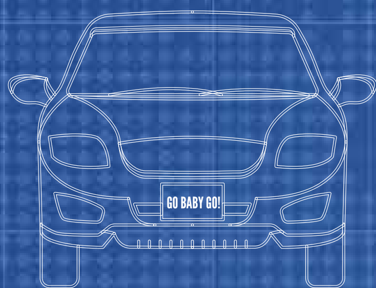
UNIVERSITY of HOUSTON | ENGINEERING

PARAMETERS

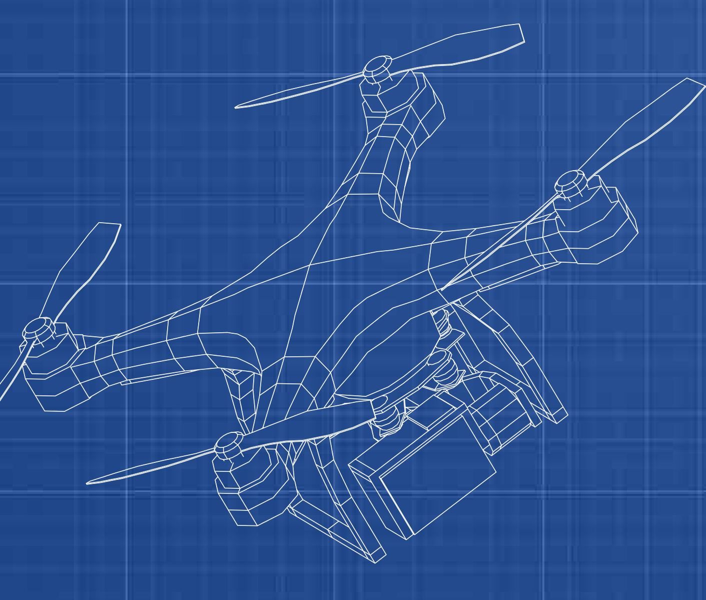
Cullen College of Engineering Magazine • Spring 2022

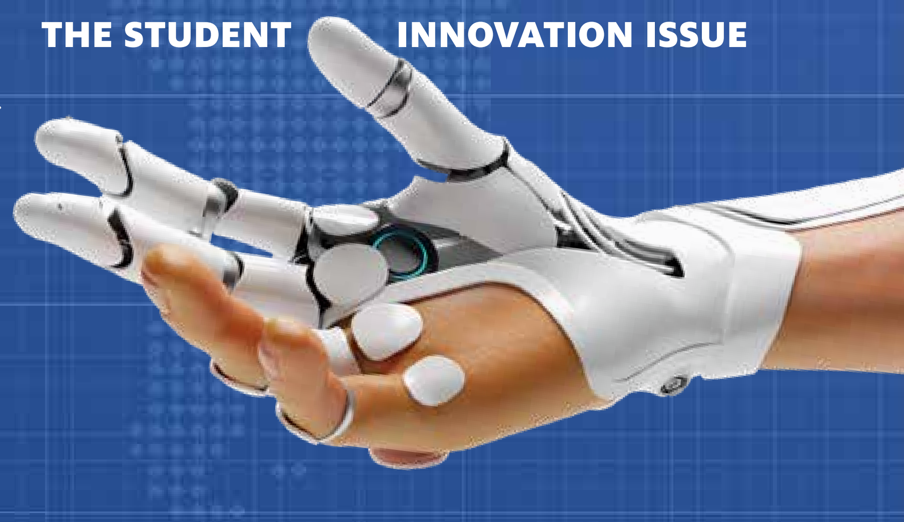


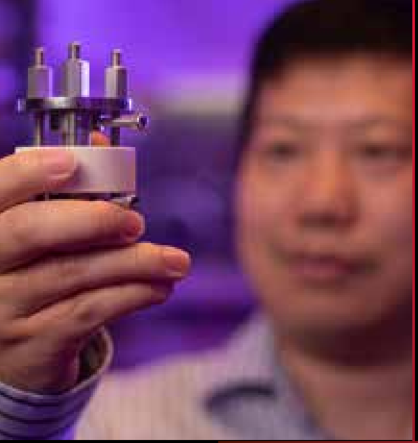
A BETTER WORLD BY DESIGN

STUDENT GROUPS AT THE CULLEN COLLEGE OF ENGINEERING

THE STUDENT INNOVATION ISSUE







In an interconnected and ever-evolving world of systems and structures, we need thinking that's far from linear.

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Because we're building it.

ENGINEERED FOR WHAT'S NEXT

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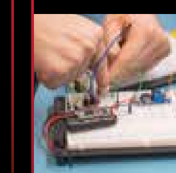
is designed
for exactly that.



SOMETHING BIG IS COMING TO THE CULLEN COLLEGE.

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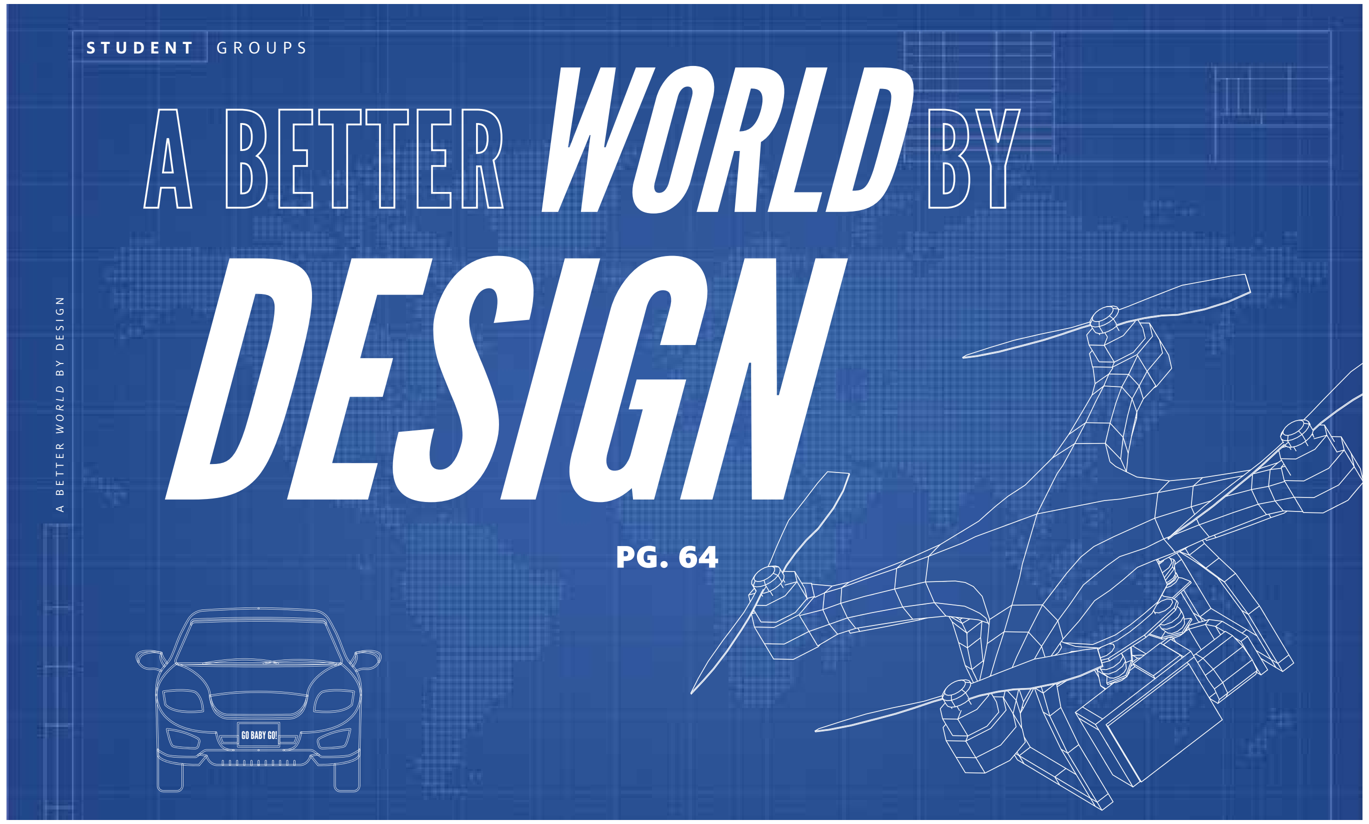

IN EVERY ISSUE

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DEAN'S LETTER

Whether it is plans for city renovations or models for a new prosthetic, it all starts with a blueprint. While they are called by many different names today, drafts, sketches, designs, etc., all engineers know and appreciate the value of a blueprint. They serve as a starting point, daring dreams and ambition put to paper. They are also a guide, a map leading us from start to finish. And after the project is complete, they serve as a memory, to either replicate or improve upon.

The most important part of the blueprint is debatable, but we can all agree that while invaluable, they would be nothing without the great ideas behind them. This is why here at the Cullen College, we first and foremost train our students to be visionaries who seek to solve the world's greatest challenges. It is what drove us to join the National Academy of Engineers Grand Challenges Scholars Program, wherein students can conduct cross-disciplinary projects and pursue groundbreaking research opportunities.

But vision alone isn't enough. Good design is made with the user in mind, and if the blueprint does not address these needs, the product is ultimately rendered useless. However, when coupled with humanitarian efforts, tailored to meet individual needs, the results have the potential to be astounding.

Changing the world for the better is a daunting task, but we are already working to make that lofty goal a reality. In this issue of *Parameters*, we tell the stories of several students who have set out to transform our world through the implementation of their designs. We see an ex-Marine who is improving lives based off his own rehabilitation experiences, students testing healthcare deliveries via drone and a student organization providing a sense of normalcy for a motor-impaired child. Each of these efforts balances precise engineering and mindful design to reach a common goal. Whether it's helping one life, or thousands, the end result is the same. Good, thoughtful design has the potential to make our world a better, more accessible place.

But the work is never done - we must always strive to do better. There is always room for improvement, and societal needs are constantly evolving. As engineers, we will be there to answer that call, with curiosity, empathy and of course, ambition.

I hope you enjoy reading through these stories and find the exciting potential in them, as I did. The Cullen College will continue to foster our world's most brilliant minds, and in turn, help leave behind thoughtful, inspiring blueprints for many years to come.

Warm regards,

Joseph W. Tedesco

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

THINK LIKE AN ENGINEER

BY ARIA SHANKAR
BIOMEDICAL ENGINEERING JUNIOR

Think like an engineer. I've been hearing this phrase ever since I was in elementary school. I didn't necessarily grasp its meaning at the time, but it was a frequent utterance my father would tell me every time I was stuck on a triple-digit multiplication problem, had a hard time learning a new piano piece, or any possible situation where he could give preachy, but well-intentioned, fatherly advice. It seemed as though his solution to any overwhelming task was to break it down into segments and solve them one step at a time, which was frustrating for an impatient 7-year old girl who just wanted to reach the correct solution as quickly as possible.

My father studied civil engineering at an engineering college in Bangalore, India. After graduating, he immigrated to the United States in 1991 for his master's degree, and later worked as an environmental engineer for 10 years. When I first asked my father why he chose to study engineering, he laughed and told me that he didn't have much of a choice. In his days in India, engineering was the automatic chosen field of study for a college-ready boy. The academic environment stressed upon mathematics and science, and because of societal norms and parental pressure, my father didn't have an option to think twice about pursuing any other discipline. Hearing this was shocking, as I assumed someone who was forced into studying a subject would be unhappy, but to my surprise, he tells me he's grateful to have pursued engineering despite having no input in the decision. In 2002, he completed an MBA from Cornell University, and greatly attributes his success to the strong technical knowledge he gained during his undergraduate years, even if his achievements lie in fields outside of engineering.

Taking inspiration from my father's positive experiences while applying to college, I was ecstatic when accepted to the University of Houston for biomedical engineering. However, my eagerness was intersected with anxiousness. Engineering is known to be a notoriously difficult major, and I was still unsure what that realm consisted of. It was only after I attended an orientation hosted by the Cullen College of Engineering for prospective freshman students when my doubts were cleared. Through hearing experiences from enthusiastic upper-level engineering students, touring research labs, and meeting with encouraging professors, my sparked interest about what I was going to study for the next 4 years was solidified.

My experience as an engineering student at the University of Houston has been incredibly rewarding. Apart from the like-minded friends I've made and the engaging classes I've taken, the skills I've learned from meticulously solving physics and math problems have seeped into the decisions I make outside of being an engineering student. I currently serve as the Director of Operations for Frontier Fiesta and the president for UH's Club Theatre, and I constantly find myself using the same methodical logic I apply in my coursework to my extracurricular activities. Through my experiences, I've realized that my father's advice was applicable all along. Engineering isn't limited to the walls of my mechanics lectures or my chemistry research labs. Thinking like an engineer means looking at situations from every perspective possible. It means perseverance and ingenuity. It means slowing down to enjoy the process rather than fixating on its conclusion, which is how I like to think I'm navigating my undergraduate years. The engineering program at the University of Houston has made me a well-rounded student, giving me the technical and interpersonal skills to confidently achieve my academic and personal goals, and I'm grateful that it is at this institution where I am learning to think like an engineer.

IN THE MEDIA **SPOTLIGHT**

OLGA BANNOVA TALKS SPACE TRAVEL WITH **ABC 13**

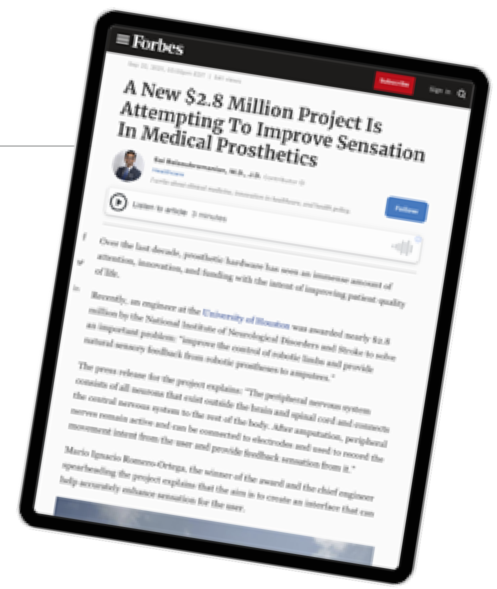
ABC 13 featured **Olga Bannova** in a segment discussing Blue Origin, billionaire Jeff Bezos and how private companies are making affordable space travel a reality. Bannova, who is the director of the space architecture graduate program at the University of Houston's Cullen College of Engineering, is excited about the potential of accessible space exploration for all.

READ ARTICLE ONLINE AT:
https://abc13.com/blue-origin-texas-space-flight-jeff-bezos-x-university-of-houston/10897914/

THE ENGINEER HIGHLIGHTS ASSOCIATE PROFESSOR'S RESEARCH

Mohammad Reza Abidian's recently developed electrochemical actuator was spotlighted by *The Engineer* magazine, a well-established publication that dates back more than 160 years dedicated to all things related to technology and innovation. Abidian's recent technological breakthrough has the potential to advance all sorts of applications, from soft robotics to artificial muscles.

READ THE FULL STORY ONLINE AT:
https://www.theengineer.co.uk/osnt-actuator-houston-soft-robotics-artificial-muscles/



FORBES.COM SHOWCASES ROBOTIC PROSTHESES ADVANCEMENTS

In an online article, Forbes.com highlights the work of **Mario Ignacio Romero-Ortega**, Cullen Endowed Professor of Biomedical Engineering at the University of Houston, which could ultimately improve the control of robotic limbs while providing natural sensory feedback to the user. The work has the potential to improve the lives of countless amputees who struggle with day-to-day functionality issues with their prosthetics.

READ THE FULL STORY ONLINE AT:
https://www.forbes.com/sites/saibala/2021/09/22/a-new-28-million-project-is-attempting-to-improve-sensation-in-medical-prosthetics/?sh=60cb93d31498

CHECK OUT THE LATEST UH ENGINEERING **STEMINIST PODCAST**

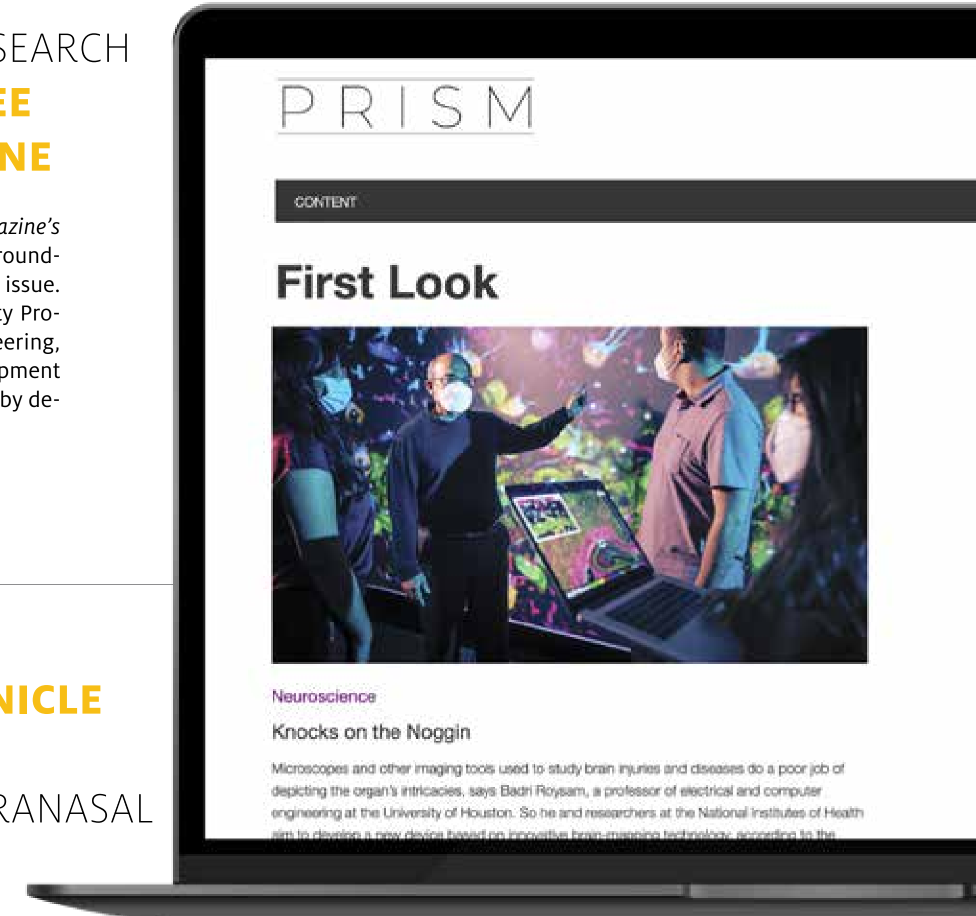
Nicole Guinn explores the powerful stories of and groundbreaking research by women in STEM at the University of Houston's Cullen College of Engineering. Season 2 airing now.

LISTEN TO THE STEMINIST PODCAST:
https://www.egr.uh.edu/news/podcast

BRAIN INJURY RESEARCH FEATURED IN **ASEE PRISM MAGAZINE**

"Knocks on the Noggin," part of *ASEE PRISM Magazine's* First Look section, featured **Badri Roysam's** groundbreaking work mapping unhealthy tissue in a recent issue. Roysam, Hugh Roy and Lillie Cranz Cullen University Professor and Chair of Electrical and Computer Engineering, and his team are working to speed up drug development to treat brain diseases and injuries like concussions by developing new tools.

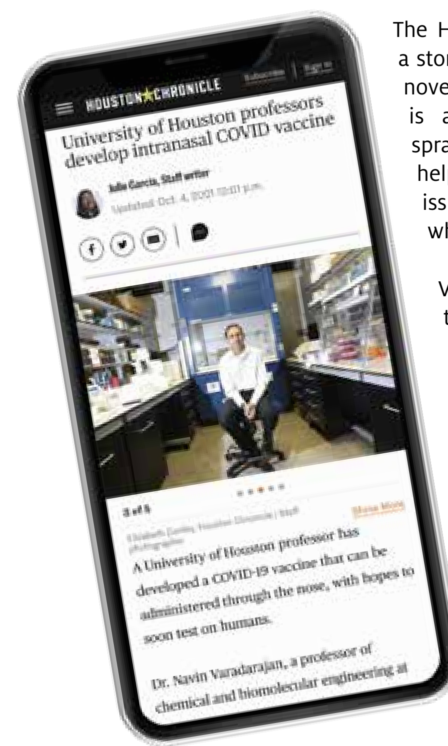
READ THE FULL STORY ONLINE AT:
http://www.asee-prism.org/first-look-6/



HOUSTON CHRONICLE SPOTLIGHTS UH RESEARCHER'S INTRANASAL COVID-19 VACCINE

The Houston Chronicle featured a story on **Navin Varadarajan's** novel COVID-19 vaccine, which is administered via a nasal spray. The alternate form could help with vaccine hesitancy issues, particularly for those who are averse to needles.

Varadarajan, who serves as the M.D. Anderson Professor of Chemical and Biomolecular Engineering at the University of Houston, has dedicated much of his research work to immunotherapy efforts.



READ THE FULL STORY ONLINE AT:
www.houstonchronicle.com/news/houston-texas/

CHECK OUT OUR LATEST VIDEOS ON **YOUTUBE**

Check out our recent video about the Cullen College's long-lasting labs as well as videos about STEM engagement, community outreach and more!

VIEW OUR VIDEOS ONLINE AT:
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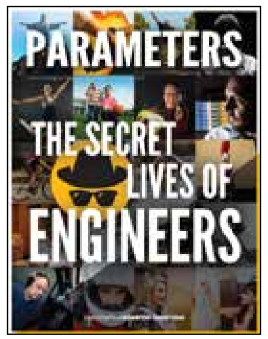
ENGINEERING SNAPSHOTS

PARAMETERS ON THE FIVES

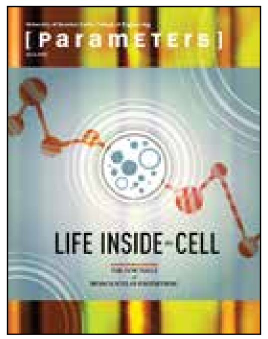
BY STEPHEN GREENWELL

A look back at past **PARAMETERS** *stories and interview subjects, and what those Cougars are up to now...*



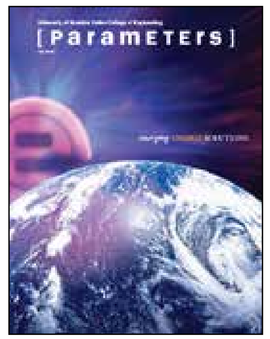
5 YEARS BACK...

"The Secret Life of Engineers," Spring 2017, highlighted some of the after-hours and after-class interests of students and professors. Mechanical engineering student **Jalal "Jay" Yazji** served as the president of eNABLE, a group devoted to providing 3D-printed prosthetics to area children. Yazji graduated with his B.S. in Mechanical Engineering from UH in 2019, and he has been working as a structural components design engineer at Greene Tweed's Houston office since then.



10 YEARS BACK...

The Spring 2012 edition biopsied "Life Inside The Cell: The New Tools of Biomolecular Engineering." Six of the professors profiled – **Peter Vekilov**, **Patrick Cirino**, **Navin Varadarajan**, **Richard Willson**, **Jeffrey Rimer** and **Raman-an Krishnamoorti** – continue to produce high-quality work for the college to this day. Elsewhere in the issue, **Pradeep Sharma** was recognized as the new chairman of the Mechanical Engineering Department, effective January 2012, and outstanding junior **Preston Broom** (Chemical Engineering) and senior **Brian Clark** (Electrical Engineering) were spotlighted. Broom has been a gas processing and process engineer at Shell for more than eight years. Clark went on to earn his master's degree in electrical engineering from The Ohio State University. "I now live in the Dallas area working for L3Harris, mainly doing antenna and RF circuit design," he said. "In my free time, I play as many sports as possible and also play the French horn in a local community band."



15 YEARS BACK...

In 2007, **Fritz Claydon** was serving as acting dean, bridging the gap between **Raymond Flumerfelt** – stepping down after nine years in that role – and current dean **Joseph Tedesco**, who started in January 2008. Civil engineering graduate student **Courtney Bird** was featured for her work on a new concept shopping development at Pearland Town Center, as part of Carter & Burgess. Bird completed her master's degree in 2008, and worked for Jacobs Engineering as a project manager, and Phillips 66 as an operations engineer. She is now a business development manager for Bovay Engineers, Inc.

20 YEARS BACK...

"One of the fiercest fighting martial artists in the world sits in an office on the second floor of the Cullen College of Engineering Building 1 on the University of Houston campus." **Sandy Geffert** – now Moore – earned her mechanical engineering degree from the Cullen College of Engineering in 2001, her master's in 2003, and a doctorate in 2007, all while continuing a championship karate career. From 2001 to 2006, Sandy earned 27 medals for WKA Team USA, including six World Titles. She completed an internship with NASA in 2006, and since then, has been employed in the aerospace industry, primarily as an EVA flight controller and instructor, and a spacewalk specialist. In 2007, she married a fellow Cougar, Brian Moore (BSChE '01) and they have two daughters. "I am beyond grateful for my time at the University of Houston," she said. "I came away with so much more than a degree. I gained real-life problem-solving skills, confidence, and a group of friends that I consider family."

COLLEGE NEWS

CULLEN COLLEGE ENTERS INTO

NAE GRAND CHALLENGES FOR ENGINEERING
NATIONAL ACADEMY OF ENGINEERING

SCHOLARS PROGRAM

BY STEPHEN GREENWELL

As part of the Cullen College of Engineering's continued effort to provide robust and diverse learning opportunities, students can now apply to be part of the first cohort ever at the University of Houston for the National Academy of Engineering's Grand Challenges Scholars Program.

Dan W. Burleson, Ph.D., an instructional associate professor with the First Year Experience and the Director for the Engineering Student Innovation and Design Experience (ESIDE), is spearheading the college's effort to establish the program. He saw it as a natural extension of the First Year Experience, which currently engages students with projects centered around the NAE Grand Challenges.

"The Grand Challenges program itself is meant to have more longevity than just a single project," he said, comparing it to a distinction like graduating with honors that could be put on a resume. "It's about giving students a full experience in engineering and beyond, and bringing in some components that aren't typically in an engineering curriculum. That's where you see an entrepreneurship component, a multicultural component, a social consciousness component." »

LEARN MORE ABOUT THE GRAND CHALLENGES PROGRAM AT THE CULLEN COLLEGE OF ENGINEERING:
www.egr.uh.edu/nae-grand-challenge-scholars-program

ACCORDING TO THE NAE GRAND CHALLENGES FOR ENGINEERING WEBSITE, THE CHALLENGES WERE CREATED IN 2008 TO PRESENT A VISION OF WHAT ENGINEERING NEEDS TO DELIVER TO ALL PEOPLE IN THE 21ST CENTURY. IN JUST 15 WORDS, THE VISION IT CALLS FOR IS: "CONTINUATION OF LIFE ON THE PLANET, MAKING OUR WORLD MORE SUSTAINABLE, SECURE, HEALTHY AND JOYFUL." THIS WAS BASED ON 14 GOALS THAT THE NAE RECOGNIZED AS NECESSARY TO DELIVER THIS VISION IN THE 21ST CENTURY. »

These 14 goals and the challenges program have been adapted into the Grand Challenges Scholars Program, which identifies 5 competencies for students:

1. Talent Competency:
mentored research or creative experience on a Grand Challenge-like topic.

2. Multidisciplinary Competency:
understanding multidisciplinarity of engineering systems solutions developed through personal engagement.

3. Viable Business or Entrepreneurship Competency: understanding, preferably developed through experience, of the necessity of a viable business model for solution implementation.

4. Multicultural Competency:
understanding different cultures, preferably through multicultural experiences, to ensure cultural acceptance of proposed engineering solutions.

5. Social Consciousness Competency:
understanding that engineering solutions should primarily serve people and society reflecting social consciousness.

While the program has an emphasis on cross-disciplinary learning, Burleson stressed that technical knowledge was an important part.

"You have research, and that's an emphasis of our program, getting students engaged in research, highly technical co-ops or internships, and getting them that experience," he said. "But what they saw across the country at some of these programs was just a really highly engaged group of students. We have a lot of students that are interested in having a more broad scope of study."

Students must also pair up with a professor to do research, which Burleson identified as an important part of the program. As part of the application process, students have to identify a potential faculty member to work with, although Burleson said they will be hosting open houses and mixers to publicize the program and to allow the interested parties to meet.

"This is encouraging mentorship, and having faculty mentors engaging with undergrads," he said. "The way academia works is that a lot of the mentorship tends to happen at the graduate level because you have faculty and graduate students working together. This program is bringing that mentorship down farther to the undergraduate level. Students are gaining an additional network that they might not have already had access to."

Burleson added that the program would also allow the college to leverage their existing research efforts through the Office of Undergraduate Research and Major Awards (OURMA), and existing design, innovation and entrepreneurship efforts through ESIDE and the Engineering Program for Innovation and Entrepreneurship (EPIE).

Applications for students opened in October. The program consists of regular mentor meetings, a Grand Challenge Seminar Series, and a NAE Grand Challenge Summit featuring efforts made by the scholars.

The program is open to undergraduates, although Burleson noted that they were targeting sophomores and juniors, since it was a multi-year effort. Students should be highly-motivated to apply technical knowledge to all five of the competency areas.

KLOTZ FAMILY ESTABLISHES NEW FELLOWSHIP FOR GRADUATE STUDENTS

THIS NEW FELLOWSHIP IS DESIGNATED FOR A GRADUATE TO STUDY WATER RESOURCES.

BY STEPHEN GREENWELL

For **D. Wayne Klotz** (MSCE '76), it wasn't a tough decision when it came to the specific resource he wanted a new Cullen College of Engineering fellowship to support. The 2018 recipient of The Outstanding Practitioner in Water Resources Engineering Award from the American Academy of Water Resources Engineers, he has devoted much of his career to providing the important resource.

"I truly believe that as we go forward, the one thing that engineers do that is required for life, and not just for comfort, is water," he said. "This fellowship is designated for someone to study water resources. This fellowship is a commitment to education, it's a commitment to water in the future, and it's a commitment to UH."

The Karen and Wayne Klotz Endowed Fellowship in Civil Engineering will help to fund the graduate studies of a Cullen College of Engineering graduate student, and reinforces a strong foundation of giving by the Klotz family. In 2018, Wayne and Karen – individually – and Klotz Associates – as a company – were recognized as Bridgebuilders. The Bridgebuilder Society represents the college's most generous donors, who have accumulated a lifetime of giving greater than $100,000. »

Wayne and Karen met while he was an undergrad at Texas A&M, where he earned his bachelor's degree in civil engineering in 1974. She was a student at Baylor, and they met after Wayne's junior year.

"We were attending the same church that summer," Wayne said. "She was a student at Baylor at that time, so we burned up Highway 6 that senior year. I graduated in May 1974, and we got married in July. We're 47 years into our marriage now."

Wayne knew he wanted to continue his education, despite landing a job right out of college.

"Some part of me really wanted to pursue the master's degree. My job was in Houston, and as I looked around, my options were Houston or Houston," he said. "I say that with my tongue in my cheek, because at that time they were the only graduate program where you could do all of your classwork at night. I would work a full 40-hour week, then go to class at night, and I'd reserve the weekends for Karen. She was a good sport for two years."

At the time, Wayne and Karen lived in the Greenway Plaza area, before it was significantly renovated. Karen was a secretary at the time, as the young couple saved for a house.

"I worked for a law firm that I could thankfully walk to, because we only had one car," she said. "That was a good experience for me though."

The Klotz family has given extensively to the university in the past, establishing a scholarship for an undergraduate student. A similar scholarship was also established at Texas A&M. But Wayne noted that establishing this fellowship was especially appealing because he received the benefit of a similar graduate-level fellowship when he was at UH, from the Texas chapter of the American Society of Civil Engineers.

"Back then, every dollar was helpful," he said. "When I was going to grad school, I was making an entry level salary, and I had a wife and an apartment and a car payment."

After earning his master's degree in civil engineering in 1976, Wayne continued to work as a professional engineer. He created his own firm, Klotz Associates, in 1985, and did his best to fight through an economic recession. While the United States was recovering from a recession by that year, the Houston metro area was hit by what the Federal Reserve Bank of Dallas would call a "speculative fever" in oil, real estate, savings and loans, and banking that would last from 1982 to 1990.

"Once we started the company, everything was on the line, and it was sink or swim," he said. "The reason that small businesses succeed is not because the people who start it are so focused on success. It's because there is at least one person there who says, 'I don't know what's going to happen, but we aren't going to fail.'"

Karen said that during this time period, she was a new mother, but she wasn't worried. She noted that she and Wayne tended to complement each other.

"If Wayne isn't worried, then I'm not worried, and he hides it really well," she said. "Wayne is a great money manager, and I've learned to follow his lead on that. I think that we've made a good team throughout the years, and balance each other out."

Wayne said his firm "turned the corner" around 1987, and "never looked back" as it expanded in the ensuing decades. At its peak, the firm employed about 175 people.

"At any given time, I told them we weren't aspiring to be the biggest company, but we do want to be the best company," he said.

As the company flourished, so did the Klotz family. Wayne and Karen have four children – Kaytie, David, Brad and Valerie – and eight grandchildren. There are also Cougar bloodlines throughout the family. Wayne's mother, Dorothy, attended UH for nursing in the 1940s, and David graduated from the Clear Lake campus with a degree in graphic design.

Wayne served as president of Klotz Associates until his retirement in 2017, and now serves as president of Klotz Strategies, a consulting service. Even when he was working though, Wayne attempted to give back when appropriate, as his firm did many projects for the general public, and he frequently volunteered for professional organizations.

Wayne was on the Public Works transition teams for two Houston mayors, and served for 12 years on the Board of Harris Galveston Subsidence District as a County Judge appointee. He currently serves as the President of the Board of the Coastal Water Authority, a position he has held for 11 years. He also served on the Community Resilience Task Force for the Department of Homeland Security. Wayne is a founder of the Transportation Advocacy Group – Houston Region and served on the board for five years.

In addition to being a longtime member of the organization, Wayne also served as the national president of the American Society of Civil Engineers in 2009, which has more than 150,000 members. He led ASCE efforts to co-found the Institute for Sustainable Infrastructure, and served as the national chairman of that organization in 2013. In 2011, he was named the Texas Engineer of the Year, as well as the Houston Engineer of the Year.

Some specific contributions he has made to the university include the Klotz Associates Endowed Scholarship in Civil Engineering (sponsored by the company); being named a Distinguished Engineering Alumni and to the Academy of Distinguished Civil & Environmental Engineers; serving on both the Civil Engineering Advisory Board and Engineering Leadership Board; and making class presentations for many years, as well as serving as a Fall 2018 commencement speaker.

Although Wayne kept busy with the work of his firm and his involvement in a slew of different professional organizations, he and Karen have also been active members of the Tallowood Baptist Church for the past 40 years.

"Being involved in our church keeps our eyes on the right things," Karen said. "God comes first in our life, and everything flows from that."

When it came to his professional career, Wayne always made sure he had time to give to the church or to his family, which he tried to stress to his employees as well.

"I used to tell guys, 'Consulting engineering will take as much time as you give it. Don't ever sacrifice your family on the altar of your business.' I've seen dozens of guys do that, and ultimately, they're unhappy people."

KAREN AND WAYNE KLOTZ

PICTURED:
FOUNDERS OF THE THE KAREN AND WAYNE KLOTZ ENDOWED FELLOWSHIP IN CIVIL ENGINEERING.

Shifting Focus to ENGINEERING EDUCATION

BY STEPHEN GREENWELL

A multi-college effort to enhance opportunities for underrepresented student groups in the Houston region and beyond via the establishment of an Engineering Research Center has received a $100,000 planning grant from the National Science Foundation.

Jerrod Henderson, Ph.D., an assistant professor in the William A. Brookshire Department of Chemical & Biomolecular Engineering, is the PI for the planning grant, "Engineering Research Center for Engineering Student Success Initiatives." Joining him on the grant are co-PIs **Daniel Burleson**, Ph.D., an instructional associate professor at the Cullen College of Engineering's First Year Experience; and **Virginia Rangel**, Ph.D., Assistant Professor of Educational Leadership and Policy Studies at the College of Education.

According to the grant's abstract, the National Science Board reports that since 2000, the portion of engineering degrees awarded to underrepresented students has improved very little or not at all. In 2000, 8.6 percent, 7.3 percent and 0.7 percent of engineering degrees were awarded to African Americans, Latinx and Native American students, respectively. In 2015, the figures were still low – 8.7 percent, 12.8 percent and 0.5 percent.

"Recent statistics on engineering education shows that underrepresented students are more likely to attend Minority-Serving Institutions (MSI). Yet, most of the research on engineering education comes from Predominantly-White Institutions (PWIs), which may limit the generalizability of findings for underrepresented students and more diverse institutions," the authors wrote. "Furthermore, research often is done in silos with insufficient interdisciplinary collaboration. If we are going to move the needle on Broadening Participation in Engineering and engineering workforce development – our targeted societal impact – we we need a convergent approach led by stakeholders at the forefront of supporting a diverse engineering future – MSIs."

