MOMENTUM

Cullen College Department of
Mechanical Engineering Magazine | Issue No. 5

BUILDING 3D PRINTED PROSTHETICS FOR THOSE IN NEED

Issue No. 5 I www.me.uh.edu

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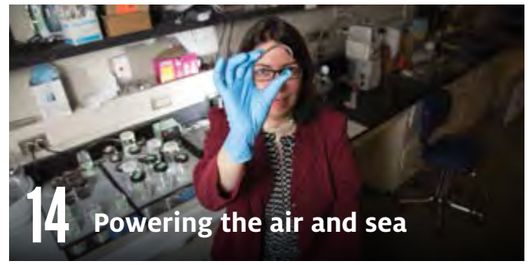

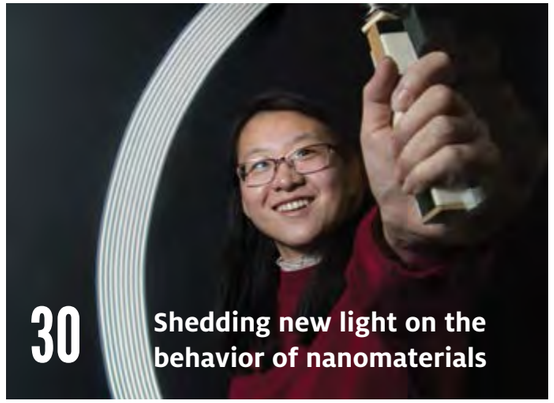

MOMENTUM

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Communications Director	Audrey Grayson
Art Director	Rachel Knudsen
Graphic Designer	Jose Cruz
Photography	Carlos Landa
Writers/Editors	Laurie Fickman Audrey Grayson Natalie Thayer

Office of Communications
Cullen College of Engineering
University of Houston
E301 Engineering Bldg. 2
Houston, Texas 77204-4009
Phone: 713-743-4220 Fax: 713-743-8240

Contact ME:
Phone 713.743.4500
Website www.me.uh.edu

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

UNIVERSITY of HOUSTON
CULLEN COLLEGE of ENGINEERING

CHAIR'S MESSAGE

In the Mechanical Engineering (ME) Department at the University of Houston Cullen College of Engineering, our central mission is to educate the next generation of globally competitive engineers and to perform cutting-edge research in the broad area of mechanical sciences. In this issue of *Momentum*, we invite you to explore the ways in which we continue to succeed in this mission and to take a closer look at our plans to continue driving the field of mechanical engineering forward for generations to come.

A modern mechanical engineer is very versatile. In our department alone, our students and faculty are currently involved in research related to cell biology, drug delivery, missile design, radiation-hardened materials, quantum dots, hypersonic flights, shale gas exploration, nanostructured Li-ion batteries for energy storage, environmentally-friendly engines, high temperature superconductive materials, subsea engineering, sensors, control of complex systems, thermal management, mechanics of complex fluids, artificial muscles and ultra-strong materials. This abbreviated list of active research within our department should give you at least a glimpse of the amazing array of career and research choices a mechanical engineer has in our current economy.

The University of Houston's highly-ranked ME department boasts very close ties with Houston's energy and engineering industrial complex as well as the medical center. Our graduates can be found in key positions in some of the leading companies both locally and internationally.

The ME program has seen record growth in recent years, with a total enrollment of nearly 1,300 students. Mechanical engineering is currently one of the most sought-after degrees within the Cullen College of Engineering. With our high standards of admission and passion for teaching, we prepare our graduates with a strong foundation in mathematics, physical sciences and engineering principles for applications in industry, research and academia.

I invite you to explore our website at www.me.uh.edu to see what we have to offer. If you need more information about our programs or department, please email me at psharma@uh.edu.

Pradeep Sharma
M.D. Anderson Professor and Chair
Mechanical Engineering
Cullen College of Engineering
University of Houston

MECHANICAL ENGINEERING BY THE NUMBERS

240 DEGREES AWARDED IN 2016

1,297 TOTAL STUDENTS IN 2016

29 FULL-TIME FACULTY MEMBERS

BEST GRAD SCHOOLS U.S.News ENGINEERING

BEST ENGINEERING PROGRAM OF 2017

MEAN ENTRY-LEVEL SALARIES IN HOUSTON VS. NATIONWIDE

	MEAN ENTRY-LEVEL SALARY IN HOUSTON, TX	MEAN SALARY NATIONWIDE
B.S. MECHANICAL ENGINEERING	$65,593	$72,000
M.S. MECHANICAL ENGINEERING	$75,391	$85,000
Ph.D. MECHANICAL ENGINEERING	$93,652	$159,000

SOURCE//PAYSCALE.COM

UH ENGINEERING BY THE NUMBERS

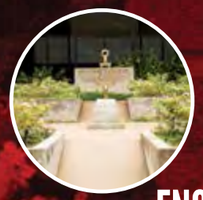
130 TOTAL FACULTY

1300 AVG SAT SCORE OF ENTERING FRESHMEN

19,000+ TOTAL ALUMNI OF THE CULLEN COLLEGE

$26 MILLION + RESEARCH EXPENDITURES

5,000+ STUDENTS



TOP 100 ENGINEERING PROGRAMS IN THE U.S.

(**SOURCE:** *U.S. NEWS & WORLD REPORT*)

13 NATIONAL ACADEMY OF ENGINEERING FACULTY MEMBERS

OF UH ENGINEERING UNDERGRADS ARE EMPLOYED IN TEXAS WITHIN ONE YEAR OF GRADUATION

$104,640 AVERAGE ANNUAL SALARY OF ENGINEERING PROFESSIONALS IN HOUSTON, TEXAS

(**SOURCE:** *U.S. BUREAU OF LABOR STATISTICS, 2016*)

BEST ENGINEERING SCHOOL OF 2017

(**SOURCE:** *U.S. News & World Report*)

BRAGGING POINTS

#1

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

#2

Named one of *Princeton Review*'s "Best Colleges for Undergraduate Education" and "Nation's Best Colleges" (2016, 2014)

#3

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

#4

Located in the Energy Capital of the World – the city with the highest demand for engineering talent in the U.S. **(Source: Kelly Services)**

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

HOUSTON CHRONICLE

Venkat Selvamanickam, who created high-temperature superconductors that can transport electricity with very little resistance, was profiled by the *Houston Chronicle* as a professor who is changing the world and engineering the future.

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

ScienceDaily
Your source for the latest research news

Houston Public Media

Hadi Ghasemi's ice-repelling material was covered by *Science Daily* and Houston Public Media.

LEARN MORE AT

www.houstonpublicmedia.org/articles/shows/uh-moment/2016/12/14/180716/uh-moment-repelling-ice/

University of Houston Launches

INDUSTRY-RELEVANT ONLINE PROGRAMS IN ENGINEERING

By Audrey **Grayson**

The University of Houston Cullen College of Engineering has launched flexible, online master's programs in civil, mechanical, subsea and industrial power systems engineering. Tailored for working professionals, the innovative digital programs include live videos of lectures, interactive web-based discussions and opportunities for one-on-one learning experiences.

All four of the online programs in engineering can be completed in as little as two to three years. The UH Engineering degrees earned online are exactly the same degrees earned by students who choose to attend classes on campus.

Students enrolled in UH Engineering's online programs take the same classes as on-campus students but in a digital environment, said **JR Rao**, director of online programs and extension services at the UH Cullen College of Engineering.

"The online and face-to-face classes have the exact same rigor, expectations and admissions processes," Rao said. "In fact, the online and in-person courses are taught by the same professors in many cases."

Many of the in-person classes are filmed and posted online for all students to view. Instructors post the materials, lectures, tests and assignments online for students to access at any time. Typically, all courses are available for download and viewing two hours after the live lecture has been captured.

The initial online course offerings were hand-picked to counteract critical shortages in engineering workforce talent in the city of Houston and across the nation, said **Joseph W. Tedesco**, Elizabeth D. Rockwell Dean of the UH Cullen College of Engineering.

"It is critical that the Houston region and the U.S. has the engineering talent required to address the grand challenges we're facing in energy, infrastructure and the environment," said Tedesco. "UH Engineering's online master's programs are a flexible and cost-effective option for working engineers to help fill those workforce gaps by acquiring specialized skills and earning advanced degrees."

Plans to launch additional online graduate programs in petroleum and industrial engineering are currently under way, Tedesco said.

UH Engineering also offers two fully online certificate programs in subsea engineering, with more online certificate programs in development.

The University of Houston's Cullen College of Engineering, located in the energy capital of the world, is one of the nation's premiere destinations for engineering research and education. Ranked among the Top 100 best engineering colleges in the country by *U.S. News & World Report*, the Cullen College is home to some of the world's most prominent engineering researchers, centers, laboratories and cutting-edge research collaborations.

FOR MORE INFORMATION
on the UH Cullen College of Engineering's online learning programs, visit onlinelearning.egr.uh.edu

BEST GRAD SCHOOLS
U.S.News & WORLD REPORT
ENGINEERING
2017

U.S. News & World Report Names

UH ENGINEERING ONE OF THE NATION'S BEST SCHOOLS

By Audrey **Grayson**

"We are a college on the move, and the most recent *U.S. News & World Report* rankings are a wonderful reflection of this."

- DEAN JOSEPH W. TEDESCO

The UH Cullen College of Engineering is well on its way to becoming a Top 50 engineering college in the nation, earning a coveted spot on the list of the Best Engineering Schools of 2017 by *U.S. News & World Report*.

The Cullen College climbed from No. 76 to No. 73 in the *U.S. News & World Report* national rankings for graduate-level engineering programs. Moreover, five graduate programs within the college – mechanical, computer, electrical, civil and chemical engineering – earned the status of Best Engineering Programs of 2017.

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

U.S. News & World Report is a leading source for rankings of colleges, graduate programs, hospitals, mutual funds and cars. Each year, the publication ranks professional school programs in business, education, engineering, law, medicine and nursing. The data for the rankings come from statistical surveys of more than 1,900 programs and from reputation surveys sent to more than 18,400 academics and professionals.

Suresh Khator, associate dean of graduate programs and computing facilities at the Cullen College, said the recent rankings reflect not only the success of the college's professors and students, but also the relevancy of its programs to the city of Houston and the entire nation.

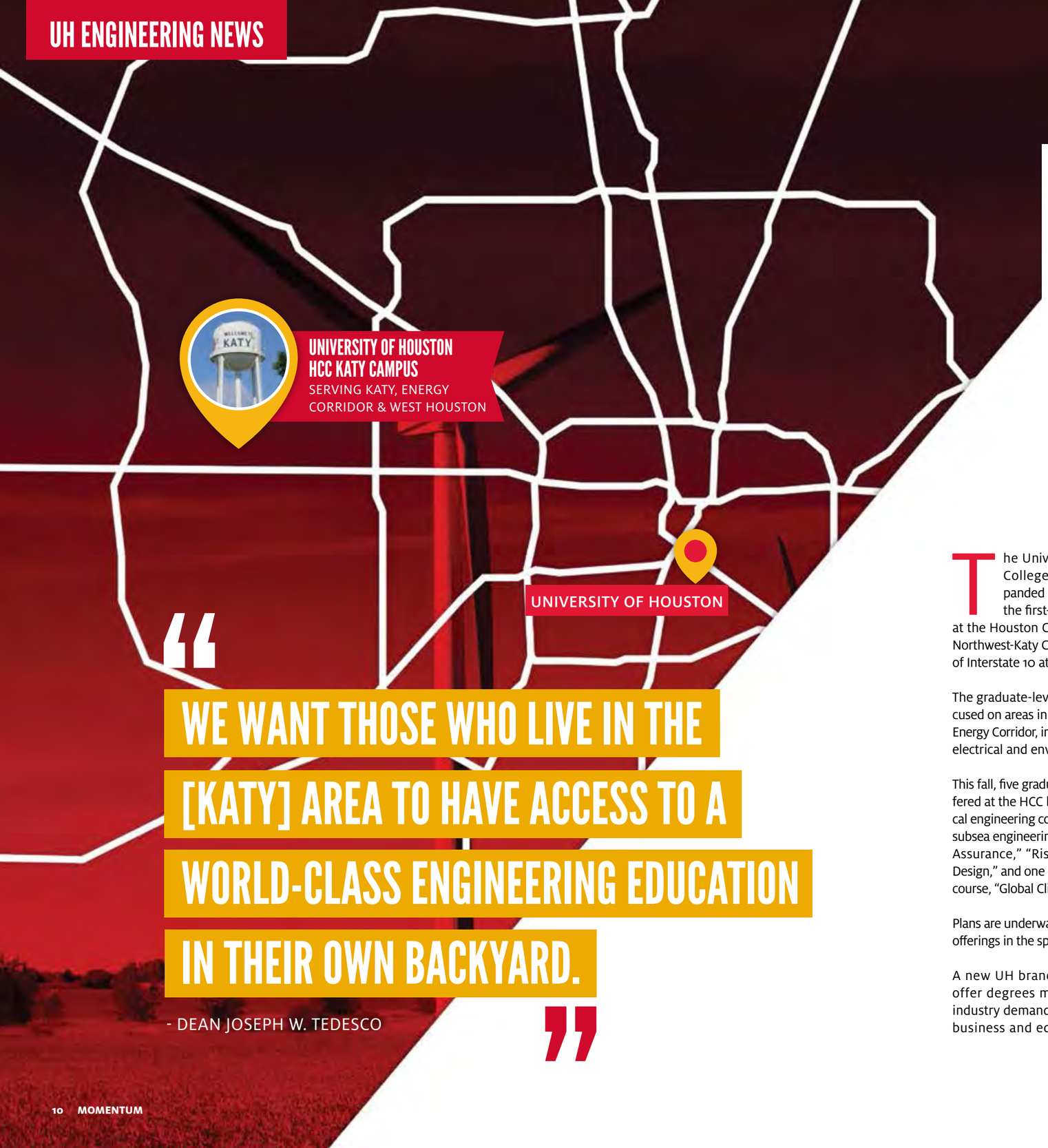
"Graduate programs at the UH Cullen College of Engineering are designed to immerse students in the grand challenges of engineering represented in our city, and our programs encourage students to conduct research that finds solutions to some of the most pressing challenges facing our city and our world," Khator said.

