for manufacturing, helping companies who use these motors in manufacturing save energy and money over the long run."

Selvamanickam is one of the world's leading experts on manufacturing superconductors. He is the co-founder of SuperPower, which produces superconducting electrical wire, and has continued his research since joining the UH faculty in 2008. He also is director of the Advanced Research Hub at the Texas Center for Superconductivity at UH and manages the Advanced Manufacturing Institute at UH.

"Superconducting motors and generators made with the wire that will be manufactured using the technology developed in this program can lead to more than 6 billion kilowatt hours of annual electricity savings and reduce CO_2 emissions by nearly a million tons per year," he said.



Superconductor devices are used in energy, healthcare and transportation, among other uses, and offer advantages including saving as much as 2 percent in electricity use in electric motors and generators and up to 10 percent in transmission and distribution equipment. That's because superconductors can transport electricity with little or no resistance, meaning energy isn't wasted in the electric machines and during transmission.

"Dr. Selvamanickam is recognized globally for his focus on the development of innovative manufacturing technologies for thin film superconductor wire, which has been supported by the federal government, as well as the state of Texas and private industry," said Ramanan Krishnamoorti, interim vice president for research and technology transfer at UH. "This grant will allow him to continue his work to overcome obstacles to more efficiently manufacture the wire."

The funding is part of Mission Innovation, an effort to double clean energy research and development investments over the next five years. The Energy Department last spring announced plans to fund up to $25 million in projects through the "Next Generation of Electric Machines: Enabling Technologies" funding opportunity, targeting technologies to boost efficiency in a cost-effective way.

Selvamanickam said the funding will enable the use of superconducting machines at liquid nitrogen temperatures, which can lead to a widespread commercialization of this technology. Until now, superconducting machines, including motors and generators, have been built for use at lower temperatures because of performance limitations in the superconducting wire. The DOE-funded program will enable overcoming those limitations.

His team was the first to manufacture thin film superconductor wire, which was used in 2008 to power 25,000 households in Albany, New York, and now is used by more than 200 institutions around the world for applications including wind generators, energy storage, power transmission cables, magnetically levitated trains, medical imaging and defense applications.

"BEND" AND "FLEX"

No Longer Just Terms for Exercise, They'll Soon Describe Your Laptop!

BY LAURIE FICKMAN

Ying Gao (left) demonstrates how thin and flexible electronics may be in the future – much like the Saran Wrap she uses to wrap fellow researcher Mojtaba Asadirad

Tired of lugging that heavy laptop in your padded backpack? Here's an idea: When you're finished using your laptop, just roll it up, fold it, stick it in your back pocket and bolt. That's the incredible future being created in a UH Cullen College of Engineering laboratory – a flexible, thin-film transistor (TFT) that may one day make your current laptop a dinosaur.

Left: Mojtaba Asadirad holds a thin-film transistor
Above: Ying Gao (left) and Asadirad flex glass tape on a roll of plastic

"Think of it as a roll of Saran Wrap or a jelly roll," said **Venkat Selvamanickam (Selva),** MD Anderson Chair Professor of mechanical engineering. **Jae-Hyun Ryou,** assistant professor of mechanical engineering, added, "You won't need a big truck to buy a 60-inch television set, if you can just roll it up and take it with you."

Their work is highlighted in the journal *Advanced Electronics Materials* in their article "High-performance flexible thin-film transistors based on single-crystal-like germanium on glass."

The bright past and flexible future

In the past, we came to know TFT technology through LCD (liquid crystal display) monitors and television sets as the brightest ones with the sharpest images. Each pixel in an LCD has a transistor that turns it on and off, creating the vivid colors.

"Each pixel has its own red, green or blue elements," explained Ryou. "So if a pixel needs to have the color red in a certain spot, the TFT turns on the red and turns off the blue and green."

But those are yesterday's transistors. The future is flexible.

"Ordinarily transistors are made of wafer material that will break if you try to roll or bend them, but if we can make flexible and bendable TFTs then we can make flexible computers," said Ryou.

Switching on the transistor

Ying Gao, postdoctoral fellow in mechanical engineering, developed the idea of how to make the TFTs flexible while she was still a Ph.D. student studying with Selva. She says superconductors inspired her to use a highly-aligned crystalline layer on a metal as a base for the TFTs.

"We already have this technology," said Gao. But she replaced the bottom, rigid metal layer with flexible glass. This pliable, thin glass is the basis for building the TFT, giving it flexibility. The performance comes from the second and third layers.

The third layer that makes the TFT work is made of the silicon-like chemical element germanium. "The germanium is very high quality with high mobility," said Gao. The second layer is an intermediate buffer film. "If we don't have this intermediate layer it will cause low performance of the TFT."

Gao's ideas leapt off the drawing board and into fabrication with Ryou's team, led by mechanical engineering Ph.D. student Mojtaba Asadirad.

With those three layers together, they created a high-performance transistor that is flexible and cost-effective, becoming what Selva calls "simple, elegant and easy to make."

"It's so easily scalable," said Selva. One day he says it will be possible to put the glass on a big roll, like the Saran Wrap, feed it into a machine and it will come out with transistors on the other end.

Stretching the imagination

Much like the three-dimensional, bendable screens in the movie "Minority Report," Selva talks about looking at a map on a computerized screen that you just stretch and bend to see the picture in greater detail.

"Just imagine being able to pull out your screen and make it as big as a conference table," said Selva. He said it makes perfect sense to be used first by the military, so soldiers could carry maps from one location to another. "They could roll this out in the middle of the desert, make it as big as they need it to be," he said.

For consumer use, the possibilities are endless.

With phone screens getting bigger and bigger, it's a good bet that people don't like squinting while they're pouring over a story they might be reading online. With this new technology, if the display itself can be expanded and still kept compact enough to carry in your pocket, it would change not only the screen view, but along with it, the world view of electronics and engineering.

UH PROFESSORS TO ROBOTS:

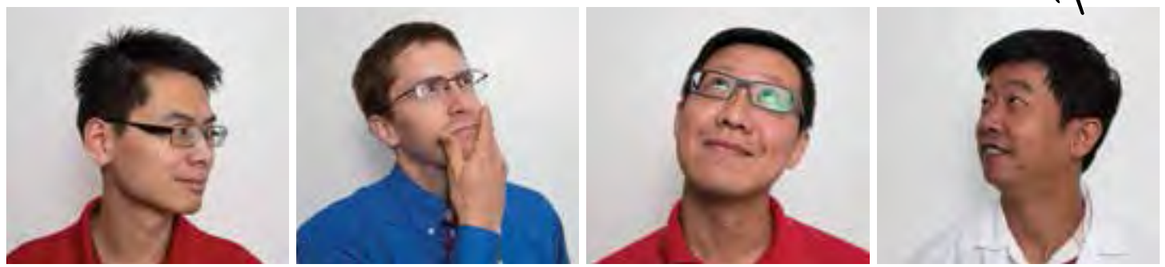
SWIM, COMMUNICATE AND BRING US DATA – FAST!

BY LAURIE FICKMAN

Deep below the sea,

thousands of sensors collect crucial oceanic data used in environmental monitoring, offshore exploration, disaster prevention and military surveillance. However, there exists a problem underwater that was conquered on land decades ago: From the ocean depths, communication is severely delayed. There is no internet or clear and powerful signal. But, a new $600,000 award from the National Science Foundation to UH Cullen College professors has them diving in deep to create an underwater communication relay that will outperform anything yet available.

> “IT’S ALL ABOUT ASSEMBLING THE RIGHT TEAM, LIKE ‘THE AVENGERS.’ OUR SUCCESS DEPENDS ON THIS TEAM.”
>
> - AARON BECKER



The superhero team, from left: Jiefu Chen, Aaron Becker, Miao Pan, Zhu Han

And it starts with robots

“We can now build these robots that go underwater, swim around and drop off sensors to monitor what happens in our waters,” said assistant professor of electrical and computer engineering **Aaron Becker**, who serves as a co-principal investigator (co-PI) on the project.

To be clear, these are not yesterday’s science fiction robots that look human – no C-3Pos here. These robots are autonomous underwater vehicles (AUVs), sometimes referred to as underwater drones.

“My part of the project is to make the robots that are going to shuttle information from the sensors to the surface,” said Becker. “My robots are going to swim down, figure out which sensors to monitor, which information to gather and the fastest way to bring that back to our mother ship.”

That description encapsulates the project that intends to create a viable cyber interconnection scheme. The project is called “DEUS: Distributed, Efficient, Ubiquitous and Secure Data Delivery Using Autonomous Underwater Vehicles.”

“We want to collect data from underwater sensor networks in the most efficient, intelligent, secure and cost-effective way,” said the project’s PI **Miao Pan**, assistant professor of electrical and computer engineering. “And we can do that with the energy of our entire team.”

Underwater super scientists

Rounding out the team from the Cullen College’s department of electrical and computer engineering are Professor **Zhu Han** and Assistant Professor **Jiefu Chen**.

Think of them all as a band of superheroes, each member with a special skill. Becker is the robot expert, Pan is the data and super security man, Zhu is the algorithm and data collection dude, and Chen is an antenna ace.

“It’s all about assembling the right team, like ‘The Avengers’,” said Becker. Pan concurs: “Our success depends on this team. The most important thing is our synergy.”

Listening in

The robot expert, Becker, is working first on a task called localization, or getting the robots underwater to recognize where they are.

“Robots in water are like us before GPS,” said Becker. That takes a moment to digest, until you remember how often you got lost before GPS.

“Once your robot goes more than a few inches underwater it doesn’t have a GPS signal, so the first problem my students and I are working on is how to figure out where you are. It doesn’t know where it is, so it can’t shuttle information back from those sensors.”

Traditionally, scientists used acoustic communication to determine location, the same way we hear whales when they sing underwater. “But the problem with acoustic communication is it has a very low data or transmission rate, a very high delay and a very high error rate,” said Pan.

Said Becker, “It’s also hard to be discreet with acoustic communication – when a whale sings his love song, everyone knows he is in love. Underwater sensors are expensive, so often we don’t want to share our data with the world.”

Electromagnetic antennas, the kind commonly in use today, wouldn’t work either because they don’t do much good underwater. So the team needed a new antenna and turned to their antenna ace, Chen.

This is not the first time Chen has had his antenna up. The antenna work in this NSF proposal was based on Chen’s previous work in the private sector where he designed antennas for underground oil and gas exploration.

“It is a similar concept, but one is underground and one is underwater,” said Chen. “We want to make a new antenna, which we hope to boost to the maximum extent that can reach further than existing antennas for underwater communication.”

For this type of antenna, with the robot moving everywhere, he is using magnetic induction, a process where the entire robot becomes magnetized by a magnetic field. But a big antenna attached to a robot would make it become too heavy to move. “So we make an antenna that can conform to the side of the drone – we integrate it to the body of the drone,” said Chen. That means it’s pliable, bendable and flexible.

Information selection and security

When Becker said his robots were going to “figure out which sensors to monitor” from so many streams of information coming from the ocean, he was talking about an old-fashioned math problem. Algorithm and data collection dude, Han, has it solved, though.

“Our algorithm will keep balance between exploitation versus exploration, basically telling us where to go to collect data and from which sensors,” said Han.

He likens the process to slot machines in Las Vegas.

“Imagine you’re in a room of slot machines,” Han explains. “You look around and wonder which one will win. Could it be one that’s already paid out a lot of money? Should I exploit that one? Or should I explore a new one? Our algorithm tells us which sensors will give us the best information.”

He’s working on that winning formula, plus new ways to keep the information confidential. To keep it secure, Pan works with Han on another algorithm and protocol development. “Our goal is to find the way to deliver information privately, with faster transmission rates and lower error and delay rates,” said Pan.

Once the data is back on land, Han processes it with yet more algorithms, reconstructing it and making it as accessible and pristine as possible.

Full speed ahead

The team’s success, with tentacles that touch offshore oil spill response, fisheries management and storm preparedness, will likely impact the economy and well-being of not only coastal regions, but also inland states.

Pan foresees long-range success from this grant for the Cullen College of Engineering, too. Since this is the first-such underwater award from the NSF to the electrical and computer engineering department, he predicts the project will kick off further underwater research in the department.

Becker sees “the big win,” he says, if the team’s breakthroughs become underwater infrastructure.