To do so, the group proposes an MSI-led Engineering Research Center (ERC) that focuses on Engineering Student Success founded on Engineering Education frameworks.

"This ERC will become a leader in the development of engineering student success research and will be uniquely positioned to translate findings into policies and practices that address the success (defined as recruitment, retention and graduation) of underrepresented engineering students, at both the undergraduate and graduate levels," they wrote. "This ERC will bring together a core team of interdisciplinary researchers from across MSIs in the Greater Houston area and beyond. The aim for the development and execution of this ERC is to become a model of MSI engagement and collaboration."

Henderson noted he has worked with Rangel and Burleson in the past, which is why they connected for this project.

"We connected on this particular proposal because of our long standing research and teaching collaborations," he said. "Dr. Rangel and I have been collaborating since I arrived at University of Houston. For example, we are co-PIs on a NSF-ITEST Grant that funds the St. Elmo Brady STEM Academy. Dr. Burleson and I have collaborated in the classroom as a part of the first-year engineering experience. Our research interests in engineering identity development fuel our collaboration.

The grant outlines the need for interdisciplinary researchers from across MSIs in the Greater Houston area. As of September, Henderson said they are using the planning grant for team formation, to build the best team possible.

"I envision an Engineering Education Research Center as a way to collaboratively move the field forward, and as a way to support the development of an engineering education department here at UH," Henderson said. "The success of our ERC demands successful collaboration between at least these colleges. We also hope to galvanize the entire UH community around this idea of 'Convergent Research' approaches that the NSF speaks about in the ERC Call for Proposals. Our collective work closely aligns with this goal."

Sustainable Alternatives for EV Battery Energy Density

BY NICOLE JOHNSON

Read Research Paper Online:
Microstructure engineering of solid-state composite cathode via solvent-assisted processing

JOULE:
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PICTURED: EV BATTERY PROTOTYPE

Only 2 percent of vehicles are electrified to date, but that is projected to reach 30 percent by 2030. A key toward improving the commercialization of electric vehicles (EVs) is to heighten their gravimetric energy density – measured in Watt hours per kilogram – using safer, easily recyclable materials that are abundant. Lithium-metal in anodes are considered the “holy grail” for improving energy density in EV batteries compared to incumbent options like graphite at 240 Wh/kg in the race to reach more competitive energy density at 500 Wh/kg.

Yan Yao, Ph.D., professor of Electrical and Computer Engineering at the Cullen College of Engineering at the University of Houston, and UH postdoc **Jibo Zhang** are taking on this challenge with Rice University colleagues. In a paper published June 17 in *Joule*, Zhang, Yao and team demonstrate a two-fold improvement in energy density for organic-based, solid state lithium batteries by using a solvent-assisted process to alter the electrode microstructure. **Zhaoyang Chen, Fang Hao, Yanliang Liang** of UH, Qing Ai, Tanguy Terlier, Hua Guo and Jun Lou of Rice University co-authored the paper.

“We are developing low-cost, earth-abundant, cobalt-free organic-based cathode materials for a solid-state battery that will no longer require scarce transition metals found in mines,” said Yao. “This research is a step forward in increasing EV battery energy density using this more sustainable alternative.” Yao is also Principal Investigator with the Texas Center for Superconductivity at UH (TcSUH).

Any battery includes an anode, also known as negative electrode, and a cathode, also known as positive electrode, that are separated in a battery by a porous membrane. Lithium ions flow through an ionic conductor – an electrolyte, which allows for the charging and discharging of electrons that generates electricity for, say, a vehicle.

Electrolytes are usually liquid, but that is not necessary – they can also be solid, a relatively new concept. This novelty, combined with a lithium-metal anode, can prevent short-circuiting, improve energy density and enable faster charging.

Cathodes typically determine the capacity and voltage of a battery and are subsequently the most expensive part of batteries due to usage of scarce materials like cobalt – set to reach a 65,000-ton deficit in 2030. Cobalt-based cathodes are almost exclusively used in solid-state batteries due to their excellent performance; only recently have organic compound-based lithium batteries (OBEM-Li) emerged as a more abundant, cleaner alternative that is more easily recycled.

“There is major concern surrounding the supply chain of lithium-ion batteries in the United States,” said Yao. “In this work, we show the possibility of building high energy-density lithium batteries by replacing transition metal-based cathodes with organic materials obtained from either an oil refinery or biorefinery, both of which the U.S. has the largest capacity in the world.”

Cobalt-based cathodes generate 800 Wh/kg of material-level specific energy, or voltage multiplied by capacity, as do OBEM-Li batteries, which was first demonstrated by the team in their earlier publication, but previous OBEM-Li batteries were limited to a low mass fraction of active materials due to non-ideal cathode microstructure. This capped total energy density.

Yao and Zhang uncovered how to improve electrode-level energy density in OBEM-Li batteries by optimizing the microstructure for improved ion transport within the cathode. To do this the microstructure was altered using a familiar solvent – ethanol. The organic cathode used was pyrene-4,5,9,10-tetraone, or PTO.

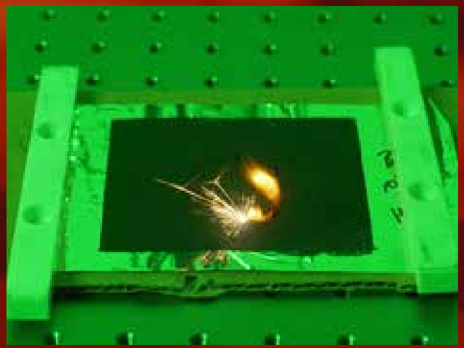
“Cobalt-based cathodes are often favored because the microstructure is naturally ideal but forming the ideal microstructure in an organic-based solid-state battery is more challenging,” Zhang said.

On an electrode level, the solvent-assisted microstructure increased energy density to 300 Wh/kg compared to the dry-mixed microstructure at just under 180 Wh/kg by improving the utilization rate of active material significantly. Previously, the amount of active materials could be increased but the utilization percentage was still low, near 50 percent. With Zhang’s contribution, that utilization rate improved to 98 percent and resulted in higher energy density.

“Initially I was examining the chemical properties of PTO, which I knew would oxidize the sulfide electrolyte,” Zhang said. “This led to a discussion on how we might be able to take advantage of this reaction. Together with colleagues at Rice university, we investigated the chemical composition, spatial distribution and electrochemical reversibility of the cathode-solid electrolyte interphase, which can provide us hints as to why the battery could cycle so well without capacity decay,” Zhang said.

Over the last 10 years, the cost of EV batteries declined to nearly 10 percent of their original cost, making them commercially viable. So, a lot can happen in a decade. This research is a pivotable step in the process toward more sustainable EVs and a springboard for the next decade of research. At this rate, perhaps just as literally as euphemistically, the future looks much greener on the other side.

This research was funded by the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy (EERE), as part of the Battery 500 Consortium.



TOP: YAN YAO WATCHES AS STUDENT BENJAMIN J. EMLEY WORKS IN A GLOVEBOX; **BOTTOM LEFT:** LASER CUTTING A SOLID STATE BATTERY CASING; **BOTTOM RIGHT:** VISUALIZING BATTERY INTERNALS UNDER STRESS.


PICTURED: A SAMPLE OF SHALE ROCKS BEING STUDIED IN KYUNG JAE LEE'S LAB.

EVOLVING the Energy Industry

BY STEPHEN GREENWELL

Kyung Jae Lee, Ph.D., an Assistant Professor in the Petroleum Engineering Department at the Cullen College of Engineering, has received funding for two recent grants totaling more than $350,000.

A grant approved by the American Chemical Society, "Mechanisms of Wettability Alteration by the Interactions between Kerogen and Hydraulic Fracturing Fluid and Its Impact on Fluid Transport in Organic–Rich Shales," received funding of $110,000. The research began in September 2021, and will continue through August 2023.

Lee provided a motivation statement for the proposed research, as well as a summary of the proposed research plan.

"Organic–rich shales, which contain significant amount of organic matter called kerogen, are widely distributed across the U.S. and have been found to be a substantial source of oil and gas with the significant advancement of hydraulic fracturing technologies in recent decades," she wrote. "Kerogen is a solid organic matter insoluble in water and organic solvents, which converts into oil and gas at high temperatures above 150°C. Volume of kerogen in organic–rich shales can be as much as 40 percent with significant surface/volume ratios."

Despite the prominence of kerogen, not enough is known about how it reacts with fluids used for fracking, Lee said.

"Even though the interactions between hydraulic fracturing fluid and mineral components of shale have been actively researched and elucidated, only little is known about the fundamentals of interactions between fracturing fluid and kerogen and their impact on multiphase fluid transport. Kerogen has been considered to be relatively unreactive and stable, and its chemical alteration during the hydraulic fracturing processes has been overlooked. Consequently, the lack of knowledge in the alteration of surface chemistry of organic pores and fractures has led to the undesirable absence of advanced modeling capability, which can reliably predict the dynamically changing spatial distributions and flow rates of hydrocarbons during the production in hydraulically fractured organic–rich shales."

As a result, Lee has two research objectives for her proposal.

"To attain this goal, this proposed project will achieve the two research objectives. First, to experimentally determine the mechanisms of wettability alteration of kerogen by interacting with organic additives in hydraulic fracturing fluid. Secondly, we want to advance the understanding of multiphase fluid transport in organic–rich shales by integrating this information into pore–scale modeling."

Her second proposal, "Analysis of Geochemical Factors Affecting Bentonite Swelling Pressure and Development of Prediction Model," has been funded by the Korea Atomic Energy Research Institute for $280,000. The purpose of the research is to determine the stability of an engineered barrier system (EBS) for the safe isolation of high-level radioactive waste.

"To secure the stability of EBS, it's necessary to precisely predict the swelling pressure change by chemical alteration of bentonite, but there have not been the microscale experimental research conducted to analyze the changing bentonite swelling pressure during the hydrothermal reaction," she said. "In addition, there has not been previous research of the analysis of Gyeongju bentonite, which is used for Korean disposal system of high–level radioactive waste."

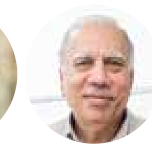
The proposed research plan will require several steps to accomplish.

"This proposed research has the objective of identifying the chemical alteration of Gyeongju bentonite during hydrothermal reaction, analyzing the subsequent change of swelling pressure, and developing the prediction model of swelling pressure," she said. "To attain this goal, we employ the suite of experimental methods including the hydrothermal reaction of Gyeongju bentonite, analysis of the resulting change of chemical compositions, measurement of changing swelling pressure, and the analysis of factors affecting the swelling pressure of Gyeongju bentonite such as chemical compositions of bentonite and pore water."

The research will be done through the end of 2023.

ONLINE CALCULATOR for Minimum Miscibility Pressure

BY STEPHEN GREENWELL

Birol Dindoruk, Ph.D., the American Association of Drilling Engineers Endowed Professor in the Petroleum Engineering Department at the Cullen College of Engineering, has developed an online calculator for minimum miscibility pressure (MMP), which has already received more than 13,500 visits since being brought online in May 2021.

The calculator is based on a March 2021 paper, "Prediction of CO_2 Minimum Miscibility Pressure Using an Augmented Machine-Learning-Based Model," published in the *SPE Journal* (SPE 200326-PA). Dindoruk, Petroleum Engineering chairman **Mohamed Soliman** and graduate student **Utkarsh Sinha** are the authors.

"This is an application that brings the outcome of complex research to the fingertips of the users," Dindoruk said. "Deployment of methods and methodologies that work is our mission here. We want to reach users utilizing methods that reduce the barrier to entry for some of the work that they do."

According to their paper, MMP is one of the key design parameters for broader gas injection processes and as well as CCS projects. This physical parameter is a measure of local displacement efficiency, while subject to some constraints due to its definition. MMP is also used to tune compositional models, coupled with proper fluid description constrained with other available basic phase behavior data, such as bubble point pressure and other volumetric properties.

"This value can be calculated quite accurately using the minimum number of easy to obtain and cheap parameters, rather than time consuming expensive experiments," Dindoruk said. "At minimum, it will reduce the cycle time as well as the cost. The use of MMP is pretty broad in our business, from getting more oil from the subsurface to getting rid of CO_2 more efficiently using hydrocarbon reservoirs."

Dindoruk noted that for their paper, it took effort to sort out what data was appropriate for the development of the methodology. Therefore, understanding the underlying key assumptions behind the concepts and the content knowledge were essential for the work.

"We spent a significant amount of time acquiring the data and quality checking," he said. "Unfortunately, about half of the data was not useful for various reasons, from accuracy all the way to missing or incomplete information. That was perhaps the invisible part of the iceberg so to speak."

He continued, "After gathering the data, we used all our knowledge and available software capabilities to get to the final version of the model that we developed and published. We only put the final outcomes in the paper when we had a tremendous amount of work done to get to that point."

Dindoruk pointed out that it was a balancing act to determine how much information their calculator would require.

"One of the challenges is, 'How can we get the maximum value with the minimum information?' If we want the users to provide a lot of info, it inherently defeats the purpose. Getting extra info takes time and money, and physical existence of the representative fluid samples, and if all these factors are satisfied, you might as well go and measure what you need directly. If that is the case, there's no need for a correlation or a calculator. Even for the cases that we can do the measurements, the calculator can still be used as a quality-check tool."

He added, "We developed all the methodology backed with the data and the app concurrently, but it took us an additional two months to figure out the easiest and the cheapest way to bring it to the fingertips of the potential users, no matter what system they are on, as the computations are done at the back end elsewhere."

Read Research Paper Online:
Prediction of CO_2 Minimum Miscibility Pressure Using an Augmented Machine-Learning-Based Model

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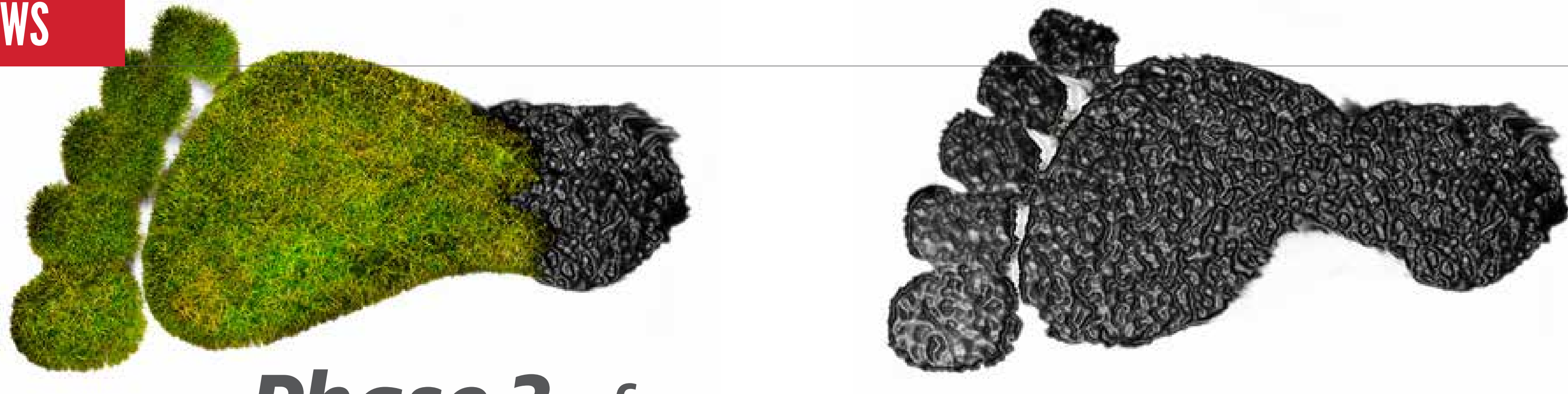


Phase 3 of UH-Oil India Project Completed

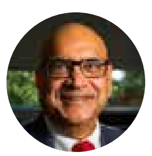
Project funded by: GURI Governor's University Research Initiative

BY STEPHEN GREENWELL

An innovative partnership between the University of Houston and Oil India Ltd. (OIL) has offered benefits for both partners, boosting production in Oil India fields while providing UH researchers and graduate students with research opportunities and practical experience.

The $4.8 million partnership, launched in late 2016, completed its third phase in June 2021. This phase consisted of a project to enhance oil recovery in the fields in the Indian state of Assam, using carbon dioxide captured from nearby petrochemical plants. That project is slated to continue through 2022-23 (implementation time) and is designed to both increase the country's ability to fulfill its energy needs and to reduce its carbon footprint. The collaboration has included training for Oil India executives and employees in Houston and India.

The project is led by **Ganesh Thakur**, Ph.D., Distinguished Professor of Petroleum Engineering and Director of Energy Industry Partnership (pictured above right). It is an outgrowth of a trade mission to India led by Texas Gov. Greg Abbott in early 2016. Thakur, a member of the National Academy of Engineering, was recruited to UH in 2016 with a $3 million grant from the Governor's University Research Initiative (GURI). This was matched by UH, for a total research budget of $6 million from 2016 to 2021.



"The Phase 3 research work involved more than 18 months of amazing teamwork between UH researchers and Oil India executives in the challenging pandemic time," Thakur said. "The project in the past involved several US and India visits by both parties, but due to the Covid-19 situation, most of the weekly interactions happened by videoconferencing at midnight, Houston time. The UH researchers made real sacrifices, and the fruits of their hard work paid off in creating tremendous business impact."

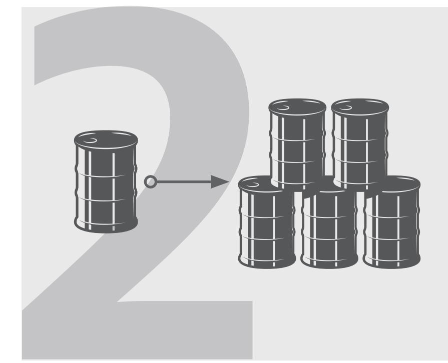
Thakur, a world recognized leader in reservoir management, Enhanced Oil Recovery (EOR) and Carbon Capture, Utilization and Storage (CCUS) is a former industry executive that spent years working with CCUS techniques for conventional wells in the Permian Basin for Chevron. In addition to Thakur, the UH team is composed of more than a dozen scientists and engineers, including faculty members, post-doctoral researchers and graduate students, in disciplines including petroleum engineering, chemical engineering and geosciences.

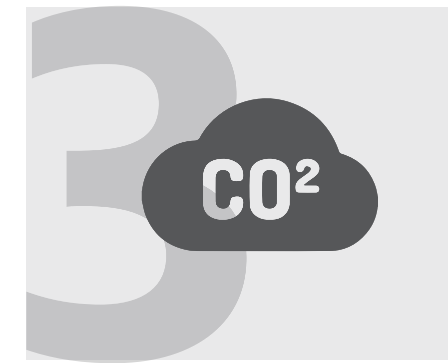
The initial MOUs for the partnership were signed in late 2016. Ratifying the agreement for the University of Houston were Chancellor and President **Renu Khator**, and **Ramanan Krishnamoorti**, Ph.D., Chief Energy Officer and professor of chemical and biomolecular engineering.

Durga D. Agrawal (pictured below), Ph.D., a member of the UH System Board of Regents that was present when the MOUs for the project were signed, praised the collaborative work done by UH and Oil India to shepherd the project through another successful phase.

"The partnership between Oil India and the University of Houston's Cullen College of Engineering is proof of the valuable contributions that we can make with expanded industry relations," he said. "To foster further improvement at the college level and throughout our university system, creating more of these successful partnerships internationally and domestically is vital. As an alumni of the University of Houston, I'm proud to see international initiatives like this thrive."

Completed work on the project includes:





Phase 1 – The project began in December 2016 with a $500,000 Reservoir Screening Study, which is an assessment of the suitability of a site for further development. The study focused on analyzing wells in the Makum-North Hapjan field, located in the northeastern corner of India, in order to provide recommendations that could quickly boost oil production. More than 50 reservoirs were screened for Enhanced Oil Recovery (EOR) applications. This revealed that there were more than 2.5 billion barrels of original oil-in-place. India currently produces about 1 million barrels per day, but consumes nearly 4.4 million barrels, showing the importance of increasing supply in the country.

Phase 2 – This portion came with funding of $1.4 million, with an additional $325,000 for lab-based research. Among a number of significant accomplishments and recommendations, the UH team developed a new petrophysical model for Oil India for the Makum-North Hapjan Field. Together with new core data and reservoir simulation work, this modeling revealed a significantly higher amount of original oil in place, suggesting Oil India's reserves are greater than originally estimated. An additional amount of more than 130 million barrels of oil has been identified by rigorous research involving development of a new petrophysical model, and integrated geoscience and reservoir engineering and simulation activities.

Phase 3 – This is the most recently completed phase. The $2.6 million project and lab research work focused on enhancing oil production by using carbon dioxide captured from nearby petrochemical plants to boost oil recovery in several fields in Assam, and built upon the field improvements undertaken in the second phase. The recommendations will make current water influx and future water flood more effective, CO_2 EOR applicable, and increase RF from 31 percent to 40 percent, with the overall potential to add 19 million barrels of incremental oil. In addition, more than 150 professionals from Oil India were trained on a variety of topics from seismic to simulation, EOR, petrophysics, and petroleum engineering lab capabilities.

"Oil India acknowledged in the Phase 3 concluding video conference meeting that the above-mentioned three phases of extensive research and fieldwork by the UH researchers and the Oil India professionals have created immense values for the oil fields in Assam, India," Thakur said.

Thakur added, "We are looking forward to our continued involvement with Oil India during Phase 4, and creating more business impacts in terms of incremental oil production and profitability, and more carbon sequestration. The three phases of this industrial partnership between UH and Oil India has not only helped tangibly, but also played a key role in developing the capabilities of the executives and professionals of Oil India."

LEAD NEWS

Mitigating

Houston's Flood Response

BY STEPHEN GREENWELL

Research grant funded by the National Science Foundation

ENVIRONMENT

Professors from the College of Liberal Arts and Social Sciences, and the Cullen College of Engineering, have received a National Science Foundation grant for their multi-faceted proposal to study how the community reacts to flood mitigation strategies.

The grant, "Community Perceptions of Flood Mitigation Strategies," was approved for $299,504 in funding via the NSF initiative Strengthening American Infrastructure. **Kathryn Freeman Anderson**, Ph.D., associate professor and the Director of Graduate Studies in the Department of Sociology, is the principal investigator for the grant. **Hanadi Rifai**, Ph.D., Moores Professor of Civil and Environmental Engineering and Associate Dean of Research and Facilities, is the co-PI.

According to the proposal's abstract, "Extant research has examined social vulnerability to climate disasters, demonstrating that poor and minority communities have greater exposure to the negative effects of such events. However, little research has attempted to understand how objective risk of disaster relates to perceptions of risk and how communities make sense of public mitigation strategies. This project combines these perspectives to examine how neighborhood perceptions of risk and mitigation relate to the physical infrastructure, the natural environment, and proposed plans to mitigate risk. Specifically, the project examines how these perceptions relate to flood risk and the flood mitigation infrastructure in Houston, Texas."

This is the first time that Anderson and Rifai will be collaborating on research together. Anderson said that Rifai brought the grant opportunity to her attention.

"This particular call for proposals was looking for social science and engineering collaborations, which is a bit of an unusual pairing," Anderson said. "The idea was to apply social science perspectives to engineering and infrastructure questions. Dr. Rifai read one of my prior publications on community perceptions of environmental hazard risk, and thought that this could be a good fit for a collaboration. She contacted me about it, and we started talking about possible project ideas that merged our two interests. We decided to focus on flood risk in Houston, as this is probably the most pressing environmental risk in our area. However, we think that the ideas from the project could extend to other areas of environmental hazards and disaster risk."

PICTURED: HANADI RIFAI (RIGHT) AND PH.D. STUDENT, DANA REED.

Rifai has done several studies on environmental effects on health, such as looking at life expectancy for populations near Superfund sites, and identifying Houston populations most vulnerable to Covid-19. Anderson comes at the issue from a sociological perspective.

"My research is generally focused on social vulnerability in neighborhoods and how this relates to the health and well-being of individuals within those communities," she said. "I'm interested in how and why certain communities with certain demographic characteristics, especially race and class, experience vastly different outcomes in a manner that is not simply a product of their individual-level choices and behaviors. Rather, people are embedded within particular contexts that shape their outcomes and constrain their choices."

Anderson added, "With this particular project, we are interested in understanding how social vulnerability relates to objective flood risk, the built environment, infrastructure and their perceptions of flood mitigation."

The funding for the project will support two graduate students – one in Environmental Engineering, one in Sociology. Anderson identified **Nicole Hart**, an M.A. student who earned her undergraduate degree at UH, as working with her. Anderson noted that Hart was a 2020 Mellon scholar, with a senior thesis project on racial inequalities in educational opportunities.

Read NSF Grant Overview Online:
Award Abstract # 2121931
Community Perceptions of Flood Mitigation Strategies

NATIONAL SCIENCE FOUNDATION:
www.nsf.gov

The Potential of Block Copolymers

Research grant funded by the National Science Foundation

BY STEPHEN GREENWELL

Alamgir Karim, the Dow Chairman and Welch Foundation Professor of the William A. Brookshire Department of Chemical and Biomolecular Engineering at the Cullen College of Engineering, has seen the potential of block copolymers when it comes to dealing with some of the impending crises of the next century, whether the issue is climate change, water shortages or materials engineering for nanotechnology and energy.

"Block copolymers are potentially a key component in solving some of these problems in my mind, because of the versatility of what you can do with them and the structures you can create with them," he said. "They can be templates for transistor chips to membranes for water filtration and energy storage. We were the first to show that highly ordered block copolymers can act as solid state energy storage devices for flexible devices. Whether the goal is to cut down on global and CO_2 emissions, or energy management, you need a lot of baseline nanotechnologies to enable sustainability. And block copolymers can provide potential solutions."

Karim's work has achieved further recognition nationally, as the National Science Foundation announced that he has earned the Special Creativity Award. The honor comes with an additional two years of enhanced support for his NSF grant, "Ordering of Block Copolymer Systems with Enhanced Molecular Interactions and Diffusional Dynamics."

"I've been working on this particular grant for two years, but in the general area of block copolymer self-assembly, it's been pretty much my career for at least the last two decades," Karim said. "I believe this award is recognition for a pair of very important papers resulting from that research."

According to **Triantafillos "Lakis" Mountziaris**, William A. Brookshire Department Chairman, the NSF acknowledged Karim for "excellent research, productivity, and impact in the area of directed assembly and ordering of block copolymer systems with enhanced molecular interactions, as well as the broader impacts emanating from his NSF project."

"It was excitement and jubilation," Karim said of his thoughts when he was notified that he had won the award. "Most importantly though, I felt it was recognition for work that I thought was important in the field of nanotechnology. It would give an opportunity for my academic colleagues to recognize that this was important work."

Karim's research focuses on using ionic liquids (IL) to create self-processing chains in block polymer films. The NSF grant and award related to the use of these non-volatile ionic liquids for highly efficient solution processing to obtain versatile morphologies for block copolymer nanotechnology, rather than energy intensive thermal annealing, which is advantageous. For example, using them in an industrial process could reduce the number of steps needed to be done – an automatic chemical process could take the place of a machine process that heats up a material to a liquid form. Using this newly developed IL based block copolymer processing strategy, efficiencies can be obtained throughout the manufacturing process, ideally.

In his department, Karim said he collaborates closely with **Megan Robertson**, an Associate Professor, as well as **Ramanan Krishnamoorti**, Professor of Petroleum Engineering and Chemistry. He also cited **Jeremy Palmer**, Ernest J. and Barbara M. Henley Associate Professor, and **Jacinta Conrad**, the Frank M. Tiller Professor, as experts he consults with regularly, on physics theories and colloids respectively.

Outside of his department, Karim said **Hadi Ghasemi**, an associate professor in Mechanical Engineering that specializes in coatings, was someone he worked with, as well as **Haleh Ardebili**, Bill D. Cook Professor of Mechanical Engineering, on polymers for flexible gel electrolyte batteries. Karim was also interested in exploring research partnerships with T. Randall Lee and Eva Harth of UH's Department of Chemistry.

Karim, who also serves as director of the International Polymer & Soft Matter Center (IPSMC), and the director of the Materials Engineering Program, first came to the University of Houston in 2017. He was previously a professor at the University of Akron for eight years, and a researcher at the National Institute of Standards and Technology (NIST) for 15 years. His research group now includes about 20 students.

"Having good students is key to making good progress," he said. "The Chemical Engineering Department here, we get some of the world's most outstanding student applications. That makes a big difference. The quality of the student matters."

Karim also brings in professionals from industry to help. One example he cited was Patrick Brant, Ph.D., a private consultant now, but who served as Chief Polymer Science Advisor at ExxonMobil for more than seven years, and Chief Scientist there for more than 11 years.

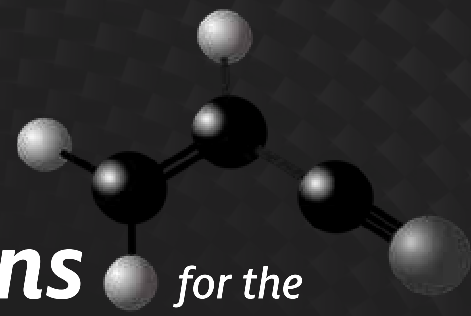
"He's a real expert in polymer synthesis, so now that he's retired, he works in my lab part-time sort of training students in fundamental studies of different kinds of semi-crystalline polyolefin polymers that are commercially important," Karim said. "He's working in my lab, mentoring my students, so that's great. I would really say that this area, in particular, we have so many amazing retired people from the polymer industry and the petrochemical industry. If they want to work with people at the university, we'd love to get their help."

Read NSF Grant Overview Online:
Award Abstract #1905996
Ordering of Block Copolymer Systems with Enhanced Molecular Interactions and Diffusional Dynamics.

NATIONAL SCIENCE FOUNDATION:
www.nsf.gov

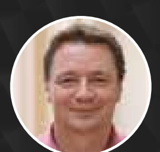
SHOWN BELOW: ALAMGIR KARIM TEACHING GRADUATE STUDENTS IN THE LAB.

Engineering Dynamic Solutions for the CARBON FIBER MARKET



Research funded by the U.S. Department of Energy

BY NICOLE JOHNSON



You may know little to nothing about the carbon fiber market, but products produced with carbon fibers are pervasive in your everyday life … from bicycles and computer hardware to automobiles, apparel and medications.

A University of Houston researcher is working to resolve a major carbon fiber industry pain point that routinely threatens to bring U.S. manufacturing from disparate industries to a temporary but costly halt.

Lars Grabow, Ph.D., at the University of Houston received a $2 million award from the U.S. Department of Energy to develop the technology for a catalytic process to produce acrylonitrile in small modular reactors near geographically distributed carbon fiber plants, meaning cheaper products with reduced energy costs.

The bulk of U.S. petrochemical feedstocks are located on the U.S. Gulf Coast, in close proximity to upstream products such as oil and natural gas as well as refineries, reducing the cost of logistics. Additionally, most ports and terminals for import and export are located along the Gulf Coast to facilitate intrastate barge and international vessel movements.

While the location offers many advantages, disruptive weather events like hurricanes, freezes and floods — particularly in recent years — often push Gulf Coast facilities offline. Manufacturers responsible for producing end-products, or derivatives, of these main petrochemicals often see feedstocks stranded during these seasonal force majeure events and their production halted due to a bottleneck hundreds or even thousands of miles away.

The story of the U.S. carbon fiber market

Carbon fiber is a strong but lightweight material used in high-performance products such as sporting equipment, aircrafts and racecars. This ubiquitous material is made from the feedstock acrylonitrile produced primarily on the Gulf Coast, but most carbon fiber manufacturing facilities are located on the East and West Coasts and areas in between.

The challenge of bringing acrylonitrile (ACN) production closer to carbon fiber production facilities is a question of upstream feedstock access, safety, affordability and catalytic flexibility to optimize acrylonitrile production.

But a solution might be on the horizon.

Grabow, who serves as Dan Luss Professor in the William A. Brookshire Department of Chemical and Biomolecular Engineering at the Cullen College of Engineering, is the principal investigator for a $2,091,874 award from the U.S. Department of Energy to resolve this industry pain point. He will do this by engineering a dynamic process using small reactors near geographically distributed carbon fiber plants that would effectively bring acrylonitrile production onsite. Grabow will work in tandem with team members from Idaho National Laboratory, the University of Virginia, Pacific Northwest National Laboratory and KX2 Development.

The ingenuity behind how this innovative, ACN-producing reactor works is not dissimilar to how your car works.

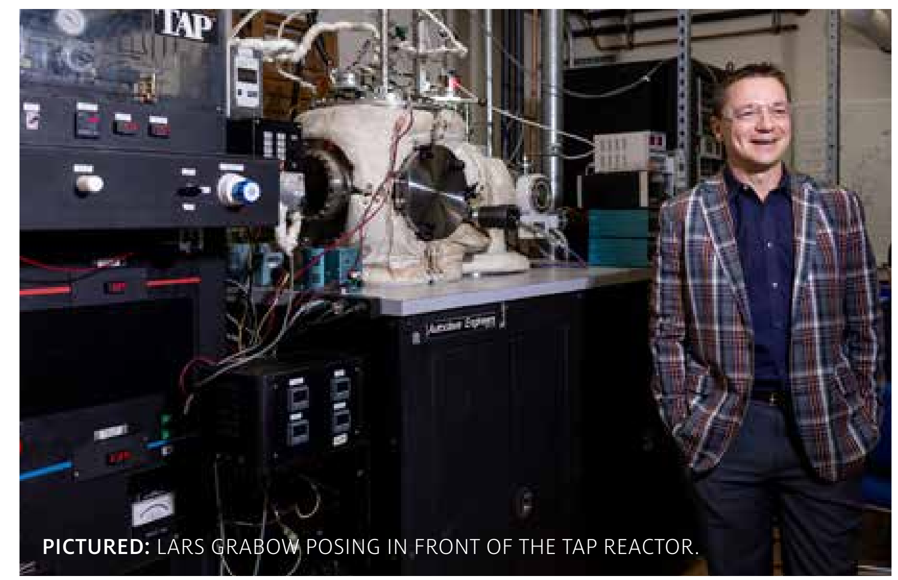
“Most people are familiar with how the three-way catalytic converter in a car converts carbon monoxide, nitrogen oxide, and hydrocarbons into carbon dioxide, nitrogen and water. This inspires the research we are doing,” said Grabow.

“Car engines are dynamically operated and undergo different driving cycles. To maintain optimal performance of the engine and the three-way catalytic converter under all driving conditions a lambda sensor (oxygen sensor) is used to control and continuously adjust the air to fuel ratio. We have evidence that this externally forced dynamic operation between more fuel-rich versus oxygen-rich states can improve the performance of these smaller reactors.”

This has not been previously done in larger-scale petrochemical units because the concentration of large flow rates cannot be altered quickly, limiting flexibility capabilities. But smaller reactors have more flexibility and shorter response times, such that small pulses of oxidant can be delivered as needed and leveraged to improve the kinetics and performance of the overall process.

“Distributed Chemical Manufacturing, or DCheM for short, is a concept that aims to revolutionize the process industries sector by deploying modular processes and small chemical plants close to the feedstock or to the customer,” said **Triantafillos "Lakis" Mountziaris**, William A. Brookshire Department Chair and Professor of Chemical & Biomolecular Engineering at the University of Houston.

“This approach can take advantage of geographically scattered feedstocks and provide opportunities for economic development to rural and remote areas. It can also enable on-site production of dangerous chemicals to avoid their transportation and storage costs and risks. The project that Dr. Grabow will pursue is very timely and addresses such a need. If successful, the project may yield significant economic and environmental sustainability benefits. It will also set a new paradigm for the design or retrofitting of additional chemical processes.”



PICTURED: LARS GRABOW POSING IN FRONT OF THE TAP REACTOR.

The development of small-scale reactors onsite also means improved safety opportunities for ACN production, as the feedstock is a highly explosive chemical that presents high risks during transportation.

On top of strategic geographic access to feedstock and improved safety, the potential of these small-scale modular reactors also points to improved affordability, which speaks volumes for a typically energy-intensive and therefore costly production process for ACN.

“Our process involves periodically switching the oxidation and reduction state of the catalyst surface to speed up the overall catalytic cycle,” said Grabow. “In the first 18 months of funding we are aiming to demonstrate a 20°C reduction in reaction temperature while maintaining identical ACN yield, but there will likely be room for more.”

The production process for ACN using this innovative process can even utilize biomass as a feedstock as opposed to petrochemicals generated from fossil fuels – a step toward improving the energy mix in the energy transition.

But varied feedstocks are not the only flexible factor of this new production process. Improved yield of acrylonitrile versus its poisonous byproducts is another aim of this project, as well as improved lifetime of the catalyst.

“There are indications that by changing the frequency of lean/rich cycling you can change product distribution, and favor selectivity and yield to the desired product,” said Grabow. “We are looking to find the right frequencies that produce the desirable product – acrylonitrile – versus a byproduct, such as hydrogen cyanide, which is a poison.”

The catalyst for acrylonitrile, promoted bismuth molybdate, lasts with regeneration periods of about 10 years.