"UH engineers are making major contributions to society both nationally and globally, and it is wonderful to see our programs recognized among the best in the country," he added.

Nearly 5,000 students are enrolled in engineering courses – 3,722 undergraduates as well as 1,247 master's and doctoral students in biomedical, chemical, civil, computer, electrical, environmental, geosensing systems, industrial, mechanical and petroleum engineering. The college also offers interdisciplinary graduate programs in subsea, aerospace, materials, and computer and systems engineering.

The Cullen College is home to some of the country's highest ranked graduate-level engineering programs, including aerospace engineering (#56), biomedical engineering (#73), chemical engineering (#38), civil engineering (#60), environmental engineering (#59), electrical engineering (#65), industrial engineering (#50), materials engineering (#71), mechanical engineering (#69) and petroleum engineering (#12).

FOR THE FULL LIST OF RANKINGS from *U.S. News & World Report*, please visit *grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-engineering-schools*



"WE WANT THOSE WHO LIVE IN THE [KATY] AREA TO HAVE ACCESS TO A WORLD-CLASS ENGINEERING EDUCATION IN THEIR OWN BACKYARD."

- DEAN JOSEPH W. TEDESCO

University of Houston Offers Energy-focused Engineering Courses

IN KATY

By Audrey **Grayson**

The University of Houston's Cullen College of Engineering has expanded into the Katy area, offering the first-ever engineering courses at the Houston Community College (HCC) Northwest-Katy Campus, about a mile north of Interstate 10 at 1550 Foxlake Drive.

The graduate-level course offerings are focused on areas in high demand in Houston's Energy Corridor, including petroleum, subsea, electrical and environmental engineering.

This fall, five graduate-level classes will be offered at the HCC building in Katy: an electrical engineering course, "Well Logging," three subsea engineering courses, including "Flow Assurance," "Riser Design" and "Pipeline Design," and one environmental engineering course, "Global Climate Change & Energy."

Plans are underway for several more course offerings in the spring.

A new UH branch campus in Katy will offer degrees most relevant to current industry demands, including engineering, business and education. A grand opening of the UH Katy facilities located near I-10 and the Grand Parkway is tentatively scheduled for 2018.

Joseph W. Tedesco, Elizabeth D. Rockwell Dean of the Cullen College, said the college's administrators didn't want to wait that long to begin offering engineering courses in Katy.

"Katy is one of the fastest-growing areas in the Houston region, and the demand for energy and engineering talent in Katy has never been greater. We want those who live in the area to have access to a world-class engineering education in their own backyards," Tedesco said.

Phaneendra Kondapi, one of the pioneering instructors in the college's subsea engineering program, will serve as founding director of engineering programs in Katy.

Kondapi, who returns to UH after serving as the director of subsea engineering at Texas A&M University for the past year, will spearhead the expansion of UH Engineering program offerings in Katy.

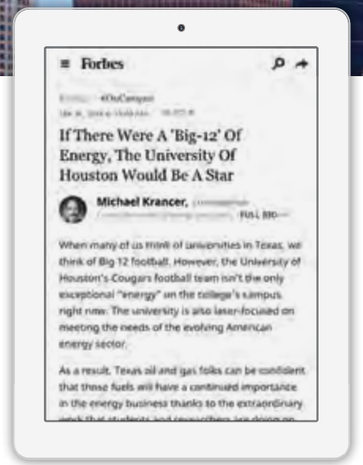
With more than 20 years of experience managing engineering projects at energy industry giants FMC Technologies and KBR, Kondapi brings a unique and invaluable skillset to his new role at the college.

"Dr. Kondapi was vital to developing the first subsea engineering program in the U.S. here at the Cullen College. I am tremendously proud that he will now bring our top-ranked engineering programs to the Katy community," said Tedesco.

The HCC building in Katy is easily accessible for professionals in the Energy Corridor who are looking to pursue higher degrees or certificates to enhance their skills. "We are here in Katy to serve both the community and the industry," Kondapi said.

FOR MORE INFORMATION
on the UH Engineering courses in Katy, visit *www.egr.uh.edu/engineering-katy.*

TAKING HOUSTON TO THE NEXT LEVEL



FORBES.COM LAUDS UNIVERSITY OF HOUSTON AS LEADER IN ENERGY RESEARCH AND EDUCATION

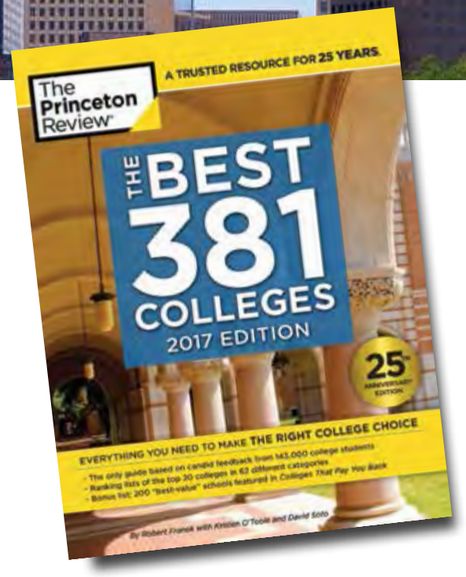
Forbes.com calls UH an epicenter of energy education and research, saying it is "increasingly a rival to places like MIT in advancing not just cleaner, safer and more efficient ways of extracting oil and gas from the earth, but also cleaner energy and zero-carbon energy."

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 magazine ranked the UH Cullen College of Engineering No. 73 in the list of top schools 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

POWERING THE AIR AND 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.

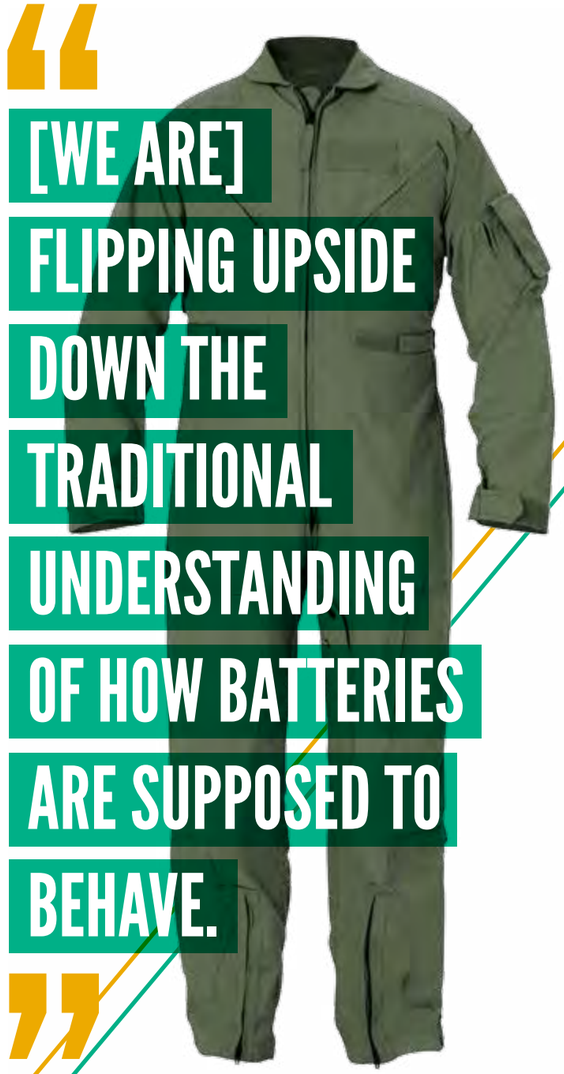
Ardebili is a bit of a juggler, with two new grants worth more than half a million dollars. What's more, her funding for energy storage research stretches – like her batteries – from the depths of the sea with an award from the Subsea Systems Institute, to the outer reaches of the atmosphere with money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



> "[WE ARE] FLIPPING UPSIDE DOWN THE TRADITIONAL UNDERSTANDING OF HOW BATTERIES ARE SUPPOSED TO BEHAVE."
>
> – HALEH ARDEBILI

"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."

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.

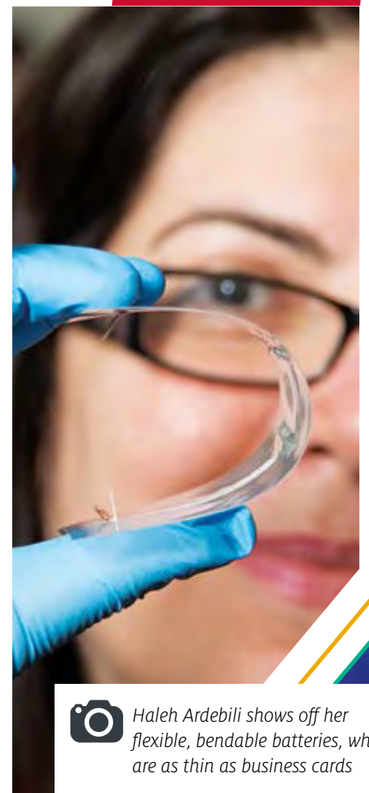
"Materials are very important, and if they are flexible and can conform to various spaces, at least you are opening up some design parameters that allow more space-efficient design, so hopefully you have more space for other requirements in those vehicles," she said.

Energy becomes her

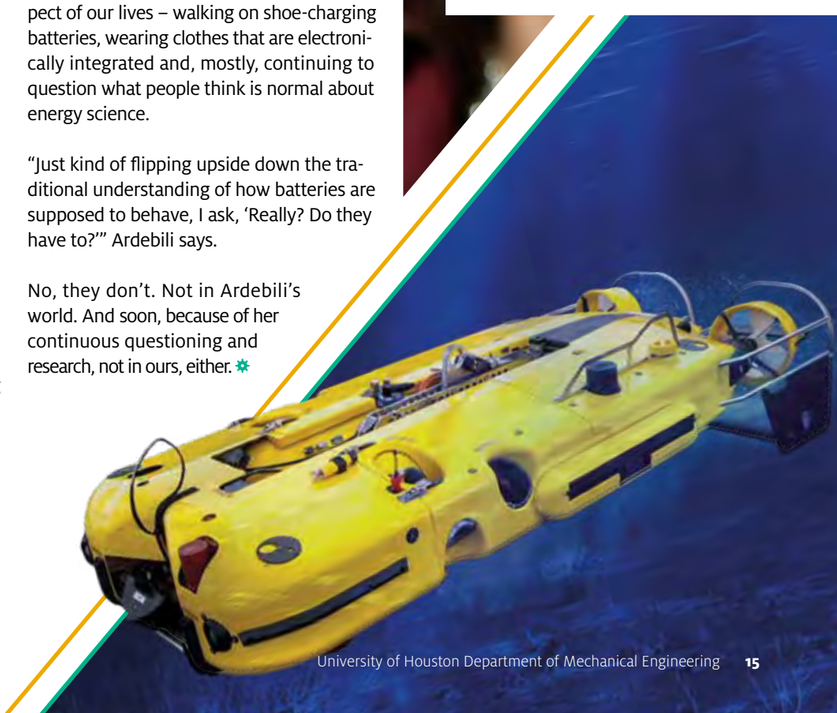
Ardebili herself is filled with energy as she speaks about the world she envisions, where batteries are integrated into every aspect of our lives – walking on shoe-charging batteries, wearing clothes that are electronically integrated and, mostly, continuing to question what people think is normal about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



Haleh Ardebili shows off her flexible, bendable batteries, which are as thin as business cards



UH Engineer Improves Computer Model to Find

BETTER OIL SPILL REMEDIATION STRATEGIES

By Audrey **Grayson**

After a major oil spill, government agencies and energy companies have limited time to make decisions on how to remediate the disaster and clean up the spilled oil. Officials currently rely on computational models that predict the behavior of an oil plume in order to determine the best strategies for containment and clean-up.