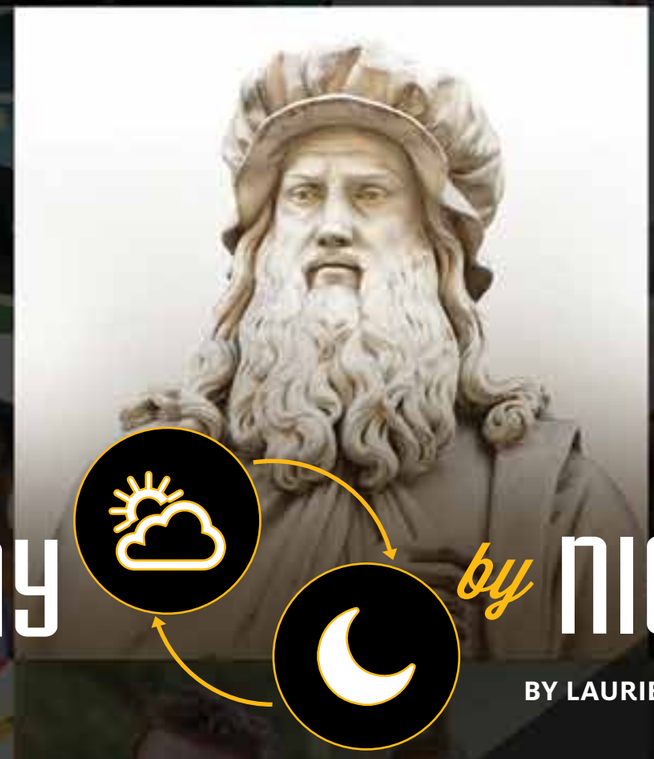
“This infrastructure includes mathematical theory, antenna design and robot motion-planning,” said Becker. “We share this through research papers, patents, training students and sharing code.”

So far, they’re doing swimmingly.

THE SECRET LIVES OF ENGINEERS

"I HAVE BEEN IMPRESSED WITH THE URGENCY OF DOING. KNOWING IS NOT ENOUGH; WE MUST APPLY. BEING WILLING IS NOT ENOUGH; WE MUST DO."

- LEONARDO DA VINCI



by DAY by NIGHT

BY LAURIE FICKMAN

Maybe it was Leonardo da Vinci who set the tone for the great engineers and polymaths to come. For centuries his fame centered on artistic masterpieces. You've no doubt heard of his "Mona Lisa."

But it was during his artistic journey that he also indulged other passions – writing and drawing sketches in the fields of engineering and science that would become as impressive as his works of art. In his notes he conceptualized flying machines, concentrated solar power and even the adding machine.

So lest you think any engineer is a one-note thinker, you need only look to the past to see the secret lives of some of the world's great minds.

Da Vinci's tradition of talent in a variety of fields is strong at the Cullen College of Engineering, where some of our great thinkers and engineers by day reveal other talents in diverse fields by night.

More than 500 years ago da Vinci picked up the brush and began painting the picture of the secret lives of engineers.

We add to his canvas in this issue of *Parameters* as we introduce you by day and by night to some of our multi-talented peers.

THE SECRET LIFE OF

JOHN LIENHARD:

Perhaps you've heard of John Lienhard.

At the UH Cullen College of Engineering, he's a legend – professor emeritus of mechanical engineering, member of the National Academy of Engineering and consummate storyteller, as the creator and voice of the one radio program in the world that makes engineering accessible to the masses, the nationally-syndicated "Engines of Our Ingenuity."

Sound familiar from this thumbnail of his day trades? If not, maybe you've seen him in yet another of his talented roles when the books close and the microphone mutes.

That's when Lienhard's shutter opens and you can find him at UH football games, or a myriad of other places, snapping one photograph after another, captivating shots that – like his other works – will stand the test of time.

HOW IT COMES TOGETHER

Though Lienhard's accomplishments are vast and his talent expansive, his body of work might have seemed unlikely for a boy who grew up with severe learning differences. In fact, he says that's what drew him to engineering.

"I got into engineering because I was seriously dyslexic," said Lienhard, now 86, recalling his early days in Minnesota when his parents would read to him often – opening a new world for a child who, himself, struggled to read and write.

"It was good stuff. They were reading Dickens and Melville and Chesterton," Lienhard said. "I was raised with the maxims of writing ringing in my ears. I could barely read and write but I could make pictures in my mind. So that was the way I managed to learn anything I learned – it was sight and sound."

And through the countless hours he spent listening to his parents read, he became a symphony of ancestral talents, an amalgam of the Lienhards who came before him. His mother, a singer in early radio, and his father, a newspaper reporter and photographer (once a science editor), revealed their talents to John and he lapped them up hungrily.

He couldn't know then that listening to his parents' storytelling would lead him, one day, to become one of the nation's great radio storytellers, but that's what happened. He would also become an engineer, teacher, author, musician and photographer. Yes, he does them all. Very well.

Teaching the teacher.:

"Because of my dyslexia, all through my master's degree I used work arounds. Then, when I got drafted into the army, they made us stand in line an enormous amount.

You see the top pocket in my army fatigue? It's just big enough to accommodate a pocket book. So I would stand in line, pull out the pocket book and practice eye tracking, getting my eyes to move smoothly across text.

I really worked at it. By the time I got to my Ph.D. I was finally reading for pleasure, which I had never been able to do before."

Lienhard in the army at the former Fort Monmouth base in New Jersey, pictured here, in a familiar position.

ENGINEERING EVOLVING TO EMERITUS

It's impossible to characterize Lienhard's career highlights in a short article, or even a long book, but he's proud of a few things.

"I was the first to use thermodynamics to predict direct rainfall runoff in 1964 and then I parlayed that idea and started predicting all sorts of other things," he said. "We developed that whole thing a lot further to predict completely different things, such as wage distribution."

"You see," he says, "we showed that with all of the standard distributions, you can actually form physical models behind them," his words echoing the excitement of a young boy who could picture sights and sounds, but not yet read or write.

To this day engineers still apply his model. A quick Google search finds his work quoted immediately and often.

With the same joy of making engineering accessible through his radio show, Lienhard makes learning engineering accessible through another of his proud accomplishments, his heat transfer textbook.

Yes, you could say he wrote the book on heat transfer. You'd be right. It's called "A Heat Transfer Textbook," now in its fourth edition and available for free download. That was very important to Lienhard, who says he and his son, also an engineering professor, were fed up with the $150 textbooks that students couldn't afford.

Lienhard's son, John, an MIT professor of engineering, made contributions to all editions, signing on as co-author to manage the first free typeset version, the third edition.

The 755-page tome has been "downloaded internationally a third of a million times," said Lienhard. For those who still want a hard copy, he found a publisher that would publish it as is and make it available on Amazon for about $18.

ENGINES REVVING

"'You wonder how these things begin.' El Gallo says that to himself in the musical, 'Fantastiks.' He invites us to ponder the origins of major threads in our lives."

So starts another of Lienhard's books, "How Invention Begins." Lienhard quotes sources as varied as El Gallo and Albrecht Dürer. With that cultural chorus and storytelling prowess continually playing in Lienhard's head, he found himself, one night in 1987, in the office of then dean of engineering Roger Eichhorn, who was searching for ways to promote the college.

> "What people really want to do is listen to a story. So I cooked this up and wrote two episodes the next day."
>
> - JOHN LIENHARD

Lienhard recalls, "I said to myself, 'What people really want to do is listen to a story.' So I cooked this up and wrote two episodes the next day."

Easy as that. He just "cooked up" one of the longest-running, nationally-syndicated radio shows in history, now in its 29th year on KUHF-FM, a show that turns science and engineering into stories of "drama" and "intrigue," according to National Public Radio (NPR). Another of his sons, Andrew, composes the music you hear in the background of so many episodes, communicating his thoughts lyrically.

The series is broadcast five days a week by dozens of NPR affiliates. In Houston you can hear it three times a day. Lienhard has written about 2,500 radio scripts for the series, each one more intriguing than the last, telling us the story of engineering and creativity itself and how it forms our culture. The show is truly a passion project for Lienhard, who produces the program as a volunteer activity and receives no compensation.

So the boy who had trouble writing became the man who pens so prolifically. Add to that the natural gift of his dulcet tone and Lienhard manages to teach drive-time commuters how to communicate about engineering, how to understand science. He uses the storytelling techniques absorbed by the child he was and shares word images so vibrant that each of his radio pieces become a beautifully choreographed theater of the mind.

THE LOVE OF PHOTOGRAPHY DEVELOPS

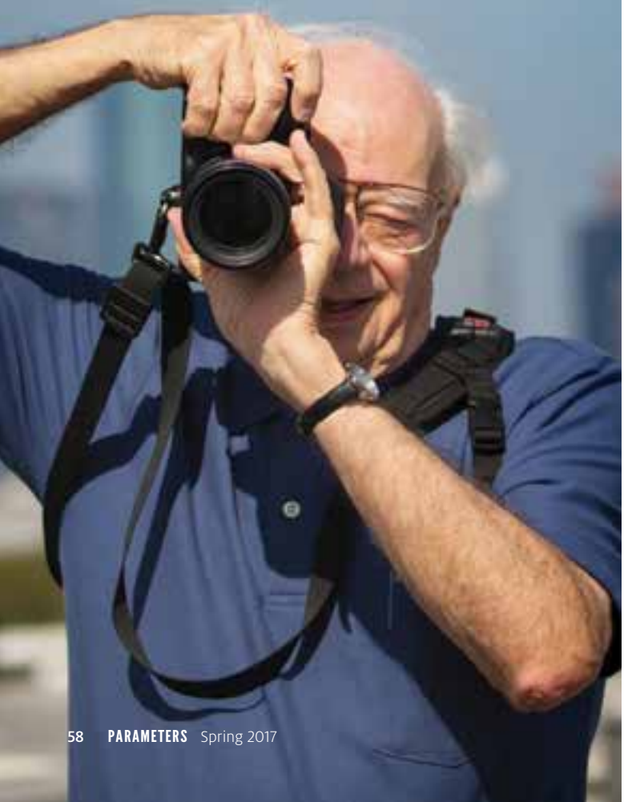
In the early days, Lienhard had to find creative ways to learn. "Everything I did had to be a visual workaround. I didn't do decently in any K-12 course until my senior year in high school," he said. "Then I took drafting and was hypnotized by it – finished all three years of the course in one. That led me into engineering, which was, for me, always a visual sport."

A visual sport, not unlike photography, the hobby that should come as no surprise. Lienhard has been tinkering with cameras since elementary school, when he attempted making pinhole cameras following a diagram published in 1925.

His penchant for photography developed further in the early 1960s, when he took high-speed images of boiling liquids to determine the mechanisms of vapor removal.

It was a natural fit for someone who painted pictures in his mind as his parents read to him years earlier.

Nowadays you can find Lienhard's photography online at enginespics.smugmug.com. At the website you'll get a peek inside what revs Lienhard's own engine – sports, travel, nature and music.



Through Lienhard's lens: a sampling of his stunning photography
VIEW MORE PHOTOS AT
enginespics.smugmug.com

WORDS AND PICTURES FROM THE MIND

Lienhard closes every episode of "Engines of our Ingenuity" by drawing you back in:

"I'm John Lienhard at the University of Houston, where we're interested in the way inventive minds work."

Primarily his mind – the mind of a man who blends engineering and poetry to create prose by day and who, by night, watches the rest of life develop, recording it frame by frame.

THE SECRET LIFE OF JALAL YAZJI:

ENGINEERING STUDENT *by day*

GIFT GIVER *by night*

Cullen College mechanical engineering undergraduate student Jalal Yazji caught the bug early, this passion for engineering as a way to build prosthetics for people in need.

Yazji fits Rafael for his custom, 3D-printed prosthetic hand

By the time he was a senior at Klein High School he was already working on a year-long prosthetic project for his engineering and design class. For Yazji it was a hand-in-glove fit.

"I didn't know anything, so I did online research and found a design online, but our assignment was to design something, so we redesigned the whole thing," Yazji said of he and his high school friends. The original designer of the online model was so impressed by the high schoolers' effort that he introduced Yazji to the Enable Community Foundation, a group that improves options for those with upper limb loss or differences worldwide by developing specifications for affordable or free prosthetics.

Now at the ripe old age of 20, Yazji has already founded the UH eNABLE chapter (the only such club in Texas). Also a member of the Honors College and PROMES, he studies by day to become the engineer he seems to naturally be, and by night he makes dreams come true for those who need artificial limbs and cannot afford them.

YAZJI BY NIGHT

One wintry Wednesday evening, Maria Sanchez sat quietly weeping inside a private room on the first floor of the University of Houston M.D. Anderson library.

"My baby just held a cell phone with his left hand," she allows, as the tears continue to stream.

This might not seem tear-worthy to most, but her baby is 8-year-old Rafael. Likely born with a form of symbrachydactyly, Rafael's fingers never formed in utero, leaving him with only a tiny fist-like hand.

Now in this UH library room surrounded by family and friends, Rafael is grabbing cell phones, playing online games and waving with his new 3D-printed hand. The hand is a gift to Rafael from Yazji and his team, including 20-year-old Daniel Bahrt majoring in mechanical engineering technology in the UH College of Technology.

Yazji met Bahrt as a freshman when they were matched as suitemates in Cougar Village Two. While Yazji was building models in high school, Bahrt was learning CAD software. A perfect partnership and creative collaboration was born. Before long, Yazji had a breakthrough idea – to form a UH chapter of eNABLE. They recruited dorm friends to round out the club and Kenneth Garcia, administrator for the Cullen College of Engineering and PROMES advisor, became the chapter advisor.

In less than two months they had received three requests, now all filled.

Putting the 3D-printed hand to good use, Rafael and Yazji play ball

EVERYONE WELCOME

Although UH eNABLE turns no one away, they seem to deal mostly with children. Their hands cater to a young crowd. To appeal to children, the hands all have names like the Cyborg Beast or the Raptor and the youngsters pick the colors.