“The cycling done to lower the temperature in our dynamic process can also be used to regenerate the catalyst while it is in use,” said Grabow. “This continuous regeneration would eliminate production downtimes due to catalyst deactivation. One of the first steps we take in this project will be to establish the opportunities and limits of dynamic operation.”

The multifaceted benefits of this project would provide a myriad of solutions to several pain points in the carbon fiber market industry, ultimately leading to a cheaper, safer product for the average person.

“Grabow’s U.S. Department of Energy-funded project to develop a cyclic dynamic transient process for acrylonitrile production offers an excellent prospect for making a step-change in the operational performance and efficiency of this industrially important process,” said **James Brazdil**, professor of chemical and biomolecular engineering at the University of Houston, who previously served as research and development (R&D) manager at INEOS Technologies and Head of the Nitriles Catalyst R&D division.

“The research will provide new fundamental mechanistic insights into the redox chemistry that can apply broadly to the chemical catalysis of heterogeneous selective oxidation. The industrial application of transient kinetics to selective oxidation and ammoxidation processes has been long recognized as offering potential for increased selectivity to valuable industrial products, including acrylonitrile. So, it is with the recent advances in both the equipment and computer capabilities for precise process control, both of which are at the heart of Grabow’s project, that these benefits could now be realized.”

And the chemistry of it all is akin to making your car go. Who’d have thought?

FUNDAMENTALS

Adulteration and mislabeling of honey to mask its true origin has become a global issue. To evade tariffs or sanctions, some illicit importers slap fake labels on the honey, indicating it is from a different country of origin. Some unscrupulous honey peddlers substitute cheap honey into bottles of the expensive stuff. Others even "water down" honey by adding in cheap ingredients like syrups and sugar.

To fight those who fake the real thing, the Science and Technology Directorate joined forces with the Borders, Trade, and Immigration Institute (BTI) for the Honey DNA project, investing in cutting-edge forensic science that can quickly and efficiently determine the true origin of honey. BTI is an Emeritus Department of Homeland Security (DHS) Center of Excellence led by the University of Houston College of Technology.

"This project developed a means to identify the country of origin of honey using the DNA in pollen and DNA dissolved in filtered honey," said Kurt Berens, executive director of BTI when it was under the DHS.

Through the Honey DNA project, BTI was able to establish techniques that will help mitigate fraud and provide authentic and safe food for consumers. BTI recently published a report on the findings, including assembling country-specific plant DNA sequences from 300 honey samples, and successfully isolating soluble trace DNA and sequencing it from pollen-free, filtered honey.

SHOWN ABOVE: A MERE SAMPLING OF THE VAST ARRAY OF HONEY PRODUCTS NOW AVAILABLE TO CONSUMERS.

The Fight Against Impure Honey

BY LAURIE FICKMAN

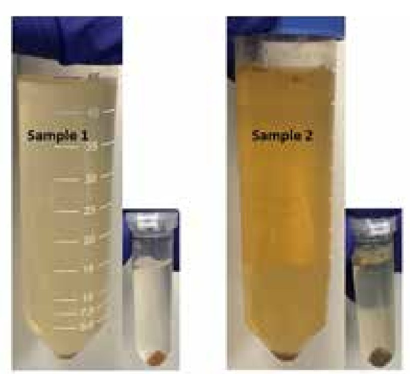
One plant species of particular interest is manuka, as manuka honey can fetch an extremely high price, sometimes more than 100-fold higher than other honey types.

"We collected 37 honey samples labeled as 'manuka honey,' of which 21 so far passed our strict sample filtering criteria," said **Richard Willson**, Ph.D., Huffington-Woestemeyer Professor of Chemical and Biomolecular Engineering and principal investigator on the Honey DNA project. "We detected reads matching manuka (Leptospermum scoparium) in nine out of the 21 samples. The highest count of manuka reads was detected in a New Zealand sample with 4.26 percent (379/8884) of reads originating from manuka."

Willson and his team of scientists developed methods for sequencing DNA not only from whole pollen grains in unfiltered honey, but also from the small amounts of DNA leaked from broken pollen grains in filtered honey.

"The Honey DNA tracing methods could find broad applications in other types of forensic cases, including identifying the species of other natural products, and even tracing the origins of shipments, narcotics and people," said Willson. "Also, the DNA sequences obtained from this project will enrich the public DNA database and help link occurrences of source plants across the world for a more precise identification of honey origin."

In a recent lawsuit, U.S. beekeepers claim counterfeit honey from Asia has caused prices to plummet and forced them into financial ruin.

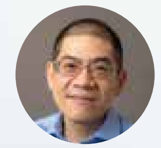


SHOWN ABOVE: SPECIFIC POLLENS CAN NOW BE FILTERED FROM SAMPLES OF HONEY IN ORDER TO CREATE DNA PROFILES AND TO PROOF THE VERACITY OF THE SWEET STUFF.

HEALTH & MEDICINE

Counting Exosomes to Detect Cancer

BY LAURIE FICKMAN



University of Houston engineering researcher **Wei-Chuan Shih** was awarded $2.7 million from the National Institute of Biomedical Imaging and Bioengineering to detect cancer biomarkers in blood by counting exosomes.

Known as "liquid biopsy," the process, which requires only a simple blood draw, can improve the accuracy of measuring nearly invisible minimal residual disease (MRD) in cancer tumors. Circulating tumor exosomes (CTE) are excreted by cells and contain surface proteins and genetic materials (DNA and RNA) that reflect the characteristics and make-up of the parental cell. Cancerous tumors send them off into the bloodstream in mass quantities.

"A CTE assay is virtually non-invasive and can be performed at small clinics more frequently than tissue biopsy. Therefore, it could provide 'real-time' tumor status monitoring with respect to treatment and for MRD applications," said Shih, a professor in the Computer and Electrical Engineering Department at the Cullen College of Engineering. "Unlocking the wealth of information in CTE can potentially cause a paradigm shift."

Exosomes have been cruising under the radar for a long time because they are small and there are many other circulating vesicles of similar sizes with similar structures, plus they've always been considered cellular waste. But they are now having their moment, due to their potential to complement or even outperform other circulating biomarkers such as circulating tumor cell (CTC), circulating tumor DNA (CTDNA), and traditional circulating protein biomarkers, which also aim to survey the tumor information from the blood.

Plus, blood draws do not require large equipment, and the exosomes can eventually read the tea leaves.

"A CTE assay can be carried out even before any sizable tumor is identified thus providing unprecedented early detection power and capture the golden time window for treatment decision," said Shih.

Shih's immediate goal is to obtain a high-resolution, digital exosome map with both multiplex surface protein and cargo D/RNA biomarker profiles.

"The proposed technology will become a cost effective, point-of-care-friendly, translational platform that will address a critical need in early cancer and MRD detection to improve cancer healthcare outcomes. The technology can also be broadly applied to exosome-based diagnostics of non-cancer diseases and basic biomedical research," said Shih.

Shih's team includes Steven Lin, M.D., a physician-scientist and radiation oncologist at University of Texas M.D. Anderson Cancer Center.

*Docking **Peptides**, Slow to Lock,* Open Possible Path to *Treat Alzheimer's*

BY LAURIE FICKMAN

Progress on treating Alzheimer's disease has been frustratingly slow. A group of scientists in Houston suggest frustration at a very small scale may lead to a new path toward treatment. Researchers at the University of Houston (UH) and at Rice University, associated with the Rice-based Center for Theoretical Biological Physics (CTBP), found through experiments and computations that amyloid beta peptides, small molecules that are abundant in the brain, go through several intermediate stages of frustration as they "dock and lock" to the tips of growing fibrils.

Folding proteins tend to look for the easiest way to get to their functional forms. Similarly, amyloid beta peptides look for the easiest way to bind to the tips of growing fibrils, but are sometimes held back — or frustrated — when the positive and negative forces between atoms don't immediately align.

When they do finally align, the growing fibrils form the gummy plaques implicated in Alzheimer's and other neurological diseases. New research in the *Proceedings of the National Academy of Sciences* shows that drugs might be developed to take advantage of the peptides' frustrated intermediate states to stabilize the fibril tips and block further aggregation.

Peter Vekilov, Moores Professor in the William A. Brookshire Department of Chemical and Biomolecular Engeering, said it wasn't a stretch to look at amyloid beta fibril growth in his lab. "Previous studies that observed fibrilizing proteins with an atomic force microscope focused on more exotic behaviors because amyloid beta fibrils with a steady rate of growth are kind of boring," he said.

"But I was fascinated because the correlation of the growth rate to the concentration of peptides in the solution carries loads of information," Vekilov said. "It helps to measure the rate constant, a quantity which is easy to model."

He said Rice physicist Peter Wolynes, whose lab specializes in building computer models of protein and chromosome folding, suggested that disrupting the steady growth with urea, known to denature (or unfold) proteins, might provide useful data about how amyloid fibrils form. It sure did.

"A weird thing happened," Vekilov said. "Urea made the fibrils less stable, which meant the bonds between the molecules in the fibrils became less strong. But it also made them grow faster. This is a very serious contradiction, a violation of the empirical rules of chemistry.

"But there are empirical rules, and then there are fundamental laws," he said. "We thought, this is trying to tell us something."

Further experiments showed that urea "destabilized the wrong peptide bonds," Vekilov said. "It made the fibril grow faster but also showed us the intermediate frustrated steps. The big thing is we now have evidence that at the end of the fibril there's a crown of frustrated, disordered peptide chains trying to dock and lock, and these are druggable targets.

"It's irrational to block every single peptide, because there are probably 100,000 times more of them than there are fibril tips," he said. "The beauty of what we found is that the fibril tip is an Achilles' heel of fibrilization, and all we have to do is block the complex at the tip."

Wolynes noted there were signs of frustration in an earlier study that saw evidence of hitches in fibril aggregation. "Two things have emerged from the experiments," he said. "One is that almost all of the kinetic models people use for amyloid beta growth are too simple. That's not unexpected. The other is that denaturing changes the equilibrium, and it can also change the rate of folding in ways that tell you where the transitions states appear.

"In the earlier paper on fibril nucleation, we remarked that it looked like there were some strange processes where the proteins had to backtrack from the transition state," Wolynes said. "So Peter went and investigated this, and I think he is the first person to do so."

He said having a way to halt fibrils from growing may help settle a long-standing disagreement among scientists over whether fibrils cause neurological disease or protect the brain from another suspect, particularly tangled tau proteins.

"Our idea is to poison the tip so that it can't grow, rather than to destabilize the whole fibril," Wolynes added. "This, of course, gets into the big argument over whether fibrils are good or bad."

Computational models might show that arresting the fibrils could either stem the effects of Alzheimer's or make it worse. Regardless, Wolynes said scientists will have a more definitive answer.

"To my mind, what's interesting here is to provide a new target, and we will explore some possible drugs that could change the nature of the tip," he said. "Either way, those molecules will provide interesting tools to understand how fibril growth happens."

Graduate students **Yuechuan (Alex) Xu** of UH and Kaitlin Knapp of Rice are co-lead authors of the paper. Co-authors are Rice postdoctoral researcher Nicholas Schafer and visiting faculty member Aram Davtyan; UH alumnus Mohammad Safari, now a postdoctoral researcher at Princeton University; and Kyle Le, a UH alumnus and former Rice research intern. Wolynes is the D.R. Bullard-Welch

Foundation Professor of Science and a professor of chemistry, biosciences and physics and astronomy, and co-director of CTBP.

PICTURED: PETER VEKILOV IN HIS RESEARCH LAB.

Research funded by NASA and the National Science Foundation

STOPPING
Epileptic Seizures *Before* They Begin

BY LAURIE FICKMAN

University of Houston associate professor of biomedical engineering **Nuri Firat Ince**, who pioneered a dramatic decrease in the time it takes to detect the seizure onset zone (SOZ) in the brain, has received a $3.7 million BRAIN Initiative grant from the National Institute of Neurological Disorders and Stroke to translate his work into creating a next-generation device that can stop epileptic seizures before they begin.

Ince reduced the time – by weeks – of locating the SOZ, the actual part of the brain that causes seizures in patients with epilepsy, by detecting high frequency oscillations (HFO), which form repetitive waveform patterns that identify their location in the SOZ. Now he plans to use those HFOs to close the loop, translating them into seizure control applications, a method never before explored.

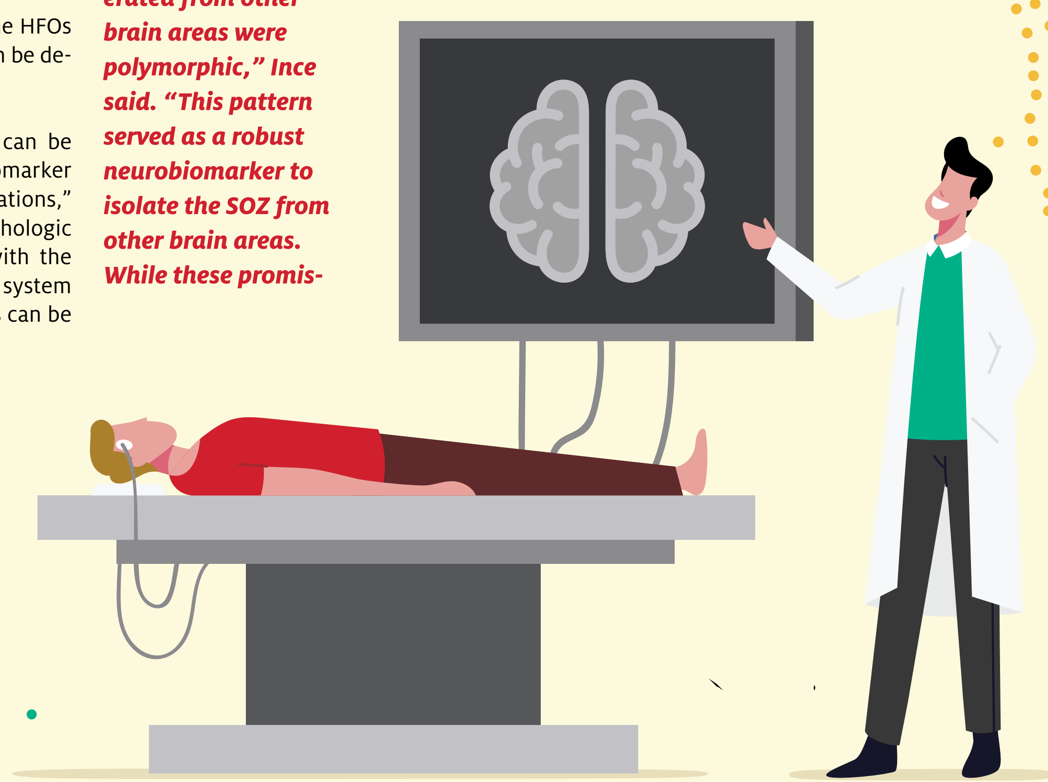
But first, he must figure out whether the HFOs generated by the seizure onset zone can be detected with an implantable system.

"If this can be achieved, then HFOs can be strategically translated as a neurobiomarker into closed-loop seizure control applications," Ince said. "We hypothesize that pathologic stereotyped HFOs can be captured with the implantable Brain Interchange (BIC) system and spatial topography of these events can be utilized by the implantable system to deliver targeted electrical stimulation to achieve seizure control."

The BIC is supplied by the project's neurotech partner, Cortec GMBH of Freiburg, Germany. Baylor College of Medicine is the project's clinical partner and will be the eventual site where pediatric and adult epilepsy patients will be observed when they receive the BIC.

Previously, Ince distinguished between the kind of waveforms created in the SOZ and other non-epileptic sites including eloquent regions such as motor, visual and language cortices.

"Specifically, in our preliminary studies, we observed that the SOZ repeatedly generates sets of stereotypical HFO waveforms whereas the events generated from other brain areas were polymorphic," Ince said. "This pattern served as a robust neurobiomarker to isolate the SOZ from other brain areas. While these promising preliminary results are in place, the functional utility of stereotyped HFOs in a closed-loop seizure control system remains unknown."



This closed-loop system does not have to wait for a seizure to start in order to deliver the stimulation at its onset as done by RNS systems. It intends to prevent the seizures from occurring. "If the outcomes of our research in acute settings become successful, we will execute a clinical trial and run our methods with the implanted BIC system in a chronic ambulatory setting," Ince said.

Research funded by:

NIH National Institute of Neurological Disorders and Stroke

Does Zinc Inhibit or Promote Growth of Kidney Stones? Well, Both.

BY LAURIE FICKMAN

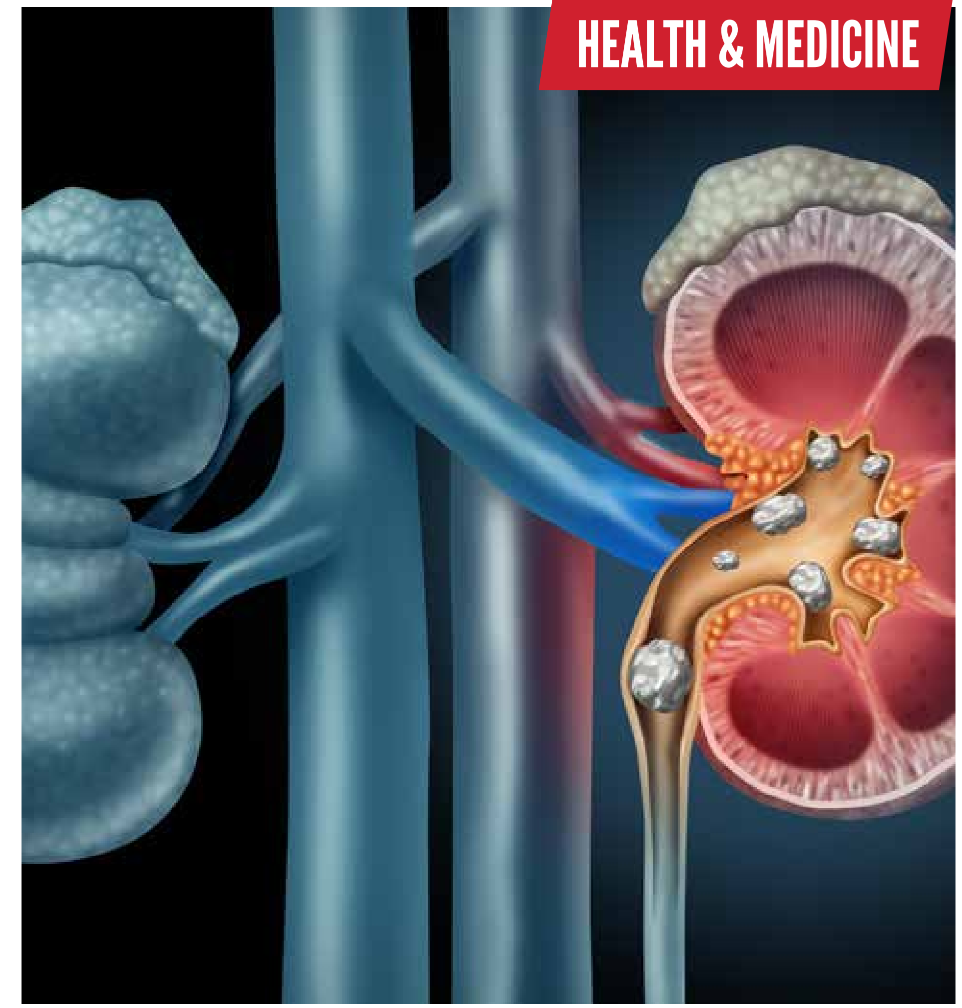
A funny thing happened on the way to discovering how zinc impacts kidney stones — two different theories emerged, each contradicting the other. One: Zinc stops the growth of the calcium oxalate crystals that make up the stones; and two: It alters the surfaces of crystals which encourages further growth. Now it can be told – both theories are correct as reported in the American Chemical Society journal *Crystal Growth & Design* by **Jeffrey Rimer**, Abraham E. Dukler Professor of Chemical and Biomolecular Engineering at the University of Houston, who conducted the first study to offer some resolution to the differing hypotheses.

"What we see with zinc is something we haven't seen before. It does slow down calcium oxalate crystal growth and at the same time it changes the surface of the crystals, causing defects in the form of intergrowths. These abnormalities create centers for new crystals to nucleate and grow," reports Rimer, who refers to the effect as a double-edged sword.

The formation of kidney stones is a pathological condition that has increased in frequency among patients, leading to an increased amount of suffering and steep rise in medical costs.

Though calcium oxalate crystals are found everywhere, the most naturally abundant form of these crystals are calcium oxalate monohydrates (COM), the kind found in human kidney stone disease. Along with COM, kidney stones are composed of various hard deposits of inorganic salts and organic compounds (e.g., proteins) crystallizing or sticking together in concentrated urine. They can be severely painful to pass through the urinary tract.

In this study, Rimer and his team used a combination of in vitro experiments and computational modeling to decode the effects of zinc on COM crystal growth.



"The techniques we're using in our lab to investigate these systems enable us to get a better picture and to deconstruct these complex systems as a means of identifying new ways to prevent kidney stone formation," said Rimer. "These are enabling tools that allow us to understand at an almost molecular level how various species in urine can regulate crystal growth."

Rimer's findings on the dual role of zinc on COM was confirmed by atomic force microscopy measurements showing a unique ability of zinc ions to alter the termination of crystal surfaces. The team compared the impact of zinc on COM, with similar ions like magnesium.

"We wondered what would happen if we used alternative ions commonly found in urine, such as magnesium, and the answer was nothing. It had little to no effect, whereas zinc had a major effect. This is an excellent demonstration of how subtle differences in the nature of various species impacts their interaction with crystal surfaces," said Rimer.

The paper's first author is **Bryan G. Alamani,** a former doctoral student of Rimer's and now a professor at University of the Philippines Diliman. Rimer also partnered with Julian Gale, Curtin University, Perth, Western Australia.

Read Research Paper Online:
Zinc Ions Modify Calcium Oxalate Growth by Distinct Transformation of Crystal Surface Terminati

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More Efficient Tests May One Day Replace Endoscopy

BY LAURIE FICKMAN

In two journal articles, a University of Houston biomedical researcher reports a step forward in diagnosing intestinal diseases, including colorectal cancer, ulcerative colitis and Crohn's disease using stool proteins. The current gold standard for colon cancer testing measures blood (hemoglobin) present in stool, and tests for inflammatory bowel disease (IBD) measure levels of calprotectin, a protein that detects inflammation in the intestines.

"The unique aspect of both research reports is that we are looking at stool samples comprehensively, and not just at one or two favorite molecules," said Chandra Mohan, Ph.D., Hugh Roy and Lillie Cranz Cullen Endowed Professor of biomedical engineering in the UH Cullen College of Engineering. "We are casting a wide net, and this has never been done before."

With colon cancer, typical fecal blood tests look for hemoglobin in stool samples. In Mohan's work, hemoglobin is just one of more than a thousand proteins being hunted.

"By the time you see blood, it might be too late, and there are other proteins that appear in the stool if someone has colon cancer, and they may appear much earlier than when the blood appears," reports Mohan in *Nature Communications*.

Using aptamer-based screening, Mohan and team screened 1,317 proteins searching for precursor biomarkers of colon cancer and found five elevated. Stool MMP9, fibrinogen, myeloperoxidase, and haptoglobin emerged as promising stool biomarkers of colorectal cancer, outperforming stool hemoglobin.

Aptamers are pieces of DNA that can be selected to bind to other molecules. They serve as bait, carefully selected for each protein they will try to detect. If the protein is present in the stool, it will bind to the aptamer in the library. If the protein is not present, it will be washed away.

"Longitudinal studies are warranted to assess the clinical utility of these novel biomarkers in early diagnosis of colorectal cancer," said Mohan.

Mohan's research team includes Robert S. Bresalier, University of Texas MD Anderson Cancer Center; Nicholas Chia, Mayo Clinic; Hao Li and Kamala Vanarsa, University of Houston.

Predicting the Future with Markers for IBD

In the *Journal of Gastroenterology*, Mohan is reporting similar findings in early diagnosis of ulcerative colitis and Crohn's disease, finding several proteins elevated in pediatric patients with the disease after screening for 1300 proteins. Those proteins are stool Ferritin, Fibrinogen, Haptoglobin, Hemoglobin, Lipocalin-2, MMP-12, MMP-9, Myeloperoxidase, PGRP-S, Properdin, Resistin, Serpin A4, and TIMP-1, all significantly elevated in both ulcerative colitis and Crohn's disease.

The team took samples from patients at four different time periods, allowing the researchers a rare window into disease progression.

"Using the new biomarkers, we can predict if the disease will become worse or if the intestines will become more inflamed. Stool proteins assayed at baseline can predict how the disease might progress in the weeks and months ahead," reports Mohan.

The IBD study represents the first use of the aptamer-based screen of stool samples in IBD, representing the largest-ever targeted stool proteomic study in IBD.

"We demonstrate the utility of comprehensive aptamer-based proteomic screens in identifying novel disease biomarkers for IBD that outperform the current gold standard, fecal calprotectin," said Mohan.

Mohan's hope is to replace the invasive endoscopy test by finding stool markers that can predict what is happening in the intestine without having to do an endoscopy. Stool tests for proteins can be done at home and through the mail.

On this paper, Mohan was joined by Subra Kugathasan from Emory University whose lab supplied the stool samples; Suresh Venkateswaran, Emory University; **Sanam Soomro** and **Kamala Vanarsa**, University of Houston.

In Through the Nose...

BY LAURIE FICKMAN

Breathe in, breathe out. That's how easy it is for SARS-CoV-2, the virus that causes COVID-19, to enter your nose. And though remarkable progress has been made in developing intramuscular vaccines against SARS-CoV- 2, such as the readily available Pfizer, Moderna and Johnson & Johnson vaccines, nothing yet – like a nasal vaccine – has been approved to provide mucosal immunity in the nose, the first barrier against the virus before it travels down to the lungs.

But now, we're one step closer.

Navin Varadarajan, M.D. Anderson Professor of Chemical and Biomolecular Engineering at the Cullen College of Engineering, and his colleagues are reporting in *iScience* the development of an intranasal subunit vaccine that provides durable local immunity against inhaled pathogens.

"Mucosal vaccination can stimulate both systemic and mucosal immunity and has the advantage of being a non-invasive procedure suitable for immunization of large populations," said Varadarajan. "However, mucosal vaccination has been hampered by the lack of efficient delivery of the antigen and the need for appropriate adjuvants that can stimulate a robust immune response without toxicity."

To solve those problems, Varadarajan collaborated with **Xinli Liu**, associate professor of pharmaceutics at the UH College of Pharmacy, and an expert in nanoparticle delivery. Liu's team was able to encapsulate the agonist of the stimulator of interferon genes (STING) within liposomal particles to yield the adjuvant named NanoSTING. The function of the adjuvant is to promote the body's immune response.

"NanoSTING has a small particle size around 100 nanometers which exhibits significantly different physical and chemical properties to the conventional adjuvant," said Liu.

"We used NanoSTING as the adjuvant for intranasal vaccination and single-cell RNA-sequencing to confirm the nasal-associated lymphoid tissue as an inductive site upon vaccination. Our results show that the candidate vaccine formulation is safe, produces rapid immune responses - within seven days - and elicits comprehensive immunity against SARS-CoV-2," said Varadarajan.

PICTURED: NAVIN VARADARAJAN HARD AT WORK IN THE LAB.

He added, "Equitable distribution requires vaccines that are stable and that can be shipped easily."

A fundamental limitation of intramuscular vaccines is that they are not designed to elicit mucosal immunity. As prior work with other respiratory pathogens like influenza has shown, sterilizing immunity to virus re-infection requires adaptive immune responses in the respiratory tract and the lung.

The nasal vaccine will also serve to equitably distribute vaccines worldwide, according to the researchers. It is estimated that first world countries have already secured and vaccinated multiple intramuscular doses for each citizen while billions of people in countries like India, South Africa, and Brazil with large outbreaks are currently not immunized. These outbreaks and viral spread are known to facilitate viral evolution leading to decreased efficacy of all vaccines.

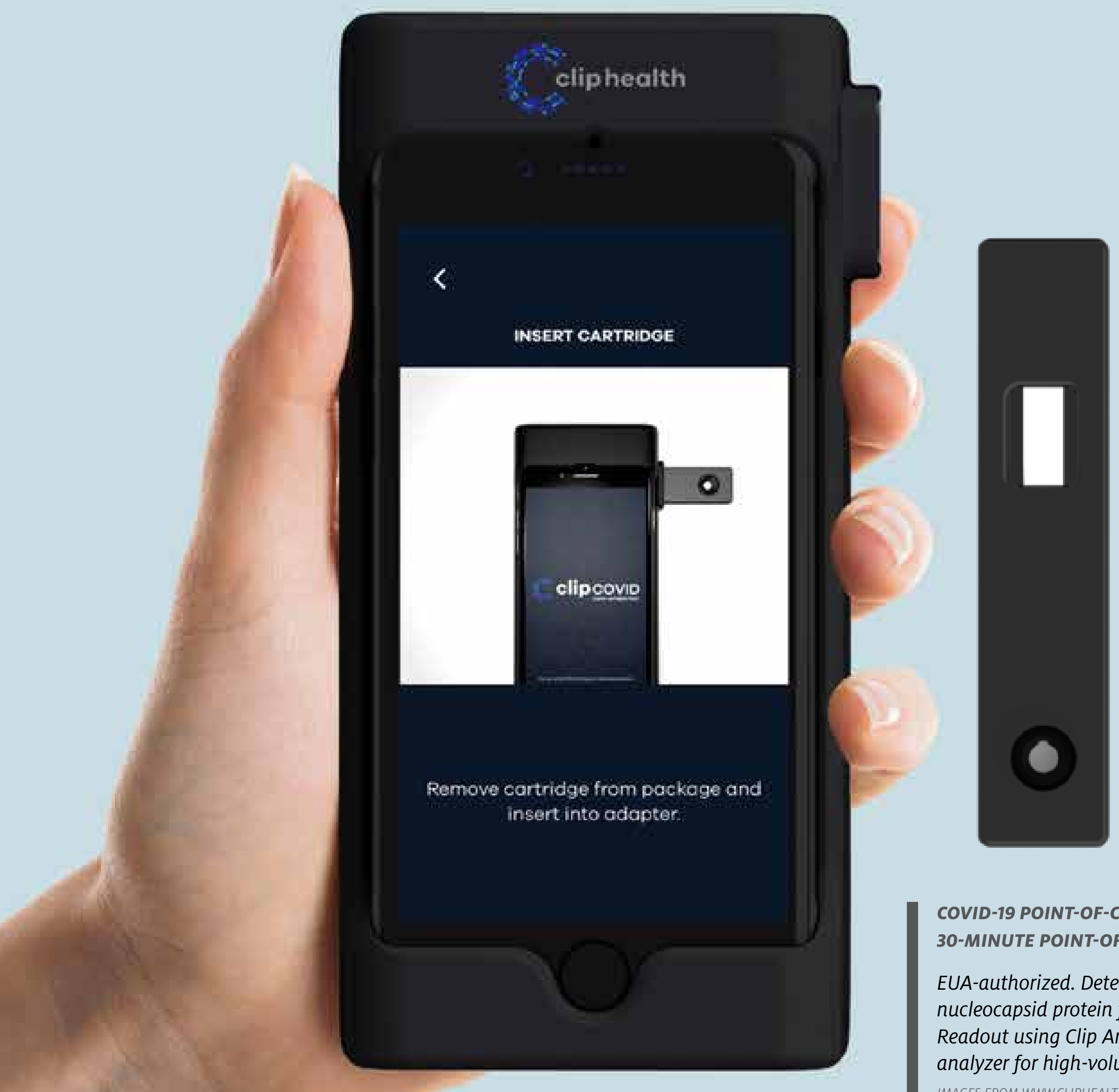
"Equitable distribution requires vaccines that are stable and that can be shipped easily. As we have shown, each of our components, the protein (lyophilized) and the adjuvant (NanoSTING) are stable for over 11 months and can be stored and shipped without the need for freezing," said Varadarajan.

Varadarajan is co-founder of AuraVax Therapeutics Inc., a pioneering biotech company developing novel intranasal vaccines and therapies to help patients defeat debilitating diseases, including COVID-19. The company has an exclusive license agreement with UH with respect to the intellectual property covering intranasal vaccines and STING agonist technologies. They have initiated the manufacturing process and plan to engage the FDA later this year.

Along with Liu, Varadarajan's team includes postdoctoral researchers **Xingyue An, Melisa Martinez-Paniagua**; research assistants **Ali Rezvan, Mohsen Fathi** and **Sujit Biswas**; doctoral student **Samiur Rahman Sefat**, all from the University of Houston; and Shailbala Sing, postdoctoral researcher at University of Texas M. D. Anderson Cancer Center; Melissa Pourpak, BD; and Cassian Yee, M.D., University of Texas M. D. Anderson Cancer Center.

Smartphone-Based COVID-19 Test Hits Market

BY LAURIE FICKMAN



COVID-19 POINT-OF-CARE TEST: 30-MINUTE POINT-OF-CARE ANTIGEN TEST

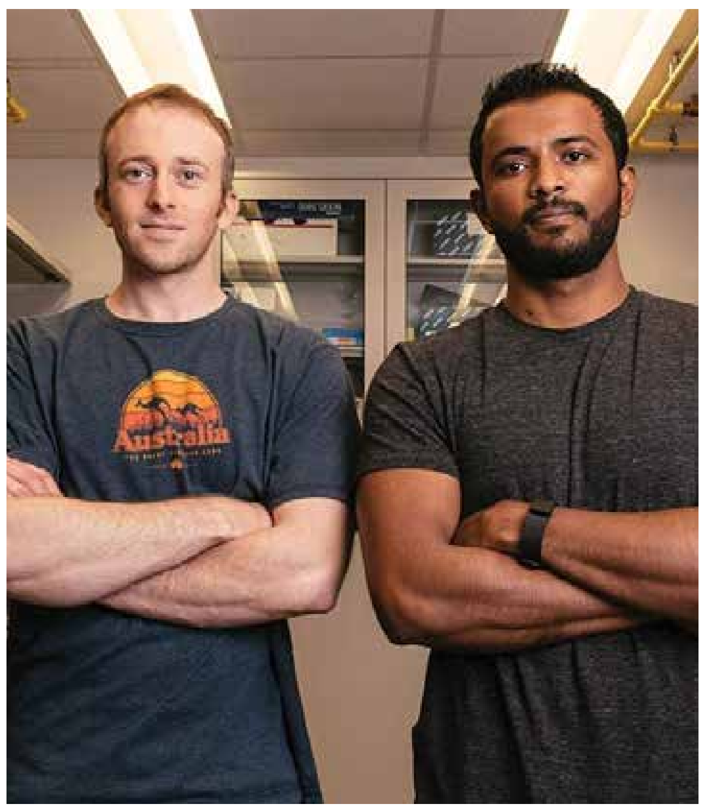
EUA-authorized. Detection of SARS-CoV-2 nucleocapsid protein from anterior nares swab. Readout using Clip Analyzer, an iPhone-connected analyzer for high-volume point-of-care use.

IMAGES FROM WWW.CLIPHEALTH.COM

HEALTHCLIP 30-MINUTE COVID-19 POINT-OF-CARE ANTIGEN TEST

IMAGES FROM WWW.CLIPHEALTH.COM

In 2020, just as the SARS-CoV-2 coronavirus caused a pandemic of respiratory illness called COVID-19, two chemical engineers and alumni of the University of Houston decided to pivot the product strategy of Luminostics, the company they began forming while in the UH lab of Richard Willson, Huffington-Woestemeyer Professor of chemical and biomolecular engineering and professor of biochemical and biophysical sciences. Based on technology developed in the Willson lab, Luminostics' goal was to empower consumers with rapid self-diagnostics.



SHOWN ABOVE: CLIP HEALTH *(FORMERLY LUMINOSTICS)* FOUNDERS: ANDREW PATERSON (LEFT) AND BALA RAJA (RIGHT).

PHOTOGRAPH BY BEN CORDA.

Talk about timing.

By May 2021, having gotten Emergency Use Authorization from the FDA, Luminostics, now known as Clip Health, founders **Andrew Paterson** and **Bala Raja** had distributed their Clip COVID Rapid Antigen Test across the United States.

The Clip COVID test, a revolutionary test based on a smartphone-coupled analyzer, uses a nasal swab, a smartphone, and glow-in-the-dark nanoparticles to detect SARS-CoV-2 infection within 30 minutes. In the phone, an image processor quantifies the intensity of the luminescence signal. If the signal is strong enough the result is positive, if it's weak the result is negative.

"We live in a world where you can have all your basic necessities delivered to your home through an app, and yet this pandemic has exposed how far behind the diagnostics industry lags compared to consumer technology and the convenience economy," Paterson said.

"The diagnostics industry is saturated with products that cater to big, centralized labs or testing in the doctor's office," said Paterson. "There are many applications where it does make sense to do testing in a centralized lab, but there are dozens of other applications where there should be home-tests and there are not, because few companies have tried to take on the technical and regulatory challenges with developing home-testing." »

CLIP HEALTH'S LATEST PRODUCT: COVID-19 + FLU TEST

WWW.CLIPHEALTH.COM/PRODUCTS/COVID-19-FLU/

TOP PHOTO: GLOW-IN-THE-DARK STARS
BOTTOM PHOTO: RICHARD WILLSON AND HIS DAUGHTER'S GLOW-IN-THE-DARK STAR THAT INSPIRED LUMINOTICS.