While these models provide insights on the spill that are crucial for rapid response clean-up efforts, existing simulations don't account for some processes that play important roles in determining the direction, shape and overall size of an oil plume.

A professor at the UH Cullen College of Engineering is improving the computational model used to predict the behavior of oil plumes in deepwater blowouts, such as the BP Deepwater Horizon disaster in 2010. Once deployed, the improved models will provide insights to more effectively remediate these kinds of oil spill disasters

Di Yang, assistant professor of mechanical engineering at the Cullen College, and his collaborators at Johns Hopkins University and the University of California, Los Angeles, received $877,162 from the Gulf of Mexico Research Initiative (GoMRI) in support of this research. A total of $247,490 will support Yang's portion of the research at UH.

In order to glean as much useful information as possible about an oil spill within an hour or less, officials rely on rapid response models, or integral plume models, that simulate only the average behaviors of an oil plume in the near-field of a leaking oil well. These models provide general information on the amount of oil spilled, how long it will take for the oil to reach the ocean's surface and in what direction the oil plume will likely travel.

But there are many small-scale interactions and processes that can have a profound impact on the overall behavior of an oil plume. For instance, the sizes of the oil droplets and gas bubbles released from the site of an underwater blowout have an impact on the shape of the near-field plume and its interactions with the ambient seawater. Small-scale turbulence at the edge of the oil or gas plume also plays a vital role

in the mass and momentum exchange between the plume and the ambient sea.

Due to time and computational power constraints, this information is either averaged together or filtered out of simulations in integral plume models.

"The rapid response model has critical value for quickly determining how to respond to an oil spill, but the accuracy of this prediction heavily relies on the incorporation of other physical models to supplement the rapid response model. This accounts for the effects of some critical physical processes that are filtered out due to averaging," Yang said.

Yang and his colleagues are using Large Eddy Simulation (LES), a high-fidelity computational simulation technique for modeling turbulence in fluid dynamics, to fill in the gaps of the current integral plume models. The physical models developed by Yang's team can be seamlessly integrated into existing integral plume models without requiring additional computational power or time to receive the results.

"Using the computer power and resources currently available, we will directly resolve as much information as possible that the current integral models can't resolve," Yang said.

Yang began this research as a postdoctoral researcher at Johns Hopkins University in 2013. With funding from GoMRI, Yang's team studied the complex physical systems at play when spilled oil travels across the surface of the ocean.

Results of the research showed that not only large-scale systems – such as climate and ocean flow – play important roles in the dispersion of oil, but also small-scale interactions between oil droplets and upper-ocean turbulence. His team also found that the use of dispersants – chemicals used to break oil into smaller droplets so that it biodegrades more readily in the ocean – can profoundly impact how and where an oil plume travels across the ocean's surface.

They used their findings to supplement the large-scale ocean circulation models used for predicting regional dispersion of an oil spill in the Gulf of Mexico.

"There's a big gap between the smallest scale resolved by ocean circulation models and the scales at which the oil plume and ocean turbulence interact, so that's what we're filling in," he said.

Next, Yang and his colleagues focused on modeling the behavior of an oil plume at the site of a deepwater blowout. In a study published in the *Journal of Fluid Mechanics* last year, Yang's team simulated a lab-scale multiphase plume that mimicked the dynamics of the Deepwater Horizon plume as it burst vertically from the well at the ocean floor. The team then used a numerical model they developed to understand the underlying physics of the oil plume's behavior.

In the case of the BP Deepwater Horizon Blowout in 2010, government officials approved the company to apply dispersant directly at the site of the burst well, nearly 1,500 meters below the surface of the ocean.

"It reduced the damage a lot, but it's been questioned how efficiently that strategy actually worked," Yang said. "We want to provide insights to find better remediation strategies for responding to these kinds of oil spills in the future."

Using LES, Yang's team advanced the understanding of the fundamental physics and physical processes that contribute to the behavior of the oil as it shoots upward from the well at the ocean floor.

"The more we understand the fundamental physics, the more accurate our integral models will be. Now, when the rapid response model spits out averages, there will be fundamental physics underlying its results," said Yang.

With the current funding from GoMRI, Yang's group will take their research a step further by integrating both the vertical and horizontal model of oil dispersion into a complete framework.

"Right now, if a company or the government wants to look for a model that can capture all of the essential flow physics to provide a precise prediction of how an oil plume will behave during its entire fate – from the bottom of the ocean to the surface – we don't have that kind of model," Yang said. "After we understand the true physics and integrate these models together, we will be able to predict with greater accuracy how an oil plume will behave, and that will lead to better remediation strategies for future oil spills."

> "WE WANT TO PROVIDE INSIGHTS TO FIND BETTER REMEDIATION STRATEGIES FOR RESPONDING TO THESE KINDS OF OIL SPILLS IN THE FUTURE."
>
> - DI YANG

GIVING A HAND TO THOSE IN NEED:

UH Engineering Undergrads Share Their Gifts

By Laurie **Fickman**

Jalal Yazji (left) plays ball with 8-year-old Rafael, who recently received a 3D-printed prosthetic hand

On a Wednesday evening in November, Maria Sanchez sits 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.

It may 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 newly-printed 3D hand. The hand is a gift to Rafael from UH students, 19-year-old **Jalal Yazji** majoring in mechanical engineering at the UH Cullen College of Engineering (also a member of the Honors College and PROMES) and 20-year-old **Daniel Bahrt** majoring in mechanical engineering technology in the UH College of Technology.

Yazji and Bahrt have made it their mission to make prosthetics for people in need, even founding the first eNABLE chapter in Texas, right here on the UH campus. The Enable Community Foundation creates 3D-printed hands and arms for those in need. They publish prosthetic blueprints online and the local chapters create them on 3D printers and put them together for their clients.

It's not the first time Yazji and Bahrt have seen a mother tear up while a child squeals with joy. Less than two months after they formed UH eNABLE, they had received three requests, now all filled.

Searching for help

Until this special night, when Yazji and Bahrt fitted Rafael with his new hand, there wasn't much to be done for Rafael's condition, but Maria persisted.

They were turned down for a prosthetic hand several times. She's still not sure why. It may be because the goal of conventional treatment is to help a child be as independent and confident as possible, and Rafael's always had that down pat.

"He does everything everyone else does, only he just has to try twice as hard," Sanchez said. "That's what I've always taught him and it's normal to him."

That could be a huge hurdle to some, but not to Rafael. He possesses a bouncy nature, confident smile and a sense of perpetual motion – traits you'd want to see in any carefree 8-year-old.

Empathy first

When Rafael's stepdad, Daniel Ramirez, joined the family, he wanted to make sure everyone really understood just how tough things were for Rafael, though he didn't often show it.

"Daniel sat us down one day and said, 'Ok, today everyone tapes their left hand shut, so we can see what Rafael actually goes through on a daily basis'," said Sanchez. "It was impossible, none of us could believe how hard it was."

The experiment and his compassion were truly stunning, one of those rare family moments frozen in time, where years later you can still recall the exact instant your respect grew for certain family members – in this case, Daniel and Rafael.

Across town

At about the same time the family was adjusting in Humble, about 45 miles east at Klein High School, Yazji was about to discover his passion for engineering.

By the time he was a senior he chose a year-long prosthetic project for his engineering and design class.

"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 schooler's effort that he introduced Yazji to the Enable Community Foundation.

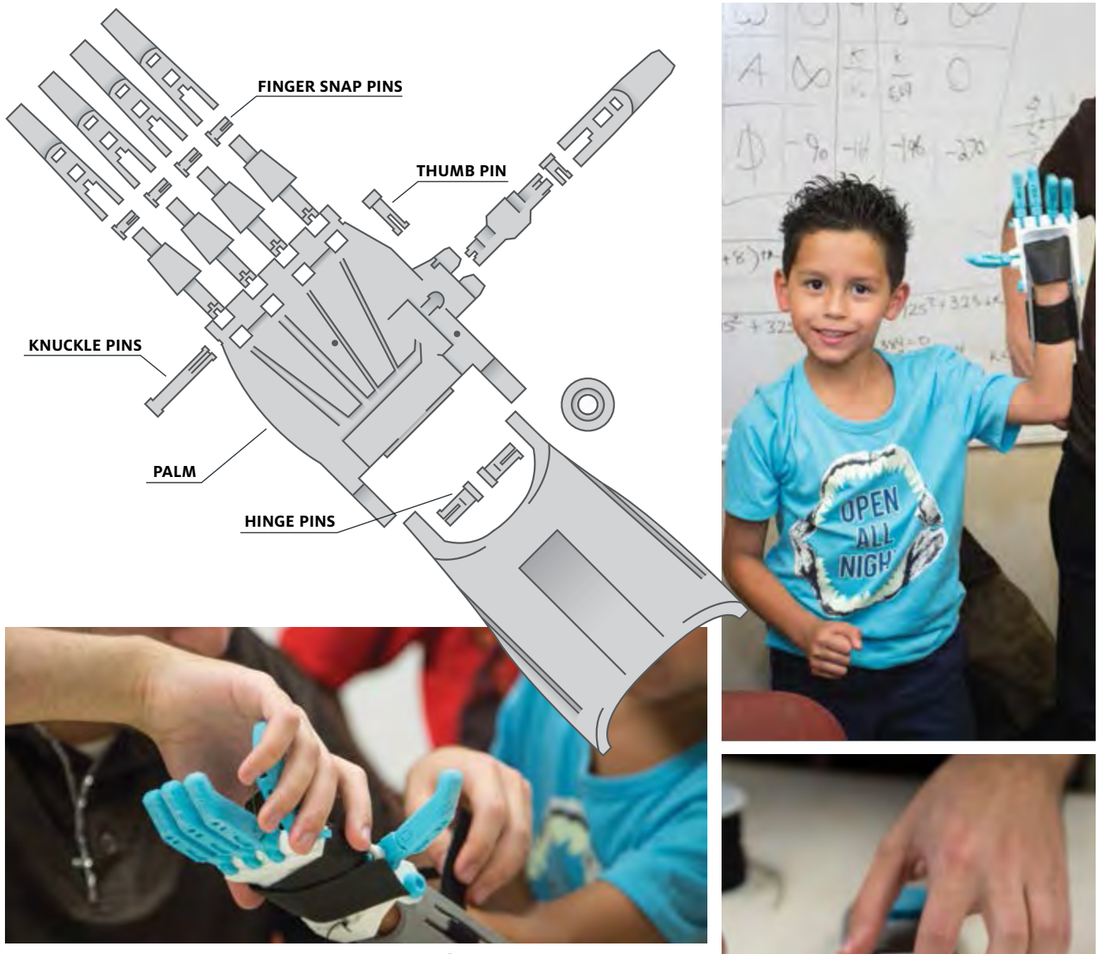
A partnership is born

Once in college it seemed that making prosthetics became a fait accompli. During his freshman year at UH, Yazji lived in Cougar Village Two where he met his suite mate, Bahrt. While Yazji was building models in high school, Bahrt was learning CAD software.

"One night we were just having a casual dinner and Jalal said he made a prosthetic model," said Bahrt. "I said 'Really? I'd love to see this!' Then he showed it to me and I was like, 'This is really cool and I see you messed up a few things'," he said, chuckling.

So a 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.

RAPTOR HAND



Raptor Hand Assembly

Each of the components is printed on a 3D printer before the team members assemble it – a process that includes trimming and sanding the pieces. Each finger has three pieces, or about 30 components per hand. If everything fits together, assembly can take an hour. The team uses elastic cord and fishing line to connect the hand, along with medical-grade foam padding to provide comfort inside.

After the Raptor Hand is assembled, 8-year-old Rafael takes his new hand for a test run, waving eagerly to the camera

Life in Humble

On any given weekend you might find Rafael hanging out with his best friend, 9-year-old Amir, or scores of cousins and friends, partaking in the pure joys of childhood. On the surface all seemed well, but some stress cracks were about to show.

One day during gym class, Rafael asked to speak privately with his Lakeland Elementary School gym teacher Tracy Wong. On the playground Wong says Rafael broke down, crying because he couldn't hold the rope to participate in the simple exercise of jump rope.

"I try to do the jump rope," said Rafael. "And we tie the ropes to my hand with rubber bands and it kind of hurts," he said.

Wong felt heartbroken. That night at dinner, unable to put it out of her mind, she shared the story with her husband and her own 9-year-old son, Tristen, who had never met Rafael. Tristen immediately got on the computer and started looking for a way to help.

His remarkable compassion and computer skills (sometimes only reserved for kids) led Tristen to the UH eNABLE chapter and Yazji.

No one was more stunned with Tristen's discovery than Rafael.