"Kids will outgrow the gift we give them and they will come back to us and we will build them another one. That's the beautiful thing about eNABLE," said Yazji.

"Our biggest problem is always finding a place to print the prosthetic, since we don't have our own 3D printer," said Yazji. CougarByte, a store run by UH's Information Technology that offers discounted computers, software and other technologies to the campus community, gave the team access to their 3D printer to print Rafael's Raptor.

Want to help?

Help UH eNABLE buy its own printer.

Visit www.gofundme.com/2mek6vg to learn more

The chapter has set up a GoFundMe account to collect enough money to buy its own printer.

Each of the hand's components is printed and then the team members assemble it, a process that includes trimming and sanding. Each finger has three pieces, or about 30 components per hand.

As with many fittings and gift sessions, Yazji works late into the night to make sure the new hand works perfectly and the recipient and family are delighted.

And then, first thing in the morning, he's hitting the books, admittedly trying not to schedule too many 8:30 a.m. classes.

In the daytime, Jalal Yazji (second from right) works with classmates on a project to separate ping pong and golf balls automatically

STUDYING BY DAY

"I love mechanical systems, stuff that I can see and visualize, rather than looking at things under a microscope," said Yazji. "I like how gears work and all kinds of big systems. Prosthetics are a kind of system."

It is a natural inclination for Yazji. As a young boy he remembers building a da Vinci clock, a model based on a sketch by Leonardo da Vinci, which uses a pendulum's weight as the power source.

As a sophomore, Yazji continues to put models together.

"Mechanical design is by far my favorite class," he said. "We're working in teams on projects, so it's like working in the real world the way engineers actually work."

His current project has him working with classmates to design a mechanism that can separate golf balls and ping pong balls. "This provokes our imagination and ability to think," he said. "We have to come up with our own solution and it has to actually work and have a concept behind it."

As for the future, Yazji thinks he'll always work with prosethetics as a volunteer, but his interests may be on the road.

"I really love cars, because they're, you know, awesome," he laughs. One day he might be found working in Detroit (where he happens to have family) in the auto industry. He's on the UH Society of Automotive Engineers team, helping to build a race car from the ground up to compete in the Formula SAE Series (FSAE) races. Yazji is working on building the chassis.

"I'll get a lot of hands-on experience, welding and cutting, so it's not just theory. It's applying everything I've learned," he said about the project.

When you ask Yazji about engineering, in no time at all you'll hear him say, "I love it. It's my passion," or something equal to his devotion to the science.

It's no wonder he's working at it day and night.

THE SECRET LIFE OF RYAN LINK:

VISIONARY *by day*

NOVELIST *by night*

By day he works in the power industry, using software tools to create wind turbines. By night he writes science fiction books about a future, one thousand years from now, in which mankind has already created a non-ending energy supply that actually brings the world, at first, many riches, but ultimately many tragedies. The two worlds are linked together by a man aptly named Ryan Link – a UH Cullen College engineer and published author.

"Engineering helps me stay in reality, to discern what is or is not possible," said Link, who received his bachelor's in electrical engineering and master's and Ph.D. in mechanical engineering all from the Cullen College.

What's possible to Link are things like photographs injected directly into your visual cortex that you just "call up" (from his first novel, "renatus") and transpatches, planted behind your ear, to receive and transmit data (from his second novel, "A Year Owed") in a relatively dark but captivating fictional future.

Not only does his engineering knowledge help him understand the science behind his writing, Link says it also affords him the opportunity to write.

"If I was working two jobs to maintain a living versus writing, I'd have to maintain a living and my writing would suffer. Being an engineer allows me to do both," he says.

Such a practical answer for a guy who is so deeply drawn to the fantastical.

ENVISION AT DAY

Three days a week Link is at his office in downtown Houston at the energy company Envision, striving to make renewable energy affordable.

"The ultimate goal with developing wind turbines is to bring down the cost of energy. We work on both solar and wind energy and would like to get these clean, renewable energy sources to the point where they are absolutely competitive with fossil fuels," said Link.

Consumed with thoughts of the future, Link seems a perfect fit for Envision as it works to bring the future of renewables closer to the present.

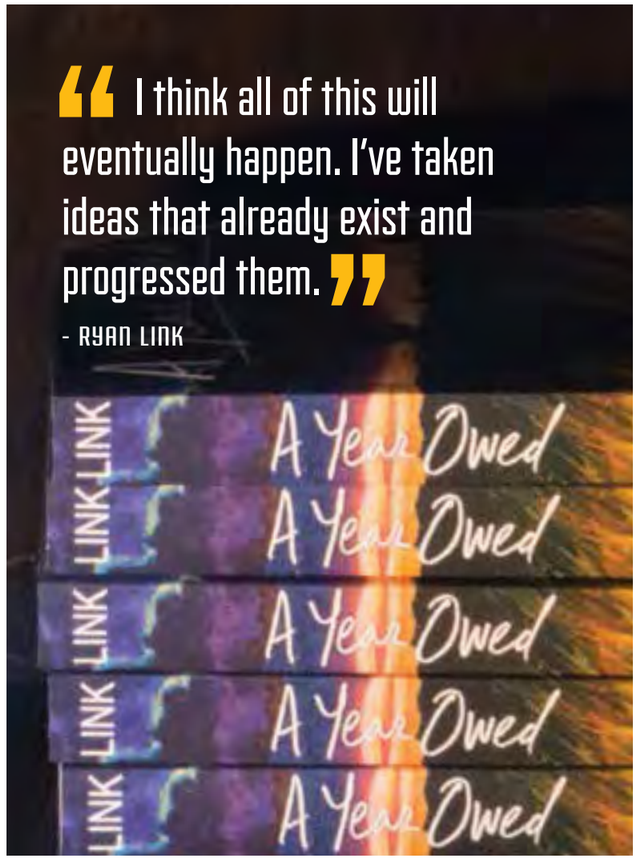
Link has worked steadily in the energy sector since he obtained his doctorate in 2008. His current role is specific to developing software in the creation of turbines, which he sees as instantly gratifying.

"It's very appealing because you can see the results as you're working. You develop software and you can deploy it immediately. Users start to use it and they get the benefits right away," said Link.

And there's something else. Working as an engineer forces him to live a less solitary life, which is often the fate of writers, sequestered as they are for days and weeks, even months on end to create their works.

"It gets me out and working with teams, which is good for people," said Link.

While he toils away trying to create a more sustainable future through technology, he writes about one that is much bleaker – part science fiction, part science fact and all eerily dystopian.



IT STARTED YOUNG

Link describes himself as a "mish-mash of a creative and analytic type of person." As a boy he was a steady reader, writer and fan of science fiction novels, and by middle school he was heavily into computer programming.

"I've always felt I'm not right brained or left brained, if that's really a thing. I feel like I've been both creative and analytic," he said.

The sci-fi books he read steadily impacted him. "A lot of what happens when you read is you form vast images in your mind," said Link. "I wanted to be able to write that kind of thing," was his natural thought as a teen reader.

And so he does, with every story full of scientific concepts mixed with high art.

In "renatus," he tells of a successful scientist, inventor of integrated limb technology, who is now drug-addicted and homeless, with visions of the time he and his wife rode to orbit and back in a type of elevator that goes straight to outer space.

"A Year Owed" tells the story of Earth and how it was nearly decimated by technology run amok, including biological augmentation where human heads are grafted into polished aluminum chassis complete with mechanized limbs and sensors. Those kind of modifications would soon be outlawed after the tragic lessons learned from them.

Link bases his fiction on the engineering facts he learned at the Cullen College of Engineering.

"I think all of this will eventually happen," said Link. "I've taken ideas that already exist and progressed them or done them differently than have been done before," said Link, admitting that without his training as an engineer his concepts might have been impaired.

PRESENTLY WORKING ON THE FUTURE

Link, 36, began writing in 2013, though he always remembered enjoying it when he was young. “It was always a thing like, ‘I wonder if I could actually do this and write something like this?’,” he said of the numerous books he devoured.

And then one day, while reading short horror stories by H.P. Lovecraft, it clicked.

“They were small bites and really compelling, so this was encouraging to me. I thought I could start by writing something short and so I began writing a number of short stories,” said Link. He had a few of them published in online magazines and then it was onto “renatus,” a novella written in 2014, before writing the full novel, “A Year Owed,” in 2016.

Link’s books are self-published and sold on Amazon.com and other online stores. He does bookstore appearances and arts fairs, too.

But instead of taking too much time on the PR trail, in the evenings you’ll mostly find him writing. And though the future worlds he creates seem desolate and, at times, shocking, you’ll read them with eye popping interest. Or as Link describes in “A Year Owed”:

The woman “removed her left eye from her skull, unspooling a twisted pair of wires from her empty socket along with it. When she released the eye, it retracted rapidly on the wire until it came to rest, nestled again in her head.”

Good choice of words for books you can’t take your eyes off of once you start reading.

Want more?

Ryan Link’s books are availabe
for purchase on Amazon and other online retailers.

> “I’ve always felt I’m not right brained or left brained, if that’s really a thing. I feel like I’ve been both creative and analytic.”
>
> - RYAN LINK

LNG: 101

UH Engineer Collaborates With ConocoPhillips on LNG VIDEO SERIES

BY NATALIE THAYER AND LAURIE FICKMAN

The renowned University of Houston mechanical engineering professor **John Lienhard,** who heralds "how inventive minds work" as the creator and voice of the KUHF radio program "The Engines of Our Ingenuity," is collaborating with ConocoPhillips to rev up audiences in a different way.

This time it's not engines revving, but excitement over liquefied natural gas (LNG). The team created a series of fascinating videos that bring to life the amazing story of how natural gas becomes a liquid – and why it should. The five-part series is called "LNG: 101."

Lienhard, professor emeritus of mechanical engineering at the Cullen College, is widely recognized for his unique flair in explaining high-level scientific concepts in a down-to-earth, narrative style.

"Very few storytellers can take technical topics and explain them in a quick, engaging way that appeals to subject matter experts and novices alike," said Greg Thomas, ConocoPhillips project leader. "Dr. Lienhard has a unique way of storytelling that ties together history and engineering concepts."

Lienhard was equally enthused with the collaboration. "Getting to interact with ConocoPhillips' experts was a great treat and a rare learning experience," he said. "I was especially pleased with the generous way the engineers at ConocoPhillips set out to create a teaching tool not tied to company interests. The process was truly collaborative."

Ever the teacher, Lienhard was excited about how much everyone learned in making the series and how much there is still to learn for those who watch it. Lienhard begins with a profound quote about human history in the first video of the series, "Right for the Times."

"We humans are an energy-hungry species," he says, recalling the words of 16th century writer Miguel de Cervantes who spoke of "the fire that warms cold, the cold that moderates heat, the general coin that purchases all things."

Lienhard's narrative spans the human use of power from the time when wood was the essential fuel source to the modern LNG era. It is a series full of history and storytelling that makes complicated subjects understandable and thought provoking.

Lienhard notes the stunning importance of fossil fuels being transformed by the sudden availability of natural gas. "A huge piece of that use is the liquefaction that makes it available worldwide – across oceans," he narrates.

Unlike natural gas, which is commonly transported through pipelines that are limited by distance and terrain, LNG can be transported in tankers, allowing producers and users from around the world to connect across thousands of miles of ocean.

Natural gas has become abundant and affordable and causes less harm to the environment, so its demand has risen, but it takes up a lot of space.

"We can put 600 times as much LNG into the same space as gas. That makes it safer and cheaper," says Lienhard.

In a world that revolves around energy, safety and value, the series asserts that it is time for LNG to be understood by all.

"It's really about making this information accessible," said Thomas. "We wanted to create something that would appeal to anyone who is interested in energy and its impact on society — from decisionmakers in the LNG industry to members of the communities impacted by the selling or purchasing of LNG."

The video series premiered last spring at the LNG 18 Conference in Perth.

WATCH THE ENTIRE "LNG: 101" VIDEO SERIES AT
lnglicensing.conocophillips.com/Pages/LNG-101.aspx

IT’S CRYSTAL CLEAR:

Jeff Rimer is an Award Winner

BY LAURIE FICKMAN

A diamond continues to shine in the Cullen College department of chemical and biomolecular engineering. Expert in the world of crystallization, **Jeffrey Rimer,** Ernest J. and Barbara M. Henley Associate Professor, has scored another award – the Joe W. Hightower Award from the American Chemical Society - Greater Houston Section (ACS-GHS). The award is based on “significant contributions in the areas of research, education and community service,” according to the ACS-GHS.

It’s hard to highlight milestones in a career that keeps hitting them. Most people know Rimer for his expertise in the processes behind crystal growth and formation, which impacts everything from drug development to the production of chemicals and fuels to pathological diseases such as kidney stones and malaria.

“Jeff’s postdoctoral research and his findings at UH have made critical contributions in the area of drug design for kidney stone disease through the discovery of crystal growth inhibitors, thus marking the first advancement in stone therapy in the past 30 years,” said Michael P. Harold, Chair and M.D. Anderson Professor of chemical and biomolecular engineering at the UH Cullen College of Engineering.