PHOTOGRAPHS BY BEN CORDA.

The path to development

It started as a dream – or at least while on the way to dreamland.

One night in 2012, when Willson was putting his young daughter to bed, he fixed his gaze on a glow-in-the-dark star on her ceiling. The mind of this scientist/dad wandered to detectable particles for medical testing.

He had long thought the technology of the home pregnancy test was almost mystical.

“The home pregnancy test format is one of the most remarkable technical developments that anybody ever made," Willson said.

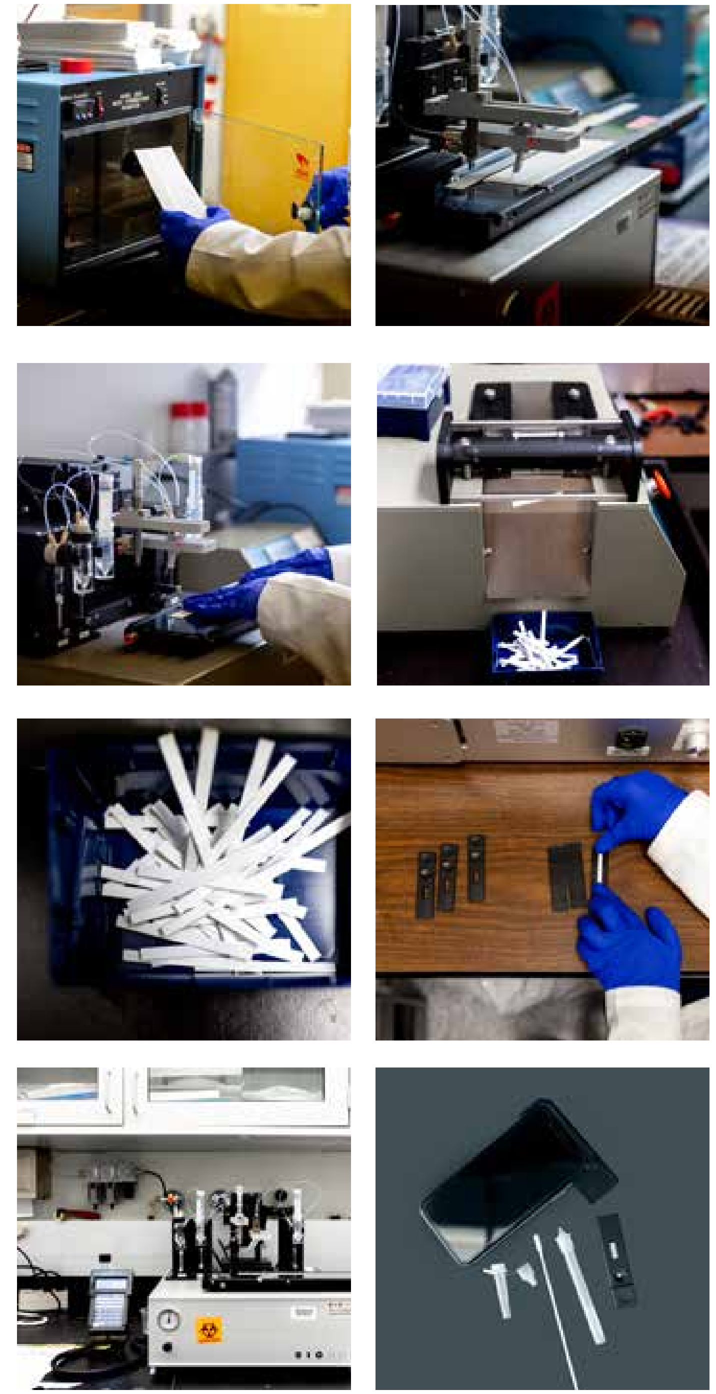
After all, he said, you can buy them inexpensively and they allow people – at home, with no medical training – to measure human chorionic gonadotropin (the pregnancy hormone) with high reliability, at parts-per-billion concentrations.

Willson believed that he and his group of doctoral students could go even farther, creating a test with glowing nanoparticles rather than one that just changes color. The glowing phosphor would make the particles even more detectable and the test more accurate.

Perhaps it was fated, or at the very least, in the stars.

The next day Willson handed the star to Paterson, who was working on light-based diagnostics at the time. Though his interest was piqued, Paterson said he could never have predicted then where that exchange would take him.

"I never would have imagined that the glow-in-the-dark star would have kicked off a chain of events that included glow-in-the-dark nanoparticles for diagnostics becoming the main focus of my Ph.D., the creation of Luminostics, and ultimately using the technology to launch a rapid test during a global pandemic,” said Paterson. »



SHOWN ABOVE: A BEHIND THE SCENES LOOK AT THE RAPID TESTING TECHNOLOGY.

PHOTOGRAPHS BY BEN CORDA.

cliphealth

LEARN MORE ABOUT CLIP HEALTH (FORMERLY KNOWN AS LUMINOSTICS) AT:
www.cliphealth.com

The star that sparked thousands of hours of work

Late nights and early mornings - lots of work came next to make the idea of the original star usable in diagnostics. The scientists had to convert big chunks to particles in the hundreds of nanometers size range to be of use in a lateral flow test stick format. They had to make the particles stable in water and then modify the surface of the particles to attach antibodies or other molecules that allow the particles to bind to the target it is trying to detect.

A year later the team ran a successful lateral flow test with the phosphors. For the next few years, while still in the Willson lab working on technology, Paterson and Raja attended a BioVentures class designed for doctoral students in areas related to life sciences and who are interested in starting a company. Paterson described the class as being like a boot camp.

“Every week we'd present a new iteration of our pitch to a panel of seasoned life science executives who would tear the pitch to pieces," said Paterson. "We'd incorporate the feedback, make our pitch better, and present again the following week.” In 2016, the team got accepted into the famous Y Combinator, which provides seed funding for startups (including Airbnb, DoorDash and Stripe), and moved to Silicon Valley.

The sky - and stars - are the limit

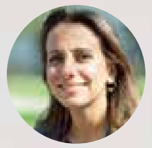
Clip Health is rapidly developing a next generation, highly affordable hardware system to reach the mass over-the-counter market at scale.

Willson still has that star he took off his daughter’s ceiling and handed to Paterson, which led to the Luminostics technology. It lives in a frame now and Willson has promised to give it to Paterson and Raja for the lobby of Building Six – when their company is big enough to have six buildings.

That’s a professor, always raising the bar.

Using Sweat on Skin to Infer Brain Stress

BY LAURIE FICKMAN



The old adage "never let them see you sweat" doesn't apply in the electrical and computer engineering lab of **Rose Faghih**, Assistant Professor of Electrical and Computer Engineering in the University of Houston Cullen College of Engineering. In fact, Faghih seeks sweat, the kind that beads on your upper lip when you're nervous - skin conductance response (SCR) as the change in sweat activity is scientifically called. It is through that measure that Faghih is reporting the ability to monitor stress and even help lower it.

To collect and study these physiological signals of stress, Faghih's research team has built a new closed-loop technology by placing two electrodes on smartwatch-type wearables. Once the signal for stress is detected, a reminder is sent through the smartwatch, for example, to listen to relaxing music to calm down. Thus, the loop is closed as the detected stress launches the subtle suggestion.

"This study is one of the very first steps toward the ultimate goal of monitoring brain responses using wearable devices and closing the loop to keep a person's stress state within a pleasant range," reports Faghih in the journal *IEEE Xplore*.

Electrodermal activity (i.e., the electrical conductivity of the skin) carries important information about the brain's cognitive stress. Faghih uses signal processing techniques to track the hidden stress state and design an appropriate control algorithm for regulating the stress state and closing the loop. The results of the research illustrate the efficiency of the proposed approach and validate its feasibility of being implemented in real life.

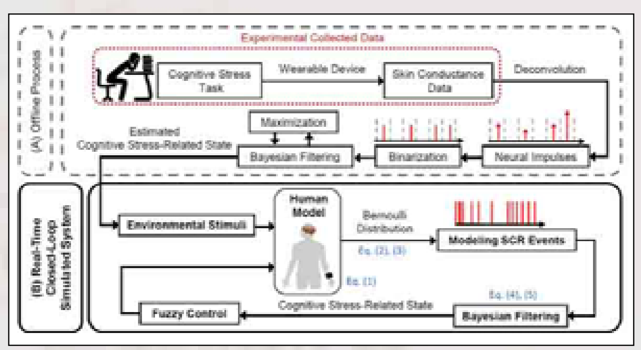
"To the best of our knowledge, this research is one of the very first to relate the cognitive stress state to the changes in SCR events and design the control mechanism to close the loop in a real-time simulation system," said UH doctoral student and lead study author Fekri Azgomi, who accomplished the task of closed-loop cognitive stress regulation in a simulation study based on experimental data.

Due to the increased ubiquity of wearable devices capable of measuring cognitive stress-related variables, the proposed architecture is an initial step toward treating cognitive disorders using non-invasive brain state decoding.

"The final results verify that the proposed architecture has great potential to be implemented in a wrist-worn wearable device and used in daily life," said Faghih.

Stress is a worldwide issue that can result in catastrophic health and financial complications. A recent Gallup poll found that more than one in three adults (35 percent) worldwide said they experienced stress during "a lot of the day yesterday."

PICTURED: EXAMPLES OF THE NON-INVASIVE SMART WATCH [LEFT] AND HEADBAND [RIGHT] TECHNOLOGY THAT CAN NOW MONITOR SWEAT LEVELS AND VITAL SIGNS.



PICTURED: THE DASHED BOX IMPLIES THE OFFLINE PROCESS (A) AND THE SOLID BOX DEPICTS THE REAL-TIME CLOSED-LOOP SYSTEM (B). THE HUMAN MODEL SIMULATES SKIN CONDUCTANCE RESPONSE (SCR) EVENTS. USING THE BAYESIAN FILTERING APPROACH, IT ESTIMATES THE COGNITIVE STRESS-RELATED STATE IN REAL-TIME. THE FUZZY CONTROLLER DERIVES THE APPROPRIATE CONTROL ACTION TO REGULATE THE STRESS STATE IN A CLOSED-LOOP MANNER.

IMAGE FROM IEEEEXPLORE.COM

Read Journal Publication Online:
Closed-Loop Cognitive Stress Regulation Using Fuzzy Control in Wearable-Machine Interface Architectures

IEEE XPLORE:
https://ieeexplore.ieee.org/abstract/document/9492148

PICTURED:
DOCTORAL STUDENT HAMID FEKRI AZGOMI DEMONSTRATES WEARABLE DEVICES USED IN COMPUTATIONAL MEDICINE LAB RESEARCH.

Neural Hand Networking

BY STEPHEN GREENWELL

Research grant funded by the National Science Foundation

Simple, everyday activities that people seldom put thought into – opening a door, cradling an egg, picking up a coffee cup – actually rely on complex interactions between your brain and the nerves of your hand and fingers, all of which are difficult to account for when it comes to creating prosthetic or programming AIs.

It's a challenge that **Nuri Firat Ince**, an associate professor in the Biomedical Engineering Department at the Cullen College of Engineering, is tackling in his research. One of his recent proposals, "Characterization and Decoding of Cortical Oscillatory Dynamics of Complex Hand Function," was approved for a National Science Foundation grant. »

"In our daily life, grasping and holding an object, such as a hammer or an egg, with our hands is something that we do frequently and dexterously. These tasks require different levels of steady grasp force and exert different somatosensory sensations on our fingers and palm," Ince said. "It is crucial to understand how brain controls sustained grasp and process sensory input in order to develop a closed-loop brain machine interface that can replicate natural hand function."

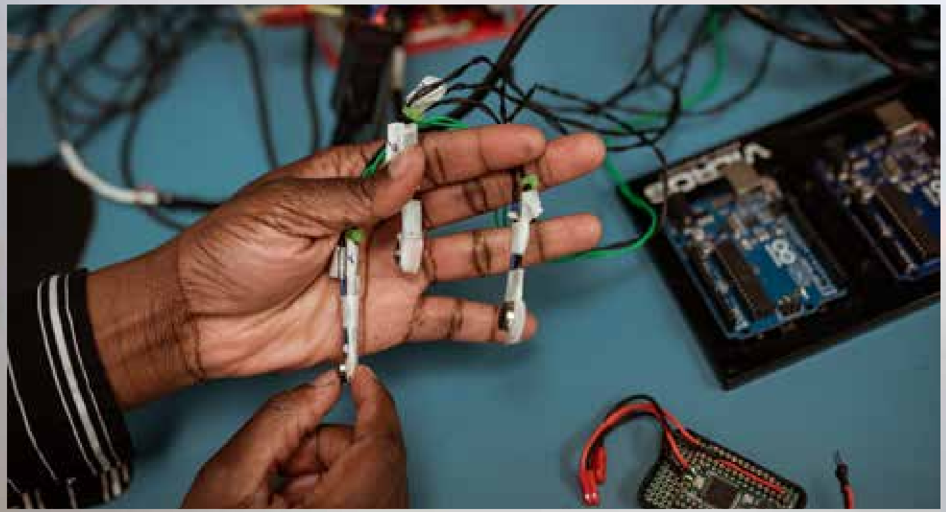
He added, "In this proposal, we investigate brain oscillations recorded from motor and somatosensory cortex of human subjects. The outcome of this project will provide essential bases for advancing Neuroengineering and Brain-Inspired Concepts and Designs, and contributing to the development of next generation hand neuroprosthetics."

Research on the $983,513 project started in September 2021, with an estimated end date of August 2025. The Cullen College of Engineering portion of the grant is about $709,000. Ince's co-PIs on the project are Sujit Prabhu, a professor in the Department of Neurosurgery at the UT MD Anderson Cancer Center (MDACC), and Giuseppe Pellizzer, Ph.D., an associate professor in the Department of Neuroscience at the University of Minnesota.

Ince, Prabhu and Pellizzer have been collaborating together for the past six years and co-authored several peer reviewed articles on the functional use of high-density ECoG for brain machine interfaces and intraoperative brain mapping using machine learning. All three are authors on "Power Modulations of ECoG Alpha/Beta and Gamma Bands Correlate With Time-Derivative of Force During Hand Grasp," a paper in *Frontiers in Neuroscience* that included the preliminary data for the NSF proposal.

SHOWN IN PICTURE: NURI INCE CONDUCTING RESEARCH.

Within the NSF, the project is funded by Integrative Strategies for Understanding Neural and Cognitive Systems (NCS), a multidisciplinary program jointly supported by the Directorates for Biology (BIO), Computer and Information Science and Engineering (CISE), Education and Human Resources (EHR), Engineering (ENG), and Social, Behavioral, and Economic Sciences (SBE).



PICTURED: PRISCELLA ASMAN TESTS A DEVICE USED TO MEASURE FORCE INPUTS FROM FINGERS.

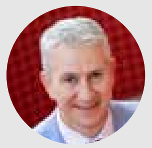
Ince also highlighted the work done by Dr. Sudhakar Tummala, an electrophysiologist at MDACC. Ince and Tummala have frequently collaborated on research work together.

Ince's former doctoral student, **Tianxiao Jiang**, and current Ph.D. student **Priscella Asman** served as the leading authors for the prior paper and contributed significantly to the success of the latest NSF grant as a result. Jiang graduated in 2017, and now works as a member of the technical staff for Cerebras Systems, a Silicon Valley company that builds computer systems for AI and deep learning programs.

Read NSF Grant Online:
Award Abstract #2124705
Characterization and Decoding of Cortical Oscillatory Dynamics of Complex Hand Function

NATIONAL SCIENCE FOUNDATION:
www.nsf.gov

BY LAURIE FICKMAN



A biomedical engineer from the Cullen College of Engineering has been awarded $2.8 million by the National Institute of Neurological Disorders and Stroke to improve the control of robotic limbs and provide natural sensory feedback from robotic prostheses to amputees.

Mario Ignacio Romero-Ortega, Cullen Endowed Professor of Biomolecular Engineering, will accomplish this by creating next-generation advanced peripheral nervous system (PNS) interface electrodes.

The peripheral nervous system consists of all neurons that exist outside the brain and spinal cord and connects the central nervous system to the rest of the body. After amputation, peripheral nerves remain active and can be connected to electrodes and used to record the movement intent from the user and provide feedback sensation from it.

"Our study will use an innovative regenerative multi-electrode interface with ultra-small recording sites using our recently developed ultra-thin multielectrode array and incorporate molecular guidance cues to influence the type of sensory neurons at the neural interface," said Romero-Ortega. "This Regenerative Ultramicro Multielectrode Array (RUMA) is designed to discriminate between motor and cutaneous neural interfacing by combining it with molecular guidance to biologically engineer the content of sensory-motor axons at the electrode interface."

With profound consequences, approximately four million amputees globally live with limb loss. Those fortunate enough use the electrically-powered prostheses guided by surface electromyographic signals from intact muscles in the residual limb for movement. But arm amputees often discontinue use due to the lack of sensation from the prosthetic hand, which makes it difficult to operate. Also, current prosthetic devices use electrodes implanted directly into the residual nerve, for sensory feel and prosthetic control. The method has its drawbacks including electrode failure, signal deterioration over time, and eliciting abnormal signals such as "stings or tingles" in users that discourage their use.

In collaboration with Stuart Cogan from University of Texas at Dallas and **Joseph Francis** at UH, this study will demonstrate the benefit of using RUMA for selective recording from motor axons. According to Romero-Ortego, this method will improve the control of robotic prosthetics by stimulating sensory axons selectively to provide a more natural control and sensation from bionic limbs.

"This advancement in peripheral neural interfaces for amputees will reduce the cognitive burden for users of robotic prosthetics and decrease the abnormal sensations associated with electrical stimulation in the PNS," said Romero-Ortega.

Research funded by:
National Institute of Neurological Disorders and Stroke

RAPID CANCER DETECTION and Monitoring

BY LAURIE FICKMAN


PICTURED: WEI-CHUAN SHIH

When it comes to cancer detection, size matters. Traditional diagnostic imaging cannot detect tumors smaller than a certain size, causing missed opportunities for early detection and treatment. Circulating tumor exosomes are especially small cancer biomarkers and easy to miss. These nanovesicles are composed of molecules that reflect the parental cells. But, because they are tiny (~30-150nm in diameter) and complex, the precise detection of exosome-carried biomarkers with molecular specificity is elusive.

Until now, reports **Wei-Chuan Shih**, Ph.D., Professor of Electrical and Computer Engineering at the University of Houston's Cullen College of Engineering, in *IEEE Sensors* journal.

"This work demonstrates, for the first time, that the strong synergy of arrayed radiative coupling and substrate undercut can enable high-performance biosensing in the visible light spectrum where high-quality, low-cost silicon detectors are readily available for point-of-care application," said Shih. "The result is a remarkable sensitivity improvement, with a refractive index sensitivity increase from 207 nm/RIU to 578 nm/RIU."

Technically speaking, Shih has restored the electric field around nanodisks, providing accessibility to an otherwise buried enhanced electric field. Nanodisks are antibody-functionalized artificial nanostructures which help capture exosomes with molecular specificity.

"We report radiatively coupled arrayed gold nanodisks on invisible substrate (AGNIS) as a label-free (no need for fluorescent labels), cost-effective, and high-performance platform for molecularly specific exosome biosensing. The AGNIS substrate has been fabricated by wafer-scale nanosphere lithography without the need for costly lithography," said Shih.

This allows fast screening of the surface proteins of exosomes for diagnostics and biomarker discovery. As an example, Shih has shown that multiple surface antigens (CD9, CD63 & CD81) were more plentiful in cancer-derived exosomes than those from normal cells.

Current exosome profiling relies primarily on DNA sequencing technology, fluorescent techniques such as flow cytometry, or enzyme-linked immunosorbent assay (ELISA), which involves sophisticated sample preparation procedures and requires labeling and amplification, all processes that are labor-intensive and costly. Shih's goal is to amplify the signal by developing the label-free technique.

"By decorating the gold nanodisks surface with different antibodies (e.g., CD9, CD63, and CD81), label-free exosome profiling has shown increased expression of all three surface proteins in cancer-derived exosomes," said Shih. "The sensitivity for detecting exosomes is within 112-600 (exosomes/μL), which would be sufficient in many clinical applications."

Read Journal Publication Online:
Exploring the Synergy of Radiative Coupling and Substrate Undercut in Arrayed Gold Nanodisks for Economical, Ultra-Sensitive Label-Free Biosensing

IEEE SENSORS JOURNAL:
https://ieeexplore.ieee.org/document/9530656

Fighting Against Corrosion in Bridges

BY STEPHEN GREENWELL

Research funded by:
NCHRP NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

PICTURED:
ABDELDJELIL "DJ" BELARBI

PICTURED ABOVE: AN EXAMPLE OF THE VARIOUS MATERIALS AND STRANDS THAT CAN BE USED IN THE CONSTRUCTION OF REBAR AND REINFORCEMENTS FOR CONCRETE USED IN BRIDGES.

A professor at the University of Houston's Cullen College of Engineering received a $600,000 award from the National Cooperative Highway Research Program to continue his research into bridge materials that would resist corrosion.

Abdeldjelil "DJ" Belarbi, Ph.D., Hugh Roy and Lillie Cranz Cullen Distinguished Professor of Civil and Environmental Engineering, received approval for his proposal, "Stainless Steel Strands for Prestressed Concrete Bridge Elements," in July 2020. NCHRP is part of the National Academies of Sciences, Engineering and Medicine.

Although his current research under the awarded grant is fairly new, Belarbi noted that it continues his work from previous research, which has now progressed from "science to direct implementation." Additionally, it is projected to run through March 2023.

Assisting Belarbi on the project is postdoctoral fellow **Damian Stefaniuk** and Ph.D. student **Khalad Elsayed**, with postdoctoral fellow Lara Zerbe having assisted in the planning stages before taking an engineering position at Thorton Tomasetti.

Belarbi described how most bridges have been made – but also, how this leads to problems with maintenance efforts and associated costs.

"The majority of the structural and transportation systems that we design and build are made of steel and concrete," he said. "Steel in prestressed concrete structures in most cases, serves as reinforcement to concrete and is embedded in concrete. With time, the steel may undergo corrosion that requires regular monitoring and maintenance and that will ultimately shorten the life of the structure. With its costly consequence of corrosion, steel is not viewed as a cost-effective option in an aggressive environment."

Belarbi compared corrosion in civil engineering to cancer in the field of medicine. Mitigation and treatment would have a cascading effect.

"Think of corrosion in infrastructure as cancer in humans," he said. "Eliminating cancer will be a breakthrough in science and the health system. We are taking the same approach for the infrastructure. I do research in structural systems, but I am targeting bridges and other types of structures that suffer from corrosion."

Because of this, Belarbi said he has been motivated in recent years to study alternatives to design and build what will provide a corrosion-free civil infrastructure.

"This would prolong the life of our infrastructure, making it more durable and resilient, and reduce the cost over the life cycle of our structures," he said. "It is similar to improving medicine, life expectancy of humans while reducing the cost of healthcare. Stainless steel strands for prestressing for bridges is another advanced material that I am investigating as a continuation of my previous work using carbon fiber-reinforced polymers strands."

The previous work that Belarbi has done in the field has built on itself, and he said that they are now investigating practical applications and new engineering methods.

"As part of this large effort, we have codified our research and developed design specifications, guidelines and procedures to enable the bridge engineers to use this new technology, and build more durable and resilient infrastructure," he said. "We have developed so far two design specifications for bridge engineers, and we are now working on two more. By the end of the on-going research and projects, we will provide the engineering community with new design tools using innovative materials."

Belarbi added that the bridges in the United States and worldwide are in need of new and advanced construction materials and engineering methods to fight corrosion.

"There are more than 600,000 bridges in the U.S., and close to half of those are more than 50 years old," he said. "Close to 50,000 bridges are structurally deficient and in poor conditions. Unfortunately, close to 180 million trips are taken on these deficient bridges. As more bridges get older, we'll see more deteriorated bridges and higher costs to keep our infrastructure healthy. One of my goals is to reverse the trend and build future bridges that last longer, at least double the current life expectancy from 60 years to at least 120 to 150 years. In addition to making our bridge last longer, this will require less monitoring and maintenance, and therefore, lower the cost overall."

Read Original Proposal Online:
Stainless Steel Strands for
Prestressed Concrete Bridge Elements

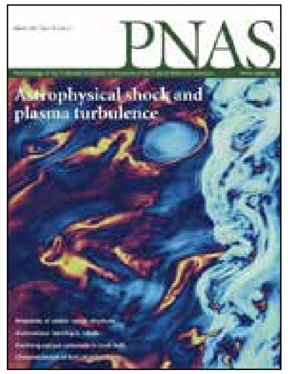
NATIONAL SCIENCE FOUNDATION:
https://trid.trb.org/View/1628607

The Powerhouse Future is

Flexoelectric

BY NICOLE JOHNSON

PICTURED: KOSAR MOZAFFARI, A GRADUATE STUDENT AT THE UNIVERSITY OF HOUSTON'S CULLEN COLLEGE OF ENGINEERING AND LEAD AUTHOR OF THE FLEXOELECTRICITY PAPER.



Read the Research Paper Online:
Flexoelectricity in soft elastomers and the molecular mechanisms underpinning the design and emergence of giant flexoelectricity

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (PNAS)
www.pnas.org/content/118/21/e2102477118

What do the following have in common: a self-powered implanted medical device, a soft human-like robot and how we hear sound? The answer as to why these disparate technologies and biological phenomena are similar lies in how the materials they are made of can significantly change in size and shape – or deform – like a rubber band, when an electrical signal is sent.

Researchers have demonstrated "giant flexoelectricity" in soft elastomers that could improve robot movement range and make self-powered pacemakers a real possibility. In a paper published last May in the *Proceedings of the National Academy of Sciences*, scientists from the University of Houston and the Air Force Research Laboratory explain how to engineer ostensibly ordinary substances like silicone rubber into an electric powerhouse.

Some materials in nature can perform this function, acting as an energy converter that deforms when an electrical signal is sent through or supplies electricity when manipulated. This is called piezoelectricity and is useful in creating sensors and laser electronics, among several other end uses. However, these naturally occurring materials are rare and consist of stiff crystalline structures that are often toxic, three distinct drawbacks for human applications.

Man-made polymers offer steps toward alleviating these pain points by eliminating material scarcity and creating soft polymers capable of bending and stretching, known as soft elastomers, but previously those soft elastomers lacked significant piezoelectric attributes.

Kosar Mozaffari, a graduate student at the University of Houston's Cullen College of Engineering and lead author of the paper, **Pradeep Sharma** (pictured above), M.D. Anderson Chair Professor & Department Chair of Mechanical Engineering at the University of Houston, and Matthew Grasinger, LUCI Postdoctoral Fellow at the Air Force Research Laboratory, offer a solution.

"This theory engineers a connection between electricity and mechanical motion in soft rubber-like materials," Sharma said. "While some polymers are weakly piezoelectric, there are no really soft rubber like materials that are piezoelectric."

The term for these multifunctional soft elastomers with increased capability is "giant flexoelectricity." In other words, these scientists demonstrate how to boost flexoelectric performance in soft materials.

"Flexoelectricity in most soft rubber materials is quite weak," Mozaffari said, "but by rearranging the chains in unit cells on a molecular level, our theory shows that soft elastomers can attain a greater flexoelectricity of nearly 104 times the conventional amount."

The potential uses are profound. Human-like robots made with soft-elastomers that contain increased flexoelectric properties would be capable of a greater range of motion to perform physical tasks. Pacemakers implanted in human hearts and utilizing lithium batteries could instead be self-powered as natural movement generates electrical power.

The mechanics of soft elastomers generating and being manipulated by electrical signals replicates a similar function observed in human ears. Sounds hit the ear drum that then vibrates and send electrical signals to the brain, which interprets them. In this case, movement can manipulate soft elastomers and generate electricity to power a device on its own. This process of self-generating power by movement appears as a step up from a typical battery.

The advantages of this new theory stretch beyond just that. In the process of research, the capability to design a unit cell that is stretch invariant – or remains unchanged under unwanted stretch transformation – emerged.

"For some applications we require certain amounts of electricity to be generated regardless of the stretch deformation, whereas with other applications we desire as much electricity generation as possible, and we have designed for both of these cases." Mozaffari said. "In our research, we discovered a method to make one unit cell stretch invariant. The tunable nature of the flexoelectric direction can be useful for producing soft robots and soft sensors."

In other words, the amount of electric power generated from various physical stimulation can be controlled so that devices perform directed actions. This can moderate the functioning of electronic devices that are self-sufficient.

Next steps include testing this theory in a lab using potential applications. Additionally, efforts to improve on the flexoelectric effect in soft elastomers will be the focus of further study.

AMPing Up Delivery of Superconducting Wires

BY LAURIE FICKMAN

Superconductivity, where electrical resistance vanishes, remains a technology that both powers science and mystifies scientists. It charges MRI scanners, enables new drug discovery through advanced spectroscopy machines, and is used to create the kind of powerful magnets that help smash atoms as scientists work to uncover how the universe is made and how it works.

In all of these and more disparate uses, the next-generation machines could have one common connection: the kind of unique wire, or superconducting material, necessary to enable the development of ultra-high field magnets that need hardly any power for sustained operation. It's a wire that nobody else makes other than **Venkat Selvamanickam**, M.D. Anderson Chair Professor of Mechanical Engineering at the University of Houston Cullen College of Engineering and director of the Advanced Manufacturing Institute.

His high-temperature superconducting wires can carry 300 to 600 times the current carrying capacity of copper wires of the same size.

His company AMPeers, short for Advanced Materials Pioneers, in partnership with UH, has received three grants totaling $1.6 million (two from the Department of Energy and one from the U.S. Navy) to accelerate utilization of the technology. These grants are from the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, which encourage domestic small businesses to engage in federal research with the potential for commercialization.

"AMPeers is scaling up UH-developed superconductor technologies to manufacturing and commercialization and these awards will help reach our goals faster," said Selvamanickam.

The superconductor wires, called Symmetric Tape Round, or STAR, are the only superconductor wires available with a diameter of just 1–2 mm, bend radius capability of 15 mm, and high current-carrying capacity over a wide range of temperatures from 4.2 Kelvin to 77 Kelvin. Other round superconductor wires cannot be bent to such small diameters or cannot be used at temperatures much higher than 4.2 Kelvin. A broader operating temperature range makes many more uses feasible.

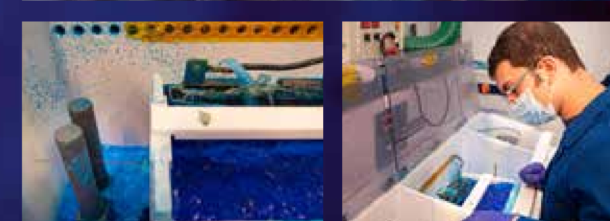
The enabling technology of STAR wires is a unique superconductor symmetric tape technology developed by AMPeers and UH. The tape is called RE-Ba-Cu-O (REBCO, RE= rare earth) superconductor film. Symmetric REBCO tapes can be bent to 0.8 mm in diameter while retaining greater than 95 percent of their current-carrying capacity, whereas standard REBCO tapes degrade even below 6 mm bend diameter. This superior bendability enables powerful, yet compact magnets.

"In our phase-one work, we reduced the cost of the wire. Now, in phase two, with $1.15 million from the DOE, we will work to scale up our manufacturing of the low-cost wire and also make the wires longer. The second grant, $200,000 also from the DOE, will be used to develop multi-strand cables with these wires," said Selvamanickam.

For the Navy, which uses the REBCO wires to enable high power density that addresses the needs of their advanced power systems, Selvamanickam and company will work out the kinks, or hot spots that can occur when such high current densities are sustained. Elimination of such hot spots is important to avoid catastrophic failure of the superconducting device.

"While long tapes with uniform current-carrying capability are highly desirable to avoid such hot spots, methods to manage local defects in REBCO tapes have to be developed since that is a lot more practical," he said.

The three grants from the DOE's High Energy Physics office and the Navy brings to six the number AMPeers has received from them in the past five years since the startup began to scale up UH-developed technologies to manufacturing and commercialization.

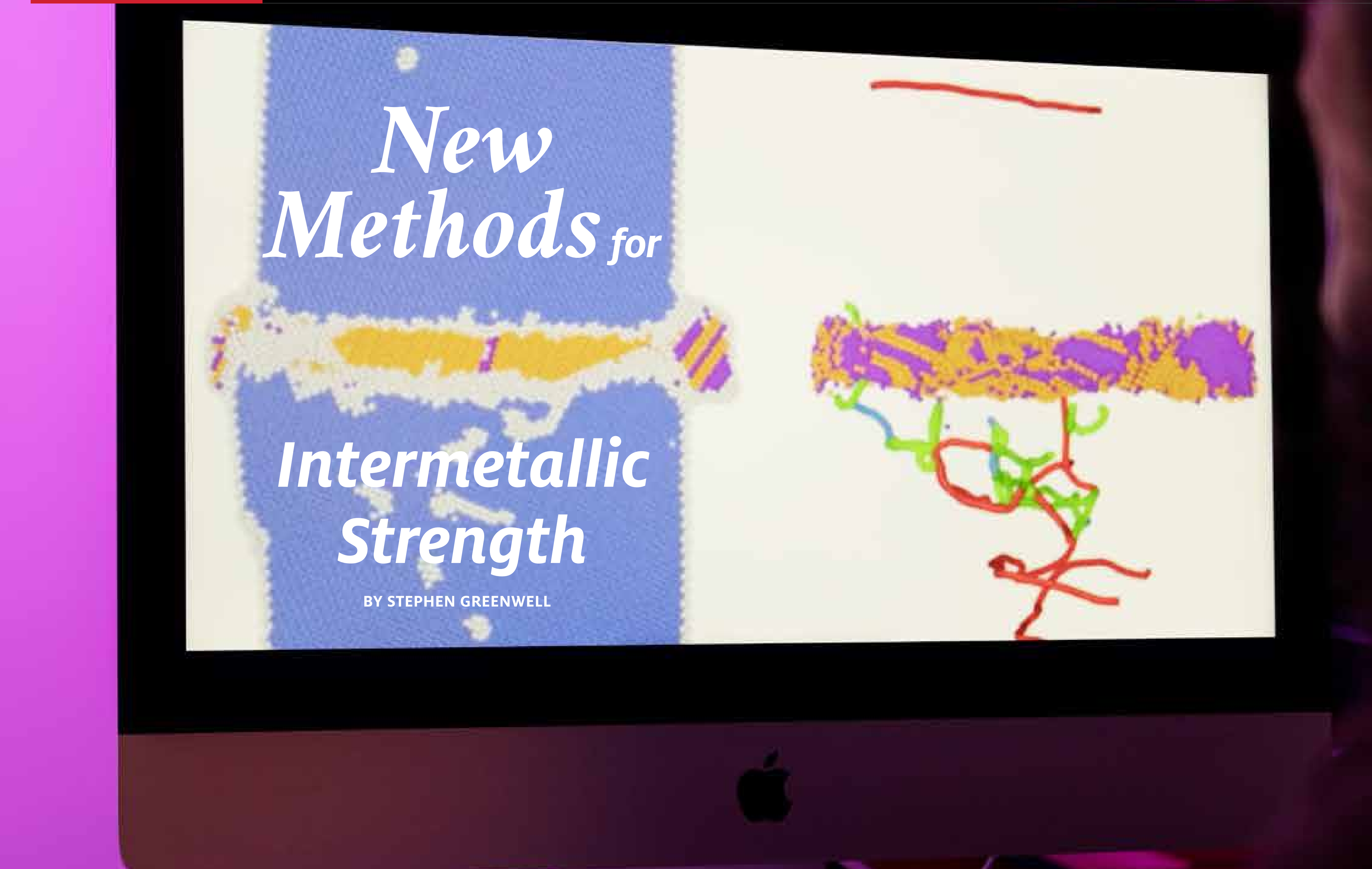


PICTURED ABOVE: DOCTORAL STUDENTS PUT STAR SUPERCONDUCTOR WIRES THROUGH STRESS TESTS.

AMPeers

LEARN MORE ABOUT THE STARTUP AMPEERS LLC:
https://www.ampeers-llc.com

Research funded by:
AMERICA'S NAVY
U.S. DEPARTMENT OF ENERGY



New Methods for Intermetallic Strength

BY STEPHEN GREENWELL

PICTURED: KULKARNI WORKING IN HER LAB. HER GROUP USES COMPUTATIONAL METHODS AND MODELS TO ANSWER FUNDAMENTAL MATERIAL SCIENCES QUESTIONS, AS WELL AS TO DISCOVER NEW NOVEL MATERIALS.

Nobody would want to drive a car made of a very strong material that shatters in a collision, so the design of materials with high strength as well as high ductility – or less brittleness – has been the holy grail of materials science since the beginning of mankind. It was important for survival then, between making tools, weapons and eventually machines, and it is just as relevant now when we think of next-generation airplanes, turbines, spacecraft and nuclear power systems.