"She told me her son had found it and I was like, 'Whoa, really nice!'," said Rafael.

For Rafael's mom, it was beyond nice.

"When she called me and told me about Tristen's discovery, I couldn't help but cry," she said. "It was so touching for someone to see a problem with him that I see on a daily basis – as a mother she knew how I felt. And for her to go home feeling bad and keep discussing it. The whole thing is amazing."

Everyone welcome

Although UH eNABLE turns no one away, they seem to deal mostly with children. Their hands are inexpensive to make and cater to a young crowd.

To appeal to children, the hands all have names like the Cyborg Beast or the Raptor.

"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.

Bahrt agreed. "That's actually our whole mission because kids are constantly growing. If you buy them a $10,000 prosthetic, they're going to need a new one in another six-to-eight months, so a temporary fix is best for kids. That's why we deal mostly with kids."

Plus, the children get to pick the colors.

Waving goodbye

As Yazji and Bahrt were finishing the assembly of Rafael's hand, with the help of Ramirez, who was watching intently to make sure he can fix it if it breaks, Rafael was sharing thoughts on the most important thing he wants to do with his new hand.

"I want to hold a bottle and open it without having to press it on my stomach. My favorite drinks like water, Coke, Big Blue, or sparkly water," he said.

Rafael will make you remember it's the little things in life that we overlook that can pose the biggest hurdles.

He'll teach you more lessons, too, if you listen to why he picked the colors for his made-to-order hand.

"I picked white, gray and baby blue because they're actually my favorite colors. Baby blue, the sky; white, God; and gray, sharks," said Rafael.

The really important things all 8-year-olds should be thinking about.

WATCH OUR VIDEO TO LEARN MORE ABOUT THE BIG BRAINS AND EVEN BIGGER HEARTS BEHIND UH ENABLE
www.youtube.com/watch?v=i64WYlB7m2s

WANT TO HELP?

Help UH eNABLE buy its own printer.

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

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).

"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.

Ashutosh Agrawal (left) and Mehdi Torbati are facing down their donuts to uncover the secrets of our cells

RESEARCH SPOTLIGHT
ON HADI GHASEMI

#1

Hadi Ghasemi Creates 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 – ceramics, 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 participated 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

#2

Hadi Ghasemi Creates New Material, Breaks Limits of

LEIDENFROST PHENOMENON

By Laurie **Fickman**

Bill D. Cook Assistant Professor **Hadi Ghasemi** is set to change history with his invention of a new material that provides efficient heat dissipation at high temperatures and eliminates a 250-year-old scientific event known as the Leidenfrost Phenomenon.

If you've ever cooked a meal on your stove, you're probably familiar with the phenomenon, though you may not realize it. It occurs when you sprinkle a few drops of water into a hot skillet to make sure it's heated to your satisfaction. In those precious moments when the little droplets dance around – rather than boil – you are witnessing the Leidenfrost Phenomenon, in which a vapor barrier is created when liquid touches a hot surface, and that barrier prevents the drops from boiling on impact.

Scientist Johann Leidenfrost recognized the dynamic in 1756. Since then, scientists have been trying to prevent it, because its impact extends far beyond the kitchen. Think re-entry of a spacecraft or the Fukushima Daiichi nuclear disaster during which inadequate cooling led to three nuclear meltdowns.

"When you have a hot surface and you're going to cool it down with a liquid, you need contact of the liquid with the surface," said Ghasemi. "Otherwise the vapor becomes an insulating layer and it blocks the heat transfer."

Now, a scientist – among the hundreds around the world working to eliminate the vapor barrier – has succeeded, effectively working around the problem. That scientist is Ghasemi.

The heat is on

"We have developed a new approach to completely eliminate this phenomenon," said Ghasemi. His approach is the invention of a new metal surface called a "decoupled hierarchical structure" that removes the vapor barrier. His work has been published in the American Chemical Society's journal *Langmuir*.

The new structure is made of two layers: a micro-pillar surface with a nano membrane on top. The nano membrane keeps the droplet in contact with the surface while the micro-pillars take away the generated vapor. The new material allows unprecedented heat dissipation because there is direct contact with the liquid to the surface.

Ghasemi created the new surface in his Nano Therm lab and currently has a patent pending on the product. Lab members Nazanin Farokhnia, Seyed Mohammad Sajadi and Peyman Irajizad contributed to the research project. Ghasemi is already onto phase two of the material, to be made of copper in order to lower the cost.

Compared to today's technology, no other surfaces come close to Ghasemi's new one, which removes the bottleneck for the heat transfer process.

"With current surfaces, the maximum temperature reported is 400 degrees Celsius when the Leidenfrost effect occurs. But in our surface we couldn't find any Leidenfrost, even at 600 degrees Celsius, and we believe we can go to much higher temperatures with no Leidenfrost effect," said Ghasemi. "It is unprecedented heat dissipation."

Infinity and beyond

Imagine one day that heat shields are made out of Ghasemi's material, or power generators and chemical reactors. He does, as he researches the widespread applications of the material.

"We envision these surfaces opening a new avenue in thermal management through spray cooling," he said.

#3

Based on Frogs,

a New Adaptive Surface

HOPS OUT

of Hadi Ghasemi's Mind

By Laurie **Fickman**

Of the almost 5,000 species of frogs around the world, one of them hops immediately to Hadi Ghasemi's attention.

You might wonder why the Bill D. Cook Assistant Professor of mechanical engineering has amphibians on his mind when he is so clearly a man versed in mechanics.

For Ghasemi, who is freezing out the competition in the field of anti-icing surfaces and has created better than state-of-the-art materials to repel ice, the link is this: Wood frogs are part of a small group of animals that can freeze, but not die. The species can tolerate freezing of 65 percent of their total body water and still survive in the winter.

So Ghasemi thought if frogs can do it, then he can, too.

He studied the frogs and built a new anti-icing material than can withstand critically low temperatures. His newly created adaptive surface works like a pair of glasses that change to sunglasses when you walk outdoors. In this case, Ghasemi's material performs normally at ambient temperatures, but when exposed to extreme cold, it becomes an ant-icing surface.

For this innovating idea, Ghasemi won top prize in the NASA iTech competition, a year-long initiative to "find innovative ideas that address challenges that will fill gaps in critical areas identified by NASA as having a potential impact on future space exploration," according to NASA.

"We think the idea of these anti-icing surfaces selected by NASA can be revolutionary for the aerospace industry," said Ghasemi. "We are delighted we can make contributions to future NASA missions."

Research jumping off the page

Ghasemi says a vast domain of knowledge has been overlooked and is hidden inside of living species.

"We got the idea of these surfaces through nature. It is bio-inspired," said Ghasemi. "The wood frogs can tolerate the freezing of their blood and tissues while being alive. When we looked closely at the cell biology of these frogs we observed that the ice formation was restricted to the surface of their cells."

That means they protect themselves from freezing.

So he decided to use this knowledge of wood frogs to develop the new material that can have the same adaptive properties.

Developing products based on animals is not as odd as it may seem. Ghasemi points to an adhesive material developed at UMass Amherst based on the mechanics of gecko feet, which was named one of the top five science breakthroughs of 2012 by CNN Money. In theory, if you applied GeckSkin to your hands you might be able to wall crawl like Spiderman. Or a gecko.

But this is the first time someone has based a low-temperature material on a frog.

"We think we can develop new surfaces for the next generation of aircrafts and any infrastructure that is going to stand at really low temperatures subject to freezing," said Ghasemi.

Only from the mind of Ghasemi can cold-blooded creatures warm up outer space.

SHEDDING NEW LIGHT

on the Behavior of Nanomaterials

By Audrey **Grayson**

In a paper recently published in the journal *Nano Letters*, mechanical engineers at the UH Cullen College of Engineering describe a novel method for characterizing and understanding the behavior of nanomaterials.

The invention of methods and tools to better understand the behavior of materials is partially responsible for the technological revolution of the 21st century. Understanding the electronic properties of semiconductors, for instance, led to their utilization as the "brains" of computers, and determining the mechanical behavior of metal alloys made modern aircraft construction possible.

In order to understand the behavior of materials, researchers recently have taken to using atomistic simulations – that is, modeling a material one atom at a time – to unravel the fundamental mechanisms underpinning its physical or chemical behaviors.

But such simulations can only account for phenomena that take place in under a few nanoseconds. By comparison, the blink of your eyes takes about a second, or roughly 1 million nanoseconds. This time-scale limitation precludes atomistic simulations from revealing what's happening when a material is stretched or deformed slowly, among many more phenomena. Studying how materials – especially nano-sized materials – will react under mechanical stress in real-life applications or even during laboratory tests was impossible until now.

Doctoral student **Xin Yan** used a suite of algorithms that collectively provide some resolution to the time limitations of atomistic simulations. Guided by intuition and "an enormous body of excellent past work," Yan said she deployed an algorithm suite to simulate what happens at the microscopic level when a nanomaterial is slowly compressed. Under the guidance of her advisor Pradeep Sharma, professor and chair of the mechanical engineering department at the Cullen College, Yan studied the behavior of nano-sized pillars of nickel made up of only a few hundred atoms.

Traditional atomistic simulations have shown that when nickel nano-pillars experience a fast application of force, the length of the pillar will simply shorten, much like a rubber eraser would if you pushed down on it. When studied using Yan's models, her simulations revealed that the nano-pillars actually behave more like a liquid when slowly squeezed.

"The nano-pillar behaved like a soft, mushy blob being squished, with material oozing out in ugly spirals – or beautiful spirals, depending on your point-of-view," said Yan.

Experiments using electron microscopes to observe the behavior of nanostructures have confirmed the same liquid-like deformation when the materials undergo slow mechanical stress.

> *"Time-scaling is a very hard problem and may be considered the 'Holy Grail' of computational materials science."*
>
> - XIN YAN

"Time-scaling is a very hard problem and may be considered the 'Holy Grail' of computational materials science," Yan said.

Although the computational methodology that Yan and Sharma deployed provides interesting insights into the behavior of nanostructures undergoing slow mechanical deformation, the researchers said a complete resolution to the time-scale bottleneck remains elusive. However, the novel method represents another step towards the creation of materials with never-before-seen applications.

"Such computer simulations provide a unique window into the behavior of materials at the microscopic level and provides us with clues for how to design next-generation materials with brand new applications," said Yan.

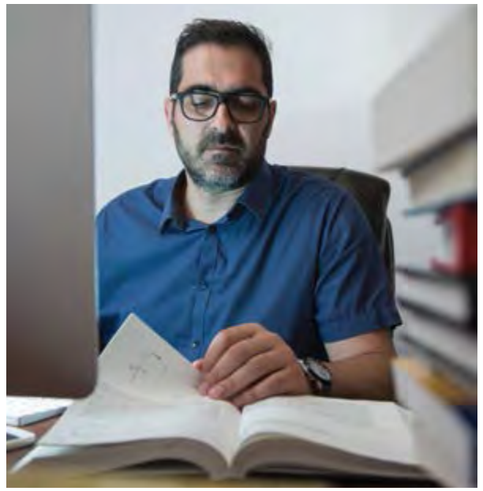
The research published in *Nano Letters* was initially funded by a grant from the Air Force Office of Scientific Research and is partially funded by the National Science Foundation.

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, similar to 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.



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

"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.

> *"I'm trying to design the material that will make this new technology available for the aerospace industry as soon as possible."*
>
> - THEOCHARIS 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 toward where we should look next, 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.