The molecules identified in Rimer’s research are not yet approved as drugs, but that’s the trajectory.

“All of our laboratory results look promising,” said Rimer. “The drug that we propose would be used as an agent to slow the rate of crystal growth.” Kidney stones are actually made of crystals that form inside the body.

As you might guess, the research explaining such a leap in the field of the painful kidney stones went viral. Since it appeared in the journal *Nature*, 77 international news stories appeared along with an entry in Wikipedia.

“I work with several doctors who have told me their patients come in carrying our recent article, asking questions about treatment,” said Rimer. And though Rimer, himself, doesn’t have any kidney stones, he has family members who’ve suffered from them.

“Working on drug development is satisfying in that you feel as though you are doing something that has the potential to improve people’s lives,” he said.

Zeolite research

Since arriving at the University of Houston in 2009, Rimer has continued to build on both his graduate and postdoctoral studies. His Ph.D. research was on zeolites and his postdoctoral work was on kidney stones.

Harold added, “After joining UH, Jeff quickly established a formidable research group in the area of crystal engineering. What has been impressive is Jeff’s ability to make major advances in two different areas of crystallization.”

And the best of all crystals, according to Rimer, are zeolites. Zeolites have been used for years in the oil and gas industry as catalysts to convert crude oil to gasoline. In fact, their use is credited as one of the most important accomplishments in the last generation to make energy refining efficient. Zeolites take big molecules of crude and crack them into smaller molecules that become gasoline and other byproducts. The process, simply enough, is called hydrocracking.

But as well as these catalysts perform, Rimer thinks they can do better.

“After decades of use in the petrochemical industry, there are still substantial opportunities to optimize their performance,” said Rimer. “We’re taking a step back and looking at how these materials crystallize, from which we can learn how to better control their synthesis. In particular, our ability to observe how zeolites grow, in real time, is somewhat of a paradigm shift in the field.”

Malaria therapeutics

Hard to believe, even Rimer admits, but the disease malaria involves crystals, too. To come up with a cure, he’s working with Peter Vekilov, John and Rebecca Moores Professor of chemical and biomolecular engineering at the Cullen College.

Most malaria cases occur in equatorial regions of the world and are caused by parasites delivered to humans by a mosquito bite. The parasites infiltrate the bloodstream and attack red blood cells. The parasite catabolizes, or destroys, hemoglobin in the red blood cell, which releases toxins (e.g., heme molecules) that crystallize.

“We are studying the crystallization of heme using a biomimetic protocol developed in our labs. With this platform, we have been able to assess the role of antimalarial drugs as modifiers that slow the rate of crystal growth,” said Rimer. “We feel that the knowledge we’ve gained has established a nice platform to screen crystal modifiers and to identify lead candidates for new drugs.”

New drugs are needed, he said, because parasites develop resistance to current lines of treatment. “We always have to stay ahead of the game,” Rimer said.

In the crystallization world, Rimer is not only ahead of the game – he seems to set the rules.

Society of Petroleum Engineers Chooses

BEST OF THE BEST

Each year, the Society of Petroleum Engineers (SPE), an international society with more than 168,000 members, recognizes the best of the best in its international awards program.

In 2016, three Cullen College faculty members were honored for their professional and technical excellence, career achievements, service to colleagues, industry leadership and public service.

HONORARY MEMBERSHIP AWARD

Ali A. Daneshy, petroleum engineering adjunct Daneshy is noted as one of the creators of the undergraduate petroleum engineering degree. “None of us can accomplish much alone,” said Daneshy. “Our accomplishments reflect the collective knowledge and contributions of the people we work with. I have been blessed with very capable and smart friends who have helped me reach my goals.”

JOHN FRANKLIN CARLL AWARD

Esteemed petroleum engineer **Christine Ehlig-Economides,** Hugh Roy and Lillie Cranz Cullen Distinguished University Chair, was recognized for distinguished contributions applying engineering principles to petroleum development and recovery. The first American woman to earn a Ph.D. in petroleum engineering in 1979, now she is the first woman to receive this award.

DRILLING ENGINEERING AWARD
DISTINGUISHED MEMBERSHIP AWARD

Robello Samuel, petroleum engineering adjunct professor, won two awards. The drilling award honors outstanding contributions to the advancement of petroleum engineering. The membership award recognizes only 1 percent of SPE members “who have attained eminence in the petroleum industry or the academic community, or who have made significant contributions to SPE.”

LEARN MORE ABOUT THE SPE INTERNATIONAL AWARDS PROGRAM AND THE THREE UH CULLEN COLLEGE WINNERS AT
www.egr.uh.edu/news/201607/society-petroleum-engineers-picks-three-best-cullen-college

Society of Hispanic Professional Engineers at UH is #1 IN THE U.S.A.

BY LAURIE FICKMAN

"THERE ARE TANGIBLE BENEFITS OF MEMBER-*SHEP*. YEAH, WE'RE BIG ON THE SHEP PUNS." - LUIS ESPINOZA

MEET THE TEAM

Maria Violeta Paez

President

Luis Espinoza

VP for external affairs

Katherine Velasco

Historian

Belinda Herrera

New member rep.

Samantha Bryant

Secretary

Daniel Cariel

VP for internal affairs

Oscar Rodriguez

Treasurer

Diana Enriquez

Regional rep.

Every year, as a marketing activity, the leadership board of the Society of Hispanic Professional Engineers at UH, recently named outstanding large chapter of the year by the national organization, brainstorms to create the next slogan that typifies their mission. For the 2016-2017 school year the motto is: "It does not matter where you come from, SHPE (they pronounce it "Shep") will help you build your future."

As branding goes, it's a bullseye. Their executive board is filled with immigrants from different Latin American countries including Mexico, Colombia, Panama and Venezuela – all on the way to successful careers that they credit SHPE with helping them find.

"Most of our members are first generation Americans," said Maria Violeta Paez, a mechanical engineering senior, president of the SHPE UH chapter and immigrant from Caracas, Venezuela.

That's what makes the UH chapter feel like a safe place for its members rather than a formal organization. Individually, the 300 UH members may be mostly immigrants to America, but together they are family.

"Fostering 'la familia' is really what makes Shep so great. Sometimes you don't have someone to look up to in your house or someone who's been through college, but the fact that you have a friend who supports you here that you can rely on and help you when you're struggling, that you'll struggle together, side by side to succeed, that's why we are all successful," said Paez.

She would know. When she graduates in May, Paez has a high-powered job waiting as a consultant with Accenture. How'd she snag such an opportunity? "It's all Shep!" she exclaims.

Her excitement is well placed. She met Accenture recruiters through her SHPE meetings.

The award winners

The UH branch of SHPE is one of 2,050 across the country in the organization that boasts more than 10,000 members in both the professional world and on college campuses. But as far as large SHPE chapters go, it's number one, grabbing the title from more than 200 other large universities competing at the national organization's annual conference last November.

SHPE's vision is a world where Hispanics are highly valued and influential as the leading innovators, scientists, mathematicians and engineers.

They start their influence with young students, through a program they call "MentorShep." Every other Friday, 15 members of the UH chapter go to Houston's Heights High School, which is 80 percent Hispanic and 60 percent low income, to mentor young students in an after-school program and try to inspire them to choose science, technology, engineering and math (STEM) fields in their future.

"We are so passionate about these kids," said Luis Espinoza, senior in mechanical engineering, vice president of external affairs for SHPE UH and immigrant from Valencia, Venezuela. The SHPE UH members helped the Heights High students set up their own club, "Shep Junior," said Espinoza. Together they build an assortment of engineering projects like mini bridges. "There are kids there that don't even speak English," he said.

"If they need help with their college essays or the SATs, we also mentor and help them with school," said Paez.

"It's so cool to watch," said Espinoza. "You see Shep Junior members go from high school and now they're here at UH and they're part of the Shep UH chapter. You get to see that growth."

Getting ahead, together

"There are tangible benefits of member-Shep," said Espinoza, adding, "Yeah, we're big on the Shep puns." The group even has a social event called "Sheps and Salsa," where they dance, or at least try to learn, the Salsa.

But the professional benefits really rock.

More than 200 representatives from Fortune 500 companies attend the SHPE national conference and industry professionals attend events with SHPE UH members throughout the year. Of the 86 students that went to the annual conference, there were 73 interviews by industry members for either jobs or internships. Espinoza graduates in May and begins working at Shell in July as an associate mechanical engineer, a job he says he got by meeting a contact through SHPE.

In fact, Paez's final interview with Accenture took place during the award ceremony when her chapter was named the outstanding large chapter in the country.

"They asked me why I was so nervous, was it because of the interview," she said. "But no, I wanted to know if we were winning first place! They laughed and said they'd hire me if we won." They hired her before she found out.

Later in the day, Paez walked by the Accenture recruiters carrying the 3-foot-tall first place trophy just to prove they had made the right decision.

MAKING A SPLASH:

Cullen College Ph.D. Student Wins Scholarship for Water Work

BY LAURIE FICKMAN

As a Ph.D. student in environmental engineering, **Amin Kiaghadi** already has a patent under his belt and won awards for his idea of how to treat "produced water," the dirty, non-usable water created during hydraulic fracturing. Now Kiaghadi can add scholarship recipient from Texas American Water Works Association Southeast Chapter to his burgeoning list of credits.

Kiaghadi, from Iran, studies the climate intensely to develop his concepts and chose Houston for his graduate work, also with the climate in mind.

"I hate cold weather," Kiaghadi said with a big grin. So he narrowed his graduate choices to warmer American cities and Professor Hanadi Rifai, director of the environmental engineering graduate program and associate dean of research and facilities at the college, won him over.

"She's was a perfect match for my research interests and she is so supportive and generous, even allowing me to file my own patent," he said.

It seems the sentiment runs both ways. "Amin is one of the top students in the environmental engineering program," said Rifai. "He has boundless energy and passion for research and for teaching and I foresee a great academic career in his future."

Kiaghadi models water quality, using either developed software or programs and codes he writes himself.

Dirty water, a solution and patent

In 2015, the challenge Kiaghadi met was creating a way to utilize the unusable water produced as a byproduct of oil and gas wells and exploration.

"It's super dirty, super salty – seven times saltier than sea water," said Kiaghadi. Current practices call for disposal of such water into deep injection wells below the ground. Kiaghadi says that process may just cause more problems and treating that water is too expensive.

So Kiaghadi had a better idea: to use the heat from the earth (geothermal energy) from existing oil and gas wells to treat the water. He and his colleagues developed a process to harness that energy to distill the water.

"Then that water can be used for agriculture or industrial use, and that's what the patent is about. No one ever thought before about using existing or abandoned oil and gas wells to harness geothermal energy for treating water," he said.

That could be why Kiaghadi continues to win awards, like this $1,500 scholarship.

He's got other ideas, too, just waiting to be tested. He explains the inequality of water distribution in the world and predicts water to be a major crisis in the next 10 years.

"My research emphasis is on water but also the nexus of water and energy, the relationship between the two," he said. "You cannot separate them nowadays. You need energy to treat that water and you need water to produce energy. You always need both. I'm trying to expand the horizons and come up with new ideas to – I think – save the world."

He may need another scholarship for that.

UH Space Architects Present Plans for Mars Mission to BUZZ ALDRIN

BY AUDREY GRAYSON

Apollo 11 astronaut Buzz Aldrin, the second person to walk on the moon, met with University of Houston space architecture students to hear their plans for establishing human settlements on Mars.

Space architecture graduate students Suzana Blanco, Kyle Kesling and Taylor Phillips-Hungerford presented their project to the space legend at the Sasakawa International Center for Space Architecture (SICSA), home to the world's only space architecture master's program.

The group's presentation focused on orbital and surface integrated systems, or OASIS, and how those systems would be used to colonize Mars. The team utilized the Aldrin Mars Cycler, a spacecraft conceptualized by Aldrin to send human missions to the red planet.

Aldrin's son, Andrew Aldrin, president of Moon Express, Inc., attended the presentation, along with former NASA astronaut Bonnie J. Dunbar and Ondrej Doule, assistant professor in the Human-Centered Design Institute at the Florida Institute of Technology.

VIEW MORE PHOTOS AT
www.flickr.com/photos/cullencollege

From left: Suzana Blanco, Kyle Kesling and Taylor Phillips-Hungerford present their plans to Buzz Aldrin

A BARREL

of Fun and Science for Cullen College Students Launching Payloads

BY LAURIE FICKMAN

It actually does take a rocket scientist to be a rocket scientist.

Case in point: Professor of physics and electrical engineering at the UH Cullen College of Engineering **Edgar Bering,** whose business card really does say he's a rocket scientist – and for good reason. He's been working with NASA on sending things airborne for decades. In August he was in Sweden where he and his students watched their payload launch in NASA's fourth BARREL balloon campaign mission. Bering was joined on this quest by three colleagues, associate professors **Jinghong Chen,** electrical and computer engineering, and **Craig Glennie** and **Debora Rodrigues,** both civil and environmental engineering.

BARREL stands for Balloon Array for Radiation-belt Relativistic Electron Losses and its purpose is to study the Van Allen belts, two huge radiation bands circling the globe. The radiation belts do most of their damage to spacecraft flying through them, which is why the space station's orbit is selected to minimize its exposure to the radiation belts, but some of their particles are flung out into space.