Because of this, the quest for ultra-high strength materials with ductility is still an active area of research. For example, research over the past few decades generated a lot of excitement about the discovery of intermetallics, a special class of metallic alloys formed from two metals and having their own crystalline order. Although they have great mechanical properties such as high strength, they are inherently brittle, which has severely dampened the enthusiasm surrounding intermetallics.

In a paper published recently in *Science Advances*, two Cullen College of Engineering researchers – **Dajla Neffati**, Ph.D., a recent graduate, and **Yashashree Kulkarni**, Ph.D., Bill Cook Professor of Mechanical Engineering – offer a novel solution with their collaborators at Purdue University.

The group shows that intermetallics can exhibit ultra-high strength as well as improved ductility when they are designed with grains (regions with different crystalline orientation) only a few hundred nanometers in size separated by thick grain boundaries (boundaries between adjacent grains with different orientations).

In this study, Xinghang Zhang, Ph.D., and his group at Purdue University, synthesized nanocrystalline CoAl, an intermetallic compound made of Cobalt and Aluminum with nano-scale grains, which had thickened grain boundaries as Co atoms segregated to these boundaries between the grains. Their nanopillar compression tests together with atomistic simulations performed by Neffati, led to a startling revelation. These novel grain boundaries imparted exceptional strength by arresting the movement of defects generated during deformation and also acted as a sink to accommodate the defects thereby leading to enhanced ductility.

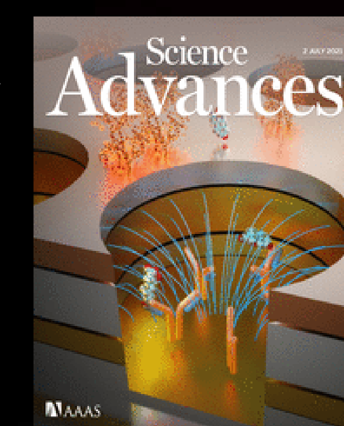
"Whenever a material deforms or ultimately fails, it all starts at the scale of atoms, where defects are formed breaking the crystalline order," Neffati said. "In this study, we show experimentally and computationally, how specially designed 'thick' interfaces can provide an amazing solution to the strength-ductility trade-off."

Kulkarni collaborated with Zhang briefly during her post-doctoral stay at University of California at San Diego. After she joined the faculty at UH, they continued discussing their many research intersections, which eventually led to an NSF grant and this collaboration.

Kulkarni recalled 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."

The overarching focus of Kulkarni's work is to understand the atomistic underpinnings of how defects, such as surfaces and interfaces, play a vital role in determining the physical properties of crystalline materials and how simulations can suggest routes for experimentalists to manipulate materials at the scale of atoms to design new materials with unprecedented properties.

"In my group, we will continue to use and develop computational methods to seek answers to fundamental materials science questions and enable the discovery of novel materials including nanostructured metals, intermetallics and high entropy alloys, to name a few exciting avenues," Kulkarni said.



Read Research Paper Online:
High-strength nanocrystalline intermetallics with room temperature deformability enabled by nanometer thick grain boundaries

SCIENCE ADVANCES:
www.science.org/doi/10.1126/sciadv.abc8288

IMPROVING Neural Energy Networks

BY STEPHEN GREENWELL

A Cullen College of Engineering professor has received just shy of $500,000 from the National Science Foundation to study how to make the decision-making networks in devices like self-driving cars and medical imaging devices more efficient.

PICTURED: XIN FU

Xin Fu, Ph.D., an associate professor of Electrical and Computer Engineering, received $499,999 in funding for her grant proposal, "Enabling On-Device Bayesian Neural Network Training via An Integrated Architecture-System Approach."

Fu described her research as looking at ways to improve the energy needs of products that rely on machine learning, which is one of her research interests.

"This project targets energy-efficiently training Bayesian Neural Networks (BNNs) locally on mobile devices," she said. "BNNs are generally used in real-world AI applications that request reliable and robust decision-making, like autonomous driving and medical image diagnosis. In this project, we will explore hardware-software co-designed methods to significantly reduce the computation workloads and memory accesses required by BNN training. This will enable the BNN training on the resource-constrained mobile devices."

Fu stressed that finding more energy-efficient ways to train BNNs was vital for improving their reliability and safety.

"Deep Neural Networks have recently achieved amazing success in numerous AI applications. However, the neural network models can become unreliable due to the uncertainty in data, giving a false judgment and incurring a disaster," she said. "To address this issue, BNNs have been increasingly applied in a wide range of real-world AI applications, which demand reliable and robust decisions.

Training a BNN model is very time and energy consuming, so this motivates us to explore the energy-efficient training for BNN models. Enabling the BNN training on mobile devices, and furthermore, at the edges, can greatly help the AI technologies become more adaptive and intelligent to fast-changing environments, and benefit every day living and working."

Read NSF Grant Overview Online:
Award Abstract #2130688
Enabling On-Device Bayesian Neural Network Training via An Integrated Architecture-System Approach.
NATIONAL SCIENCE FOUNDATION:
www.nsf.gov

NSF

Research grant funded by the National Science Foundation

FROM LEGOS to Self-assembling Blocks

BY STEPHEN GREENWELL

As he puts it, **Aaron T. Becker**, Ph.D., an associate professor in the Electrical and Computer Engineering Department at the Cullen College of Engineering, is interested in finding "a new type of small-scale manufacturing method, with the precision of modules, the reusability of LEGO blocks, and the self-assembly of DNA."

Now, Becker has received a $299,963 grant from the National Science Foundation for his proposal, "Magnetically-Controlled Modules with Reconfigurable Self-Assembly and Disassembly." It is research that has grown from his initial CAREER award, and from collaborations with colleagues in Dallas and Germany.

Becker said his research is ultimately about using self-assembly and magnets to improve things like health outcomes. He used an example of self-assembly in a surgery setting.

"Often, it is hard to get a robot inside places like a human body, because you have to cut a hole big enough for the robot to reach inside," he said. "However, living things can be built inside human bodies because they use self-assembly – consider the wonder of a developing baby inside the womb, where the baby's body is executing programs stored in her DNA. However, DNA is tiny, and making something in the centimeter scale takes months of constant effort."

Becker's goal is to create small, magnetic building blocks, which can then be used to build structures and modules that can be assembled and disassembled.

"Like DNA, the magnetic patterns we encode on the sides of the modules control how they can connect and what shapes we can build," he said. "We use magnets because we can push, twist and pull on them by using larger, computer-controlled magnets that are outside the body. This allows us to put the complicated, power-hungry parts – the magnets, magnetic controller and motion planner – outside the body and use relatively simple cubes with different patterns of permanent magnets inside the body."

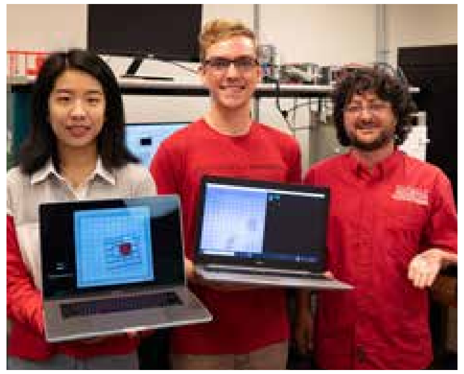
Becker often likes to compare the process to that of playing with LEGO blocks, because it's easy for someone to envision and to understand the appeal of. He compared his love of the building medium to that of his children's love of it now.

"As a kid, I loved LEGO bricks, and today my four boys love LEGO bricks," he said. "However, my wife discovered something interesting – Our boys will happily play with a box of them for a couple of days, but once all the pieces are incorporated into fantastic creations... The boys lose interest and their creations gather dust. Then my wife and I need to sneak into the play room at night and disassemble the pieces. The next morning, after brief mourning, the boys return to building and creating. Learning how to make reusable robot modules is exciting in a similar way."

Becker identified two students that will be helping him with his research.

"**Yitong Lu**, a Ph.D. student, did incredible work on the motion planning and simulation that helped generate this grant," he said. "She is researching better planners and techniques. Undergraduate researcher **Conlan Taylor** is developing image feedback so that we can improve the speed and quality of our assembly."

The research started in January 2021, with an estimated length of two years.



SHOWN ABOVE: YITONG LU, PH.D. STUDENT, CONLAN TAYLOR, UNDERGRADUATE STUDENT, AND JULIEN LECLERC, RESEARCH ASSOCIATE, DEMONSTRATE MAGNETIC MANIPULATION CONTROLS IN ASSOCIATE PROFESSOR AARON BECKER'S LAB.

Read NSF Grant Overview Online:
Award Abstract #2130793
Magnetically-Controlled Modules with Reconfigurable Self-Assembly & Disassembly.
NATIONAL SCIENCE FOUNDATION:
www.nsf.gov

Actuator Discovery *Outperforms Existing Technology*

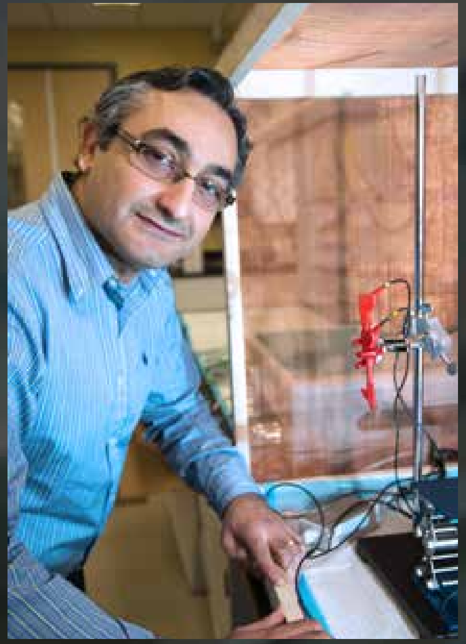
BY SARA STRONG

University of Houston researchers are reporting a breakthrough in the field of materials science and engineering with the development of an electrochemical actuator that uses specialized organic semiconductor nanotubes (OSNTs).

Currently in the early stages of development, the actuator will become a key part of research contributing to the future of robotic, bioelectronic and biomedical science.

"Electrochemical devices that transform electrical energy to mechanical energy have potential use in numerous applications, ranging from soft robotics and micropumps to autofocus microlenses and bioelectronics," said **Mohammad Reza Abidian**, associate professor of biomedical engineering in the UH Cullen College of Engineering. He's the corresponding author of the article "Organic Semiconductor Nanotubes for Electrochemical Devices," published in the journal *Advanced Functional Materials*, which details the discovery.

Significant movement (which scientists define as actuation and measure as deformation strain) and fast response time have been elusive goals, especially for electrochemical actuator devices that operate in liquid. This is because the drag force of a liquid restricts an actuator's motion and limits the ion transportation and accumulation in electrode materials and structures. In Abidian's lab, he and his team refined methods of working around those two stumbling blocks.



"Our organic semiconductor nanotube electrochemical device exhibits high actuation performance with fast ion transport and accumulation and tunable dynamics in liquid and gel-polymer electrolytes. This device demonstrates an excellent performance, including low power consumption/strain, a large deformation, fast response and excellent actuation stability," Abidian said.

This outstanding performance, he explained, stems from the enormous effective surface area of the nanotubular structure. The larger area facilitates the ion transport and accumulation, which results in high electroactivity and durability.

"The low power consumption/strain values for this OSNT actuator, even when it operates in liquid electrolyte, mark a profound improvement over previously reported electrochemical actuators operating in liquid and air," Abidian said. "We evaluated long-term stability. This organic semiconductor nanotube actuator exhibited superior long-term stability compared with previously reported conjugated polymer-based actuators operating in liquid electrolyte."

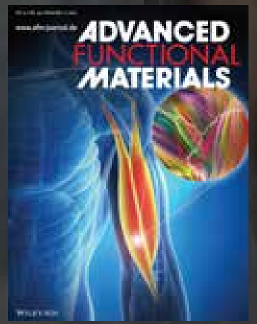
Joining Abidian on the project were **Mohammadjavad Eslamian**, **Fereshtehsadat Mirab**, **Vijay Krishna Raghunathan** and **Sheereen Majd**, all from the Department of Biomedical Engineering at the UH Cullen College of Engineering.

The organic semiconductors used, called conjugated polymers, were discovered in the 1970s by three scientists – Alan J. Heeger, Alan MacDiarmid and Hideki Shirakawa – who won a Nobel prize in 2000 for the discovery and development of conjugated polymers.

For a new type of actuator to outshine the status quo, the end product must prove not only to be highly effective (in this case, in both liquid and gel polymer electrolyte), but also that it can last.

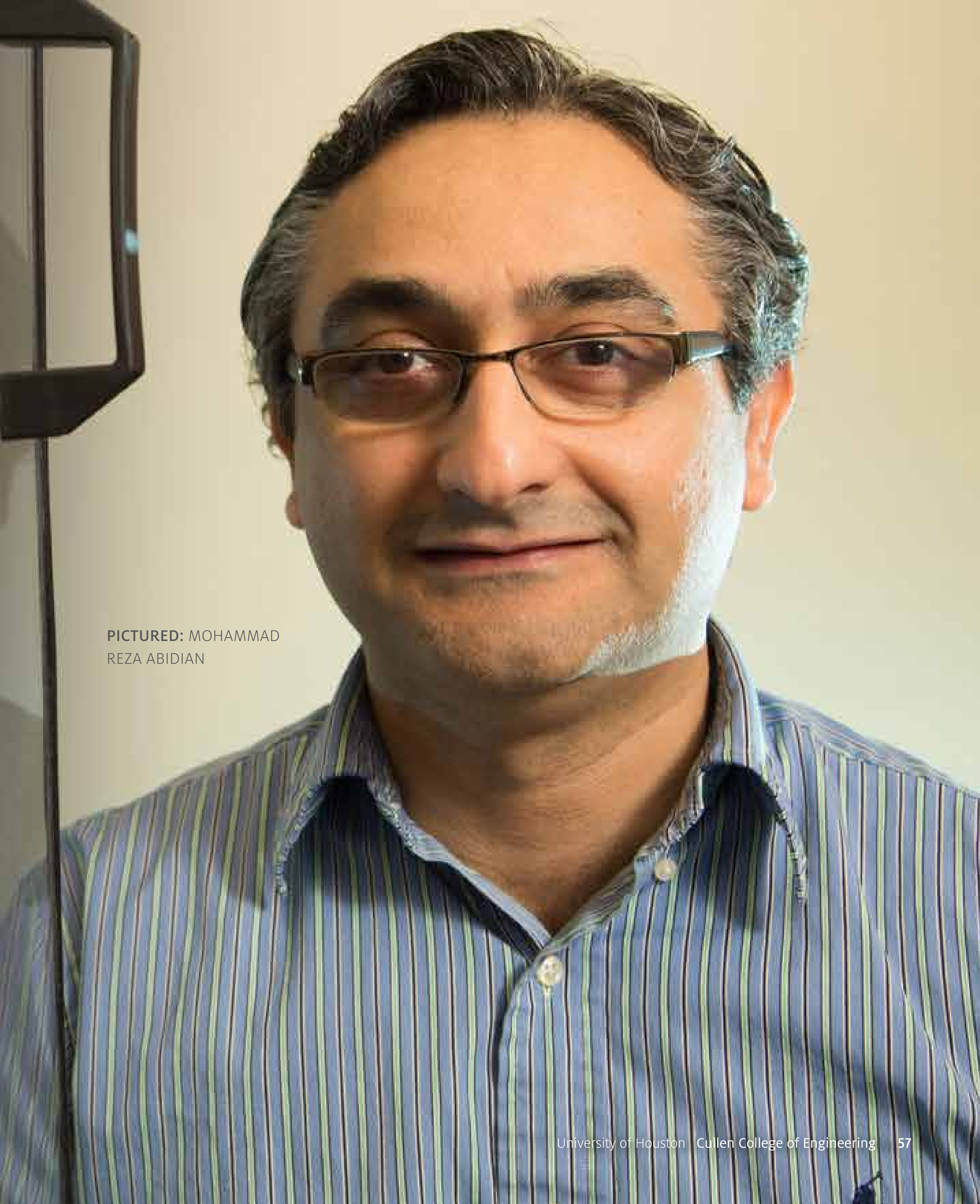
"To demonstrate potential applications, we designed and developed a micron-scale movable neural probe that is based on OSNT microactuators. This microprobe potentially can be implanted in the brain, where neural signal recordings that are adversely affected, by either damaged tissue or displacement of neurons, may be enhanced by adjusting the position of the movable microcantilevers," said Abidian. The next step is animal testing, which will be undertaken soon at Columbia University. Early results are expected by the end of 2021, with longer term tests to follow.

"Considering the achievements so far, we anticipate these new OSNT-based electrochemical devices will help advance the next generation of soft robotics, artificial muscles, bioelectronics and biomedical devices," Abidian said.



Read Research Paper Online:
Organic Semiconductor Nanotubes for Electrochemical Devices

ADVANCED FUNCTIONAL MATERIALS:
https://onlinelibrary.wiley.com doi/ 10.1002/adfm.202105358



PICTURED: MOHAMMAD REZA ABIDIAN

Using the Ancient Art of Kirigami to make an Eyeball-Like Camera

BY LAURIE FICKMAN

PICTURED ABOVE: CUNJIANG YU CONDUCTING RESEARCH IN HIS LAB.

LEARN MORE ABOUT THE YU RESEARCH GROUP AND THEIR LATEST PROJECTS:
https://yu.me.uh.edu

Researchers at the University of Houston recently reported the development of a camera with a curvy, adaptable imaging sensor that could improve image quality in endoscopes, night-vision goggles, artificial compound eyes and fish-eye cameras. Among the researchers was **Cunjiang Yu**, Ph.D., the Bill D. Cook Associate Professor of Mechanical Engineering at the University of Houston.

"Existing curvy imagers are either flexible but not compatible with tunable focal surfaces, or stretchable but with low pixel density and pixel fill factors," reports Yu in *Nature Electronics*. "The new imager with kirigami design has a high pixel fill factor, before stretching, of 78 percent and can retain its optoelectronic performance while being biaxially stretched by 30 percent."

Modern digital camera systems using conventional rigid, flat imaging sensors require complex and bulky lenses to correct optical aberrations. The curvy camera, like a human eyeball, on the other hand, can work with a single lens while correcting aberrations and offering other merits, such as a wide field of view and compact size.

Yu has shown that the curvy and shape-adaptive cameras with high pixel fill factors can be created by transferring an array of ultrathin silicon pixels with a kirigami design onto curvy surfaces using conformal additive stamp (CAS) printing, a manufacturing technology invented in his lab.

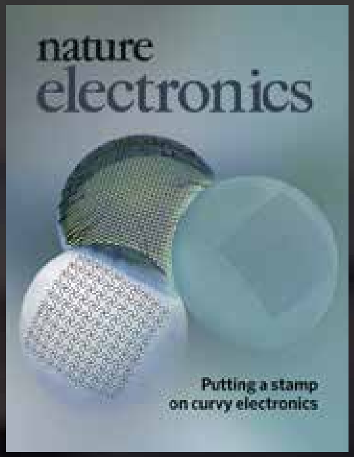
Kirigami is the Japanese art of paper cutting, similar to origami, or paper folding. Yu used the kirigami principal on a thin sheet of imaging sensors, making cuts which allows it to stretch and curve. Compared to other stretchable structure designs, such as thin open-mesh serpentine or island-bridge structures, this new kirigami structure has a much higher fill factor, meaning it retains high pixel density, creating better images.

Not only is the camera curvy, Yu also makes it shape-adaptive, enabling it to capture objects at different distances clearly.

"The new adaptive imager can achieve focused views of objects at different distances by combining a concave-shaped camera printed on a magnetic rubber sheet with a tunable lens. Adaptive optical focus is achieved by tuning both the focal length of the lens and the curvature of the imager, allowing far and near objects to be imaged clearly with low aberration," said Yu, who is also a principal investigator of the Texas Center for Superconductivity at UH.

In CAS printing, an elastomeric, or stretchy, balloon with a sticky coating is inflated. It is then used as a stamping medium, pushing down on prefabricated electronic devices to pick up the electronics and print them onto various curvy surfaces.

In addition to Yu, researchers include first authors **Zhoulyu Rao** and **Yuntao Lu**, both with UH; Zhengwei Li and Jianliang Xiao, University of Colorado, Boulder; Zhenqiang Ma, University of Wisconsin-Madison; and Sim Kyoseung, former member of the Yu group and currently assistant professor at the Ulsan National Institute of Science and Technology in Ulsan, Korea.



Read Research Paper Online:
Curvy, shape-adaptive imagers based on printed optoelectronic pixels with a kirigami design

NATURE ELECTRONICS:
www.nature.com/articles/s41928-021-00600-1

Optimized Drilling Operations

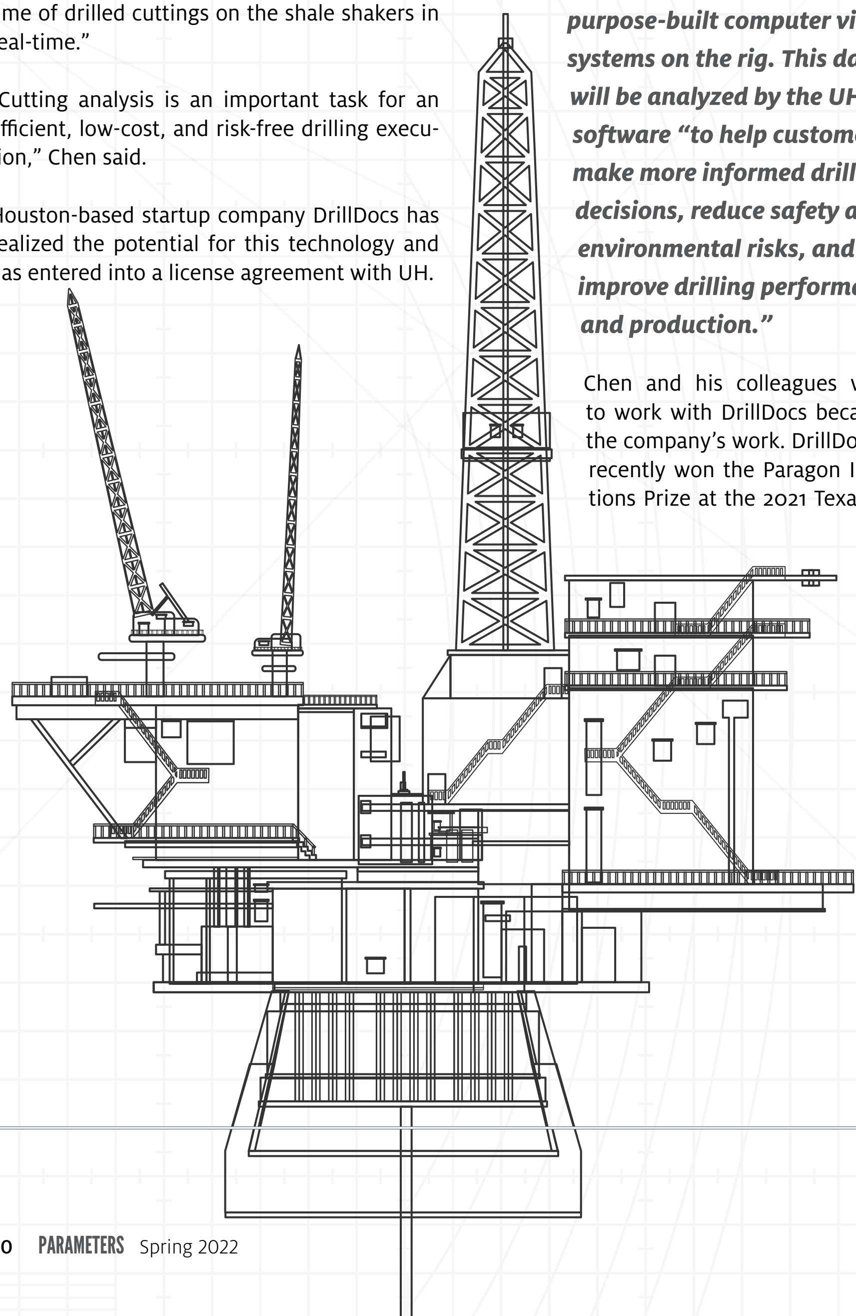
BY STEPHEN GREENWELL

Drilling can be a challenging and expensive operation, and the industry is always looking for ways to innovate and make it more efficient and safer.

Two assistant professors at the University of Houston, **Jiefu Chen**, Ph.D., and **Xuqing (Jason) Wu**, Ph.D., along with **Zhu Han**, PhD, a professor in the Electrical and Computer Engineering Department at the Cullen College of Engineering, created a software that uses "a Deep-Learning model to automatically analyze the monitoring video stream from the onshore and offshore drilling rigs and classify the volume of drilled cuttings on the shale shakers in real-time."

"Cutting analysis is an important task for an efficient, low-cost, and risk-free drilling execution," Chen said.

Houston-based startup company DrillDocs has realized the potential for this technology and has entered into a license agreement with UH.



"Our mission is to provide oil and gas operators with healthier wellbores by preventing stuck pipe and lost-in-hole events while reducing hole cleaning time and hole instability issues," said Calvin Holt, DrillDocs chief executive officer.

DrillDocs, which is backed by an experienced SCADA, drilling engineering and geomechanics team with decades of wellsite experience and millions of feet drilled, will provide key real-time surface data from existing and/or purpose-built computer vision systems on the rig. This data will be analyzed by the UH software "to help customers make more informed drilling decisions, reduce safety and environmental risks, and improve drilling performance and production."

Chen and his colleagues wanted to work with DrillDocs because of the company's work. DrillDocs also recently won the Paragon Innovations Prize at the 2021 Texas A&M New Ventures Competition.

READ MORE ABOUT DRILLDOCS STARTUP AT: *www.drilldocs.com*

The purpose of this solution, which DrillDocs calls the Pulse™ cuttings classification service, is to make it easier to monitor advanced drilling equipment.

"The functionality provided by this software is critical for an integrated control and information system to boost drilling operations, reduce costs and minimize drilling risks," Chen said.

Drill techs usually must repeatedly examine and analyze cutting manually, which could hold-up progress and opens the possibility of human errors.

"As a result, this technology will help build an "intelligent digital infrastructure to improve drilling efficiency, reduce costs, and minimize environmental impacts," Chen said.

"The DrillDocs team is excited to license the Pulse Deep-Learning solution from the University of Houston and look forward to helping reduce costs and risks while creating better, more sustainable wellbores. We plan to continue advancing this important work beyond determining the volume in the shale shaker and move into object classification, detection, and recognition," said Holt.

This technology was featured by the *Journal of Petroleum Technology*, the Society of Petroleum Engineers' flagship magazine.

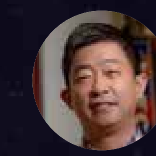
Read Technology Overview Online:
Deep-Learning Techniques Classify Cuttings Volume of Shale Shakers

JOURNAL OF PETROLEUM TECHNOLOGY: *https://jpt.spe.org*

Ramping Up
Wireless Efficiency

BY STEPHEN GREENWELL

Research grant funded by the National Science Foundation



A professor at the University of Houston's Cullen College of Engineering has received a substantial grant from the National Science Foundation to support his research into improving the energy and spectrum efficiency of wireless networks.

Zhu Han, Ph.D., Moores Professor of Electrical and Computer Engineering and a fellow of the IEEE and AAAS, is the author of the research grant proposal, "Nonlinear and Inseparable Radar And Data (NIRAD) Transmission Framework for Pareto Efficient Spectrum Access in Future Wireless Networks." The proposal was accepted and provided $249,999 in funding under the NSF's SWIFT initiative – Spectrum and Wireless Innovation enable by Future Technologies.

According to the abstract written by Han, "The study devises a nonlinear and inseparable radar and data (NIRAD) transmission scheme, in which the functions of communications and radar sensing are integrated in the same waveform and use the same hardware. In contrast to linearly superimposed communications and radar sensing, the NIRAD scheme integrates both functions in an inseparable manner, thus allowing each to fully exploit the resources of the other."

The NIRAD technique is applicable to various practical systems, such as high-definition maps in autonomous driving, space-terrestrial communications and reconfigurable intelligent surfaces, by improving the efficiencies of bandwidth, power and hardware, according to the abstract. The proposed algorithms and protocols will be tested using software simulations and field experiments based on a 5G testbed.

"We are trying to unite wireless communication and sensing together utilizing cross-disciplinary research in future 5G, 6G and beyond networks," Han said. "Typically communication and sensing tasks are separated using different resources, while this proposal proposes to jointly utilize the resource to conduct both jobs."

Han noted that he is still deciding student assignments for the research, which will likely come from his ECE 4117, 5397, 6331, and 6333 classes. The research is estimated to take place during the next three years.

Read NSF Grant Overview Online:
Award Abstract # 2128368
Nonlinear and Inseparable Radar and Data (NIRAD) Transmission Framework for Pareto Efficient Spectrum Access in Future Wireless Networks

NATIONAL SCIENCE FOUNDATION: *www.nsf.gov*

Cutting Down the NOISE in Data

BY STEPHEN GREENWELL

A new paper from **Taewoo Lee**, an assistant professor of the Industrial Engineering Department at the Cullen College of Engineering, examines decision-making preferences using past decision data, using a novel, data-driven inverse optimization method.

"Quantile Inverse Optimization: Improving Stability in Inverse Linear Programming" was featured in the November 2021 edition of *Operations Research*, which is published under the umbrella of the Institute for Operations Research and the Management Sciences (INFORMS).

"Operations Research is read not only by Industrial Engineering professionals, but perhaps more so by researchers in business schools and mathematicians," Lee said. "The journal is on The Financial Times top 50 journal list of management and economics (also known as the FT50) and is considered one of the most prestigious journals in the field of operations research and management science (OR/MS), in which I do research. I hope this work might be of interest to a broader audience beyond IE."

According to Lee, the paper is built on his previous research on inverse optimization and machine learning, using human decision data to infer decision models. His co-author for the paper is Zahed Shahmoradi, a recent UH doctoral graduate in Industrial Engineering, who is joining the University of Texas Health Science Center at Houston as a post-doctoral researcher.

Lee noted that with the recent advances in machine learning, artificial intelligence and growing availability of data, there is more of an opportunity to execute decision-making via data. However, this still usually relies on a human setting parameters and deciding what criteria are and aren't important.

"This study focuses on learning decision-making preferences from past decision data—instead of directly predicting the decisions themselves—and using the learned preferences to derive automated decision models," Lee said. "This is particularly important when the decision data have been generated by rational decision-makers who make decisions through some kind of logical yet autonomous decision-making processes. For example, consider learning the task of 'driving.' When we learn how to drive, instead of naively mimicking the turn-by-turn driving actions of the 'expert,' we consider many important criteria, such as not driving too fast, maintaining a reasonable distance from nearby cars, and so on. As we develop our own driving behaviors, each driver displays a unique trade-off between some of these criteria. Now, if we want to develop a driving decision support tool or even an autonomous vehicle that closely mimics a certain driver's behavior, it is these latent preferences of this driver that we want to learn."

Lee said the challenge here is that human decisions are inherently noisy and inconsistent, which undermines the reliability of the preference-learning process. Their new preference-learning method via inverse optimization accommodates any type of decision data and attempts to prune out outliers and errors in the data. Further, this method can adapt to changes in the decision-maker's preferences over time. "A novel contribution of this work is that it explicitly accounts for data noise and inconsistency, which is a common issue in data involving human decisions. By integrating recent advances in robust machine learning techniques with the inverse optimization framework, this new method can automatically detect noise in the decision data such as errors and outliers while learning a decision model, hence stable under data imperfection."

This paper applies this preference learning method to the diet recommendation application where past diet data from each individual is used to infer a personalized, adaptive diet recommendation system that adheres to the nutritional guidelines while being consistent with the user's preferences. This method is also used for the transportation optimization problem where past decision data is used for predicting how the cost of each transportation route is perceived by each decision-maker, which is then used for predicting their decisions in the future."

Lee noted that the research builds off his prior work in cancer therapy optimization, and also continues an interest he first had while completing his graduate studies.

"While my advisor and I were working on the optimal design of radiation therapy plans for cancer treatment, we noticed that the design process needed to capture complex trade-offs over different criteria such as delivering sufficient radiation to the patient's prostate while sparing the nearby healthy bladder and rectum. To address this, I developed a first inverse optimization technique for cancer therapy that quantifies such complex trade-off preferences from the collaborator cancer center's past successful treatments. Since the success of this method for cancer therapy, I have been expanding this area of research towards many different applications, such as diet recommendation and disease screening."