Superconducting motors and generators made with the wire that will be manufactured using Selvamanickam's technology can lead to more than **6 billion kilowatt hours of annual electricity savings** and **reduce CO2 emissions by a million tons per year**

THIN FILM SUPERCONDUCTOR WIRE IS USED IN:

MAGNETICALLY LEVITATED TRAINS

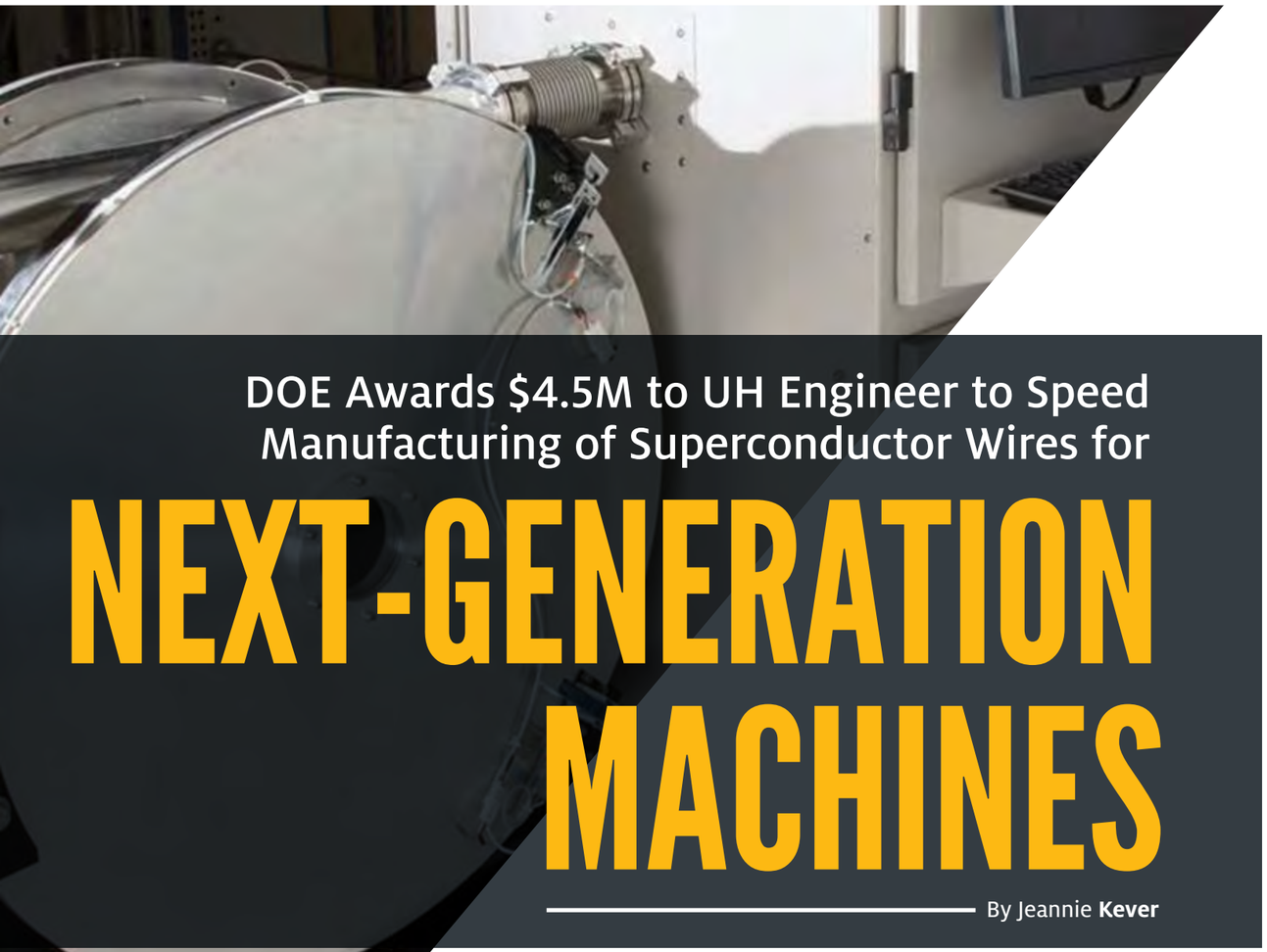
ENERGY STORAGE

POWER TRANSMISSION CABLES

MEDICAL IMAGING

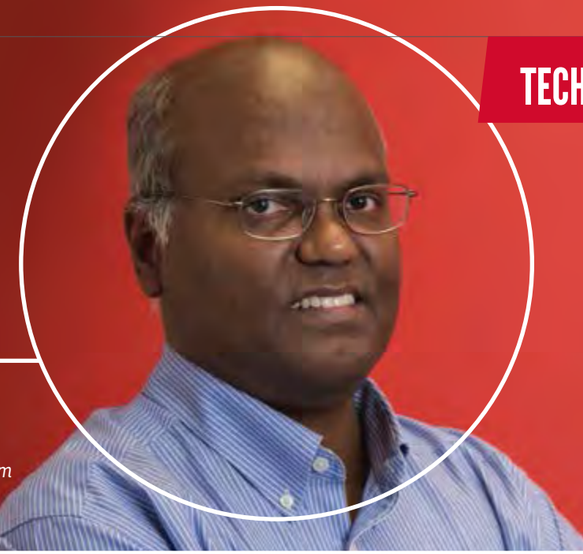
DEFENSE APPLICATIONS

WIND GENERATORS



DOE Awards $4.5M to UH Engineer to Speed Manufacturing of Superconductor Wires for NEXT-GENERATION MACHINES

By Jeannie **Kever**



Venkat "Selva" Selvamanickam

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, chief energy officer 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 year 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" & "FLEX"

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

By Laurie **Fickman**

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.

"Think of it as a roll of Saran Wrap or a jelly roll," said **Venkat "Selva" Selvamanickam,** 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.

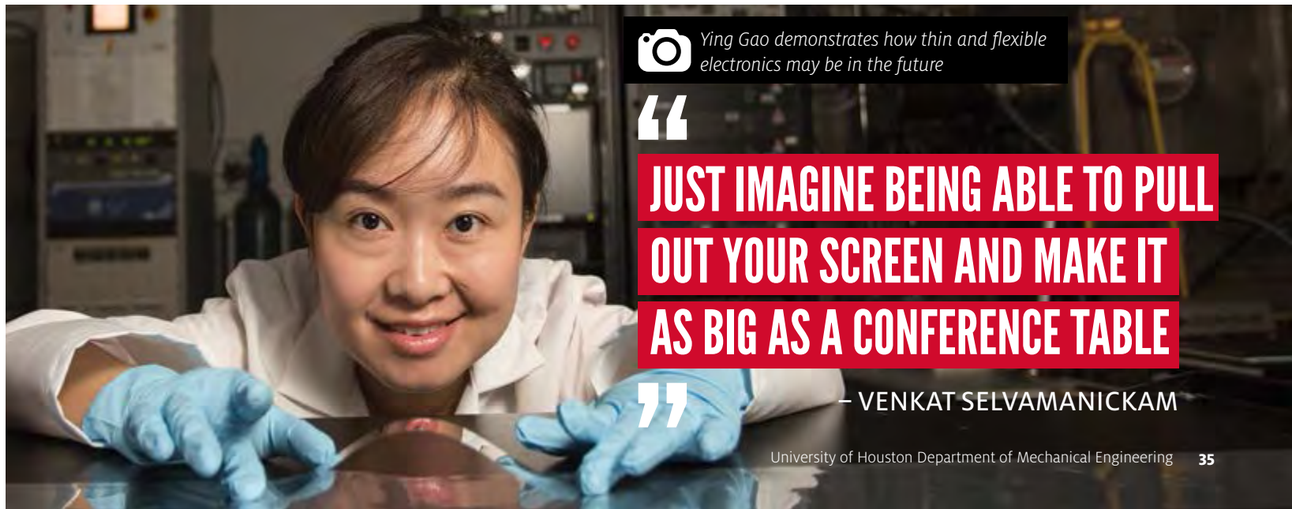
Stretching the imagination

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.

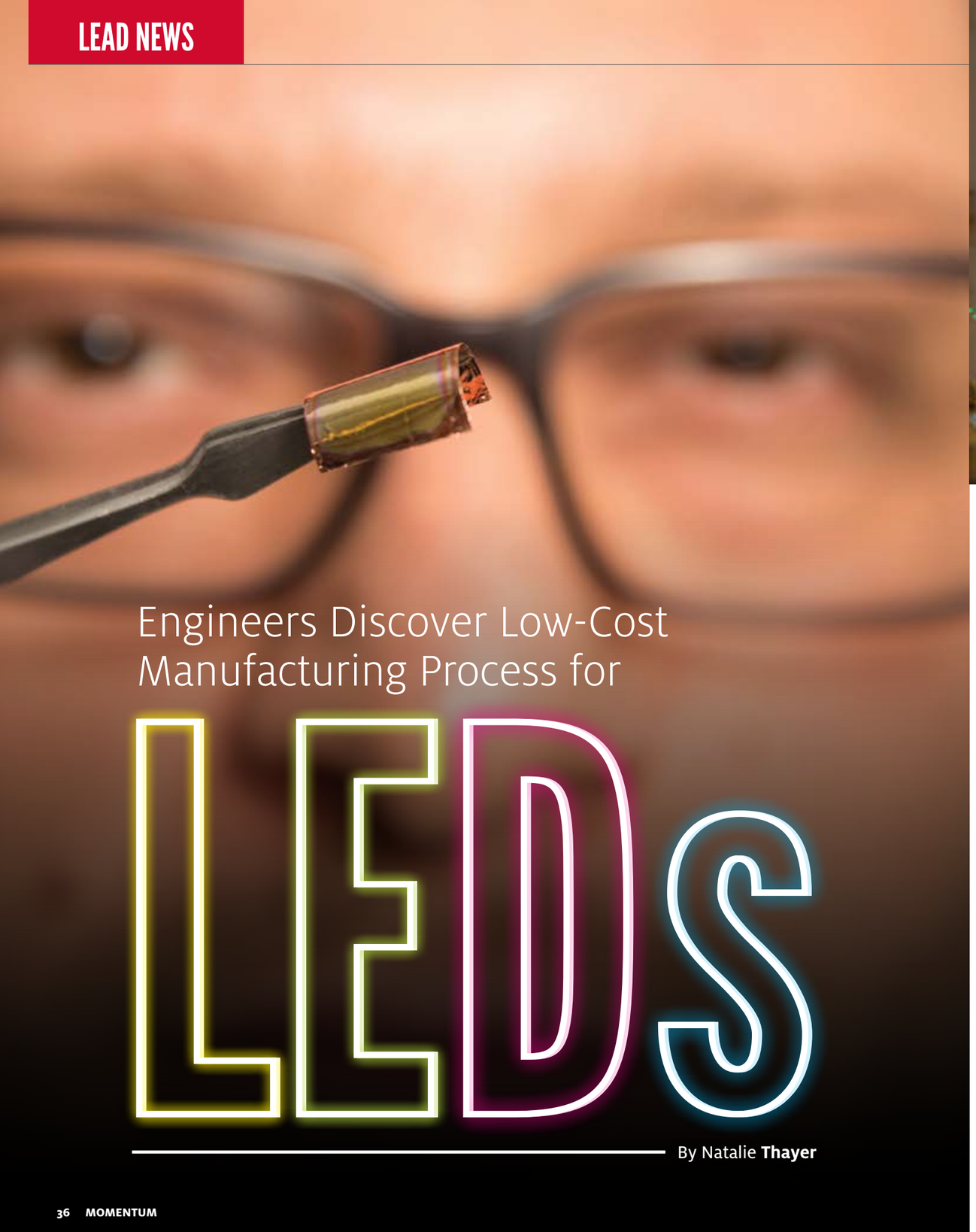


Ying Gao demonstrates how thin and flexible electronics may be in the future

"JUST IMAGINE BEING ABLE TO PULL OUT YOUR SCREEN AND MAKE IT AS BIG AS A CONFERENCE TABLE"

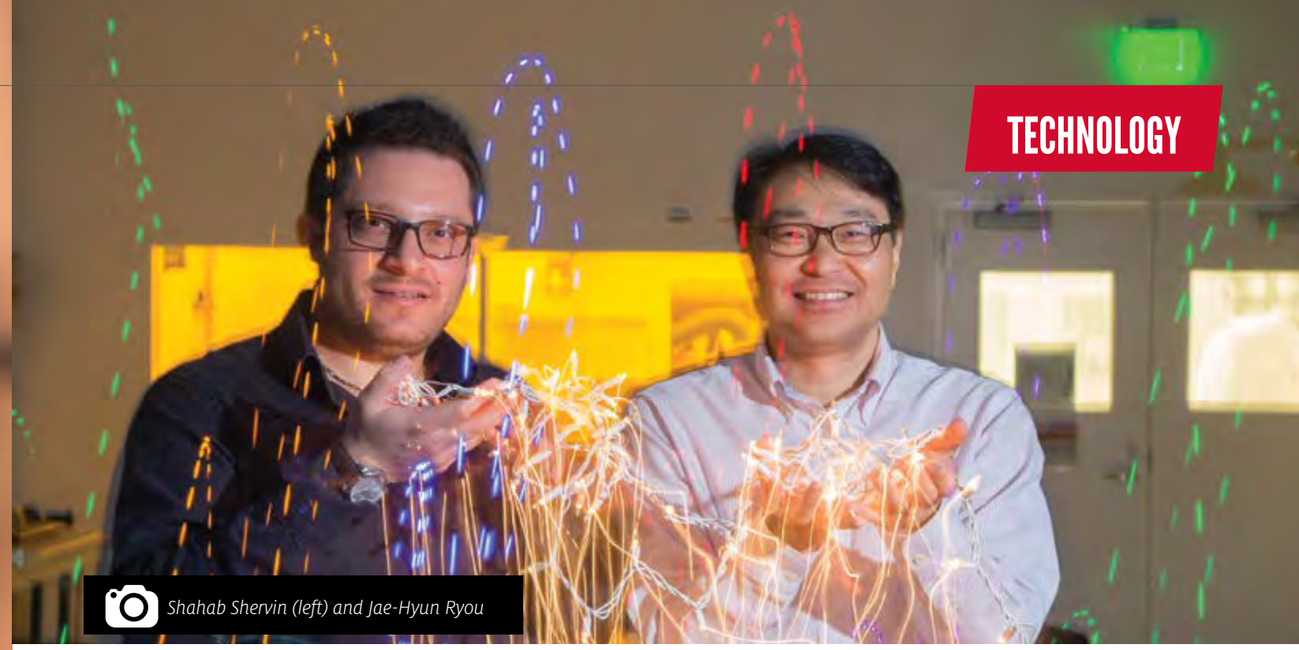
– VENKAT SELVAMANICKAM

University of Houston Department of Mechanical Engineering



Engineers Discover Low-Cost Manufacturing Process for LEDs

By Natalie **Thayer**



Shahab Shervin (left) and Jae-Hyun Ryou

Researchers at the UH Cullen College discovered a new, low-cost approach to manufacturing color-changing light-emitting diodes, or LEDs.