"The particles in the radiation belts don't stay there forever. They're eventually lost to the atmosphere," said Bering. That process of loss is called precipitation, like a rain of radiation from the upper atmosphere. To understand their atmospheric impact, NASA and company measure X-rays produced by electrons from the Van Allen belts.

"What we're trying to do is understand how the radiation belts are created and filled and how and why the particles are lost," said Bering. Lost particles can wreak havoc on satellite systems, knocking them out instantly.

"These killer electrons kill satellites," said Bering. Getting a handle on the activity of the belts and precipitation will help predict whether satellites will be lost during a certain atmospheric event. "If you know that, you can turn the satellites off to prevent it," he said.

Putting undergrads to work

And who better to work on such a heady project than the next generation of rocket scientists, the Cullen College undergraduates taking part in NASA's Undergraduate Student Instrument Project (USIP)? USIP provides real-life earth or space science flight project experience.

Samar Mathur, a junior in mechanical engineering, and **Michael Greer,** a senior in mechanical engineering, joined Bering's very low frequency (VLF) team. "Our goal was to create the proper instrumentation, a VLF circuit, to gather the data, to read and process the waves," Mathur said. They also built a complicated timecode circuit, called the IRIG-B, which keeps track of the exact time when data is actually gathered.

The work was intense, beginning in May for the August launch.

"Michael and I are mechanical engineers," said Mathur. "We knew nothing about electricity coming into this, except basics, but nothing about circuitry."

Greer agreed. "It was a lot of us sitting in the lab, changing out resistors, researching filters ourselves, banging our heads against the wall – that's when we would go talk to Dr. Bering," he said.

That's very much Dr. Bering's style, said Mathur. "He's taught us to learn trial by fire and then come to him when we're stuck."

"I lit fires with these students," said Bering proudly. "But they did it and I'm incredibly proud."

Christian Behrend, also a senior in mechanical engineering, worked on building the receiver that would actually listen to the VLF hiss in the atmosphere, made up of the electron precipitation.

"We repaired a VLF receiver that already existed and redesigned the antenna," said Behrend.

Blastoff

The balloons, carrying the Cullen College payloads, were launched at the Esrange Space Center near Kiruna, Sweden, nearest to the Northern Lights, or Aurora Borealis. Since the aurora is the result of electrons colliding with the upper atmosphere it's the best place to measure electron movement.

Takeoff launched the students into a world of excitement. Said Behrend, "It's really satisfying to make and put something on a payload and then watch it leave while you're thinking, 'That's the thing that I did!'"

The entire group shared that sense of accomplishment.

Mathur said, "Honestly, when we were going to Sweden, we were in the airport and I was like, 'Wait, what are we doing here?'"

Greer added a sense of uneasiness to his excitement. "It is a little bit scary watching everything we've worked on just float away, but it's really a great feeling."

Credit: NASA/University of Houston/ Michael Greer

The view from above

Bering is delighted, not only with his students' work, but also with the success of USIP.

"I am extremely proud of the entire USIP project. My colleagues and I have put together a program of instruction in science and engineering that is unmatched," said Bering.

Interestingly, he actually radiates with excitement when he speaks of it.

STUDENT SPOTLIGHT

SECRET LIVES OF ENGINEERS:

Meet Michael Pincus,

Electrical Engineering Student and Professional Cyclist

In the video series "Secret Lives of Engineers," the University of Houston's Cullen College of Engineering challenges conventional engineering stereotypes by exploring engineers' lives beyond the classroom and workplace. The series highlights the wealth of diverse talents, ambitions and passions that engineers embody.

The second installment of the series introduces electrical and computer engineering student **Michael Pincus,** a professional cyclist who races in competitions all over the world when he's not in the classroom.

For Pincus, who serves as coach for the UH collegiate cycling team, cycling isn't just a way to blow off steam while earning his engineering degree – bicycles and cycling are a natural extension of his passion for engineering.

"Cycling and engineering are quite similar," he said. "Cycling is actually a very engineering-friendly sport."

Pincus said many of his engineering peers find cycling to be a natural fit because of the focus and regimented training required to succeed at a professional level – qualities that are also required for completing an engineering degree. Some engineering and cycling enthusiasts take it a step farther, Pincus said, by studying and perfecting the aerodynamics of their bicycle.

WATCH OUR VIDEO ABOUT PINCUS IN THE "SECRET LIVES OF ENGINEERS" SERIES AT
www.egr.uh.edu/secret-lives-cyclist

HOW OVARIAN CANCER CAN KILL ITSELF – DISCOVERED BY UH ENGINEER

BY LAURIE FICKMAN

A 2013 graduate of the UH biomedical engineering doctoral program, now completing her fellowship at MD Anderson Cancer Center, has discovered the existence of a tumor suppressor – a micro ribonucleic acid (miRNA) – inside ovarian cancer cells that could lead to new ways to combat the deadly disease.

"The biggest problem with ovarian cancer is that it is generally diagnosed at very late stages," said **Pinar Kanlikilicer,** who studied at the University of Houston under Metin Akay, founding chair and John S. Dunn Endowed Chair Professor in biomedical engineering.

"I would like to discover a biomarker that enables early diagnoses in ovarian cancer patients, which may prolong their survival rates," Pinar added.

She seems well on her way. Her discovery about the exosomal tumor suppressor is now published in the *Journal of Cancer Research*, making her the first Ph.D. student from the Cullen College of Engineering and Akay's lab to earn such a distinction.

"Pinar's intellectual contributions, high ethics, dedication and elegance mean a lot to our lab and young department," said Akay.

Kanlikilicer's work bores right through a cancer cell where she noticed it releases tumor suppressors via exosomes, or vesicles that contain genetic material. But tumors are stronger and they discard the one thing that could destroy them – the suppressors.

"We can mimic these tumor suppressors and if we use them we can enrich the cells with tumor suppressors," she said.

At MD Anderson, Kanlikilicer focuses on experimental therapeutics and the design of cancer drugs. She – along with the rest of humankind – is hoping to one day develop her discovery into a medicine.

JOURNAL FEATURES DOCTORAL STUDENT'S BATTERY RESEARCH ON COVER

BY ASHLEY SCHWARTZ

Yifei Li, a former doctoral student in the Cullen College's department of electrical and computer engineering (ECE), was garnering

Yan Yao (left) and Yifei Li

international attention for his battery research before he'd even earned his degree.

Li's research on developing safer, cheaper and more efficient alternatives to traditional lithium-ion batteries was featured on the cover of the journal *ChemNanoMat* in a special issue on nanomaterials for energy conversion and storage.

In his article titled "Intercalation pseudocapacitance of exfoliated molybdenum disulfide for ultrafast energy storage," Li discusses how he and his fellow researchers – including his advisor, assistant professor of electrical and computer engineering Yan Yao – expanded the layers of a two-dimensional material to improve the performance of a supercapacitor.

"We needed to break down the material into single layers in order to approach its theoretical limit," said Li. "By exfoliating the two dimensional material, the material delivers higher capacitance per volume due to enhanced electric conductivity."

This research was also the focus of Li's doctoral dissertation at the Cullen College, which received the best materials program dissertation award from the college's materials engineering and sciences program. Li's dissertation will also be considered for the college-level best dissertation award.

"In his dissertation, Yifei was able to pull together past research to design better materials for battery systems and because of this we now have the ability to modify and tailor the design to the system we are trying to create," said Yao.

Li's dissertation, titled "Developing beyond lithium ion batteries for electrical energy storage," discusses creating safer and more efficient alternatives to lithium-ion batteries, such as sodium-ion batteries, magnesium-ion batteries, hybrid magnesium/sodium-ion batteries and magnesium-air batteries. His dissertation reports four strategies to address the issues that often arise when utilizing big sodium ions and divalent charged magnesium ions.

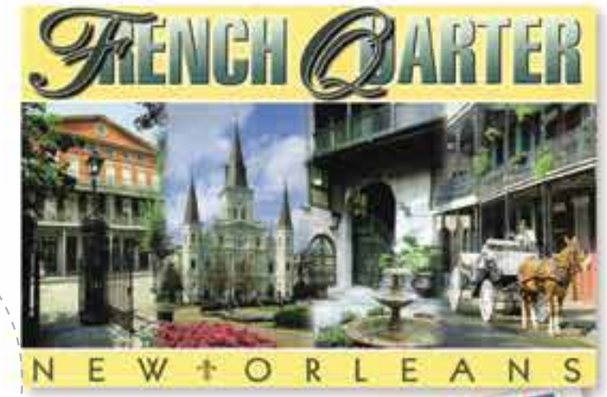
Li said he felt honored to receive this recognition from the college. "I hope that I can represent the students of our department by showing the importance of materials science and that we can make great contributions to the scientific field," he said.

In Yao's eyes, Li has already made great strides towards these goals.

"Yifei is the first Ph.D. student graduated in my group. He worked very hard and is very productive – he has authored 13 publications in the past four years," said Yao. "I have seen him transform from a student to a scholar. I congratulate him on receiving the best dissertation award from the materials engineering program."

THE CONFERENCE CIRCUIT

Cullen College students travel from coast-to-coast presenting lectures and earning awards. Here's a recent travelogue of some of their successes.



1 NEW ORLEANS, LA

Environmental engineering Ph.D. student **Aparna Balasubramani** received runner-up in the student paper award competition at the Battelle Ninth International Conference on Remediation and Management of Contaminated Sediments in January. Her research focuses on ridding waterways of toxic chemicals.

READ THE FULL STORY AT
www.egr.uh.edu/news/201701/cullen-college-phd-student-takes-home-award-international-conference

2 ORLANDO, FL

Nathaniel Piety, a Ph.D. student in biomedical engineering, received the Outstanding Abstract Award for Trainees in the Medical or Graduate Student category from the AABB (formerly the American Association of Blood Banks). Piety received $500 and was invited to give a talk at the AABB annual meeting last October. His research explores the best methods for storing donated blood to reduce deterioration of red blood cells.

READ THE FULL STORY AT
www.egr.uh.edu/news/201611/bloody-good-award-goes-uh-biomedical-engineering-phd-student

4 HONOLULU, HI

Maya Gough, *a Ph.D. student in biomedical engineering, was one of 30 students selected to present her research at the 2016 Engineering in Medicine and Biology Society (EMBC'16) International Conference. Her work explores the effects of vitamin D deficiency on cells infected by tuberculosis.*

READ THE FULL STORY AT
www.egr.uh.edu/news/201609/biomedical-engineering-student-investigates-effects-vitamin-deficiency-infectious

6 LAS VEGAS, NV

Ilknur Telkes, *a Ph.D. student in biomedical engineering, was named a 2017 North American Neuromodulation Society (NANS) Junior Scientist Award winner for her work in increasing the accuracy of target mapping and efficacy of brain surgery for Parkinson's disease. NANS sponsored her trip to Las Vegas in January to present her research at the NANS Annual Conference at Caesars Palace.*

READ THE FULL STORY AT
www.egr.uh.edu/news/201612/cullen-college-graduate-student-targets-areas-brain-surgery-wins-junior-scientist-award

5 ORLANDO, FL

3 PHOENIX, AZ

Chemical engineering Ph.D. student **Yuying Song,** received the 2016 Colt Refining Student Award from the International Precious Metals Institute (IPMI). Song presented her research on identifying new catalysts to reduce harmful emissions from low temperature combustion engines at the IPMI annual conference in June.

READ THE FULL STORY AT
www.egr.uh.edu/news/201607/doctoral-student-wins-prestigious-award-work-precious-metals

Electrical engineering Ph.D. students **Kamyar Ahmadi** and **Dongjun Wu** received travel grants to attend and present their research at the Electrodeposition Division of the Electrochemical Society's 230th Electrochemical Society Fall Meeting last October. Ahmadi's lecture described his work designing new thin-film sensors to measure corrosive chemical concentrations in water-oil slurries. Wu's talk focused on a new approach he developed to grow high quality cobalt thin film using a lead atomic monolayer as a surfactant.

READ THE FULL STORY AT
www.egr.uh.edu/news/201611/houston-hawaii-two-cullen-college-phd-students-speak-prestigious-conference

Women ENGINEERING THE FUTURE:

Meet the Brilliant Ladies Named the Cullen College's 2016-2017 Outstanding Students

BY LAURIE FICKMAN

Undergraduate mechanical engineering students **Tam Nguyen,** a senior, and **Serrae Reed,** a junior, focus on their studies with the precision of the engineers they are becoming. Upon graduation, Nguyen has an engineering job nailed down at Shell, and Reed is conducting research on solar cells and the efficiency in which light is harvested for energy production.

That's the kind of hard work and dedication it takes to be named a Cullen College outstanding student for 2016-2017, a title they've both captured. As it turns out, the pair is so outstanding they are both back-to-back winners.

OUTSTANDING JUNIOR
Serrae Reed

It's a good thing Reed is an engineering major: She is a study of energy in motion. Her days are filled with meetings, on one project or another, or with one of two writing groups she formed for youngsters.

"I wear comfortable shoes, I have to get around really fast," she laughs.