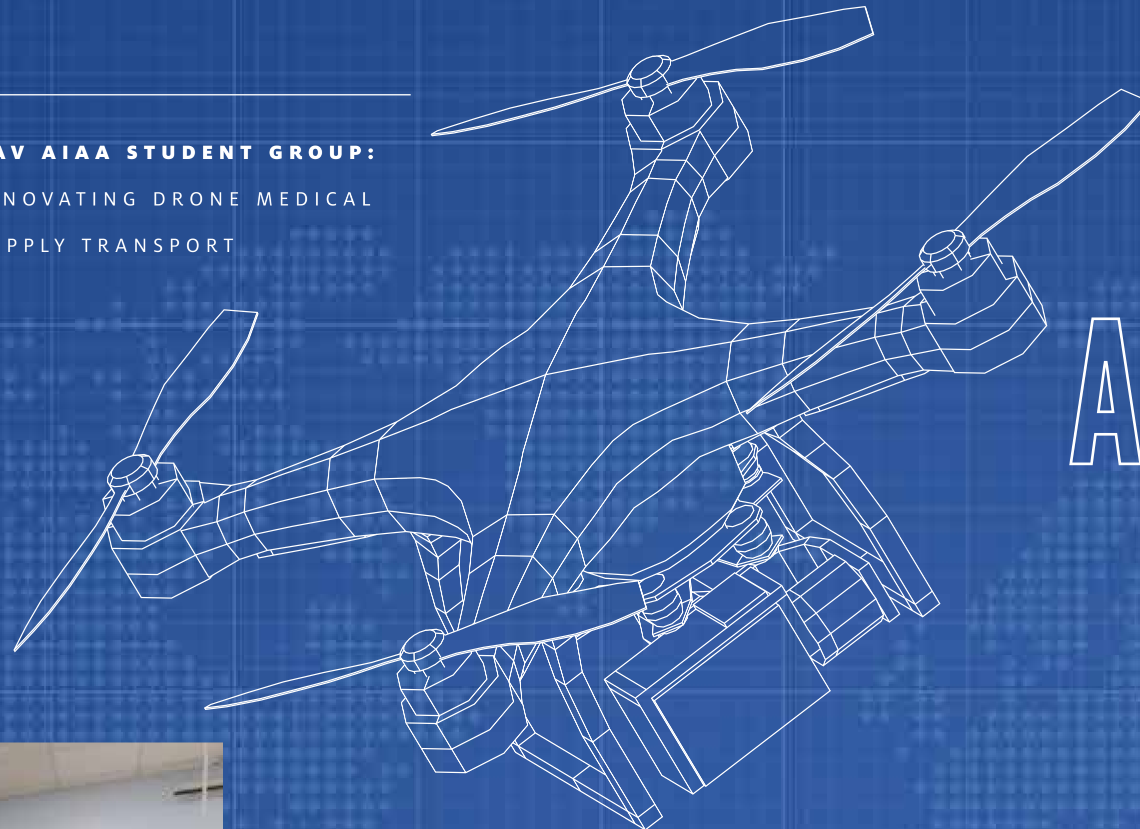
Read Research Paper Online:
Quantile Inverse Optimization: Improving Stability in Inverse Linear Programming

OPERATIONS RESEARCH
https://pubsonline.informs.org/doi/10.1287/opre.2021.2143

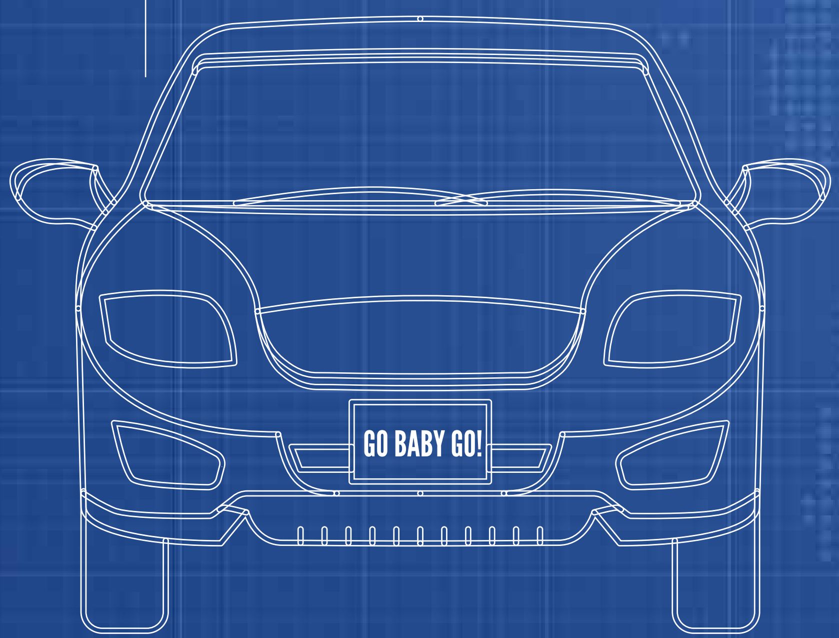
PICTURED: TAEWOO LEE

STUDENT GROUPS AT THE CULLEN COLLEGE OF ENGINEERING

UAV AIAA STUDENT GROUP:
INNOVATING DRONE MEDICAL SUPPLY TRANSPORT



BME CAR STUDENT GROUP:
DISCOVERING WAYS TO HELP SPECIAL NEEDS CHILDREN



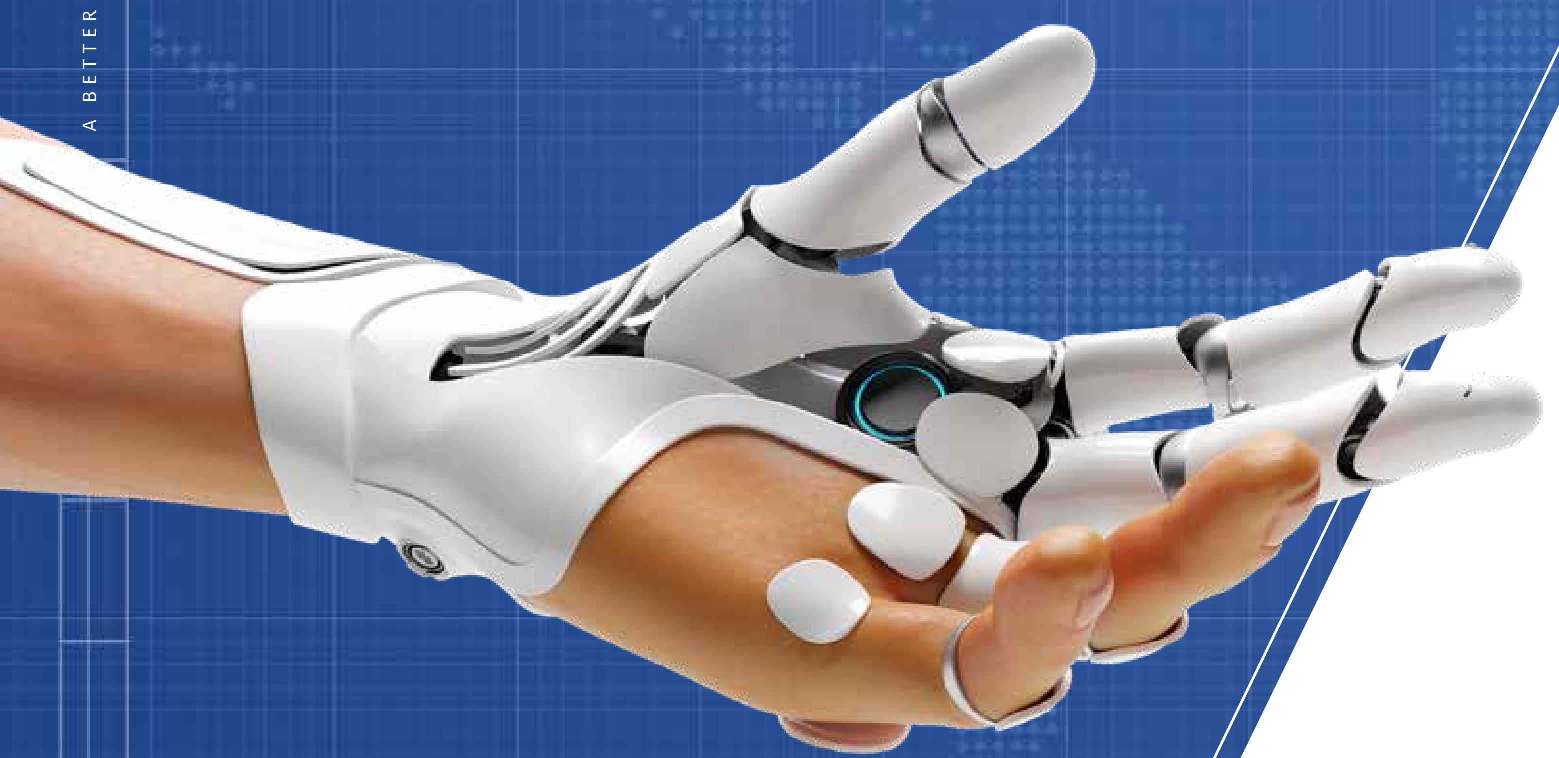
MADE OF STEELE:
IMPROVING REAL-WORLD PROSTHETICS BY BRIDGING DISCIPLINES

A BETTER WORLD BY DESIGN

BY STEPHEN GREENWELL

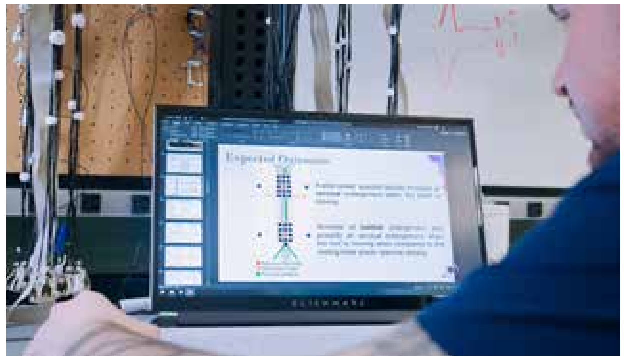
AS THE CULLEN COLLEGE OF ENGINEERING CONTINUES TO ATTRACT STUDENTS WITH THE POWERFUL MINDS NEEDED TO SOLVE THE PROBLEMS OF THE FUTURE, there are already several organizations and individuals that are using innovation and collaboration to tackle the problems of the present. In their own ways, these students are delving into research or developing technology to improve health outcomes, and that show how they're engineered for what's next. »

BRINGING PARTNERSHIPS TO PROSTHETICS



MADE OF STEELE:

IMPROVING REAL-WORLD PROSTHETICS BY BRIDGING DISCIPLINES



PICTURED BELOW:

PORTRAIT OF ALEXANDER STEELE WHILE SERVING IN THE MARINES

From when Alexander Steele joined up with the Marines in 2003, and the time he was discharged in 2007, the cell phone technology being used was relatively the same – the flip phone. The iPhone debuted in June of that year though, and soon, a display-based phone became the dominant standard, and led to other innovations and improvements of the device.

Steele was discharged because of a traumatic brain injury, and he hadn't been planning on leaving the military. The transition back to civilian life was hard, and part of what led him to pursue his degree was attempting to help his fellow servicemen who had suffered injuries. »

PICTURED: PH.D. STUDENT ALEX STEELE SORTS THROUGH A VARIETY OF SURFACE EMG SENSORS IN THE NON-INVASIVE BRAIN-MACHINE INTERFACE LAB HEADED BY PROFESSOR JOSE LUIS CONTRERAS-VIDAL.

"I had a friend who needed a prosthetic, and when I went into the service flip phones were the gold standard. Getting out and seeing how far technology progressed with smartphones, I figured prosthetic technology had to follow the same trajectory, but it didn't," he said. "A hook was still the standard, and even though the technology has improved during the past 15 years, people who use prosthetics still complain that they don't do what they really want them to do."

Steele knew that his unique life experience and perspective could help when it came to innovating the technology.

"It's a common issue with engineers who aren't disabled, they create things THEY think will help," he said. "The problem is they don't think to check with the person who will be using it. Ask a disabled person what they think of the fancy wheelchairs that can climb stairs. It's a cool engineering feat, but it's useless for the user. It's something I learned firsthand when I was using a wheelchair. So, when I teach or mentor students, I always tell them to design for the user. You can have a brilliant, award-winning idea, but if the user doesn't like it, then it's just a toy."

Returning to the Portland, Oregon area after his discharge, Steele earned his B.S. and M.S. in mechanical engineering from Portland State University in 2017 and 2018, respectively. However, he only became a doctoral student of **Jose "Pepe" Luis Contreras-Vidal**, Ph.D., Hugh Roy and Lillie Cranz Cullen Distinguished Professor and the director of the NSF IUCRC BRAIN Center at the Cullen College of Engineering, after networking with another professor.

"The story of how I found Pepe was unique," he said. "Looking into Ph.D. programs, I originally was trying to get into USC and reached out to a professor, Dr. Gerald Loeb, who ran a lab I really wanted to work in. I flew down to meet with him for the day and told him my story, what I wanted to do, and what led me to find him, which is a whole story on its own involving someone I reached out to from DARPA's advancing prosthetics project. Unfortunately, he couldn't help me, but he asked for my C.V. and said he would reach out to a few people on my behalf."

"Later that day I flew back to Oregon and when I landed, I had several emails with offers from jobs in prosthetics companies and professors who were interested in having me work with them. Thankfully, Pepe was one of them and after meeting with him, his students, and seeing the lab, I decided to come to UH."

In August 2018, Steele joined Contreras-Vidal's lab as a National Science Foundation Veteran Research Fellow. The following year, he was chosen as a University of Houston and Houston Methodist Research Institute Graduate Fellow In Translational Research. As a result, he also works in the Neuromodulation and Recovery lab led by Dr. Dimitry Sayenko, which is how he met Dr. Amir Faraji, a neurosurgeon.

Steele served as the connective tissue for the two to then submit a research proposal to the TIRR Foundation for Mission Connect. "Decoding the language of the spinal sensorimotor networks using non-invasive electrospinography" received a $150,000 grant from the program in October 2021.

Ideally, the partnership will allow each professional to offer their expertise to the other, in order to improve patient outcomes and research potential. For example, sensors employed by Contreras-Vidal could give insight into how the brain is responding – or not – following a severe spinal cord injury. On the other side of the equation, Faraji is a surgeon that can provide direct feedback from patients about what rehab devices are practical and needed, and how patients are responding to them.

Steele added, "It helps to have that feedback, because a lot of times, we don't see necessarily what helps a person. We see what we think will help the person."

From his perspective, Faraji saw it as taking the vital step of forming a collaborative team, with clinical and research perspectives.

"There's decades and centuries of good ideas that never get to patients because they haven't been worked on with a team," he said. "By having a team up front early on, some of those good ideas can be molded in a way that's practical for patients."

Steele joked that he was the "spinal cord" of the pairing, in a way.

"A lot of being a Ph.D. student is trying to find the gap in research and finding ways to connect odd things," he said. "This was just an obvious thing that I saw and it was like, pulling that together and it works. And here we are, so very lucky."

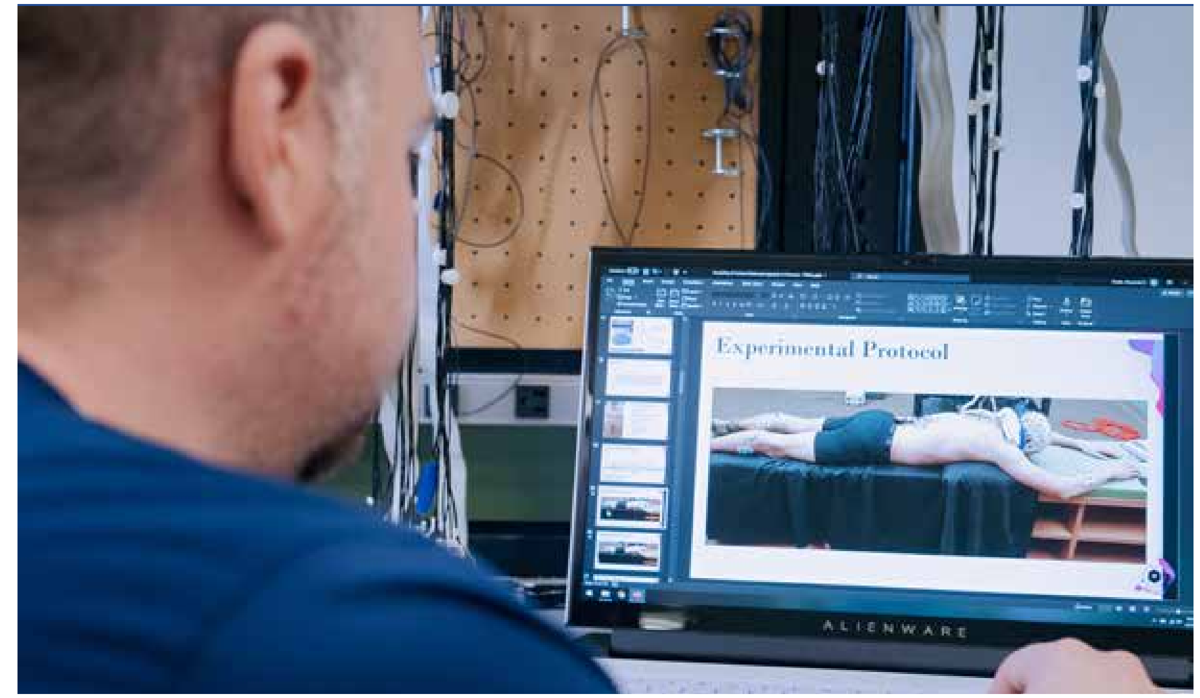
Contreras-Vidal added, "This will allow us to create some synergies, and also, bringing these two groups together can allow us to do even more challenging projects."

Faraji said the end goal is to improve patient care.

"I only know how to do my job as a physician by being a human being first," he said. "I treat my patients as a human, I talk to them, and you have to personalize their care. You have to tailor it to what their individual needs are. But for me, the whole goal of my practice is to apply new technologies and techniques to help advance their care. This collaboration with this lab and this institution is an example of building something new. There's a track record that's established from the pictures on the wall of patients that have benefited from this research, and that's what we need for our patients. That's how we're going to move this forward."

Although Faraji and Contreras-Vidal were complimentary of his role, Steele is humble when it comes to describing his own efforts in facilitating this development and research.

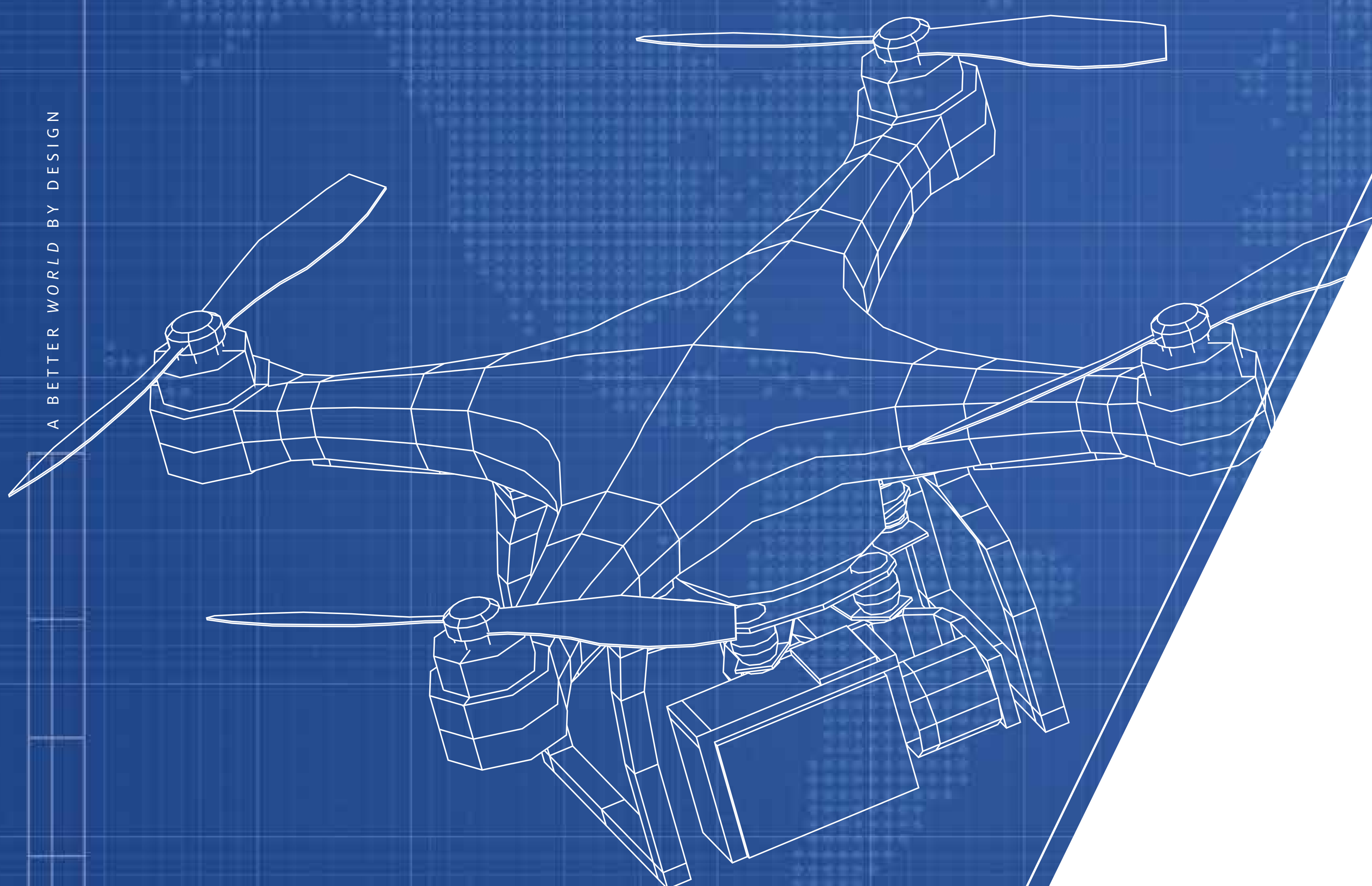
"Ironically, my journey from military to undergrad to Ph.D. is basically the same story on repeat," he said. "I've been very lucky finding people who on paper seem very busy and have no real reason to help me, but they all still managed to find time for me."



PICTURED: STEELE SHOWS A PROPOSAL FOR USING SURFACE EMG SENSORS ON THE SPINE TO DECODE THE LANGUAGE OF SPINAL SENSORIMOTOR NETWORKS TO IMPROVE OUTCOMES FOR PATIENTS EXPERIENCING SPINAL CORD INJURIES.

PICTURED: STEELE WORKING IN CONTRERAS-VIDAL'S LAB DURING THE PANDEMIC.

SPACE CITY UAV
REFINING THE SKY



PICTURED LEFT:

CHIEF ENGINEER ANDRE JIMERSON HOLDS AN EXAMPLE OF A PREVIOUS YEAR'S UAV.

The dangers of face-to-face contact imposed by a global pandemic, as well as the transportation-based problems imposed by weather in the Houston area, illustrate some of the practical value that unmanned aerial vehicles (UAV) – more commonly known as drones – can have. In these situations, important supplies and medicine could be delivered by UAV.

The next time you hear the buzzing of a drone in the air while walking outside, you might want to gaze upward and check it for that distinctive Cougar Red hue, thanks to the efforts of the students in the Space City UAV team of the University of Houston chapter of the American Institute of Aeronautics and Astronautics.

Formed in 2019, the Space City UAV Team is an engineering-focused group that's building and piloting student-made, radio controlled fixed » wing planes. It builds off a similar effort in 2018 by students completing a capstone project. Meeting three times a week throughout the semester, the group will be creating vehicles that adhere to the competition specs for the international AIAA Design, Build, Fly contest.

The Space City UAV Team is led by project manager **Shawyan Landi**. The chief engineer is **Andre Jimerson.** Landi said that they're working on refining their team structure and improving their UAV from last year, the DeltaV, although they haven't settled on a name for the new unit.

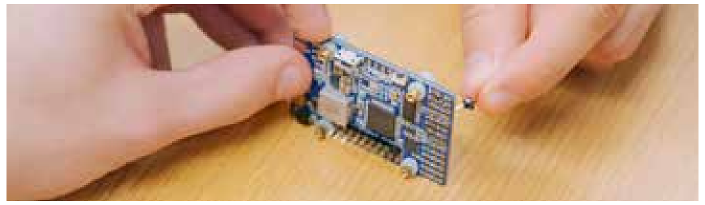
"We've created two project teams, in electronics and structures. From those two teams, we've split it off into sub-teams – electronics and avionics, and air frame and payload," Landi said. "What we wanted this year was sub-teams that did similar things to meet at similar times, in order to brainstorm and help teams bounce ideas off one another."

Landi said retaining and building membership has been a key effort on their part, pegging their current numbers at 20 to 25. He described how he got involved with the group.

"I was in a lecture for my circuits class in Fall 2020, and there was a student rep who came into our class before the lecture and told us about a rocket team on campus, and they went in depth about the kind of things they do," he said, adding that he got interested in the UAV team because they had immediate openings for hands-on work.

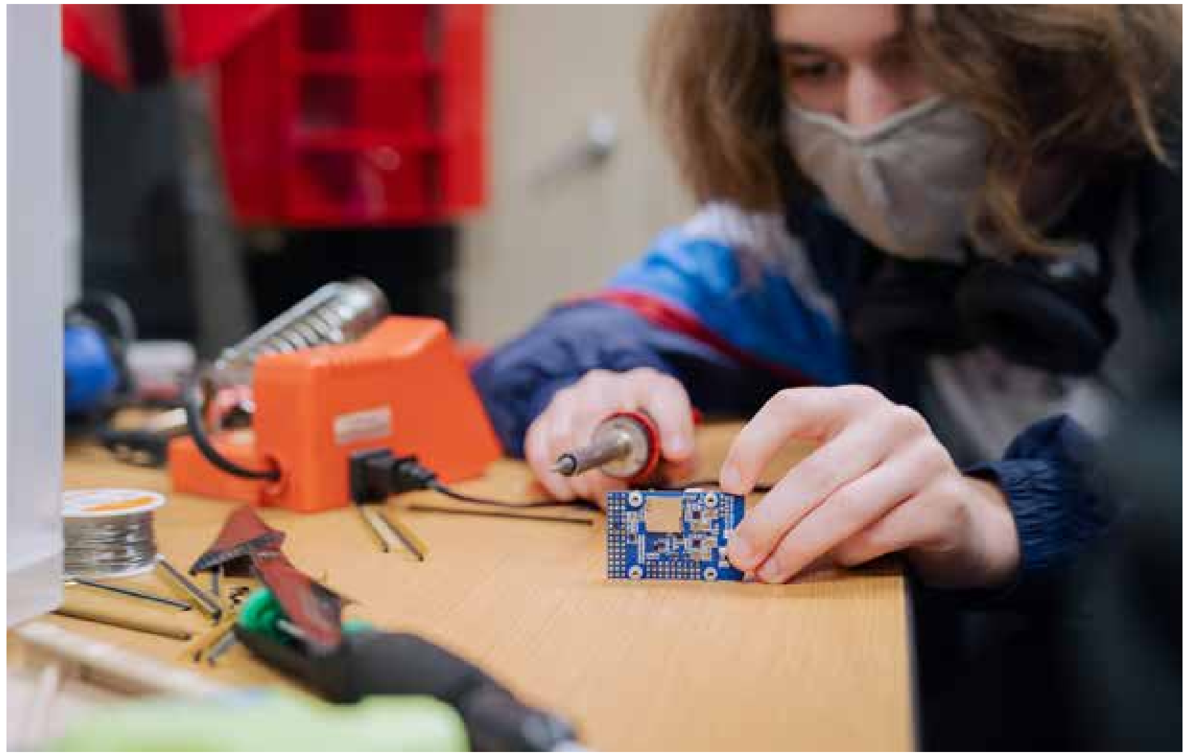
"Honestly, I took a real interest in that, and the main reason as to why is because i feel like a really big part of undergrad for engineers is applying the knowledge and the theory that they learn in their classes. That was something I was really striving to do."

PICTURED RIGHT: AN EXAMPLE OF THE DETAILED, MINIATURIZED CIRCUITRY WORK THAT GOES INTO THE UAV PROJECT.



PICTURED ABOVE: FOR MANY STUDENTS IN THE SPACE CITY UAV, THIS WILL BE THEIR FIRST APPLICATION OF CLASSROOM LEARNING ABOUT CIRCUITY ON A REAL WORLD DEVICE.

PICTURED ABOVE: SPACE CITY UAV HAS SHIFTED TO SMALLER AND TIGHTER GROUPS OF STUDENTS, BOTH TO COMPENSATE FOR THE REALITIES OF THE PANDEMIC AND TO BETTER FOCUS WORK ON THE REQUIREMENTS OF THE DEVICE.



PICTURED ABOVE:

SPACE CITY UAV MEMBERS SOLDERING COMPONENTS FOR THE DRONE.

Aya Abushmeis, a December 2021 graduate in mechanical engineering and now an operations engineering intern at NASA, was also significant in getting the effort off the ground the past year.

"The UAV team is a very young team, and the DeltaV is the first aircraft we ever built," she said. "We had a very small team last year with minimal relevant skills and experience at the start, but we are all so passionate and dedicated to the goal that without much guidance, support or even lab space, we accomplished so much."

Now in its 26th year, the AIAA Design, Build, Fly contest is sponsored by Textron, Raytheon and the AIAA Foundation. It is the premiere event for college UAV groups, and in 2021, an initial field of 115 teams competed for honors. Each year, a Top 10 is picked, with the top three teams receiving $3,000, $2,000 and $1,500 in prize money.

For the competition, there are limits when it comes to the UAV's size, and at least one-third of the team must be freshmen, sophomores and juniors. However, the rules are otherwise open-ended, to allow for innovative approaches and vehicles. After being conducted remotely the past two years, this year's DBF will be held in Wichita, Kansas in April 2022.

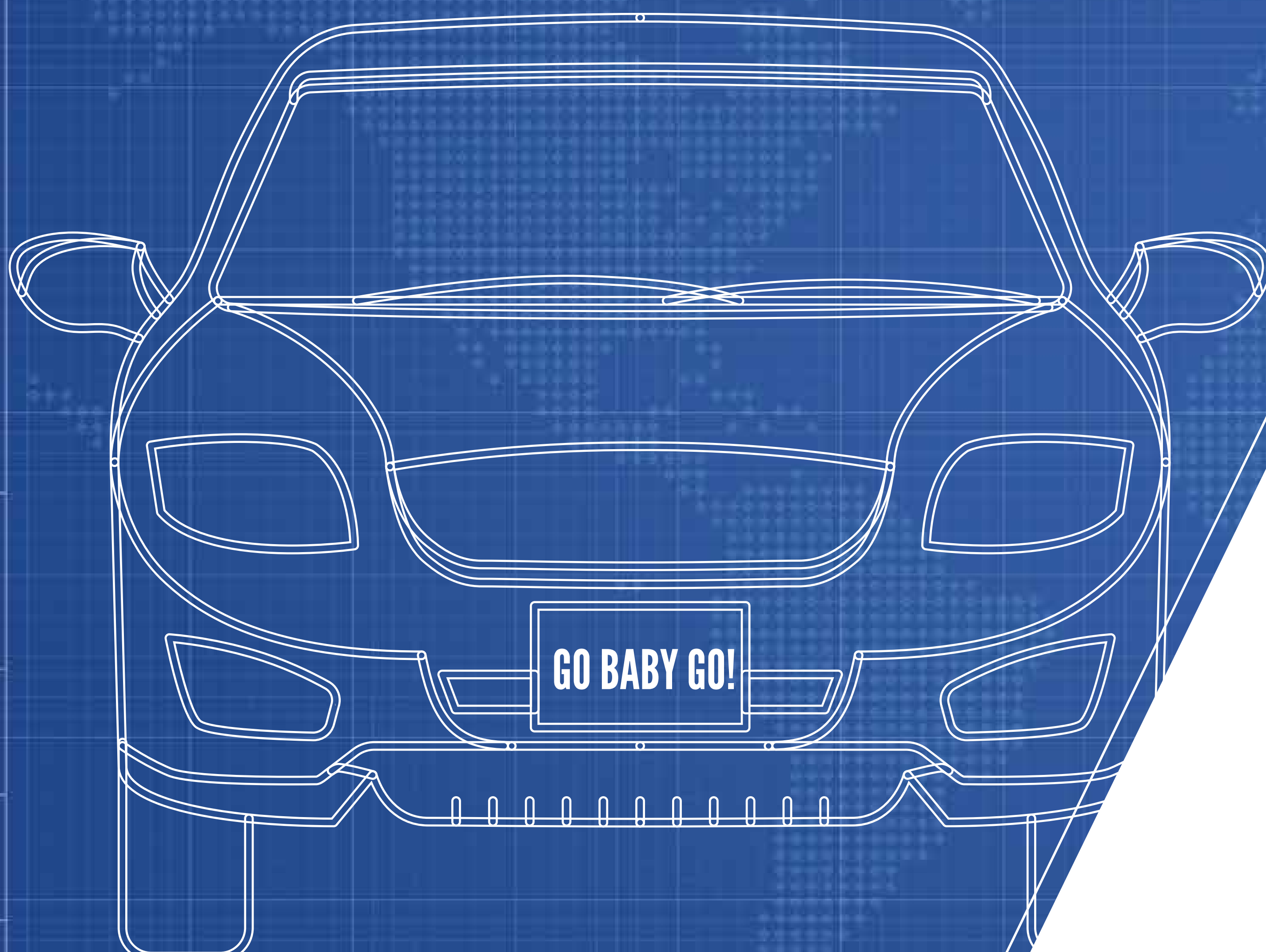
Reflecting the needs of the past few years, the contest will require UAVs to be able to transport and deliver syringes in one mission, and in another mission, vaccine viral packages. Competing teams will be scored based on how quickly they're able to complete a run, as well as how much cargo they're able to properly transport.

Landi and Jimerson also noted that this year's design is small – the wingspan is less than four feet. A smaller wingspan requires less resources but more engineering work to create, which in turn increases the potential for points on the scoring rubric.

While the Space City group didn't qualify for last year's competition, they plan to continue improving the DeltaV, and to work toward the April deadline.

"This year, we want to see the project all the way through," Landi said. "We're planning on having our own mock competition, and going through the same rule set. Our main goal is to see the project all the way through, which is 100 percent attainable for us this year."

GO BABY GO!



BME CAR STUDENT GROUP:

DISCOVERING WAYS TO HELP SPECIAL NEEDS CHILDREN

TOP: ROGELIO CASTILLA AND OMAR NOFAL WORK ON CAR ELECTRONICS. **RIGHT:** ZACH WALTHER (3) GIVES A THUMBS UP TO HIS NEW RIDE, PRESENTED BY BMES STUDENTS (LEFT-RIGHT) JASMINE DHALIWAL, MARTIN REYES, COLLIN RHODES, ROGELIO CASTILLA AND HANNAMARIE ECOBIZA.

For the second year in a row, a group of Biomedical Engineering students at the University of Houston's Cullen College of Engineering will be working on a customized small car for a local child dealing with a mobility impairment.

In 2019, members of the Biomedical Engineering Society at the University of Houston (UH BMES) founded a chapter of Go Baby Go (GBG), a national community that provides children with significant walking and running issues a means for mobility, so that they can interact with the world around them.

Martin Reyes, the society's public relations chairman, also served as the primary contact and organizer for their efforts. He described some of the practical concerns about mobility devices.

"Traditional electric wheelchairs cost hundreds to thousands of dollars, which is a large sum of money for anybody to spend," he said. "The effort of GBG is to modify pre-existing children's cars to better accommodate a motor-impaired child in place of an electric wheelchair." »

For the group's first completed project, they were contacted in January 2021 by officials at Creighton Elementary School in the Conroe Independent School District. In May 2021, they delivered a revamped, miniature red Jeep to a student.

"Considering that a paralyzed child will not be able to use their legs to drive the car, the challenge is finding a way to rewire the pedal to an alternative control method," Reyes said. "We rewired the pedal to a button that we bought and fixed onto the steering wheel. We also needed to disable the car's loud noises by removing the right wires from its motherboard. Since a real wheelchair has a supportive backrest, we constructed one from PVC pipes and cushioned it with pool noodles. This all required us to drill holes, cut pipes, and tinker with the circuit boards of the vehicle."

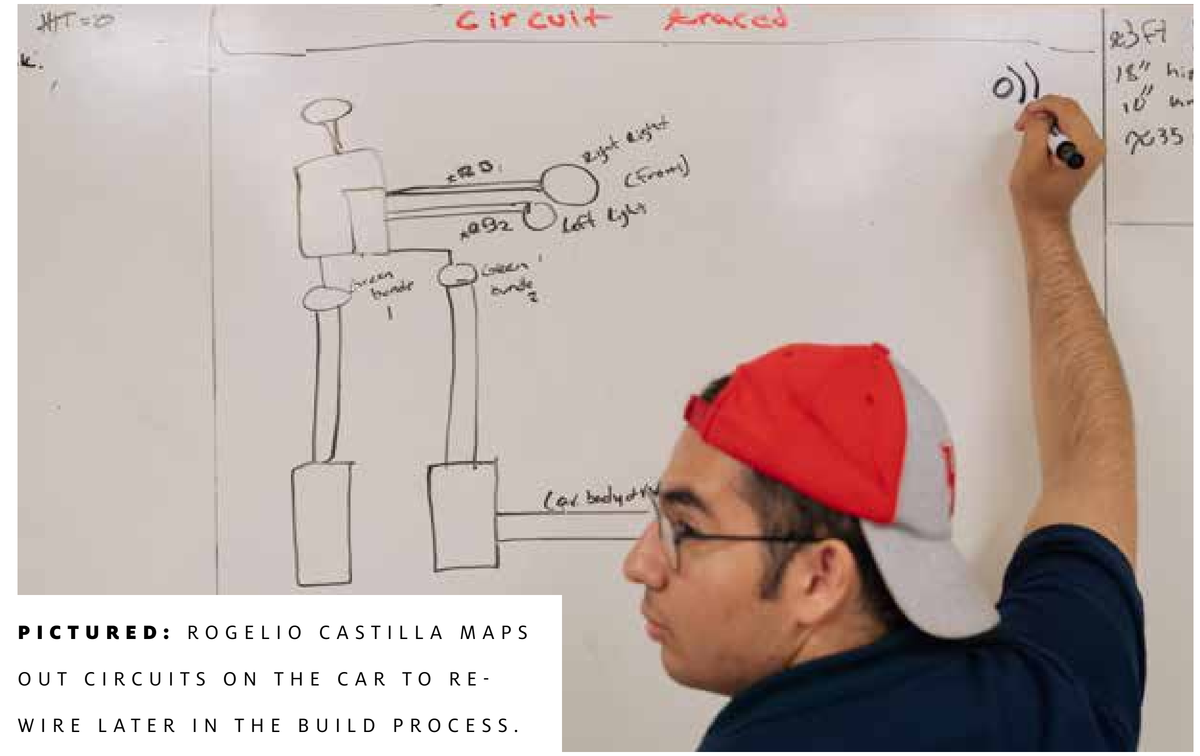
The group's primary contacts at the school were Glenn Funk, a special education teacher that is now at Stockton Junior High, and Jennifer Lee, a physical therapist at Creighton. Funk contacted the BME Society after seeing a post on a community forum for Go Baby Go chapters from around the United States.

"We started this project due to my previous experience with Go Baby Go when I worked in another district. I had a student in Tomball ISD receive a car from the Be an Angel Foundation, and it helped encourage his mobility at recess and PE," she said. "When I had our student transfer in, I reached out to Mrs. Lee, who was our school physical therapist. I wanted our student to gain access to the playground and be able to have mobility when PE was moved outside to the large play field. Mrs. Lee was the one who found this amazing connection and really helped do most of the communication between UH and Creighton Elementary."

Lee added, "We had so much fun last year working with the UHBME students and seeing the final product, and the student had a great time with it. He is at another school now, and unfortunately will no longer fit in the car, since he's grown. But the Conroe ISD therapy department has the car, and we discussed using it with different students. We haven't so far, but I feel confident it will be used in the future."

Glenn said the student was using the car daily by the end of the 2020-21 school year.

"Our student used the car at recess, and whenever the PE teachers had them out in the large play field," she said. "At recess, he was thrilled to be able to 'run' around with his peers and play, instead of sitting on the sidewalk, watching as the others played." »



PICTURED: ROGELIO CASTILLA MAPS OUT CIRCUITS ON THE CAR TO RE-WIRE LATER IN THE BUILD PROCESS.

PICTURED: ROGELIO CASTILLA AND OMAR NOFAL DETERMINE WHERE TO MAKE STRUCTURAL CHANGES TO THE CAR BODY.

Reyes identified three members of the group who helped to spearhead efforts.

"**Rogelio Castilla**, our new Project Coordinator, participated in every event day we held," Reyes said. "He was there while we purchased the first PVC pipes, the moment we got the pedal-button to work, and throughout the completion of the project."

"**Regan Persyn**, our former Vice President and new President, was my second in command when it came to organizing our efforts. She helped me conduct the initial measurements and purchase the materials needed, as well as build the car itself at every group meeting. **Omar Nofal**, our former Treasurer, was one of the ones who helped us secure the initial funding we used from the Engineering Alumni Association. He managed our project expenses and helped get the final product across the finish line."

For the 2021-22 academic year, Reyes said they are working on a new vehicle for a 3-year-old with spina bifida. The group communicated with and identified the child in September and October. The finished car was delivered to the child a few weeks later.