The March 2016 cover of *ACS Photonics* features the theoretical study authored by **Jae-Hyun Ryou,** assistant professor of mechanical engineering, and **Shahab Shervin,** a materials science and engineering doctoral student.

The study, titled "Bendable III-N visible light-emitting diodes beyond mechanical flexibility," explored the potential for low-cost, flexible and color-changing LEDs. Ryou and Shervin's co-authors included Cullen College doctoral student Mojtaba Asadirad, Seung-Hwan Kim from the Metamaterial Electronic Device Research Center at Hongik University, Sergey Karpov of STR Group and Daria Zimina of STR US, Inc.

LEDs are energy-efficient light sources with a wide array of potential applications. LEDs convert electrical current to light approximately 10 times more efficiently than incandescent lamps and approximately two to three times more efficiently than fluorescent lamps. By converting electrical current more efficiently, they offer the potential to reduce green house gas emissions caused by electricity use.

LEDs have become more prevalent in households, automobiles and even large-scale stadium displays in recent years, but they are still less commonly used than incandescent and fluorescent light sources.

One of the major barriers to market penetration and widespread household use is the relatively high cost of LED bulbs compared to compact fluorescent light bulbs, or CFLs, said Ryou. LEDs cost more to purchase because they are more expensive to mass-produce. The substrate currently used for LED production is more expensive than those used for traditional CFLs – and it can only be used in relatively small quantities, further driving up the costs of large-scale manufacturing.

"We need a cheaper option," said Ryou.

Shervin, who served as first author on the study, researches the potential for flexible LEDs on inorganic material to reduce mass-production costs and increase reliability and efficiency. He said that the theoretical ability to create color-changing LEDs was an unexpected and surprising bonus.

"Through our calculations, we've shown that bending or applying strain to an LED structure can improve its efficiency," he said. "We also demonstrated that bending an LED structure can cause it to emit different colors of light without changing the composition."

Current LED technology uses phosphorous, which is a non-environmentally-friendly material, to produce white light emission. Ryou and Shervin achieved white light emission without the use of phosphorous by combining green, red and blue light emissions from a single flexible LED. The researchers said they hope their study promotes the use of eco-friendly alternative materials.

Shervin said he envisions future roll-to-roll LED fabrication using amorphous or polymorphous substrates, enabling cost-efficient mass production.

"We are taking a totally new approach to LED manufacturing," said Ryou. With this research, he and Shervin hope to provide the foundation for the future of LED technology and contribute to its increased everyday use.

UH HONORS TWO MECHANICAL ENGINEERING PROFESSORS

for Excellence in Teaching and Research

By Laurie **Fickman**

Each spring the University of Houston shines a spotlight on the faculty's best and brightest, honoring them with teaching and research awards. This year two mechanical engineering professors earned the distinction.

HADI GHASEMI, Bill D. Cook Assistant Professor of mechanical engineering, received a W.T. Kittinger Teaching Excellence Award, the university's most prestigious teaching honor. Ghasemi runs the UH Nanotherm Lab that explores learning and research in the field of thermodynamics, heat transfer and nanotechnology.

KAROLOS GRIGORIADIS, John and Rebecca Moores Professor of mechanical engineering and director of the aerospace engineering program, is no stranger to winning these excellence awards. He received the Excellence in Research, Scholarship or Creative Activity Award for his work teaching modelling and controlling aerospace systems, internal combustion engines, active/passive vibration isolation of structural systems and intelligent biomedical systems. Recently he earned both the Fluor Corporation Faculty Excellence award, the highest honor given by the Cullen College, as well as the W.T. Kittinger Teaching Excellence Award, the college's most prestigious teaching honor.

OUR BEST AND BRIGHEST:

Outstanding Service Awards Given to Mechanical Engineering Professors

Excellence in engineering took center stage as Joseph W. Tedesco, Elizabeth D. Rockwell Dean of the Cullen College, recognized the outstanding performances of faculty, staff and students in teaching, research and service at the spring faculty and staff meeting. Four mechanical engineering professors were honored for their outstanding service to the college.

HALEH ARDEBILI, Bill D. Cook Associate Professor of mechanical engineering, received the W.T. Kittinger Teaching Excellence Award, the highest teaching award given in the college, recognizing outstanding teaching and service to students. It carries a $2,000 stipend.

JAE-HYUN RYOU, assistant professor of mechanical engineering, received a teaching excellence award and a $250 stipend.

XUEMEI CHEN, instructional assistant professor of mechanical engineering, received a teaching excellence award and a $250 stipend.

CUNJIANG YU, Bill D. Cook Assistant Professor of mechanical engineering, earned the junior faculty member (non-tenured) award for excellence in research, carrying a $2,000 stipend.

Mechanical engineering graduate student **FATEMEH AHMADPOOR** took home the Best Dissertation Award of 2016–2017 and $1,000.

SEE THE FULL LIST OF CULLEN COLLEGE FACULTY AWARD RECIPIENTS AT
www.egr.uh.edu/news/201705/best-our-brightest-outstanding-service-awards-given-cullen-college

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.

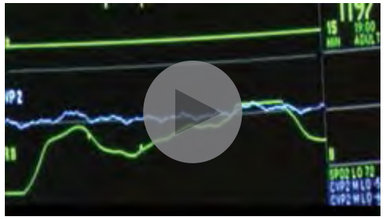
Unlike natural gas, which is commonly transported through pipelines that are limited by distance and terrain, LNG can be transported in tankers, allowing producers and users from around the world to connect across thousands of miles of ocean.

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 at the LNG 18 Conference in Perth.

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

THREE NEW FACULTY

Join Mechanical Engineering Department, Including Member of National Academy of Engineering

The UH Cullen College of Engineering's mechanical engineering department proudly welcomed three new faces and brilliant minds to its faculty, including one member of the National Academy of Engineering.

ANDREA PROSPERETTI joined the Cullen College as a Distinguished Professor of mechanical engineering. He is a member of the National Academy of Engineering for his work involving fluid mechanics, specifically multiphase flows.

In 2003, the American Physical Society honored him with the highest award in his field, the Fluid Dynamics Prize. Since 2008, he has served as editor-in-chief of the *International Journal of Multiphase Flow* and serves on the editorial board of the *Annual Review of Fluid Mechanics*.

Prosperetti comes from Johns Hopkins University, where he is the Charles A. Miller Jr. Professor of mechanical engineering. He also serves part time as the Gerrit Berkhoff Professor of applied physics at the University of Twente in The Netherlands.

He earned his M.S. in 1972 and Ph.D. in engineering science in 1974 from the California Institute of Technology.

He is the single author of approximately 40 papers and co-author of over 160 others.

THEOCHARIS BAXEVANIS
ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING
Research interests: Constitutive modeling and numerical implementation, finite element analysis, damage of geomaterials, creep failure of fiber-reinforced composites, high strain-rate response of metals, fracture of shape memory alloys, and material instability and localization.

DANIEL ARAYA
ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING
Research interests: Vortex dynamics, free-shear flows, atmospheric boundary layer flows, hydrodynamic stability, flow visualization techniques, passive flow control, urban wind farming, multi-rotor drone aerodynamics, renewable energy storage, biologically driven flows and space exploration.

Yashashree Kulkarni Receives ASME 2017 Sia Nemat-Nasser

EARLY CAREER AWARD

By Laurie **Fickman**

When **Yashashree Kulkarni** isn't singing opera (her latest pursuit), the associate professor of mechanical engineering is singing the praises of twinning, the process by which interfaces known as twin boundaries are introduced in metals to make them stronger. Twin boundaries are created when layers of atoms in crystalline materials are arranged in pairs of mirror images (twins) stacked on top of one another.

"For all structural applications, we want a material that is both ultra-strong and not brittle – we call it ductile – and that is what we do with twinning," said Kulkarni.

Here's what she also does: Picks up awards for her work on nanotwinned metals, most recently from the American Society of Mechanical Engineers (ASME). The organization chose her as winner of the 2017 Sia Nemat-Nassar Early Career Award for her "pioneering work on twin boundaries in crystalline materials and their role in next-generation nanostructured materials," according to ASME.

"It's a very prestigious award. It is national-level recognition and I am really humbled by it," said Kulkarni.

Early achievements

Kulkarni received her Ph.D. in 2007 and has a career reel of highlights in the field of computational modeling of twins in nanostructured materials.

She has explored the ability of specially fabricated nanotwinned metals to withstand prolonged exposure to high radiation through a grant from the National Science Foundation; and, she is an early pioneer of studying twin boundaries at the molecular level to understand their role in imparting high strength, ductility and mechanical stability to nanotwinned metals.

But the overarching focus of her work, she says, is to understand how twin boundaries interact with other defects, because, as she notes, there are always going to be defects in materials, and they ultimately determine the mechanical behavior of the material.

"Whenever a material deforms or ultimately fails, it all starts at the scale of atoms, where defects are formed breaking the crystalline order," said Kulkarni. "My work has been mostly on how these unique twin boundaries interact with the defects that are already present or formed during deformation to make the material stronger."

She recalls a quote by Sir Colin Humphreys, a famous materials scientist, that she works and lives by: "Crystals are like people; It is the defects in them that tend to make them interesting."

Sounds almost operatic.

Professor Wins American Chemical Society's Doctoral

NEW INVESTIGATOR AWARD

By Natalie **Thayer**

Cunjiang Yu, assistant professor of mechanical engineering at the UH Cullen College of Engineering, received the American Chemical Society Petroleum Research Fund (ACS-PRF) Doctoral New Investigator (DNI) award for his proposed research on "Electrically Responsive and Locally Programmable Hydrogel Composites."

Each year, the ACS-PRF holds a highly selective competition to award seed funding to top researchers in the petroleum field with a proven track record of producing innovative fundamental research. The DNI grant, which provides start-up funding for researchers who are within the first three years of an academic appointment as an assistant professor, aims to promote the careers of young faculty, support research of high scientific caliber and enhance the career opportunities of students through research experiences.

This award provides funding of $110,000 over two years and will support Yu's research on developing and studying the fundamental properties of a new class of smart material – an electrically-responsive hydrogel composite that can be locally actuated, or internally stimulated.

Hydrogels are soft, adaptable and highly absorbent polymers with various applications ranging from everyday materials, such as contact lenses, to advanced biomedical tools, such as skin wound dressings.

Some classes of responsive hydrogels are able to adapt to their environments by responding to external stimuli. But Yu wants to take this a step further by engineering a class of hydrogels that can also adapt to internal stimuli. Yu has proposed a strategy for creating a novel composite material made by integrating polymer-encapsulated, deformable nanoelectronics into responsive hydrogels.

With this grant, Yu and two of his Ph.D. students, Kyoseung Sim and LeiLei Shi, will conduct both experimental and theoretical investigations of the material.

Yu said he looks forward to discovering potential applications for the hydrogel composite, particularly in the biomedical engineering field. In addition to advancing technology for tissue engineering and drug delivery, Yu said he envisions this material playing an important role in the development of soft robotics that can be used by surgeons in the operating room.

"Fundamental research is invaluable," said Yu. "We have to really understand the material before we can move forward and look into practical applications."

DONG LIU CLIMBS THE ASME LADDER:

Organization Elects Liu as Editor of Journal and Member of Prestigious Committee

Dong Liu, associate professor of mechanical engineering, continues to climb the ranks of the American Society of Mechanical Engineers (ASME), the premiere organization for mechanical engineering professionals and students.

Liu was recently named associate editor of ASME's *Journal of Electronic Packaging* and was selected as vice chair of the ASME Heat Transfer Division's Committee on Nanoscale Transport Phenomena.

Liu's research explores the basic science of multiphase transport phenomena involving fluid-particle interactions (such as a vapor bubble or solid particles in a liquid) with metaphysical and multiscale effects. His goal is to come up with new ideas to control and optimize the transport process with thermal, electrical and/or magnetic fields. The applications of his research range from thermal management to biomedical engineering and nanomanufacturing.

"Involvement in both of these ASME activities is highly rewarding to me as a professor and researcher," said Liu. "It allows me the opportunity to stay abreast of the latest developments in my field and in some ways influence where the field is headed next."