Reed is a fast mover, fast thinker and as bright as the solar cells she's developing. She's deeply immersed in research with thin film photovoltaics to make solar cells from a more affordable and efficient semiconductor, gallium arsenide, rather than the traditional silicon. That work is financed through a stipend she received last year from the Houston Scholars Program, the same year she was named outstanding sophomore by the Texas Society of Professional Engineers who seem to have created the award just for Reed. It was their first year to give such an honor.

Pretty amazing research for any scientist, let alone one at the age of 20. Reed credits her parents for her upbringing to succeed and give back.

"It was a pretty strict upbringing," says Reed. "We had to go volunteering on Saturdays and I remember once crying, asking them why we had to go out every Saturday," Reed recalls. She says her mother promised she'd remember the importance of it one day, and indeed she has.

At UH Reed launched two writing-related programs, each to voluntarily tutor youngsters. She created her first group, Writing to Inspire Successful Education, as part of the UH Bonner Leaders Program.

"Our objective is to improve writing skills, increase college aspiration and raise the test scores of our partner school, KIPP Intrepid," said Reed. Her aim is to "obliterate the education gap that occurs between low-income students and their more affluent peers."

Seeing the success of her efforts, in fall 2016 Reed developed the Houston Scholars Writing Workshops for 11th graders as they prepare their college essays.

Again she tracks back to the influence of her mother, a successful writer and therapist, and her father, a former geophysicist and financial advisor in the oil industry, for her mix of interests.

Pursuing a master's degree is definitely next for Reed, but she's still trying to determine which specialty she'll pursue. In the fall she went to Shell's Drilling and Production Training Camp and now she's preparing for her summer internship at the LyondellBasell Channelview plant.

"I'm trying to get as many experiences under my belt before I concretely choose something," she said.

No grass growing under those comfy shoes for this outstanding junior.

OUTSTANDING SENIOR
Tam Nguyen

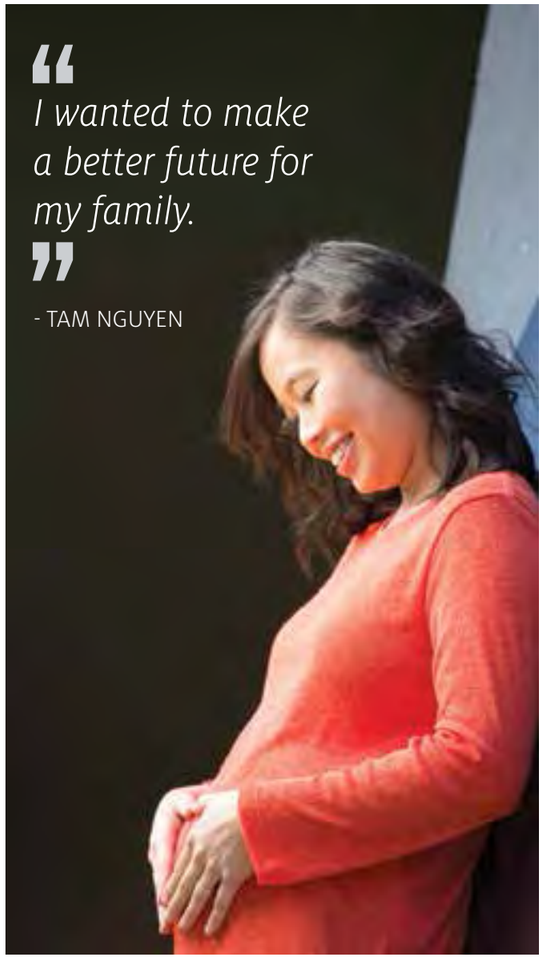
Tam Nguyen is closing out her undergraduate career with the outstanding student award for the second year in a row. Though she graduates soon, she's not coasting. At times she's worked two or three jobs along with a full course load to reach her goals.

Currently working away on her honor's thesis, she's exploring thermal batteries with an eye on making them more efficient. Thermal batteries use the differences in temperature to produce power. She's also working on her Capstone Project with the Society of Automotive Engineers to build a Formula One-style race car from the ground up to compete in the Formula SAE Series (FSAE) races.

Nguyen's part is to create the engine dynamometer that measures the horsepower and torque of an engine. With those measurements in hand, engineers can tweak the car's performance and maximize it for racing.

"Building a dyno has never been done by the UH-FSAE team before," said Nguyen proudly.

She's also active in the UH Society of Asian Scientists and Engineers, currently serving as senior advisor. Last year, in her prior role as president, she tripled the group's membership.



Nguyen says it's her basic personality that drives her forward.

"I always strive for the best," she said. "I see hurdles and obstacles as opportunities." She must. Leaving her family behind in her native Vietnam, she traveled to Houston, alone at 17, to live with an aunt. She didn't know much English yet, but was determined not to see obstacles. So she learned the language and got an associate's degree at a community college before applying to UH.

"I wanted to make a better future for my family," she said.

And so she has. In January she brought her brother over to live in Houston and this summer her parents will follow, all of them living together with her husband of four years. Her parents will make it just in time to help raise the new baby she's expecting.

Nguyen is a study in balance, taking on all roles with ease. Launching a baby and career at the same time, no hurdles here – not for Nguyen.

FELLOWSHIPS

Industrial Engineering Student Earns American Association of University Women Fellowship

The American Association of University Women (AAUW) awarded **Zaida Hernandez,** an industrial engineering graduate student at the UH Cullen College of Engineering, a 2016–2017 Selected Professions Fellowship, which is intended to support women in traditionally male-dominated fields, such as law, medicine, science and technology. The fellowship provides Hernandez with $12,000 to cover tuition for her graduate studies and related expenses.

READ THE FULL STORY AT
www.egr.uh.edu/news/201607/industrial-engineer-earns-american-association-university-women-fellowship

Materials Engineering Student Wins Fellowship to Investigate Applied Superconductivity

Meysam Heydari Gharahcheshmeh, a materials engineering doctoral student at the UH Cullen College of Engineering, received a 2016 Graduate Study Fellowship in Applied Superconductivity from the Institute of Electrical and Electronics Engineers (IEEE). Heydari Gharahcheshmeh works with Venkat Selvamanickam, MD Anderson Chair Professor of mechanical engineering and director of the Texas Center for Superconductivity Applied Research Hub, to fabricate second-generation, high-temperature superconductor tapes. His fellowship includes free membership to the IEEE and a $5,000 honorarium.

READ THE FULL STORY AT
www.egr.uh.edu/news/201608/doctoral-student-wins-fellowship-investigate-applied-superconductivity

Biomedical Engineering Student Brings Sickle Cell Disease Research to France with Chateaubriand Fellowship

Kian Torabian, a biomedical engineering doctoral student at the UH Cullen College of Engineering, is taking his innovative sickle cell disease (SCD) research to France as a 2016 recipient of the STEM Chateaubriand Fellowship. Torabian was chosen for his work in the Blood Microfluidic Laboratory led by biomedical engineering professor Sergey Shevkoplyas, where he assisted in the development of new technologies for diagnosing and monitoring the severity of SCD.

READ THE FULL STORY AT
www.egr.uh.edu/news/201607/student-brings-sickle-cell-disease-research-france-chateaubriand-fellowship

MAKING SMART BUILDINGS SMARTER:

Mechanical Engineering Alumnus Invents Smart Building Technology

BY AUDREY GRAYSON

From his office in west Houston, UH Cullen College of Engineering alumnus **Giancarlo Mitterhofer** (BSME '03) looks down at his smartphone and realizes two things: He's not making as much money as he could and his environmental footprint is growing instead of shrinking.

That's a lot of information to absorb in a simple glance. But with the invention of Mitterhofer's Renaissance Management System, it's information he gleans in the blink of an eye. The hardware-software system automatically monitors and controls energy usage in buildings, displaying crucial information on energy efficiency in a user-friendly visualization dashboard.

In practical terms, that means the office building using the system, that he happens to own, has operating expenses well below average – about $6 per square foot compared to $8 for similar commercial properties in the area.

He's multi-talented, of course

Though he graduated from the Cullen College with a bachelor's degree in mechanical engineering in 2003, Mitterhofer is not solely an engineer. He is also an entrepreneur, property manager, realtor, business owner and most recently, self-taught programmer and software developer.

You wouldn't know it by his long list of titles and successes, but he said it wasn't too long ago that he couldn't have imagined his future as an engineer and entrepreneur.

"Earning my engineering degree from the University of Houston was one of the most challenging things I have ever done in my life," Mitterhofer said. "That experience prepared me to take on anything I set my mind to afterwards."

Mitterhofer is dyslexic, intimidatingly smart and an eager, avid learner. Traditional classroom learning was tough to keep up with, Mitterhofer said, so he constantly sought opportunities to apply chalkboard lessons to real-world problems throughout his college career.

"I learn by doing," he said.

Three years after earning his bachelor's degree, Mitterhofer made an unusual career move: rather than going to work at one of Houston's many engineering and energy firms, he decided to try his hand at the commercial real estate industry, purchasing a 65,000-square-foot commercial building just west of Beltway 8, adjacent to Houston's Energy Corridor and Westchase Business District.

At the time, Mitterhofer had no prior real estate or property management experience. "I jumped in the pool in the deep end, but I didn't drown. That has a lot to do with engineering," he said.

All in the family

Mitterhofer now operates his own real estate company, G&W Holdings LLC, out of that same building at 800 Wilcrest Dr., specializing in residential and commercial real estate as well as property management tools and systems.

In Mitterhofer's opinion, he's got the best team behind him that money can buy.

"My sister is the accountant, my father helps with networking, I do the property management and my little brother supports in the development of software," Mitterhofer said, pausing to look around the room at each of his family members. "I wouldn't be anything without you guys."

The family business runs like a well-oiled machine. Along with the below-average operating costs, the office building is at nearly 100 percent capacity.

"I have a competitive advantage in that, because I'm an engineer, I'm able to look at everything in a quantitative manner, and that has allowed us to reduce a lot of costs," Mitterhofer said.

Dollars and sense

Reducing operating costs is key to ensuring a building's profitability. Rents are determined by the market, but property managers can fine-tune how much money goes out the door for expenses.

Shortly after purchasing the building, Mitterhofer replaced its 30-year-old heating, ventilation and air conditioning (HVAC) system with a brand new roof-mounted model with direct digital controls, allowing him to remotely monitor and control heating and cooling systems from his smartphone. This alone shaved more than $100,000 off of the building's electricity bill each year.

At its core, Mitterhofer's desire to cut costs is pretty noble.

"Reduced operating costs translate to reduced rents for tenants, which ultimately benefits the small business owners renting office spaces inside of our building," he said. "We are able to offer premium office spaces with top-notch property management to small business owners at affordable prices."

From a wider-angle lens, reducing electricity usage and increasing energy efficiency means less harm to the environment, he added.

In 2015, commercial and residential buildings accounted for roughly 40 percent of total primary energy consumption in the nation, according to the U.S. Energy Information Administration.

"A number of studies have shown that commercial buildings in the U.S. could use as much as 15 to 30 percent less energy if they simply improve operational practices," Mitterhofer said.

One simple way of reducing operational costs is utilizing smart building technologies, such as building automation software (BAS), but roughly 90 percent of all commercial buildings lack such technologies, according to a study published by the Pacific Northwest National Laboratory in 2012.

Giancarlo Mitterhofer is engineering the smartest buildings on the block

COMMERCIAL BUILDINGS IN THE U.S. COULD REDUCE ENERGY USAGE BY

15 to 30%

The not-so-smart building

Most smart building technologies work by leveraging all of the building's systems – cabling, lighting, HVAC, security and internet – into a single system that can be controlled remotely through a smartphone or computer. Sensors installed throughout the building collect information on temperatures and lighting, among other things, and send this information to a centralized database.

Some smart building technologies simply collect the information from sensors, and other technologies will actually analyze this information and automatically make adjustments to the building's systems accordingly.

The problem with a lot of off-the-shelf smart building technologies is the same problem with one-size-fits-all clothing – one size cannot ever truly fit all. Much like people, buildings have unique sizes and personalities, and like clothing, smart building technologies work best when tailored to fit the building's unique specifications.

At the root of many building automation systems is what Mitterhofer calls a "lack of engineering." For instance, there is an ideal time to turn the air conditioning units on and off in order to maintain a comfortable temperature while using the least amount of energy. Most smart building technologies aren't engineered to run such an analysis.

The oh-so-smart engineer

Determined to tackle his building's remaining inefficiencies, Mitterhofer conducted a regression analysis – a statistical modeling process used to identify the relationships among multiple variables – to identify the optimal times to turn the unit on in order to maintain a comfortable temperature at all times.

Ever the engineer, Mitterhofer didn't stop there. He wanted to compare his building's energy consumption and utility bills with similar properties. Mitterhofer knew if he could teach himself how to code, he could write a script that collected this information into database systems, analyzed the data and provided quantitative feedback on utilities bills and energy consumption for commercial buildings across the Houston region.

Mitterhofer also knew if he could teach himself how to program, he could integrate all of the building automation systems he had already created into a single monitoring and control system that would increase his building's efficiency even further.