PICTURED ABOVE: JASMINE DHALIWAL DECONSTRUCTS THE STEERING WHEEL. THE GROUP MOVED A PEDAL BUTTON TO THE STEERING WHEEL SO THE CAR COULD BE OPERATED WITHOUT FEET.

Vekilov Humbled and Proud to be 17th Recipient of AACG Award

BY STEPHEN GREENWELL

For **Peter Vekilov**, Ph.D., constantly being challenged and questioned about his scientific beliefs is all part of the process when it comes to his research and his teaching.

The John and Rebecca Moores Professor, in the William A. Brookshire Department of Chemical and Biomolecular Engineering at the Cullen College of Engineering, has even integrated it into his "rules" for his research group, which hang on the wall of his office. Several prominent ones include:

Peter is often wrong. Work harder than Peter. Shyness is harmful. Question everything.

Vekilov stressed that to him, being able to vigorously defend your scientific thought was a required part of the job, whether the questions were coming from a colleague in the field, or an undergraduate student researching with him.

"This is scientific exchange. When we talk about science, we're equal."

That sort of inquisitive stance has led to Vekilov earning million-dollar grants, and shifting thought about how crystal formation occurs. And, it has led to him being the 2021 American Association for Crystal Growth Award recipient – only the 17th person to receive the distinction since 1978, which is only awarded on merit every two to four years.

"The first recipients of the award were very prominent scientists," Vekilov said, outlining the history of the award. "Sir Charles Frank, an English researcher, developed the first theory of how crystals grow in the 1950s. Bob Laudise, from Bell Labs, developed the process to synthesize quartz. In your computer there are quartz crystals, in your phone there are quartz crystals, in my watch there are quartz crystals. There are quartz crystals everywhere now. I'm humbled to be in the cohort of these researchers."

"This award recognized the work my students and postdocs had done over the years and highlighted the discoveries they had made."

Vekilov first joined the AACG in 1993, when he came to the United States. His doctoral and postdoctoral advisors were both in the organization. For the past 15 years, he's been a member of the executive committee, and the chairman of the organizing committees for two of the national conferences.

"It's about getting new ideas, and checking my ideas against their opinions," he said, of the continued value of the AACG to him. "Collaborations arise at these meetings, and that's the important part."

AACGE-22 took place virtually last year in August. Vekilov served as co-chair of the event with Partha Dutta of RPI. As this year's award recipient, Vekilov gave a talk, "Two-step mechanisms of crystallization and aggregation," prior to receiving the award.

"In the evening, my wife had flowers for me," he said, laughing. "We've been together for 12 years, and flowers always go the opposite way. It was very nice."

Vekilov attributed much of his success to the hard work contributed by his students and postdocs, as well as the collaborative environment for him at UH. One point of pride for him is finding job opportunities for his students. He keeps track of where his students land on his research group's page, with most finding jobs in competitive fields or at world class institutions like MIT, even before graduation.

"This is my motivation. I train them and then they get jobs. In the last 10 years, all of my graduate students got jobs before they graduated. I haven't had anyone who's had to graduate with the anxiety of staying without a paycheck."

Vekilov was quick to praise the research environment afforded by the Cullen College of Engineering.

"In the last 12 to 13 years, our department has grown tremendously," Vekilov said. "I collaborate with four of my colleagues in the ChBE department. **Jeff Rimer** and I got four proposals funded by all the major agencies: DOE, NSF and NIH, and coauthored more than 10 papers. With him and **Jeremy Palmer** we are finishing a very successful NFF-funded project. **Jacinta Conrad** and I are working on our second joint proposal. I have submitted several proposals with **Navin Varadarajan,** and hopefully we will get funded very soon."

Vekilov noted that in balance he had collaborated with at least 20 percent of his department's faculty members, a high degree of cooperation. He has also worked to create research partnerships with other colleges at UH, and other universities in Texas.

"I worked together with Vassiliy Lubchenko, a professor from the Chemistry Department, for 11 years. We got three successive grants from the NSF, and we've probably published more than 35 papers on those projects."

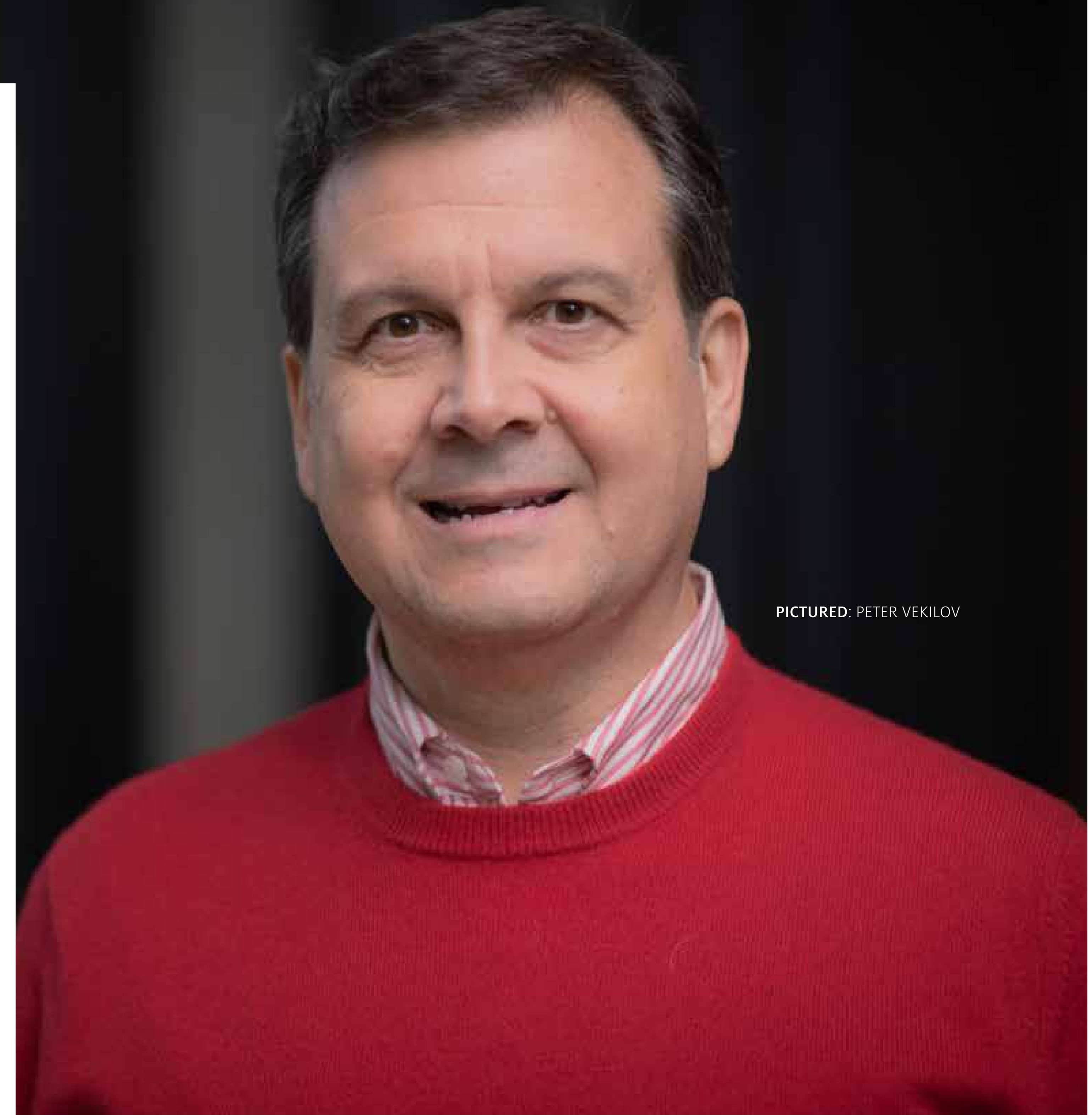
He added, "Being in Houston is very rewarding, because I collaborate with two theorists from the Rice Chemistry Department, Peter Wolynes and Anatoly Kolomeisky. I've known Anatoly since he was an assistant professor, and now he's the department chair. He's a very close friend. At UTMB in Galveston, I collaborate with Monte Pettitt and Michael Sherman."

Vekilov was pleased by how UH and the Cullen College of Engineering continue to grow.

"I'm very glad by how UH has evolved in last 10 years. In the last five years, the process has been faster and faster," he said. "We have new colleagues, we have a new building, we have a new chairman. The support we're getting from the university to further advance this department is amazing. It helps all of us, because we have better resources, and we feel more inspired to do better work."

Learn more about Peter Vekilov and the Vekilov Research Group

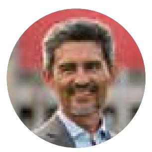
VEKILOV RESEARCH GROUP:
www.vekilovgroup.chee.uh.edu/members/



PICTURED: PETER VEKILOV

CONTRERAS-VIDAL NAMED TO NIH ADVISORY BOARD on Medical Rehabilitation Research

BY STEPHEN GREENWELL



A professor in the Electrical and Computer Engineering Department at the Cullen College of Engineering has been asked to serve on the National Advisory Board on Medical Rehabilitation Research (NABMRR) for the National Institutes of Health (NIH).

Jose "Pepe" Luis Contreras-Vidal, Hugh Roy and Lillie Cranz Cullen Distinguished Professor and the Director of the NSF IUCRC BRAIN Center, said it was a surprise but also an honor to be asked to serve.

"It was frankly a surprise, because they can pick from many talented people," he said. "I think from my work with them in the past and other federal agencies, they know I'm very enthusiastic about bringing people together, and sharing ideas. I take this position very seriously, so it's a privilege to have this recognition. Not only for me, but as a representative of the UH faculty. I think it's a great opportunity to emphasize what we do here and what we care about."

Contreras-Vidal's appointment as a member started on July 6, 2021. His term runs through June 30, 2025. The Board advises the directors of the National Institute of Child Health and Human Development (NICHD), the National Center for Medical Rehabilitation Research (NCMRR) and the NIH on matters and policies relating to NCMRR's programs. The board is composed of 12 members representing health and scientific disciplines related to medical rehabilitation, and six members representing persons with disabilities.

His first meeting with the board was held virtually in December because of the Covid-19 pandemic, Contreras-Vidal said.

"It's a great opportunity to learn about policy, to learn about the state of the nation's medical rehabilitation research, because the board gets regular reports on that," he said. "It helps direct research that's important for the NIH. I think it's also a good recognition for the university, and for the work that we're doing."

As a board member, Contreras-Vidal said that he will be interested in helping to establish standards and best practices for "research and development of ethical and trustworthy medical devices, including those based on artificial intelligence (AI) and neural interfaces, that could help advance medical rehabilitation across the lifespan. He noted that established standards and best practices would accelerate development, since it provides researchers "solid ground" to start from.

"There are also ethical ramifications of this technology, and I think we need to be proactive about that," he said. "We also need to make sure everyone has access to these developments. Diversity, equity, and inclusion are important parts, not just for UH's mission, but for the nation. I think the diversity of this board is very good, and it's a very interesting group of expert colleagues from different areas spanning rehabilitation research. We like to think about team science because everything that's important requires input from different areas from biomedical to behavioral research."

IAAM Chooses CEE's RODRIGUES FOR FELLOW HONOR

BY STEPHEN GREENWELL

Debora F. Rodrigues, Ph.D., the Ezekiel Cullen Professor of Civil and Environmental Engineering, was selected as a Fellow of the International Association of Advanced Materials by the Executive Board of the IAAM.

According to the IAAM, the recipients of the honor are required to deliver the IAAM Fellow Lecture in one of the assemblies of Advanced Materials Congress, or as part of the online Advanced Materials Lecture Series. All the Fellow lectures are published in the IAAM's Open Access audio video journal, *Video Proceedings of Advanced Materials*.

The IAAM was established in 2010, and in that time, less than 50 people have achieved Fellow status. In February 2021, Rodrigues presented "Water Chemistry and Oxidation State of Mo Affects Dissolution and Visible-light Photocatalytic Activity of MoO_3 Nanostructures." A video of that talk is online.

"The IAAM is one of the leading non-profit international scientific organizations working to promote advanced materials science, engineering and technology," Rodrigues said. "I was selected because the board believes I have made significant and direct impact to the field of materials science, engineering and technology. The IAAM has a rich legacy of more than 6,000 award winning scientists from more than 100 countries. This organization allowed me to network and connect with researchers from diverse multidisciplinary fields of engineering and science. Also, through their conferences, I was able to present my research accomplishments and gain international recognition."

While Rodrigues noted that she had research collaborators and funding in diverse materials science and engineering topics before joining the IAAM, the organization has helped her in both regards. In the past several years, she has started projects with researchers in Qatar, Brazil, and other countries in Europe.

"I already had collaborators before I joined the IAAM, but I did meet new colleagues and learn about other areas of research," she said. "Because it is an international organization, it allowed me to connect with researchers in Europe, China, India and other parts of the world, and expand my network internationally. This fellowship will certainly benefit my career in the future for larger and international projects, with collaborators from other countries than the United States. It'll also allow my research to gain further international visibility."

AKAY RECEIVES HONORARY DEGREE from Polish University

BY STEPHEN GREENWELL

The chairman of the Biomedical Engineering Department at the Cullen College of Engineering received an honorary degree from a university in Poland, as well as attended the official opening ceremony of the EU Healthcare Center – sponsored by ROYAL Philips – with the country's president as the guest of honor and provided two different talks during a trip last October.

Metin Akay, John S. Dunn Endowed Chairman of Biomedical Engineering, said he was thrilled to accept the honor.

"I am deeply honored, and humbled, to have received an Honoris Causa degree from the Silesian University of Technology," Akay said. "My students, postdocs and collaborators, as well as especially my family, tremendously supported me and tirelessly worked with me in this challenging, but rewarding, journey. They deserve most of the credit."

Akay said he was notified of the honor by the president of the Silesian University.

"The nomination and evaluations were done by two Polish Academy Members, and I received the unanimous vote of the Silesitions University Technology Senate," he said. "I was highly emotional on the phone. The Silesian University of Technology is a premier research university in Poland and has the faculty (College) of Biomedical Engineering with a brand new building and research facilities. The university will house the largest EU Healthcare Innovation Center. I was also pleased to learn that Dr. Bernand Picard, who is one of the most respected explorers, psychiatrists and environmentalists, was the previous honoree."

Akay has several connections to the school. In 2009, he was invited to speak at an international conference hosted by the Silesian University of Technology. In 2013, he was invited as an IEEE Distinguished Lecturer to speak at the IEEE Chapter. Early in 2021, he was also contacted by the faculty of the BME department at the university to work with them to develop a unique curriculum for its undergraduate and graduate biomedical engineering programs, and to explore potential collaborations between Silesian and UH.

PICTURED ABOVE: METIN AKAY RECEIVED AN HONORARY DEGREE FROM SILESIAN UNIVERSITY IN POLAND AND WAS THE GUEST OF HONOR FOR THE OPENING OF THE EU HEALTHCARE CENTER IN THAT COUNTRY IN OCTOBER 2021. AS PART OF THE TRIP, AKAY GAVE A TALK AT THE OPENING [TOP], WHILE ATTENDING THE CEREMONY [BOTTOM LEFT AND BOTTOM RIGHT].

Akay and his wife Yasemin also attended the official opening of the largest European HealthTech Innovation Center as the guests of honor, along with the president of Poland, government officials and medical industry leaders.

In addition, the Akays attended an inauguration event for the 2021-22 academic year at the Faculty of Biomedical Engineering of the Silesian University of Technology. Constructed in 2010, it was the first and remains the only faculty effort of its kind in Poland. Akay also spoke at an event, "Healthcare Innovations, Education and Entrepreneurship in the 21st Century", and attended an inauguration event for the medical school.

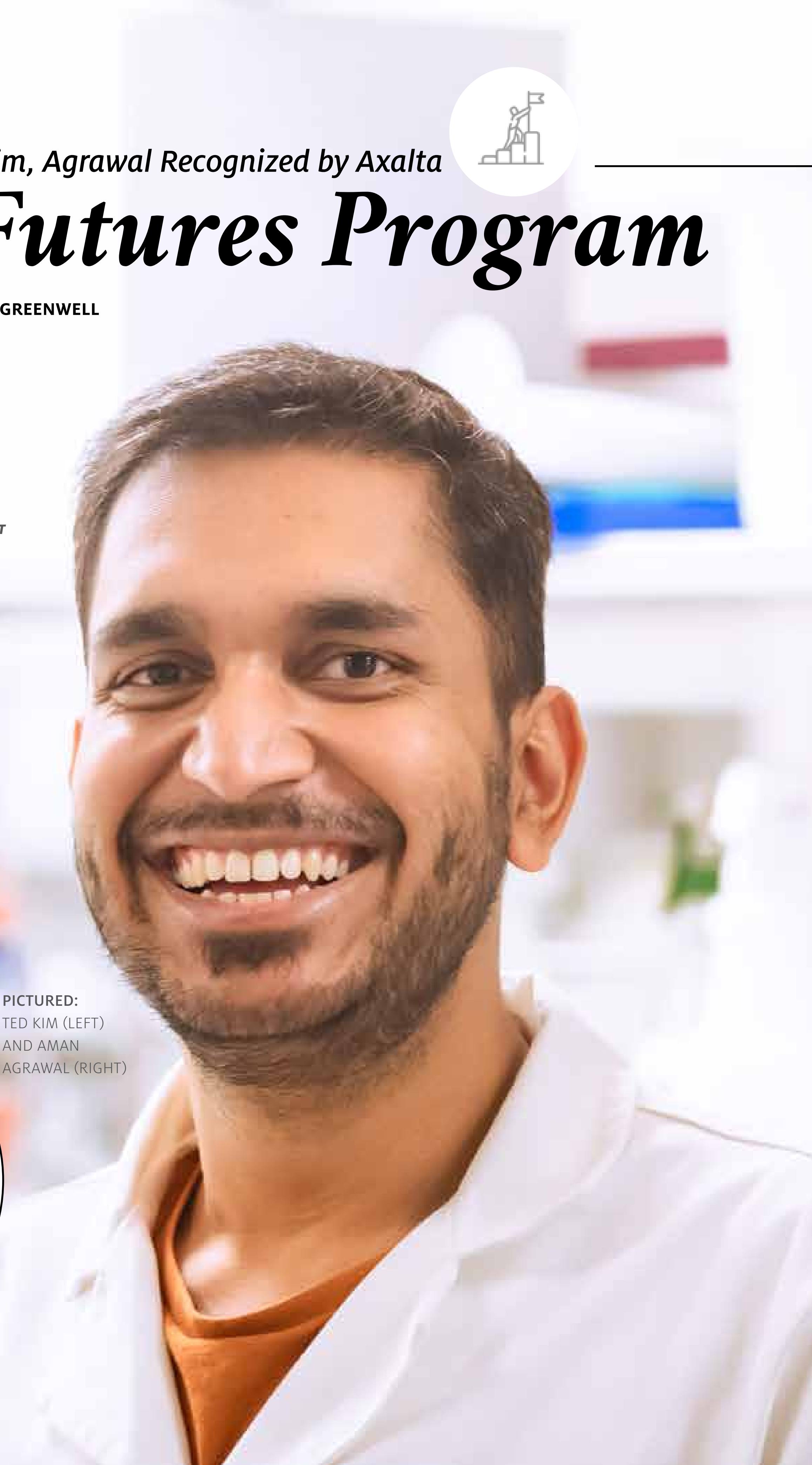
Akay also gave a televised talk, which he has titled "Challenging and Rewarding Journey."

Kim, Agrawal Recognized by Axalta

Bright Futures Program

BY STEPHEN GREENWELL

LEARN MORE ABOUT THE BRIGHT FUTURES PROGRAM AT:
www.newsroom.axalta.com



PICTURED:
TED KIM (LEFT)
AND AMAN
AGRAWAL (RIGHT)

A pair of student researchers in the William A. Brookshire Department of Chemical and Biomolecular Engineering Department at the Cullen College of Engineering have been recognized for their work by the Axalta Bright Futures Scholarship Program.

The scholarship recipients are **Ted Kim**, a senior undergraduate, and **Aman Agrawal**, a doctoral student. Both will receive renewable, $5,000 scholarships. Each year, a maximum of 16 students total are chosen from universities and colleges in five geographical areas – Houston, Philadelphia, Detroit, Rochester in New York and Fort Royal in Virginia.

Kim is an undergraduate researcher who is working in the Vekilov Lab, under the supervision of **Peter Vekilov**, Ph.D., Moores Professor.

"Current treatments of Alzheimer's disease only address the symptoms and oftentimes fail to better the patient outcomes and quality of life," he said. "Alzheimer's disease is caused by the accumulation of amyloid plaque and neurofibrillary tangles that irreversibly degrades and destroys neurons and shrinks brain tissue. The project that I am working on involves understanding the fundamentals of the growth kinetics of these different structures of amyloid beta protein fibrils that are strongly linked to the progression of Alzheimer's Disease. Once we gain a deeper understanding of how these proteins grow, we can develop more effective cures and treatments that can slow and reverse the disease."

Agrawal is working on two research topics in the Functional Polymer Nanocomposite Laboratory, which is run by **Alamgir Karim**, Ph.D., Dow Chairman and Welch Foundation Professor. Agrawal's first research topic has been related to artificial cells and the origin of life.

"A small part of the scientific community has been working to find the possible origins of life on the early Earth. The complex biological cells that we see today should have evolved from much simpler ones, called protocells, sometimes made of long, chain-like molecules called polymers," he said. "I have had the good fortune to learn about this field of research during my pre-doctoral work in South Korea. Upon arriving at UH, I started working on the idea of making minimalistic artificial polymeric cells mimics, called coacervates, capable of doing biochemical reactions. Our research not only advances the knowledge of prebiotic life, but also develops potential use of these cell mimics in drug manufacturing and delivery."

Agrawal's other research topics have been focused on making better polymer coatings, for applications ranging from waterproof packaging to anti-corrosion materials for the airline industry.

"Scientists around the world, including my advisor, have been working on a special type of polymer coating which is really thin, roughly 100 times thinner than our hair strands," he said. "These thin coatings not only reduce the amount of polymer used, they also provide interesting properties, such as structural coloration – color without pigments. My work has been to understand the structure of these thin coatings and their decay and degradation in adverse environmental conditions. By looking at how they behave at elevated temperatures or in various industrial solvents, we came up with better design ideas and improved techniques for their fabrication."

For Kim, the journey to UH and the Cullen College of Engineering specifically has been longer than for some other students. He sees this honor as a reflection of some of that hard work he's done.

"When I applied to UH as a transfer student, I was not immediately accepted into the College of Engineering because my grades weren't high enough at the previous institution, but the staff gave me the opportunity to prove myself," he said. "The staff in the Department of Chemical and Biomolecular Engineering, and the Cullen College of Engineering, were pivotal in my journey to get to this point."

Agrawal, who grew up in the small city of Etawah in northern India, said his parents, Rajesh and Nutan, have "ceaselessly supported" him, and encouraged him to continue his educational efforts, as well as Karim.

"I owe a debt of gratitude to my advisor, professor Alamgir Karim, for opening his lab door for me to do independent, blue-sky research," Agrawal said. "I met him at a conference during my undergrad work and enjoyed talking to him. I didn't realize that two years later I would be working with him. His intellectual comments and excitement toward new science motivates me everyday. This has helped me in preparing myself for a life in academic research, where I see myself in the foreseeable future."

Agrawal identified several other mentors who were instrumental for him.

"Professors **Jacinta Conrad** and Peter Vekilov have been of immense help as well, in scientific discussions and lab access. I also closely collaborate with Dr. Jack Douglas, who is a scientist at NIST [National Institute of Standards and Technology]. Discussing relevant scientific theories with him helps me in gaining deeper understanding of my experimental work. I also want to thank my previous advisors, professors Ashutosh Sharma at the Indian Institute of Technology Kanpur, and Steve Granick [now at the University of Illinois] and John King at the Institute for Basic Science, Center for Soft and Living Matter in South Korea, whose mentoring have played a major role in my interest in scientific research, leading to this award."

Long-term, Kim would like to become a R&D scientist or engineer, working on developing carbon negative solutions in the energy and materials field. Kim identified four people as being key resources while at UH.

"Dr. Peter Vekilov, and graduate students **Sima Mafi**, **David Yang** and **Alex Xu** have been instrumental in my development as a researcher and a student," he said. "It was because of them that I was able to succeed here at the University of Houston."

Sarah Hakam:

OUTSTANDING SENIOR

BY STEPHEN GREENWELL

Growing up, Sarah Hakam knew she wanted to go to medical school, but she also knew that she didn't want to go via the conventional route, by pursuing a biology or chemistry major. »

PICTURED: SARAH HAKAM

"I wanted more out of my undergraduate education," she said. "I wanted to develop a lot of my life skills, like problem-solving. I decided engineering would really allow me to mature my brain."

She was also influenced by her father, **Hassan Hakam,** who earned his master's degree in Computer Science from the Cullen College of Engineering.

"My dad majored in computer science and my mom majored in biochemistry. By majoring in biomedical engineering myself, I felt like it was the perfect combination of the two," she said. "My parents have both always encouraged me to follow my goals and are so proud of me. I could not have done it without them."

Hakam has followed her father's path to UH. She has flourished as a Biomedical Engineering student, and as a result, has earned the college's Outstanding Senior award for the 2021-22 academic year. It came as a surprise to her – and members of her household.

"At first I was confused because I wasn't sure what was going on, but then I was really excited," she said of being notified about winning the award. "The first thing I did was run downstairs and tell my parents, we were all so happy and I could not believe it."

Sarah lives in Sugar Land with her family – her father, Hassan Hakam, mother, Rana El-Hakam, and three younger brothers, Anwar, Ahmad, and Mohammad. **Anwar** is also a Biomedical Engineering student at the Cullen College of Engineering, a sophomore.

Before she enrolled, Hakam identified her A.P. Physics teacher Brit Britton and A.P. English teacher Melodi Dixon Wyatt at Stephen F. Austin High School as significant educational influences for her.

"They were always encouraging me to go out and pursue every little thing, I really miss them sometimes," she said.

Once she got to the Cullen College of Engineering, that effort and spirit persisted. Several faculty members also encouraged her to pursue an aggressive course load and advanced courses at the Honors College.

Hakam said, "Dr. **Fritz Claydon** really gave me so many opportunities. He helped me through a lot of things and honestly, I don't think I could have done my undergraduate work without him. He was amazing.

Hakam also praised the guidance she got from Gregory Spillers, the former director of the Pre-Health Advising Center and a former Biomedical Engineering advisor as well.

"He's an amazing man and so good at what he does," Hakam said. "From freshman year, when I told him what I wanted to do, to go to medical school, he laid out the entire plan for me and told me everything I needed to do."

Spillers served as the faculty advisor for the student group that Hakam started at UH, the Engineering Pre-Medical Society – Epsilon Omega Pi.

"I remember when I came in as a freshman, there was like a considerable amount of engineering students who were pursuing pre-med, but by senior year I feel like a lot of them had fizzled out," she said. "I wanted to create a society where a bunch of engineering students can have other pre-meds to talk to and be able to transition better into medicine from engineering."

After earning her degree at UH, Hakam will be continuing her studies at Texas A&M College of Medicine. She has been accepted into a dual degree program there, to pursue her medical doctorate and a master's in interdisciplinary engineering at the same time.

"I'll be studying in the Texas Medical Center," she said. "I think we're going to do our rotations at Houston Methodist Hospital, which I'm really excited about because I've always wanted to stay in Houston, close to all my family and friends and I get to study in the biggest medical center in the world."

Ideally, she would like to stay in the area once she enters the professional world, but beyond wanting to be a surgeon, her goals are ever-changing, she said.

"I like taking things one day at a time. Seeing what interests me, and making up new goals as my interests change and as my life changes. As things change, you never know what may come next."

Faouzi Tahtouh:

OUTSTANDING JUNIOR

BY STEPHEN GREENWELL

When Faouzi Tahtouh reflects upon being recognized as the Cullen College of Engineering Outstanding Junior for the 2021-22 academic year, he can't help but feel a bit surprised and a bit humbled. »

PICTURED: FAOUZI TAHTOUH

"I'm just grateful for it," he said of the honor. "I was thrilled. It was exciting because just getting recognition for your hard work, that meant a lot to me more than anything. All the hard work I'm putting into my academics is paying off. It was exciting to tell my family and my parents all about it. They were proud of me and there was a lot of excitement about it."

The mechanical engineering student attributed his success to his work ethic. When asked how he developed that ethic, Tahtouh laughed and said it was thanks to the influence of his mother, first and foremost.

"As a young child, she got me right," he said. "She made sure from a young age that she spent a lot of time helping me develop. I always wanted to do my best at everything I wanted to do. Why not do my best if I'm going to put my effort into something? She really pushed me to stay on my assignments. As a child, the last thing you want to do is sit down and do your homework, but she stressed that you had to do these things."

Tahtouh earned his high school degree from North Shore Senior High School, which is in the Houston area's Galena Park Independent School District. He then took advantage of geography when it came to continuing his studies – Before starting at UH, he took several general education courses at San Jacinto, which was close enough to his home for him to walk to campus.

Because of his work ethic, Tahtouh said he wasn't worried about the shift in workload from high school to San Jacinto, or, from San Jacinto to UH.

"I know who I am," he said. "Regardless of whether I start here or there, I know I can put the hard work in. When I transferred over to UH, I wasn't really concerned."

Tahtouh cited the good reputation of the Cullen College of Engineering and the industry opportunities of Houston as prominent reasons why he decided to stay close to home.

"I love the city of Houston, and UH is right in the center of Houston," he said. "They have an excellent engineering program, and throughout the years they've continued to make improvements."

He was drawn to mechanical engineering specifically because he's always had a fascination with how things "go" and move about in the world.

"I've always been interested in the physics of objects, and how they move," Tahtouh said. "For example, airplanes flying and cars moving, things flowing. When I was younger I didn't know how engineers dealt with that. My interest in those kinds of subjects, that's what pushed me toward mechanical engineering."

At UH, Tahtouh attributed much of his academic success to **Holley Love**, Ph.D., instructional assistant professor of mechanical engineering. He noted that she was the one who informed him about the Outstanding Junior award.

"She's really been helpful for my time at UH," Tahtouh said. "She's gone above and beyond helping me, whether it's been with classes or the opportunities with engineering. She's really gotten me excited about it."

Tahtouh has lined up his first internship for the summer with a multinational, Fortune 500-level company. After graduating in 2023, Tahtouh hopes to explore opportunities for working in industry.

"I'm interested in getting my feet wet in industry, and gaining that valuable experience," he said. "Energy, power systems, I'm interested in stuff like that. Everything is based on power, and I'm interested in learning more about that. There's a lot of things that I don't know, but I'm really open to learning more."

BME Doctoral Student Ikelle earns

NRSA for Eye Research

BY STEPHEN GREENWELL

Larissa Ikelle, a doctoral student in the Biomedical Engineering Department at the Cullen College of Engineering, has received funding from the National Institutes of Health's Ruth L. Kirschstein National Research Service Award to continue her research into the mechanisms of diseases associated with vision loss, and to develop therapeutic strategies to correct them. The award comes with funding for Ikelle's research proposal, as well as a stipend for tuition and a small spending allowance for her doctorate studies. Ikelle described her work as studying the biochemistry of retinal diseases, in order to develop therapies that can prevent or delay blindness.

The central focus of this investigation is to understand how the proteins Prph2 and Rom1 function differently in rods and cone photoreceptors, with particular interest in trafficking of the Prph2 since this protein is essential for building the photoreceptors cells necessary for vision.

"We propose two aims to address these goals: Aim 1 will assess the role of Rom1 in rods and cones and the mechanism by which it modulates Prph2-disease phenotypes," she said. "By eliminating or overexpressing Rom1 in Prph2-disease models, we will conduct careful biochemical, structural, and functional analyses to assess phenotypic differences, as they pertain to complex assembly and trafficking to the outer segments. Aim 2 will investigate the role of Prph2 interacting partners in its differential behavior in rods vs cones."

Ikelle earned her Bachelor's of Applied Science in Biochemistry and Cell Biology, as well as a B.A. in French Studies, from Rice University in 2014. After a year as a research assistant at Oxane Materials in Houston, Ikelle became a research assistant for the UH Department of Biomedical Engineering in 2016.

PICTURED: LARISSA IKELLE CONDUCTING RESEARCH.

Initially, Ikelle wasn't sure what she wanted to focus her studies on, and assumed she would be working on cancers or virology.

"However, I am really intrigued by the retina. It is really unlike any other tissue," she said. "It is a complex, almost self-sustaining, interdependent system, all housed in a globe mostly separated from the rest of the body."

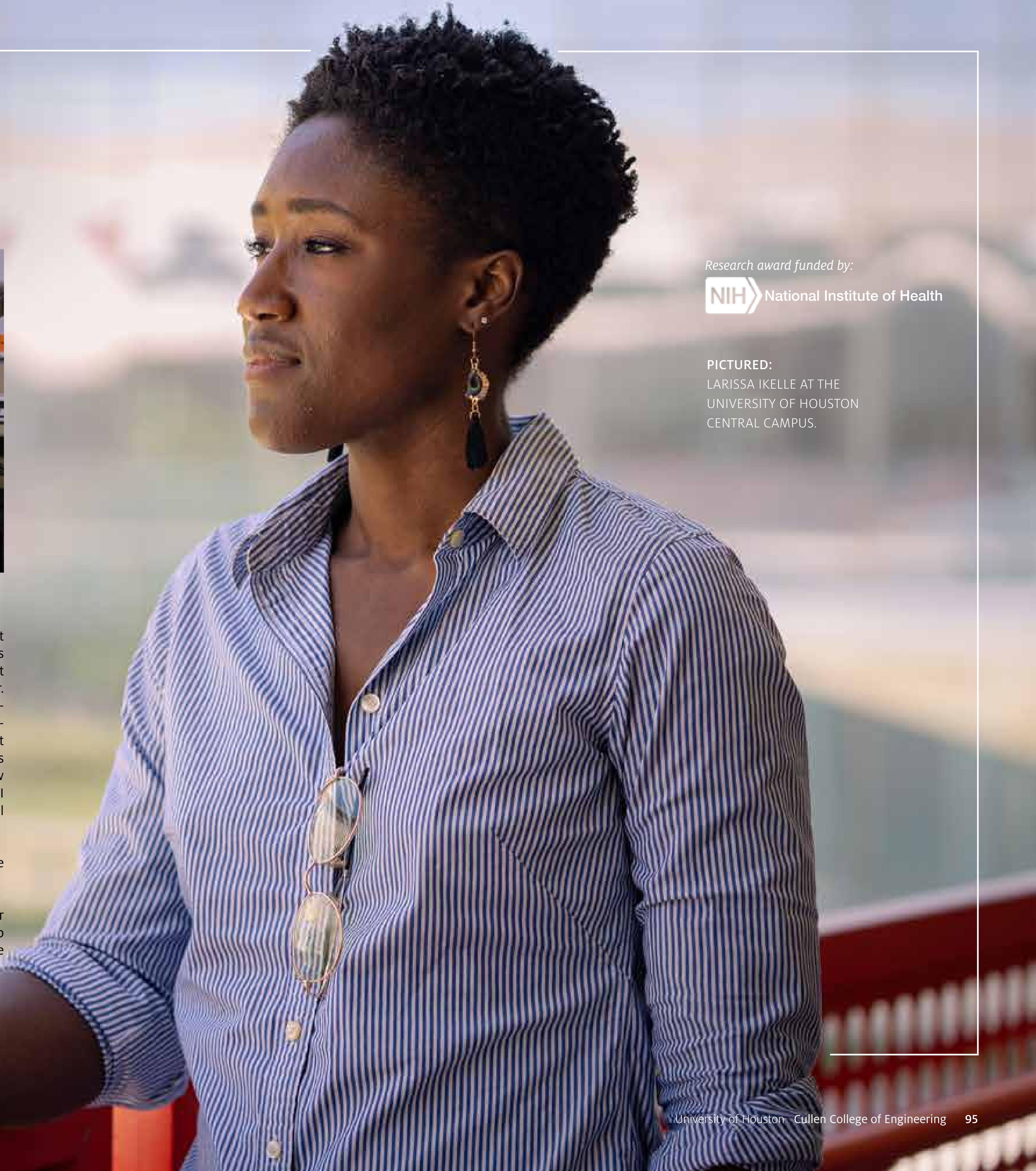
"It is such a unique tissue and its isolation from major systems makes it ideal for developing therapies and understanding diseases, since there is only a minor concern of injuring other parts of the body. It is really a microcosm that can be studied to understand the pathogenesis of a host of diseases; it can even be used as a model to understand diseases in other neuronal tissues. By this reasoning, the potential for exploration in the retina seems limitless."

At UH, Ikelle has contributed to research by **Muayyad Al-Ubaidi**, Ph.D., and **Muna Naash**, Ph.D., both professors in the Biomedical Engineering Department. She has received authorship credit for several papers with them.

Our lab is very well equipped and UH has great facilities for doing amazing research, but it is really the people that foster an environment for growth and advancement," she said. "Dr. Al-Ubaidi and Dr. Naash are such talented scientists and they have been gracious in encouraging and nurturing my growth in this field. It was them who encouraged that I apply for this award, and I am very grateful. I do have a few more years left before I get my degree, but I am very excited to see where this project will takes me."