Space Architecture Students Win

INTERIOR SPACECRAFT DESIGN CONTEST

By Natalie **Thayer**

Former space architecture students **Brett Montoya** and **Canaan Martin** won the Genesis Engineering Solutions (GES) Superior Design Award for their interior operational systems and layout design of a single-person spacecraft (SPS.)

GES, an aerospace and technology company, sponsored the three-month national competition to encourage and integrate student creativity in the development of their SPS technology.

Students from an array of disciplines, including engineering, industrial design, human factors and space architecture, were challenged with developing creative internal designs for GES's SPS that included both functional elements, such as displays and controls, and "creature comforts" using only existing technologies.

A panel of esteemed judges, which included a former NASA astronaut and leaders in engineering and design from GES, reviewed the design entries.

The judges awarded Montoya and Martin the superior design prize for their unique solution to the design challenges. Joe Fittipaldi, one of NASA's human factors experts who served as a competition judge, said he was particularly impressed by the attention Montoya and Martin paid to the human factors of their design.

"[They] paid careful attention to [ensure] a common viewpoint across the anthropometric scale," said Fittipaldi.

Though the competition focused on the interior layout and components of the SPS, Montoya said he had to consider the spacecraft holistically, as the sum of its parts, to successfully design the interior.

"In order to map the layout, I had to understand the control requirements for each system," he said. "As a result, my understanding of spacecraft systems [grew] immensely. I have Genesis Engineering to thank for that."

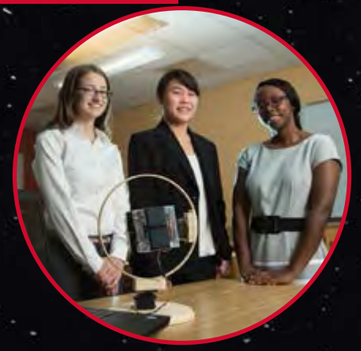
Montoya and Martin each took home $1,500 as recipients of the superior design prize. A team from Florida Institute of Technology took home the $2,500 Grand Prize.

GES is based in Landham, Maryland. Since it was founded in 1993, GES has supported various NASA projects, including the Hubble Servicing Missions and the James Webb Space Telescope.

The UH Sasakawa International Center for Space Architecture (SICSA) offers the world's only master's degree in space architecture and provides students with an advanced interdisciplinary research, design and teaching center.

TO LEARN MORE
about the space architecture program at the UH Cullen College of Engineering, please visit *sicsa.egr.uh.edu*

Canaan Martin



Undergrads Help NASA's Small Satellites

COMPLETE BIGGER MISSIONS

By Natalie **Thayer**

Three UH Engineering undergraduate students are improving NASA's CubeSat missions by programming the small satellites to orient and stabilize themselves based on the position of the sun.

The code developed by mechanical engineering student **Abby Zinecker** and electrical and computer engineering students **Julia London** and **Tiffany Yao** will solve one of the biggest obstacles to successfully completing CubeSat missions: the inability to stabilize a small satellite after it's launched into space.

"When CubeSats are launched, at first they're just tumbling and spinning in space," said London. "They need to stabilize before they can take readings and collect data."

With standard-sized satellites, the angular velocity, or the direction and speed of the spinning satellite, is often calculated using a device called an accelerometer. But the added weight and power requirements of these devices render them impractical for CubeSats.

The size, weight and power constraints of CubeSats drove the innovation process for Zinecker, London and Yao. Their goal was to develop an alternative method for calculating angular velocity in CubeSats without increasing their size, weight or power consumption. To achieve their mission, the undergrads had to find cost-effective ways to use and repurpose the components of a standard CubeSat to execute tasks more efficiently and perform altogether new functions.

CubeSats are made up of 4x4x4-inch cubes called units and can be as small as one unit (1U) or as large as six units (6U). Each unit weighs approximately 3 pounds and is covered in solar panels for energy collection. Once the solar energy is collected, it is stored in batteries inside the satellite. The entire process is managed by a microprocessor, which serves as the "brain" of the satellite.

Under the guidance of Len Trombetta, the associate chair of the Cullen College's electrical and computer engineering (ECE) department, and Steve Provence, a NASA engineer and alumnus of the Cullen College's ECE department, the team wrote code that employs a CubeSat's built-in solar panels and microprocessor to orient the satellite according to a light source, such as the sun, and stabilize the satellite in space by determining its angular velocity.

The model simulated the CubeSat's rotation using servomotors – small, energy-efficient motors often used in robotic and industrial applications – and was lined with clear acrylic walls to make the internal wiring and microprocessor visible. The students said that being able to see the internal components proved invaluable throughout the design process.

"We could see how everything connected, which was really helpful for debugging and testing," said Zinecker.

With the team's code, CubeSats can be stabilized after launch by using the sun as a reference point to determine its location and calculating the satellite's angular velocity.

"Calculating the angular velocity is important because we have to find out how fast the satellite is going to be able to accurately reverse the spin and slow it down," said Yao. The team built the CubeSat model during the fall 2015 semester and spent the following spring semester fine-tuning the algorithms and formulas used in the code. While many engineering projects can have clearly defined solutions, Zinecker, London and Yao said they encountered several challenges during this project unique to the complex and creative process of coding.

"Coding is a lot like painting or drawing, because it's never quite done," said London. "It's always evolving."

But the project also provided unique rewards. The ability to determine angular velocity in a CubeSat is a challenge currently faced by NASA and others interested in the small satellites. With their code, the team provided a novel and practical solution to a current, real-world challenge.

"My favorite part of this project is knowing that we were able to accomplish something new," said Zinecker.

To further the potential applications of their code, the team created a user interface designed so that even non-scientists could interpret the data.

"We wanted to make something with a very user-friendly display, so that anyone with a computer could open the interface and easily read the data collected from satellites," said Yao.

The team presented the CubeSat model, code and user interface at the Graduate Research and Capstone Design Conference hosted by the ECE department on April 29, 2016.

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.

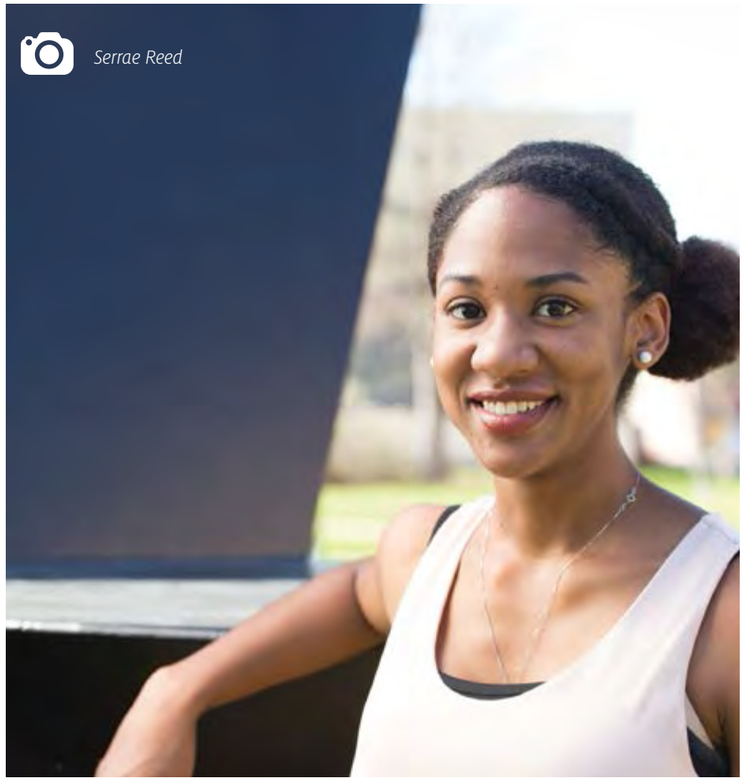
VIEW MORE PHOTOS AT
www.flickr.com/photos/cullencollege

WOMEN

ENGINEERING THE FUTURE

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

By Laurie **Fickman**



Serrae Reed

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. Last fall she went to Shell's Drilling and Production Training Camp and this summer she interned at the LyondellBasell Channelview plant.

Tam Nguyen

"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. As a senior, she was never coasting. At times she's worked two or three jobs along with a full course load to reach her goals.

For her honor's thesis, she explored thermal batteries with an eye on making them more efficient. Thermal batteries use the differences in temperature to produce power. She also worked 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 creating 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 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.

ACCELERATING SUCCESS:

Cullen College Senior Wins Automotive Leadership Award

By Laurie **Fickman**

Grant Mottershaw, a senior in mechanical engineering at the Cullen College of Engineering, received the 2016 Rumbaugh Outstanding Student Leader Award in Detroit at the Society of Automotive Engineers (SAE) International World Congress. SAE is a global association of more than 128,000 engineers and related technical experts in the aerospace, automotive and commercial-vehicle industries.

Annually, SAE identifies and recognizes an outstanding student leader and, through the award, encourages "a vision within the recipient to become an SAE leader during his/her adult career," according to SAE. Among the honors, Mottershaw becomes a lifetime member of the organization.

SAE cited Mottershaw for demonstrating outstanding leadership skills for his involvement with the UH Formula SAE (FSAE) project, in which the team designs and builds a Formula One-style race car from the ground up to compete in the Formula SAE Series (FSAE) races.

When Mottershaw joined the group, it was sputtering. There had been one group started in the College of Technology and one in the Cullen College, but neither group was positioned yet to get out of the starting gate.

So Mottershaw took the wheel and revved up the operations, financial management and new member recruitment. He also is on the team building the car's chassis, which is the frame of the vehicle.

Setting it on cruise

"The goal from the beginning was to build a sustainable organization," said Mottershaw. "I like to think of FSAE as a microcosm of what goes on in the real world – you have to raise the money, allocate your resources, deal with politics and you still have to have a product at the end of the day."

And so he went to work, studying other FSAE models of success to perfect a plan for the UH team. He recalls a quote that helped drive his success: "First you must finish, then you can finish first," said Mottershaw. And to finish, they needed money. No coincidence that if Mottershaw wasn't an engineer he says he'd like to be a financier. Since he took control, the organization has raised $115,000 in cash and in-kind services.

An Eagle Scout at 16, Mottershaw has always combined leadership skills with his love of building things and solving problems.

Even after returning from the whirlwind award ceremony in Detroit, Mottershaw says winning hasn't sunk in. Admittedly, he says "it's awesome," but what was greater for him was presenting to the groups of industry professionals and getting the opportunity to meet them.

Mottershaw has high hopes of becoming a professional in the auto industry.

Naturally. He's geared for it.

Senior's Hologram Software Could be Used to

AUGMENT REALITY

By Isabel **Pen,** *Daily Cougar Reporter*

Wearing a bulky version of La Forge's visor from "Star Trek," a man pinches and pulls the air in front of him; behind the lens of his futuristic goggles, reality is altered.

University of Houston mechanical engineering senior Evan James is developing software for a device that creates an immersive augmented reality experience. The Microsoft HoloLens can be used to aid engineers in visualizing and interacting with their ideas in three-dimensional space.

"HoloLens is the true and most superior first-generation mixed-reality device that projects for a user a layer of relevant information on top of the physical objects or environment," said computer science research assistant professor Chang H. Yun.

The technology enables the wearer to see holographic versions of objects or people and view them from all angles as if they were in the same room.

"As a mechanical engineer, it's all about developing technology that can help our work process," James said. "So, what I've built is a holographic topographical map of the Gulf of Mexico to visualize where the oil pockets are."

James is no stranger to getting creative with technology; his creative insights were recognized after making it to the finals in the U.S. Microsoft Imagine Cup 2015. Windows Insiders, a select group of developers given the first opportunity to experiment with new Microsoft technology, invited James to be a member.

Once approved, James received a developer edition of the Microsoft HoloLens in order to begin designing applications to see the technological world in a whole new dimension.

Though James uses the wearable computer to generate three-dimensional models of the ocean floor, he says the applications of this technology are limitless.

"Right now, the field is taking off," said computer science doctoral student Daniel Biediger, who researches augmented reality for visualization, education, simulation and training. "There are many projects that involve construction, planning, medicine, data visualization and even games. It's much more natural to interact with higher-dimensional data in higher dimensions."

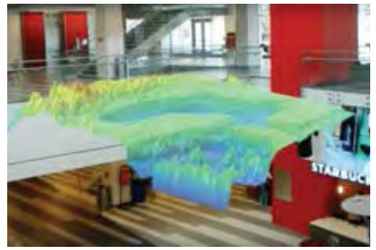
James said the HoloLens could prove to be useful in providing a three-dimensional full-size blueprint, which contractors could build on top of to ensure precision construction. Holograms could help medical students understand how the human body works by zooming in on specific organs to observe their function.

The technology could even host a game that scans the room and layers virtual walls and objects on top of the real world to create an immersive augmented-reality video game.