These were ideas that, for the last two years, kept Mitterhofer awake at night.

> "I HAVE A COMPETITIVE ADVANTAGE in that, because I'm an engineer, I'm able to look at everything in a quantitative manner, and that has allowed us to reduce a lot of costs."
>
> - GIANCARLO MITTERHOFFER

A software is born

Learning takes time, so Mitterhofer worked late into the night to teach himself programming and coding in order to create a building automation software that would make his smart building even smarter.

Rather than simply monitoring inside temperatures, Mitterhofer's Renaissance Management Suite also collects and analyzes information on all temperature-changing factors, such as weather conditions, total people inside of the building, how often the elevators are used and how many times the doors are opened and closed.

Since these factors are unique to every building, the Renaissance Management Suite offers something most other smart building technologies don't – a real-time analysis tailored to a building's unique personality.

The Renaissance Management Suite also provides information on how a building's efficiency compares to the national averages for similarly-sized buildings.

"We believe the Renaissance Management Suite (RMS) could have a considerable positive effect on the environment and profitability of commercial buildings," Mitterhofer said.

Smartest building on the block

On a personal level, Mitterhofer wants to use his Renaissance Management System as a platform to grow his portfolio of properties across the Houston area, transforming some of the most inefficient properties into the most profitable and efficient buildings in the city.

On a global level, Mitterhofer hopes his smart building software suite can help other property managers do what he managed to with his own property – address inefficiencies, reduce energy consumption and offer subscriptions at affordable prices.

"I want to create a service," he said. "I want to see as many people as possible benefit from using this software."

However, if you prefer a more "plug and play" option, G&W Holdings can also fully implement the Renaissance Management System in any residential or commercial property in the area.

That's what you call a smart move.

FOR MORE INFORMATION ON THE SERVICES OFFERED BY G&W HOLDINGS, INCLUDING THE RENAISSANCE MANAGEMENT SYSTEM, PLEASE VISIT
http://wveleg.wixsite.com/gwholdings

FOR MORE INFORMATION ON THE RENAISSANCE MANAGEMENT SYSTEM, PLEASE VISIT
https://www.bldgot.com/

Q&A With GARY GOODHEART,

UH Engineering Alumnus and Civil Engineer of the Year in the State of Illinois

BY NATALIE THAYER

Over the course of his extensive career, UH civil engineering alumnus Gary Goodheart has traveled near and far to tackle tough infrastructure questions and challenges around the globe. Goodheart began his career while he was still a student at the Cullen College. He now serves as vice president of water resources at Patrick Engineering in Lisle, Illinois and was recently named the American Society of Civil Engineers (ASCE) Illinois Section's Civil Engineer of the Year.

Q ***Why did you want to become an engineer?***

A I was very fortunate in that I figured out at an early age I wanted to be an engineer. I grew up on the south side of Houston and my father, a life-long civil servant, worked as an administrator at NASA for 18 years. He frequently took me along when he had things to do on weekends, and introduced me to a number of the scientists and engineers who were working on the Gemini program.

He and a friend also had a ranching partnership, where they raised cattle and grew hay. As the oldest of five children, I spent a lot of time in the fields helping out, particularly when it was time to bale and haul the hay. Those experiences taught me that I wanted to earn a living with my brains and not my hands.

Q ***How did you know that civil engineering was the right field for you?***

A At first, I thought I wanted to be a mechanical engineer, but two years into college I started working at Houston Lighting & Power Company as a draftsman and, later, an engineering technician. At HL&P I realized I liked civil engineering, particularly soil mechanics. I liked the idea of designing and constructing big things you could see – like power plants and earth dams. For me now, the most rewarding thing about being a civil engineer is seeing a large complex design and construction project through to completion.

Q ***You were recently named the ASCE Illinois Section's Civil Engineer of the Year. What does this honor mean to you?***

A Winning this award is certainly the biggest honor of my professional career. I am honored, grateful and humbled to be selected and have my name alongside so many great and distinguished engineers who have previously won this award. I couldn't have achieved this honor without the help and support of my family and my many friends and colleagues in the civil engineering profession.

Q ***How did your experience at the UH Cullen College of Engineering prepare you for your career as a civil engineer?***

A I have always believed that the most important thing you learn in engineering school is how to think. UH Engineering did an excellent job of preparing me for the real world. It was clear to me that I didn't have all the answers coming out of school, but I did have a pretty good idea where to go, how to start and who to talk to. My experience at UH and early in my career gave me great confidence that has served me well in my career.

Q ***What advice can you share with current UH Engineering students?***

A Getting a college education is just the beginning of your career. Remember that as an engineer, you never stop learning. You come out of college with ideals and aspirations, but you don't have all the answers yet. I would encourage young engineers to ask questions, challenge the status quo and strive to improve their skills every day.

GENEROUS ENGINEERING ALUMNUS WILLIAM A. BROOKSHIRE FUNDS $1M SCHOLARSHIP FOR TEACHERS

BY LAURIE FICKMAN

In his continued spirit of generosity, UH Engineering alumnus **William A. Brookshire** donated $1 million to the Cullen College of Engineering to create the William A. Brookshire Teaching Excellence Award Endowment. According to the endowment agreement, the annual distributed income will honor faculty members in the Cullen College "who demonstrate an unwavering commitment to exemplifying the highest levels of teaching excellence inside the classroom."

More than many others, Brookshire clearly understands the significance of high caliber mentors inside the classroom. Raised without means, he was the first in his family to earn a high school diploma. College wasn't encouraged, but he didn't need anyone to light his fire; his spark came from within.

He's often recounted his experience as a night student at UH.

"I had to work a full-time job during the day while attending night classes to finish my bachelor's degree in chemical engineering at the University of Houston," Brookshire has said.

He graduated in 1957 and later moved to Louisiana to earn his master's and doctoral degrees in the same discipline.

In the early 1960s, Brookshire put his degrees to work at Exxon. Then, in 1967 he took another big leap, investing his life savings – about $7,000 – to launch S&B Engineers and Constructors with partner James Slaughter, Sr.

The company flourished, expanding from just the two partners to more than 7,500 employees across the world. Brookshire still serves as chairman of the board. Today, S&B continues to provide a complete range of project services for the petrochemical, refining, chemical, midstream and power generation industries for clients worldwide.

This is not the first time Brookshire has shined his very generous light on the Cullen College of Engineering. Prior to this gift, he founded two student scholarships. The William A. Brookshire Scholarship is for students taking a full course load (12 hours) and working at least 20 hours a week, and the William A. Brookshire IMPACT Scholarship is for students who are working, taking a full course load and paying for college on their own with no outside financial support.

One or more awards will be granted annually from the new endowment, with a minimum of $15,000 per recipient.

"The UH Cullen College of Engineering is home to some of the most devoted and innovative engineering educators in the world," said Joseph W. Tedesco, Elizabeth D. Rockwell Dean of the Cullen College. "Many of our engineering faculty members go above and beyond to provide UH engineering students with personalized attention, tailored lessons and mentorship in order to help them achieve their personal and professional goals. At many world-class research institutions, professors who are focused on the art of teaching and student engagement are the unsung heroes – but thanks to Dr. Brookshire's endowment, that will not be the case at the Cullen College of Engineering."

CULLEN COLLEGE ALUMNUS HONORS WIFE WITH ENDOWMENT

BY LAURIE FICKMAN

When **Bertha "Bo" Lohec** passed away in November, her husband, UH mechanical engineering alumnus Ron Lohec, knew the perfect tribute – an endowment to the UH Cullen College to help students achieve their dreams of becoming engineers.

"Ron is one of our all-time great alumni and Bo was a staple at his side at every UH engineering event," said Russell Dunlavy, chief development officer at UH. "She meant so much to Ron and to all of us. It's a wonderful way to honor her."

The Bertha "Bo" Johnston Lohec Engineering Endowed Scholarship will be awarded to engineering majors who exhibit leadership qualities and maintain a 3.0 GPA.

ABOUT THE NAMESAKE

Engineering flowed alongside Bo's life from a young age. When she married Ronald in 1953 at the age of 20, she got to work immediately, supporting him while he pursued his engineering degree from UH. Two years later, degree in hand, Ron went to work and Bo stayed home as their first of three children was born. Motherhood and grandmotherhood were her favorite occupations, say family members.

Still, she maintained an adventurous spirit, even finding a way to meet the Queen Mother while living in London. Throughout her life she valued engineering, joining her husband in his unwavering support of the Cullen College and constantly encouraging young people, especially young girls, to find a sense of purpose in that field of study.

Mr. Lohec serves on the Engineering Leadership Board at the Cullen College, providing respected counsel to the school in establishing priorities and objectives. In 2006, the couple was inducted into the Bridgebuilder Society, the highest honor bestowed on donors to the Cullen College. They were also early investors in the Multidisciplinary Research and Engineering Building (MREB).

SCHOLARSHIP HONORS

a Man Dedicated to Civil Engineering and Cullen College

BY LAURIE FICKMAN

When proud UH Cullen College alumnus **Charles Beyer** passed away last May, his family shared one of Beyer's favorite mottos, which they said he imparted to anyone who met him: "The world is run by those who show up."

When it came to the UH Cullen College of Engineering, Beyer did much more than show up. Named one of the University of Houston's Distinguished Engineering Alumni in 2001, Beyer's name has been distinguished again – now with an endowed scholarship. The Charles A. Beyer Houston Contractors Association Civil Engineering Endowed Scholarship was established in honor of Beyer and his many contributions to the Cullen College thanks to the generous donations from the Houston Contractors Association as well as Beyer's family, friends and colleagues.

"We have received significant support from Charles' friends and family, which has allowed us the ability to create a permanent endowed scholarship in his name," said UH chief development officer Russell Dunlavy. "This is a true testament to his character and the number of family and friends that he meant so much to. Future engineering students who earn this scholarship will carry with them the legacy that Charles created and I hope they go out in the world and make an impact as big as Charles did."

The income distributed annually from the endowment will be used to provide scholarships in the Cullen College of Engineering to eligible juniors or seniors pursuing degrees in civil engineering.

> "THE WORLD IS RUN BY THOSE WHO SHOW UP."

ABOUT MR. BEYER

A native Houstonian and proud Cougar, Beyer received his bachelor's degree and master's degree in civil engineering from the University of Houston in 1972 and 1977, respectively. In 1983 he launched Beyer Construction, a leader in the Houston area for commercial concrete, street and road paving.

No matter his successes, Beyer always stayed close to the Cullen College, participating in the Engineering Golf Tournament each year and serving as a member of the UH Civil and Environmental Engineering Advisory Board as well as the UH Engineering Leadership Board.

In an effort to bring together alumni and friends of the Cullen College's civil and environmental engineering department, Beyer founded the annual Civil Engineering Alumni Luncheon in 2002. Since then, the event has raised thousands of dollars for scholarships for civil and environmental engineering students at UH.

ABOUT THE HOUSTON CONTRACTORS ASSOCIATION

The Houston Contractors Association, formed in 1956, has grown into one of the leading organizations representing civil construction companies in the Houston area. HCA has more than 400 members who perform over $2 billion worth of work annually and form the backbone of the civil construction industry in the region.

LIENHARD'S LENS

BY JOHN LIENHARD

This is a scene from the Main Street Theatre production of the play "Copenhagen," directed by Guy Roberts. Here, the ghost of Werner Heisenberg (center, played by Philip Hays) confronts the ghosts of Niels Bohr (played by Joel Sandel) and Margrethe Bohr (played by Celeste Roberts).

This play is a magnificent analysis of the engineer's, or the scientist's, moral responsibility. The question posed is, "Why did the German Heisenberg visit his old mentor, the Danish Niels Bohr, and his wife, in 1941?" They were two of the leading atomic scientists. Bohr, in conquered Denmark, was half Jewish, and the possibility of building a nuclear weapon was clearly the subtext of the meeting. In fact, we have a pretty clear picture of what actually happened, what was actually said. Yet the motives of all three – especially of Heisenberg – remain clouded to this day. Was Heisenberg trying to build a bomb for the Nazis, trying to build a power reactor; or was he actually preventing Germany from building a bomb? Was he trying to find out if the Allies were building a bomb, or was he trying to keep both sides from building a bomb? Bohr was horrified by the very idea, yet he later helped the Allies build the successful bomb.

Ghosts of the three seek answers. And, when they are done, you and I, engineers – builders of the future – come to a new appreciation for the moral imperatives that had better underlie our own work.

For me, the play is deeply personal. I began working as a graduate engineer in 1951, in the early days of the Cold War. The bomb – and other horrors – were there in front of me at every turn. And no decision was clean or easy. I've watched the play three times since it debuted in America in 2000. Each time, I've come away shaken – and touched – by it.

VIEW MORE PHOTOS AT
enginespics.smugmug.com/Music/Tech-Rehearsal-of-Michael-Frayns-play-Copenhagen-Feb-4-2017

John Lienhard's photo of the Main Street Theatre production of the play "Copenhagen," Feb. 2017

Each year, the UH Cullen College of Engineering brings the world's leading engineering educators and researchers to the UH campus to deliver lectures on high-impact engineering topics. This year, the college welcomed five distinguished speakers to share their groundbreaking research with the Houston community.