Virtual holograms could also revolutionize the way people live their daily lives.

"Unlike watching TV, which requires you to sit or stand in front of the device, or talking on the phone, which requires you to hold the device to your ear, this technology requires no specific posture," said James. "Your hands are completely free and you're not required to sit down; you can look at the data while you're working on something else."

James imagines a world where someone wearing a HoloLens, which is controlled either by in-air hand motions or voice commands, can pull up the user manual while they're fixing their car, or have a recipe from a cookbook in their field of vision while they're trying to prepare a new meal.



Top: Microsoft HoloLens
Bottom: James can manipulate the size and position of a hologram — in this case, a three-dimensional topographic map. Photo courtesy of Evan James

With his military background, James envisions a future in which he can communicate with his loved ones while overseas via "holoportation." By fitting a room with special cameras, he would be able to see the holographic form of his mother and children using the HoloLens as a viewing device.

While they haven't had any takers in the big oil world, they have piqued the interest of a drill bit company. In the meantime, James develops other apps that utilize this holographic capability. In the not-so-distant future, mixed reality could become a part of the everyday experience for the American household, Yun said.

"You can make a lot of stuff with this technology," James said. "It's the imagination that comes first. Everybody who created something started with a great imagination."

This article was originally published in the Daily Cougar: http://thedailycougar.com/2017/03/22/seniors-hologram-software-used-augment-reality/

UH MATERIALS RESEARCH SOCIETY

Student Chapter Hosts Campus Symposium

By Laurie **Fickman**

The University of Houston-Materials Research Society Chapter (UH-MRS) hosted its first student symposium in the main lobby of Engineering Building 1. At the symposium students presented their work to an esteemed crowd of professional members across various engineering and science disciplines at UH. The 40 presenters came from different departments including chemistry, physics; and chemical, mechanical, materials and electrical engineering.

The event was organized by the members and volunteers of the UH-MRS chapter under the supervision of the chapter faculty advisors Venkat Selvamanickam and Pavel Dutta of mechanical engineering.

"It was nice to see such a high level of participation and enthusiasm among materials researchers and it was a great experience to bring MRS activities to the UH campus," said Meysam Heydari Gharahcheshmeh, president of the UH-MRS chapter.

UH-MRS was established in April 2016. The primary goal of the chapter is to broaden participation of students in materials research and STEM (science, technology, engineering and math) fields. The chapter also provides a platform for materials disciplines to convene, collaborate, integrate, communicate and advocate materials research activities.

UH-MRS winners are:

First Place:
Yunwen Zhou
Chemical Engineering Department
Advisor: Jeffrey Rimer

Second Place:
Peyman Irajizad
Mechanical Engineering Department
Advisor: Hadi Ghasemi

Third Place:
Pratap Rudra
Mechanical Engineering Department
Advisor: Venkat Selvamanickam

Winners all around at the UH-MRS symposium!

Doctoral Student Wins Fellowship to

INVESTIGATE APPLIED SUPERCONDUCTIVITY

By Natalie **Thayer**

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).

The annual fellowship is awarded by the IEEE's Council on Superconductivity Committee (CSC) to encourage promising doctoral students studying applied superconductivity to contribute to the future of the field. Applicants are selected based on the quality of prior work, the impact of their current research and the potential impact of their future research. Applicants' financial need is also taken into consideration.

At the Cullen College, Heydari Gharahcheshmeh works with his award-winning advisor and mentor Venkat Selvamanickam, M.D. Anderson Chair Professor of mechanical engineering and director of the Texas Center for Superconductivity Applied Research Hub. Selvamanickam is also the founder of the Advanced Superconductor Manufacturing Institute, an industry-led consortium.

Heydari Gharahcheshmeh said that it has been "an honor and a deeply enriching experience to work so closely with Dr. Selvamanickam."

As a 2016 recipient, Heydari Gharahcheshmeh received complimentary membership to the IEEE and a CSC's sponsoring societies, an inscribed certificate and a $5,000 honorarium.

LEARN MORE ABOUT THE IEEE'S GRADUATE STUDY FELLOWSHIP IN APPLIED SUPERCONDUCTIVITY AT
http://ieeecsc.org/awards/ieee-csc-fellowship-award.

STUDENTS SHOWCASE CUTTING-EDGE RESEARCH

at 2016 Undergraduate Research Day

By Audrey **Grayson**

More than 200 UH undergraduate students presented their research at the 2016 Undergraduate Research Day held at the Elizabeth D. Rockwell Pavilion in October.

A total of 40 UH engineering students participated in the campus-wide event, presenting research on a wide array of topics ranging from medicine and health to energy and materials. Four engineering students won poster awards at the event.

Electrical and computer engineering student Lillian Lin, advisee of Aaron Becker, received a poster award for her research on controlling swarms of micro-robots.

Tara Mars, a chemical and biomolecular engineering student, received a poster award for her work on flow and transport of complex fluids in porous media. She worked closely with faculty advisor Jacinta Conrad on this project.

Another chemical and biomolecular engineering student, Phillip Reid, earned a poster award for his research conducted with Peter Vekilov on assessing the effects of combined anti-malarial drugs on treating malaria.

Serrae Reed, a mechanical engineering student working with faculty advisor Pavel Dutta, received a poster award for her work on antireflection coatings for thin film photovoltaics on flexible substrates.

Other projects presented at the event covered the use of fish oil supplements to treat arthritis and lupus; identification of novel catalysts for the synthesis of ammonia; enhanced oil recovery methods; evaluation of how the brain experiences art; and the development of aqueous batteries.

WATCH OUR VIDEO FROM THE 2016 UNDERGRADUATE RESEARCH DAY AT
https://youtu.be/bQN__mJdhhk.

VIEW PHOTOS FROM THIS YEAR'S UNDERGRADUATE RESEARCH DAY AT
www.flickr.com/photos/CullenCollege

— DEAN —
JOSEPH W. TEDESCO

> IF UNDERGRADUATE STUDENTS ARE MOTIVATED TO CONDUCT ADVANCED-LEVEL RESEARCH, THERE SHOULDN'T BE A SCENARIO IN WHICH THEY ARE NOT ABLE TO DO THAT AT THE CULLEN COLLEGE.

UH Engineering and Honors Colleges Launch

STUART LONG UNDERGRADUATE RESEARCH FUND

By Audrey **Grayson**

At the UH Cullen College of Engineering, undergrads are strongly encouraged to engage in hands-on, real-world research while pursuing their degrees – and there's no shortage of cutting-edge research projects for undergraduate students to get involved in at the college.

Now UH engineering students will have more opportunities than ever to pursue research in one of the world-class laboratories on campus thanks to the Professor Stuart Long Undergraduate Research Fund, which will provide support to students across the UH campus conducting innovative, high-level research.

The UH Cullen College of Engineering and the UH Honors College created the fund in honor of Stuart Long, associate dean of undergraduate research at UH and professor of electrical and computer engineering at the Cullen College. The Professor Stuart Long Undergraduate Research Fund will support undergraduate research programs at UH such as the Summer Undergraduate Research Fellowship (SURF) and Houston's Early Research Experience (HERE) for many more years to come.

Long is a long-time proponent of undergraduate research and is credited with increasing research opportunities across the UH campus for undergraduate students.

"I was blessed with many amazing mentors during my undergraduate education who encouraged me to get involved in research," Long said. "That mentorship had such a profoundly positive impact on my education and my trajectory after graduation." So much so, in fact, that when Long became a faculty member at the Cullen College in 1974, he made it his personal mission to increase and enhance the research opportunities available to undergraduate students.

Long invited outstanding undergraduate students in the Cullen College to join his laboratory group, assist with research, co-author papers and travel to conferences to give poster presentations and seminar talks.

"Engaging undergraduate students with research projects or professional opportunities not only helps them connect-the-dots between classroom lessons and their real-world applications – it also helps them earn better grades and increases the chances that they will successfully complete their engineering degree," Long said.

This model of undergraduate engagement soon became the cornerstone of a formal program, called the Electromagnetic Undergraduates Program (EMUGs), which identified outstanding undergraduate students and gave them access to a space where they could interact with graduate students and assist Long and other electrical and computer engineering professors with research projects and papers.

Thanks to Long's efforts, undergraduate research opportunities both inside the Cullen College of Engineering and across the UH campus have been steadily increasing. Long and Fritz Claydon, director of the division of undergraduate programs and student success at the Cullen College, were instrumental in securing funding to establish the UH Research Experience for Undergraduates (REU), which brought talented undergrads from all over the country into Cullen College laboratories to conduct research alongside its world-renowned professors.

Long also works closely with Karen Weber, director of the UH office of undergraduate research, to enhance undergraduate research programs at the University including SURF, PURS (the Provost's Undergraduate Research Scholarship), the Senior Honors Thesis and Undergraduate Research Day, an event wherein undergrads across the UH campus showcase their research projects to faculty, fellow students and industry representatives.

Opportunities for undergraduate research have been steadily increasing at the Cullen College. Joseph W. Tedesco, Elizabeth D. Rockwell Dean of Engineering, has devoted additional funding to support undergraduate research projects that are not funded through one of the existing undergrad research programs, such as SURF and PURS.

"If undergraduate students are motivated to conduct advanced-level research, there shouldn't be a scenario in which they are not able to do that at the Cullen College," Tedesco said. "It is my absolute pleasure and one of my highest priorities to provide additional funding to support the stunning array of professional quality undergraduate research conducted by UH engineering students."

FOR MORE INFORMATION

and to make a gift to the Professor Stuart Long Undergraduate Research Fund, please contact Ryan Kenney at rpkenney@uh.edu

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.

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.

> **"WE BELIEVE THE RENAISSANCE MANAGEMENT SUITE (RMS) COULD HAVE A CONSIDERABLE POSITIVE EFFECT ON THE ENVIRONMENT AND PROFITABILITY OF COMMERCIAL BUILDINGS."**
>
> – GIANCARLO MITTERHOFER

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 and reduce energy consumption.

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

Mitterhofer offers subscriptions for his smart building technology at affordable prices. 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/

In 2015, commercial and residential buildings accounted for roughly

of total primary energy consumption in the nation.

SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION

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).

GENEROUS ENGINEERING ALUMNUS WILLIAM A. BROOKSHIRE

Funds $1M Award Endowment 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 understood 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. 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 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."

William A. Brookshire meets the recipients of the William A. Brookshire Scholarship and the William A. Brookshire IMPACT Scholarship

† Dr. William A. Brookshire died on April 21, 2017. A memorial was held at the UH campus to honor his memory and long legacy of philanthropy.

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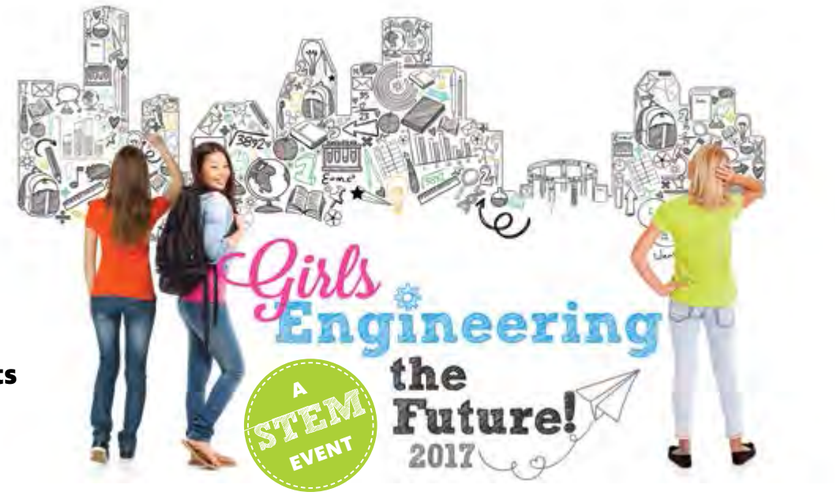

CHEVRON INSPIRES GIRLS TO ENGINEER THE FUTURE AT UH

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 4-8 to complex engineering principles through fun, hands-on activities.

LEARN MORE AT
www.egr.uh.edu/girls-engineering-the-future

WOMEN IN ENGINEERING BECOME WOMEN IN RED AT SPRING EVENT

The Cullen College played host to the 3rd Women in Engineering spring event in March. The free event was funded by alumna Cynthia Oliver Coleman, P.E. (BSChE '71). The event took place at the UH Hilton and included female engineering students, faculty and alumnae. Aside from networking, those in attendance were inducted into the Women in Red Movement, which will serve as a registry of female students and alumnae to serve as mentors for one another. The Cynthia Oliver Coleman Rising Star Award was presented to Tam Nguyen for being named the outstanding senior for the Cullen College of Engineering.

VIEW MORE PHOTOS AT
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UH Cullen College of Engineering
Department of Mechanical Engineering
Engineering Building 1
4726 Calhoun Rd, Suite N207
Houston, Texas 77204-4003