Speakers included Yonggang Huang, Walter P. Murphy Professor of mechanical engineering, civil and environmental engineering, and materials science and engineering at Northwestern University; Michael Kavanaugh, senior principal at Geosyntec Consultants, Inc.; H. David Hibbitt, former CEO of ABAQUS; Sharon Wood, Dean of the Cockrell School of Engineering at the University of Texas at Austin; and John Rogers, Louis Simpson and Kimberly Querrey Professor of materials science and engineering, biomedical engineering and medicine at Northwestern University.

The Rockwell Lecture is named after Elizabeth D. Rockwell in honor of her gift to establish an endowed chair for the Dean of engineering.

FEATURING


YONGGANG HUANG

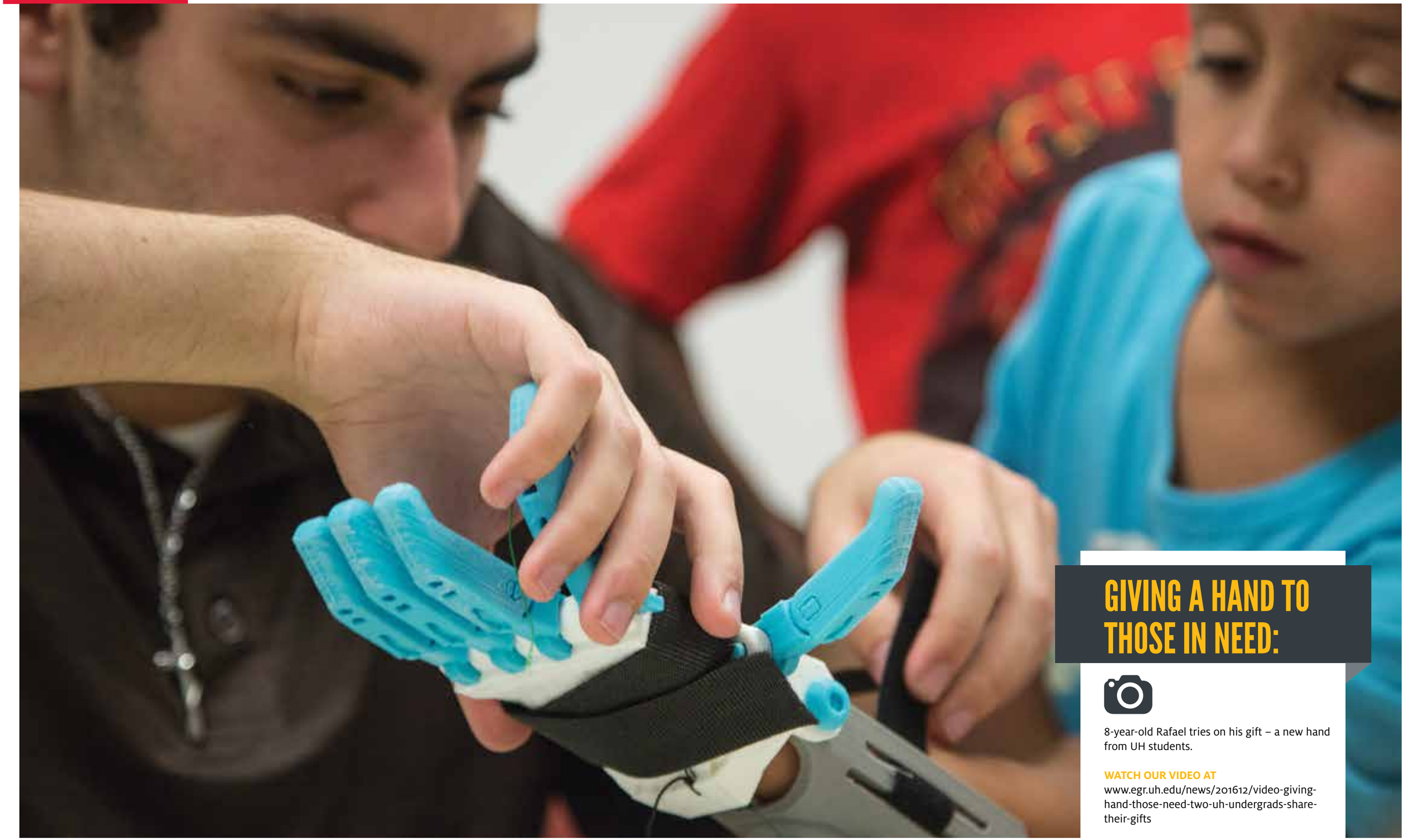

MICHAEL KAVANAUGH, NAE


H. DAVID HIBBITT, NAE


SHARON WOOD, NAE


JOHN ROGERS, NAE

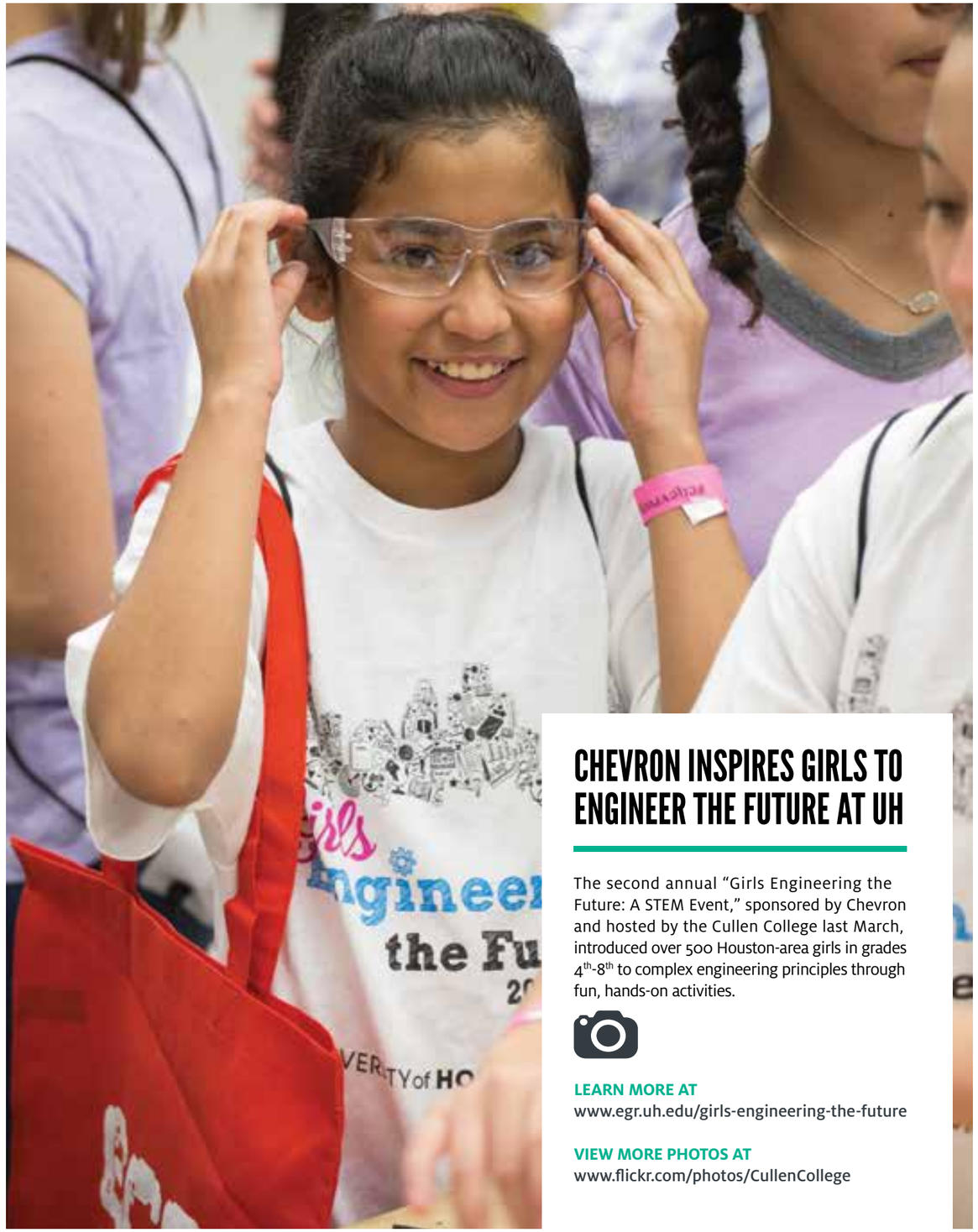
LEARN MORE AT
www.egr.uh.edu/our-college/rockwell-lecture



GIVING A HAND TO THOSE IN NEED:

8-year-old Rafael tries on his gift – a new hand from UH students.

WATCH OUR VIDEO AT
www.egr.uh.edu/news/201612/video-giving-hand-those-need-two-uh-undergrads-share-their-gifts



CHEVRON INSPIRES GIRLS TO ENGINEER THE FUTURE AT UH

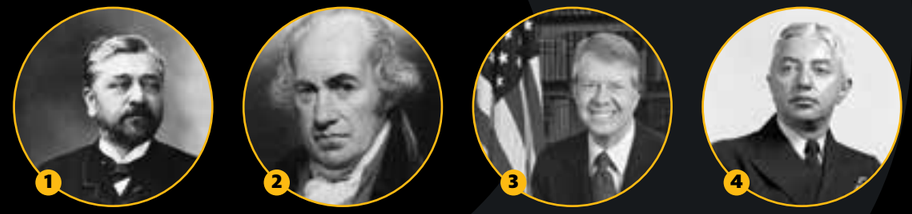
The second annual "Girls Engineering the Future: A STEM Event," sponsored by Chevron and hosted by the Cullen College last March, introduced over 500 Houston-area girls in grades 4th-8th to complex engineering principles through fun, hands-on activities.

LEARN MORE AT
www.egr.uh.edu/girls-engineering-the-future

VIEW MORE PHOTOS AT
www.flickr.com/photos/CullenCollege

ENGINES OF OUR INGENUITY:

Excerpted from "Looking for the Engineers"
Episode No. 1661



How many famous engineers can you name?

A colleague asked a group of freshman engineering students to write down nine names: three famous scientists, three famous inventors and three famous engineers. Few had any trouble with scientists. Most could name one or two inventors. But few of the engineering students could name any famous engineers.

What are the implications of that? There are plenty of names: Vitruvius, Watt, Brunel, Eiffel, Mulholland, Rickover, Herbert Hoover, Jimmy Carter, Nevil Shute, Henry David Thoreau and Josiah Willard Gibbs. But we call Vitruvius and Eiffel architects. We call Watt and Brunel inventors, and Gibbs a scientist. We call Hoover and Carter political figures, and Rickover an admiral. We know Nevil Shute and Henry David Thoreau only as writers, even though both did major engineering work. Did you know that cellist Carlos Prieto and sculptor Alexander Calder were both engineers?

I used to be more confident in defining engineering than I am today. The word engineer has evolved from the word engine and from the word ingenuity. Some people focus on engineering as a profession – an enterprise in which the public places its trust. Others see it as a source of new technology. Some expect engineers to expand our knowledge of means for building things.

An essential tension lies among these different pursuits. The most sober and reliable professional has little interest in potentially dangerous new ideas. At the same time, codes and standards are pretty far off the radar screen of someone deeply involved with, say, creating new turbine-blade cooling systems.

Maybe we need to look inside schools that teach engineers. There we find a three-part curriculum. Math and science is one part; technical engineering is another; liberal arts and writing form the third. Engineers get one of the best liberal educations available. In fact, some schools give their engineers a Bachelor of Arts degree instead of a Bachelor of Science.

That term liberal education refers to the tradition of educating students to become effective free citizens – people capable of making and carrying out good choices and decisions (it has nothing to do with politics.) It refers only to equipping a person with freedom of choice. It's about creating effective citizens.

People who see the world with an engineer's eye are typically able to move in many directions. Some become scientists, others builders, managers, presidents or beach bums, writers or artists.

Naturally, since engineers are so seldom just one thing, our students have trouble identifying famous ones. They often don't know them as engineers. They don't yet see that they're also being educated, not to do just this or that, but to maximize their own potential. Watch those students 20 years from now. Watch them. Like their predecessors, they'll form their world. But, like their predecessors, they too will do so under many guises.

I'm John Lienhard, at the University of Houston, where we're interested in the way inventive minds work.

FOR THE FULL AUDIO OF THIS EPISODE, PLEASE VISIT
www.uh.edu/engines/epi1661.htm


John Lienhard

The Engines of Our Ingenuity is a nationally recognized radio program authored and voiced by John Lienhard, professor emeritus of mechanical engineering 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.

1) Gustav Eiffel - civil engineer and architect who designed the Eiffel Tower 2) James Watt - mechanical engineer and chemist who invented the Watt steam engine 3) President Jimmy Carter - nuclear engineer 4) Admiral Hyman G. Rickover - electrical engineer and "Father of the Nuclear Navy"

UNIVERSITY of HOUSTON | ENGINEERING

UH Cullen College of Engineering
Office of Communications
Engineering Building 2
4722 Calhoun Road, Suite E311
Houston, Texas 77204-4009