Ikelle is confident that she wants to continue studying the eye.

"I want to have an academic lab studying major retinal pathologies, and a maybe also a start-up for developing therapies for addressing these diseases," she said.



Research award funded by:

NIH National Institute of Health

PICTURED:
LARISSA IKELLE AT THE UNIVERSITY OF HOUSTON CENTRAL CAMPUS.

Petro's Stewart Trades Call Sheet for SUBSEA

BY STEPHEN GREENWELL

PICTURED: JENNIFER STEWART

The transition from Broadway to the Houston energy industry might seem like an unusual one for some, but for **Jennifer Stewart**, it was one facilitated by her sister, Rebecca, and her mother, Judith.

Stewart initially graduated from Brigham Young University with a degree in musical theatre, and she moved to New York City to pursue a childhood dream of being on Broadway. She is now a recent petroleum engineering graduate of the University of Houston's Cullen College of Engineering.

"I got an agent, and did a few jobs, but I was only there for the summer," she said. "I quickly realized that I didn't enjoy the instability. Even though I didn't pursue it as a career, I am still heavily involved in the local Houston theatre scene. I love acting too much to give it up for good! I just do it as a hobby now, and make and style wigs for several theatres in town."

Stewart said she was unsure of what to pursue next, but discussions with her sister – a petroleum geologist in Houston – rekindled her interest in engineering.

"While working as a GIS analyst for a midstream oil company, I found that I enjoyed the industry and being involved in something where the produced commodity is an essential part of our daily lives," she said. "I've always loved STEM subjects – I was torn between engineering and theatre for my first degree. So going back to school for engineering was a natural next step."

Part of her initial interest in engineering was due to a strong family history in STEM fields.

"My mother and my sister were my original role models," Stewart said.

"My mother is a biology professor at the College of Southern Nevada, and she taught me to think critically from a young age. Due to her training, when I was 7, I discovered the tooth fairy wasn't real by utilizing the scientific method."

Stewart describes her mother as her "biggest supporter."

"I remember calling during my first semester, unsure if I had what it took to be an engineer. She bridged that gap in my confidence with bolstering words, and continues to do so every day," Stewart said. "My sister has also always encouraged me. I am so glad she pushed me to push myself."

When it came to the UH Petroleum Engineering Department, Stewart said that while she was grateful of all of its members, two of her professors had especially pushed her to excel.

"Firstly, Dr. **Konstantinos Kostarelos**, who taught me reservoir fluids," she said. "He recommended me for a summer job with Oxy Petroleum working on a CO_2 ground sequestration project. It was an incredible experience, and I will always be grateful to him! Also, Dr. **Christine Economides**, my professor for Pressure Transient Testing. Her passion for this industry is infectious, and she made school exciting."

Although there seemingly wouldn't be much overlap between the science-based engineering and artistic-based theatre, Stewart said her skills from the latter have consistently helped her with the former.

"Engineers are often required to present their work and ideas, and due to my time in theatre performing for large audiences, I have no fear of public speaking," she said. "Another big part of engineering is problem solving, and trust me when I say theatre people are the ultimate problem solvers! Whether it was finding a way to fasten a broken zipper five seconds before you have to be on stage, or improvising when your costar suddenly bolts off stage due to stomach flu – a true story for me – I have spent years honing the skill of creative and out of the box thinking, which has come in handy many times as an engineer."

Stewart graduated in December 2021 with honors. In addition, she received the 2021 Cynthia Oliver Coleman Women in Engineering Rising Star Award, served as UH Tau Beta Pi president and membership chairwoman for 2020, and was named the Outstanding Petroleum Engineering Student at the Houston Engineers Week Awards in 2020 and 2021. Stewart was also awarded one of the Texas Energy Council's scholarships for 2020, the first UH student to earn the honor since 2013.

IE Students' CAPSTONE Project Improves Efficiency at NASDAQ-100 Company

BY STEPHEN GREENWELL

Five students from the Industrial Engineering Department at the Cullen College of Engineering helped to improve operations by analyzing washer and dryer performance at Cintas, a NASDAQ-100 and S&P 500 company, as part of their capstone project.

Cullen College of Engineering students – and now graduates – **Eduardo Alba von Buren**, **Kenny Kiser**, **Jobin Mathew**, **Athul Johnson** and **Loc Ngo** presented "Data Analysis of Equipment Maintenance and Dashboard Improvement" to Cintas as part of the group's capstone project. The goal of their research was to look at the workload, maintenance logs and downtime for three brands of washers and dryers used at Cintas facilities, as well as the data collection methods.

"We were tasked to analyze the data of maintenance activity of three different brands of industrial washers and dryers," Alba said. "The main goal was to try to find different trends in the performance of these brands by looking at the amount of corrective and preventive work they required, as well as the labor hours spent working on these. By finding and comparing the trends between each brand, we wanted to find out if one brand was performing better than the other, or if one brand was consuming more resources than the other, like breaking down more often and having more labor hours spent on fixing the breakdown."

The work by the students found real performance differences between the three brands of industrial washers and dryers – as much as $170,000 in labor costs during the last 5 years, based on nine datasets of washer and dryer performance, three for each brand. The students also highlighted the need for more robust and consistent data collection.

"In order to do the analysis, we developed different graphs and dashboards that could illustrate this data in a more efficient way, in order to find the trends mentioned before and for them to be used to analyze future data," Alba said.

Alba noted that the feedback they received from the professionals at Cintas that they presented to was very positive. Since then, he has also been hired into their trainee program.

"They mentioned that we went above and beyond expectations with the project and were able to give them a deep dive into statistics they had not considered before," Alba said. "We found the experience to be very positive for our professional growth, since we had the chance to explain the results of our work to the experts."

Randal Sitton, Ph.D., is an Instructional Associate Professor in the Industrial Engineering Department and served as the faculty advisor for the capstone project.

PICTURED: RANDAL SITTON

"Our course was online due to Covid, but Dr. Sitton took the time to set up Microsoft Team calls on key dates to make sure we were progressing with the project at the required pace," Alba said. "Whenever we explained a current task or problem, he would advise us on how to proceed, or tell us where we could find resources, whether it was from a textbook or a professor. He also gave us tips on how to be and act professionally in front of the project sponsors, and made himself available for additional meetings if we ever needed one."

Outlining A New

APPROACH FOR MANAGEMENT OF CUSHING'S DISEASE

BY STEPHEN GREENWELL

Researchers from the Cullen College of Engineering are exploring ways to automate the administration of medicine for patients suffering from Cushing's syndrome, with a proposal establishing architecture for that recently published in Frontiers in Neuroscience. »

PICTURED: HAMID FEKRI AZGOMI

The lead author for the paper is **Hamid Fekri Azgomi**, a doctoral student of **Rose Faghih**, Ph.D., an assistant professor in the Electrical and Computer Engineering Department and director of the Computational Medicine Lab (CML). "Closed-Loop Fuzzy Energy Regulation in Patients with Hypercortisolism via Inhibitory and Excitatory Intermittent Actuation" builds off of the other recent work in Faghih's lab, which has centered on using wearable technology like smartwatches to track vitals.

A fellow author on the paper is Jin-Oh Hahn, an associate professor in the Mechanical Engineering Department at the University of Maryland. In a summary of the paper written by Fekri Azgomi, he outlined the extent of the problem.

"Hypercortisolism, or Cushing's syndrome, is associated with tiredness and fatigue during the day and disturbed sleep at night. Approximately 13 per million people are affected every year. Cushing's syndrome most commonly influences adults ages 20 to 50, and it is more frequent in females."

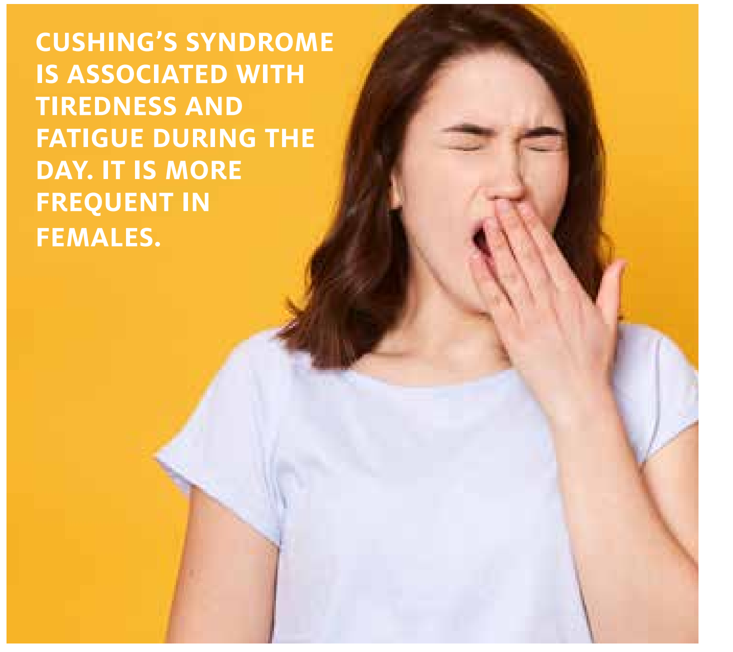
Surgery is typically recommended for Cushing's disease – It has a 78 percent success rate. But the relapse rate is about 13 percent. Using medications could help with those patients, as well as those who can't undergo surgery.

"Due to recent advances in employing novel compounds that can regulate energy state, medical therapy has attracted more attention. Automating the time and dosage of medications that are effective by either enhancing the energy state or lowering it could be one major first step toward treating other hormone-related disorders," Fekri Azgomi wrote.

"Inspired by the recent advances in wearable technologies, we propose an architecture to track and control internal energy state in Cushing's patients by monitoring cortisol measurements. We demonstrate how the proposed algorithm and designed control are successful in both inhibiting and exciting the internal energy state in a closed-loop manner. In the proposed architecture, the time and dosage of the medications would be determined based on the individual's needs and will lead to a more efficient outcome. The results verify the efficiency of the proposed architecture in regulating the energy state in cortisol profiles associated with Cushing's patients."

Fekri Azgomi first contacted Faghih about her research in 2018, and to express his interest in it.

"Over the last few years, my main field of research has been on control systems and system identification. Prior to joining the CML, I had experience in applying my background expertise in various fields, such as fault detection in electrical machinery and unmanned aerial vehicles," he said. "When I contacted Dr. Faghih, I noticed that there could be a unique opportunity for me to apply my expertise in physiological systems and further expand it in biomedical applications. Learning more about the research projects at CML, I understood that I can join into a novel idea that was supported by the National Science Foundation. The exciting part was that I felt, by joining this research team, I could further extend my research fields, bridging engineering and medical sciences. Having this excellent opportunity to explore these high-demand research topics and utilizing my expertise in this multidisciplinary area further motivated me to do my Ph.D. at CML and under Dr. Faghih's supervision."



Fekri Azgomi graduated in Fall 2021, having already defended his Ph.D. proposal. He noted that working on several research projects and mentoring multiple students during the pursuit of his doctorate helped him become a multidisciplinary researcher in the areas of computational neuroscience, control systems, signal processing and biomedical applications.

"My goal is to automate medical practices by applying my background knowledge in control and signal processing," he said. "I believe there exist opportunities in the medical science problems that could be approached from an engineering perspective."

Fekri Azgomi said he would like to continue pursuing a career in academia.

"I love to explore novel research ideas and interact with students and researchers from different backgrounds," he said. "What most excites me is to explore the research gaps and identify solutions within a multidisciplinary framework. While I aim to join academia and work as a university professor, I am also open to enhancing my training to explore other relevant fields of research. With several years of research in the areas of control systems and signal processing, and applying them in biomedical applications and computational neuroscience, I feel pretty confident that I may advance this multidisciplinary field and help society by enhancing the quality of life."

Read Full Research Paper Online:
Closed-Loop Fuzzy Energy Regulation in Patients with Hypercortisolism via Inhibitory and Excitatory Intermittent Actuation
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Subsea's Rednam, Abe Earn SUT-US SCHOLARSHIPS

BY STEPHEN GREENWELL

PICTURED: SAMEERA REDNAM

PICTURED: DAMILOLA ABE

The Society for Underwater Technology in the United States (SUT-US) has selected a pair of graduate students – **Sameera Rednam** and **Damilola Abe** – studying Subsea Engineering at the Cullen College of Engineering for scholarship awards this year.

Only six students nationwide – three pairs from three different schools – were selected for scholarship honors. Sponsored by British Petroleum, Rednam and Abe were honored at a virtual awards ceremony last September. Both were surprised by the honor.

"To be honest I think I was the last one to know," Rednam said, laughing. "The email that came confirming my scholarship went straight to spam, so I did not even know until the last minute! But it was great, the confidence boost that this gives helps me to work harder and achieve more. I am really thankful to SUT-US for this."

Abe said he was "super excited" about receiving the news.

"I woke up to the email and had to read it the second time to be sure that I read it correctly," he said. "It was really great news, especially since at the time I needed it the most. I'm grateful to SUT-US."

Abe had three faculty members to point to as significant influences on his success while at UH.

"**Dr. Li Sun**, **Dr. Bennett Woods** and **Dr. Burak Ozturk**," he said. "I'd always run to them for advice, and they're always there to provide direction. Dr. Woods mentored me for a competition earlier this year and also provided guidance when I wrote a paper on carbon capture technology. I'm so grateful to them all."

When told she could list as many or as few people as she wanted, Rednam said, "I'll be the person listing 20, because a lot of people really influenced and motivated me to always become a better version of me!"

"My dad, mom and my sister have been a solid support the entire time, through a lot of strange things actually," she said. "My family in Houston, my aunt Chandrakala Rednam and my uncle Dr. Krishna Rao Rednam, they were like pillars to me when I made the difficult decision to shift from India to pursue my higher education here."

She added, "I'd like to specifically mention my graduate professors in UH Subsea Engineering, specifically Dr. Li Sun, and some of my mentors who helped me get started and navigate. **Dev Rathore** was kind enough to take me into his team during SUT competition and continuously guide me. **Abhishek Sharma** became a great friend and someone who I turn to when I need any help. There are many others, but at the end of the day, all I have to say is that I am really thankful to all the people who tolerated me!"

As far as future plans go, Rednam said she hasn't ruled out pursuing a doctorate degree, but she knows she wants to acquire some field and industry experience as well.

"I enjoy learning new things, so maybe I'll get a Ph.D., but I also want to work in an offshore field. To be honest I am really afraid of the sea and deep water, but that's how my interest in all things Subsea began. I'm not always a person with a detailed plan, but if all goes well a doctorate or working offshore will be next."

Abe said becoming a subsea engineer has been his goal for the past three years.

"I'm glad that I'm achieving my dream," he said. "I appreciate my mom and my family, for always encouraging me not to give up. I look forward to developing innovative and cost effective carbon capture technology, to reduce the carbon footprint in the industry and make strides in offshore renewable technology. I hope to work for a company that gives me these opportunities."

Award-Winner Khalid Continues to Pursue KNOWLEDGE

BY STEPHEN GREENWELL

PICTURED: OMAR KHALID

Although the locations and challenges have changed, there has always been one constant for **Omar Khalid** – learning as much as he can, in a variety of fields and disciplines.

Khalid, a native of Iraq, earned his B.S. in computer science in October 2003. But following that, he worked in a variety of fields, with an emphasis on supervising teams, project management and strategic planning in conflict zones. He also earned a B.S. in civil engineering in 2018, and a B.S. in business administration in 2020.

"I come from an educated family," he said. "My older sister has a Ph.D. in civil engineering, and she was one of the main people who motivated me. My wife has a Ph.D. in geology, my other sisters have a master's in physics and mathematics. I've always loved to learn more and go forward with my education career."

That educational journey has taken Khalid to the University of Houston, where he is pursuing a master's degree in civil engineering, studying with **Dimitrios Kalliontzis**, Ph.D., an assistant professor of civil and environmental Engineering. With his work already, Khalid has earned a national award, as he is the 2021 recipient of the Paul and Helen Lenchuck Scholarship Program, administered by the National Concrete Masonry Association.

PICTURED: OMAR KHALID (LEFT) AND DIMITRIOS KALLIONTZIS (RIGHT).

"I was so happy for winning the scholarship," Khalid said, admitting that the award came at a time when he was facing some financial difficulties. "I was thinking about how it was going to be so hard for me to cover the required costs, especially since I have three kids in school. The scholarship came in the right time to make my life easier."

Khalid first came to the United States in 2016. Khalid knew he was likely relocating to Texas, and after looking into universities in the state, he chose the University of Houston to continue his studies.

"I did my research about each university, and I found that UH is one of the best universities in the country, not just the state," he said. "When I contacted the university, the way they treated me and the professional communication made want to join them and finish my degree at this university. I'm so happy for choosing UH, as I find it the perfect community to learn and have very good professors. I've also made many good friends, and the first one was my advisor."

While Khlaid wasn't initially sure if he wanted to focus on engineering, he is now interested in pursuing a doctorate degree, as he has gotten deeper into his studies.

"I was thinking of studying law after engineering, but two reasons made me change that," he said. "I found out that engineering is a different world, and I love it so much. The other reason, I always remember that when I had my undergraduate graduation project presentation, the head of the committee – professor Sabih Al Zuhairy – asked me what I want to do after the graduation, and I told him I would like to go deeper in the engineering field. He was the first person who told me I needed to finish my graduate school. He talked to me for more than 30 minutes about it, and he advised me to do it in the United States and not somewhere else."

UH SPE Earns Highest PetroBowl Finish &

PRESIDENTIAL AWARD

BY STEPHEN GREENWELL

The University of Houston's student chapter of the Society of Petroleum Engineers continues to make headlines, as a chapter-best third place finish in the prestigious PetroBowl competition came on the heels of its first-ever Presidential award designation.

The PetroBowl competition pitches SPE student chapter teams against each other in a series of quick-fire trivia rounds, answering technical and nontechnical industry-related questions. The contest has grown in size and popularity since its debut in 2002, and in 2015 was taken global with the introduction of six regional qualifier contests.

Regional qualifier SPE competitions take place in Africa, the Pacific region of Asia, Europe, South America and the Caribbean, the Middle East, and North America. The top 32 teams are invited to the PetroBowl Championship. The competition tests the knowledge of students on the entire energy value chain – upstream, downstream, marketing, geopolitics, history, alternative energies, human factors engineering, energy statistics, sustainability and more.

"Being top placed in the competition is a testament to the depth of the curriculum in energy here at UH," said **Lotanna Ohazuruike,** the president of the UHSPE chapter and the captain of their PetroBowl squad. "For the past three years, we have been in the Top 16 teams globally. Coming in third this year was a huge improvement in our team performance. I have to give a big thanks to my fellow teammates for the excellent job we did – master's student **Nhung Nguyen** and undergraduate **Kevin Tran**."

The UH squad first competed in a round of regional qualifiers last March, coming in fifth among 24 teams in the North America region. That qualified them for the International championship, where the top 32 schools from all over the world competed virtually.

UH finished in a third place tie with the National Autonomous University of Mexico. The University of Oklahoma won the competition, with the University of Stavanger (Norway) taking second.

"After three rounds of games, UH and UNAM were still tied," Ohazuruike said. "Inspired by the sharing of medals at Tokyo Olympics 2020, both teams opted to share the prize and honors of the third place finish. It was the first time it had ever been done in PetroBowl history."

Nguyen said she was surprised at how well they did, given that they usually have five-member teams instead of just three. But, they put extra work in when it came to practicing, and tailored their approach to the format.

"We have been preparing for PetroBowl virtually since the game switched to virtual format last year," she said. "Since then, we continued to meet virtually twice a week, a few months prior to each competition, for preparation. We slightly changed our practice methods over time to adapt with how the game is operated and to ensure we are good at both speed and accuracy."

She added, "For me, one of my study strategies is making sure anything I know, I know it completely. The questions are wide and unpredictable, so one person cannot study everything. Dividing the topics makes things less overwhelming and makes team members more responsible. With the amount of efforts each team member put in, I always believed that we would achieve significant results one day."

The strong placement in PetroBowl comes shortly after the student chapter was notified in May 2021 that it had been chosen for the Presidential Award.

"It was unbelievable – we had never won it before," Ohazuruike said. "The award recognizes the top 5 percent of SPE chapters around the world. Winning it in the very unique circumstances caused by the pandemic made it even more special. At the start of the board year, we set this award as our goal, and laid out our strategy to get it. Actually winning still felt unbelievable. We just wanted to win it for UH, because we believed UH deserved it so much. The support from the Petroleum Engineering Department, faculty members, students and more needed to be recognized globally. "

The chapter has seen tremendous growth. It ranks swelled to 548 for the 2020-21 academic year, from less than 300 the previous year. Ohazuruike said they've made an effort to reach out to students beyond the Petroleum Engineering Department – to other engineering disciplines, along with science and business majors that are interested in the industry.

Because of the pandemic, Ohazuruike said they also looked closely at how they raised money and spent it. They developed fundraising strategies for fully in-person, fully virtual and a hybrid year, and tried to engage with professional companies earlier and more often on events.

"We met with company representatives virtually to sell them our plan for the year and get their commitment," he said. "More than 30 companies were on board for different kinds of events – tournaments, info sessions, resume reviews, mock interviews, mentoring and other activities. Thanking these volunteers and company reps was an integral part of our strategy, because we needed to build a relationship that subsequent SPE boards could benefit from. We also followed a similar strategy for our collaborations with student organizations. All these was driven by our team's deep desire to support our UH students, faculty and the Houston community. Our 27 person team ended up executing 106 events and programs."

Ohazuruike highlighted some of the unique programs they ran this year:

- A Peer Afar was a mentorship program targeting international students that could not enter the United States due to travel restrictions.
- The Houston Strong PC Drive collected old PCs, repaired them and distributed them to low-income families that were forced to study from home.
- Digitalization School comprised of Python and the Machine Learning bootcamps.

The last effort was especially intensive. Students partnered with the Hewlett Packard Data Science Institute (HPE DSI) to deliver a two-day Python training session, open to all majors, with 124 students participating. Based on student performance at the Python boot camp and other requirements, 20 students were selected for an intensive nine-week Machine Learning boot camp. The program culminated in a Machine Learning competition with five teams of four students vying for prizes.

"We collaborated with i2k and Halliburton to judge their presentations," Ohazuruike said. "The industry professionals were so pleased that they made additional donations to the winning teams. Halliburton offered them scholarships to Nvidia's deep learning institute, while i2k's development team mentored them on taking their projects further."

While Ohazuruike remains involved with UH SPE, he is in the fourth year of his Ph.D. program, and as a result, he serves as more of an advisor for the current UH SPE board. **Randy Jordan** has taken over as the new president of the organization. However, Ohazuruike was proud of the success that UH SPE had the previous year, as it netted more than 10 different awards.

"In summary, all we thought of was how to support our members to be successful, help our community through Covid, while growing our chapter," he said.

Nguyen earned her B.S. in petroleum engineering in Summer 2021, and is now pursuing an M.S. in engineering data science. A new graduate student – and a new mother – she continues with the group as its treasurer.

"The people that I am working with are the main reasons I'm involved and passionate about volunteering for SPE," she said. "In SPE, everyone works hard, studies hard and plays hard. We always have fun and meaningful events. Besides keeping up the good traditional work, I think a way for UHSPE to grow in the future is keep diversifying. We need to bring more people with different background to the family, let them get involved, contribute their new ideas and make those ideas come true."

UH Fields Team in National Collegiate Marine Energy

COMPETITION

BY STEPHEN GREENWELL

A team of students at the Cullen College of Engineering are among 17 nationwide competing in the 2022 Marine Energy Collegiate Competition, which challenges them to propose unique solutions to the burgeoning marine energy industry.

This is the third installment of the competition, and the first time UH has been involved. This year's teams have been given the four goals to guide their entries:

1. Develop a market-research-supported business plan and conceptual-level technical design of a system that could be commercialized to address power needs for a chosen sector of the blue economy.

2. Pitch their plan to a panel of judges and hypothetical investors.

3. Design, build and test a device to achieve energy production. (Optional.)

4. Engage with their community through outreach and educational activities.

The student leader of the UH team is **Sameera Rednam**, who earlier this year, was one of two scholarship award winners from the Society for Underwater Technology. The other winner, **Damilola Abe**, is also involved with the MECC effort.

"As a Subsea student, we study marine engineering closely. Specifically, carbon capture was a topic I wanted to look into more and I thought this platform would be perfect for me," Rednam said. "My main motivation is the collaboration of different students from varied backgrounds, where I learn so much every day. Our project can have a positive impact, and that drives me to perform my best."

Faculty advisors for the team include **Shilpa Ghuyre**, Industrial Relations and IP Manager; and **Hanadi Rifai**, Moores Professor of Civil and Environmental Engineering and Associate Dean of Research and Facilities. Other members of the UH MECC effort include: **Teja Akula**, '23; **Akash Doshi**, '22; **Harrison Ngo**, '24; and **William Ritchie**, '23.

As part of the competition, the team will have to produce a 20 to 30-page market research supported business plan; a 20-minute public pitch to present to a panel of judges, followed by a public 15-minute Q&A session; and a poster summarizing the entire technical and business plan. The presentations will be done in-person or virtually as part of Waterpower Week in Washington 2022, from April 5 to April 7, 2022.

Ponnapati Recognized as

OTC EMERGING LEADER

BY STEPHEN GREENWELL

> *"When I'm speaking to students, my advice is to look for opportunities for teamwork and collaborations with peers, and to stay thirsty to learn new things."*
>
> - RAMAKRISHNA PONNAPATI

PICTURED ABOVE: RAMAKRISHNA PONNAPATI

An interest in a variety of fields led **Ramakrishna "Rama" Ponnapati** to pursue his graduate research at the University of Houston, and that same drive to excel in multiple fields and to encourage the growth of others has led to his status as one of the members of the inaugural class of the Emerging Leaders Program of the Offshore Technology Conference.

Originally founded in 1969 and now one of the 200 largest trade shows internationally, OTC is sponsored by 13 industry organizations and held annually in Houston. Ponnapati is part of an initial class of 13 young leaders. He works as a Techno-Commercial Manager for Baker Hughes, one of the world's largest oil field service companies, with more than $20 billion in annual revenue.

Ponnapati noted that outreach, and encouraging young graduates when they want to get into industry, is now a part of his job. That was part of why he was recognized with membership in the Emerging Leaders Program.

"I always enjoy mentoring students and early career peers," he said. "In fact, I serve as the university recruiting champion for UH for Baker Hughes, and I visit campus a couple of times every year with my teams for career fairs to meet and conduct interviews and hire great talent from UH. When I'm speaking to students, my advice is to look for opportunities for teamwork and collaborations with peers, and to stay thirsty to learn new things. What you learn in school may not be what you will be using at your job, but it will help you learn what you need to learn quickly. Set up a goal and make sure you are having fun working toward it."

Practicing what he preaches, Ponnapati adapted his skill set and his educational goals while he was a student. He earned his doctorate in chemistry from the College of Natural Sciences and Mathematics at UH in 2009, studying under Rigoberto Advincula. However, he followed this with a postdoc for two years with Ramanan Krishnamoorti, in the Cullen College of Engineering's Chemical and Biomolecular Engineering Department, as it was known at the time.

"The UH Chemistry Department offers cutting-edge research projects and world class facilities for research, along with great faculty, particularly organic chemistry and material sciences, which attracted me towards the program," he said. "After I graduated with my Ph.D., Professor Krishnamoorti had a project on enhanced oil recovery (EOR) using nanotechnology in collaboration with Chevron and UT Austin. I joined Dr. K's lab as a postdoctoral fellow, where I utilized my organic chemistry and nanotechnology knowledge to produce results on EOR projects."

While at UH, Ponnapati was recognized with several achievement awards – the John Lomonte Outstanding Teaching Assistant in Organic Chemistry Award in 2007, and in 2008, the SPE's Graduate Research Award and the Excellence in Graduate Polymer Research Award, sponsored by the ACS Division of Polymer Chemistry. He attributed that success – as well as landing his first job, and several awards for performance at Baker Hughes – to the support and bedrock education he received from his various professors.

"I can never forget professor Randolph Thummel's advanced organic chemistry teaching, and I still use that knowledge in my career. His passion for teaching is certainly inspiring. My advisor, professor Gobet Advincula, I was fortunate to be part of his dynamic research team with multidisciplinary projects that gave us opportunities to learn and excel in many areas such as organic and polymer chemistry, electro-optical polymers, materials science and nanotechnology. During my time at Professor Advincula's lab, I was able to collaborate with many research teams globally and authored or co-authored 28 peer-reviewed papers in high impact journals in grad school alone. This was not only satisfying personally, but helped me in my career. Finally, Professor Krishnamoorti introduced me to oilfield chemicals and chemical engineering. He personally taught me how to use rheometers, and he is one of the best. This exposure landed me at Baker Hughes."

READ MORE ABOUT THE 2021 OFFSHORE TECHNOLOGY CONFERENCE EMERGING LEADERS: *www.otcnet.org*

ALUMNI

Eray Aydil Named

CHAIRMAN AT NYU

BY STEPHEN GREENWELL

"UH provided my first teaching opportunity, and I fell in love with teaching."

- ERAY AYDIL

PICTURED ABOVE: ERAY AYDIL

When **Eray Aydil** started at the Cullen College of Engineering in 1986, he didn't realize that he would be experiencing so many new opportunities for his professional development, research interests, and even his personal life.

Aydil initially planned to study with then UH-professor **Harry Deans**, who was known for inventing the field of Enhanced Oil Recovery. Aydil had done an internship with Standard Oil of Ohio, and his uncle and others that worked there encouraged him to study with Deans. However, he learned that Deans was leaving the department, and **Dan Luss** steered him toward a new advisor – **Demetre J. Economou**, who had joined the department as an assistant professor.

"He was just starting and setting up his lab, and he needed students," Aydil said. "I had double-majored in chemical engineering and materials science, which related to his research interests. I also liked his attitude and energy and the opportunity to set up a lab from scratch. Looking back, it is ironic that my research field now is renewable energy, given my initial interest in petroleum."

Aydil would earn his doctorate in chemical engineering from UH in August 1991. Then, after a two-year stint as a postdoctoral member of the staff at AT&T Bell Laboratories, he started as an assistant professor at the University of California Santa Barbara. He stayed there until March 2005, becoming a full professor and vice chairman of the Department of Chemical Engineering. Then, in 2005, the top-ranked University of Minnesota Chemical Engineering Department came knocking on his door, and he moved to Minnesota, where he spent thirteen years as a professor and five of those years as the department's Executive Officer.

"Those were special years, teaching at a department [Dr. Neal. R.] Amundson had built into the top-ranked program in the country before moving to the University of Houston. My office was in the "Amundson Hall," and every day, I was reminded of him and my days at the University of Houston.

In September 2018, Aydil joined the faculty at New York University's Tandon School of Engineering as the Alstadt Lord Mark Professor of Chemical and Biomolecular Engineering. In September 2021, he was promoted to chairman of the department.

However, it all started at the University of Houston, where Aydil received his first teaching opportunity, and the faculty recognized him with the Teaching Excellence Award in 1991.

"UH provided my first teaching opportunity, and I fell in love with teaching," he said. "There was an opening to teach thermodynamics to engineering students, and I applied for the position. I taught it a couple of semesters, and that is when I received the Teaching Excellence Award. I was still a graduate student. I have since taught undergraduate and graduate-level thermodynamics on and off. In fact, I am working on a graduate-level book now that combines chemical engineering and materials science thermodynamics. Although, I think the department chair position will put this book writing project on pause."

When asked if he kept in touch with anyone from his time at UH, Aydil had an easy answer.

"There is one peer I keep in touch with every day – my wife, Dr. **Marianne Aydil**, who did her Ph.D. with Professor **Vemuri Balakotaiah**. We met in grad school, and we got married when I graduated. She joined the department one year after me and graduated a year later."

Aydil said he also keeps in touch occasionally with Rusty Lacy and ***Fred Wasden***. They worked in the basement labs with **Abe Dukler**, adjacent to Aydil. Lacy is now a senior flow assurance engineer with Shell, and Wasden works as a consultant after a 31-year career at Shell.

Beyond Economou, Aydil said that several other professors at the Cullen College of Engineering and beyond shaped him into the educator and researcher he is today.

"Professor **Neal Amundson** was very instrumental in my educational development," Aydil said. "I loved his math class. He also helped me secure my first faculty interviews. I did not know this at the time, but the schools who interviewed me told me that he had called them about me. I also liked the organized classes by professors Balakotiah and Dukler very much. I liked that they were methodical and exposed the subject in an organized way."

Postdoc Pouladi Takes Home

ANOTHER AWARD

BY STEPHEN GREENWELL

"It was a great pleasure and honor for me to be selected for the best poster award for the second time in the worldwide, prestigious IEEE Photovoltaic Specialists Conference."

- SARA POULADI

PICTURED ABOVE: SARA POULADI

A doctoral graduate of the Cullen College of Engineering's mechanical engineering program has taken home another award for a poster presentation, her second while affiliated with the college.

Sara Pouladi, a postdoctoral researcher, earned the honor at the 48th IEEE Photovoltaic Specialists Virtual Conference, held in June 2021. Her poster, "Effect of Low-Angle Grain-Boundary Passivation in Flexible Single-Crystal-Like Thin-Film GaAs Solar Cells," was recognized as the best of the conference. She also won a similar award in 2017, at the 44th PVSC.

"It was a great pleasure and honor for me to be selected for the best poster award for the second time in the worldwide, prestigious IEEE Photovoltaic Specialists Conference," she said.

Pouladi's poster described the work she is doing as part of the research group of **Jae-Hyun Ryou**, Ph.D., an associate professor in the Mechanical Engineering Department of the Cullen College of Engineering. She has been researching improvements in inexpensive flexible solar cells as of late.

"We recently reported significant advances in the science and technology of photovoltaic energy harvesting – solar cells – by introducing a new type of material platform," she said. "This single-crystal-like gallium arsenside (GaAs) thin film on metal tape offers the potential for high efficiency, low cost, high-throughput manufacturing, and mechanical flexibility for GaAs solar cell."

Pouladi added, "In the current work presented at PVSC 2021, we reported a big boost by a factor greater than two – from 6.1 percent to 13.5 percent – for this newly developed flexible solar cell by effective passivation of major defects existing in the new type of material. The improvement mechanism was systematically investigated by both modeling and experimental materials characterizations. We suggested a viable technological direction to achieve conversion efficiency greater than 20 percent from this materials platform. In summary, our work proposes a critical solution for an existing challenge in PV technology. Our study lays a solid technical foundation for flexible single-crystal-like GaAs solar cells to become a major PV materials technology."

PICTURED: SARA POULADI (2ND FROM LEFT), AWARD WINNER AT THE 44TH IEEE PHOTOVOLTAIC SPECIALISTS CONFERENCE IN WASHINGTON D.C.

Ryou also served as the advisor for Pouladi's doctorate, which she earned in January 2020. She has stayed on at the Cullen College of Engineering as a postdoc since then. In addition to her poster awards, she earned the 2018 Albert Thumann in the Foundation of the Association of Energy Engineers (FAEE).

Pouladi is looking to continue her research work in the future, whether that's in an academia setting or an industry job.

"My research field is on semiconductor materials and devices for photonic, electronic and energy applications, such as photovoltaic solar cells (SCs), field-effect transistors (FETs), high-electron mobility transistors (HEMTs), light-emitting diodes (LEDs), and piezoelectric generators (PEGs) and sensors with a special focus on employing less harmful and more environmental-friendly materials and fabrication processes for these devices," she said. "I'm open to continuing my research in this high-tech field through industry or academia, which will greatly benefit our plans for a clean Earth by commercializing and reducing the cost of clean energy in near future."

LIENHARD'S LENS BY JOHN LIENHARD

GRAFFITI

PHOTOGRAPHY BY JOHN LIENHARD

YouTube

WATCH THIS EDITION OF LIENHARD'S LENS COME TO LIFE AT:
youtube.com/UHEngineering

Today, it all began with graffiti.

Graffiti is not a nice word. It calls up nasty vandalism. But graffiti has now given birth to lovely wall murals. That reminds us of another disruptive activity: namely invention. The ancient Greeks saw invention as a kind of trickery. The idea that we use machinery to fool nature. Sure, any invention brings revenge effects along with it. But its fruits can be wonderful.

Invention and art are both built into our bones – part of who we are. And remember: radically new inventions don't emerge from corporations, but from the garage. No big company gave us airplanes, automobiles, radios, computers, or … hula hoops. Same with any new art form: Art begins with expressive rebellion. And, we're back to graffiti:

People have spilled their anger out on walls since before Pompeii. But anger and protest alone can't make art – any more than necessity alone can produce invention. Something more has to be there. Both rise from our deep desire to create beauty.

Wonderful things emerge when that aesthetic impulse takes over. So: back to graffiti: People – usually people living on the fringes – have begun with protest. But as they wield their cans of spray paint, they create increasing beauty. Protest might remain, but protest mutates into part of the solution. Street Art has become a new way to make a plain world, beautiful.

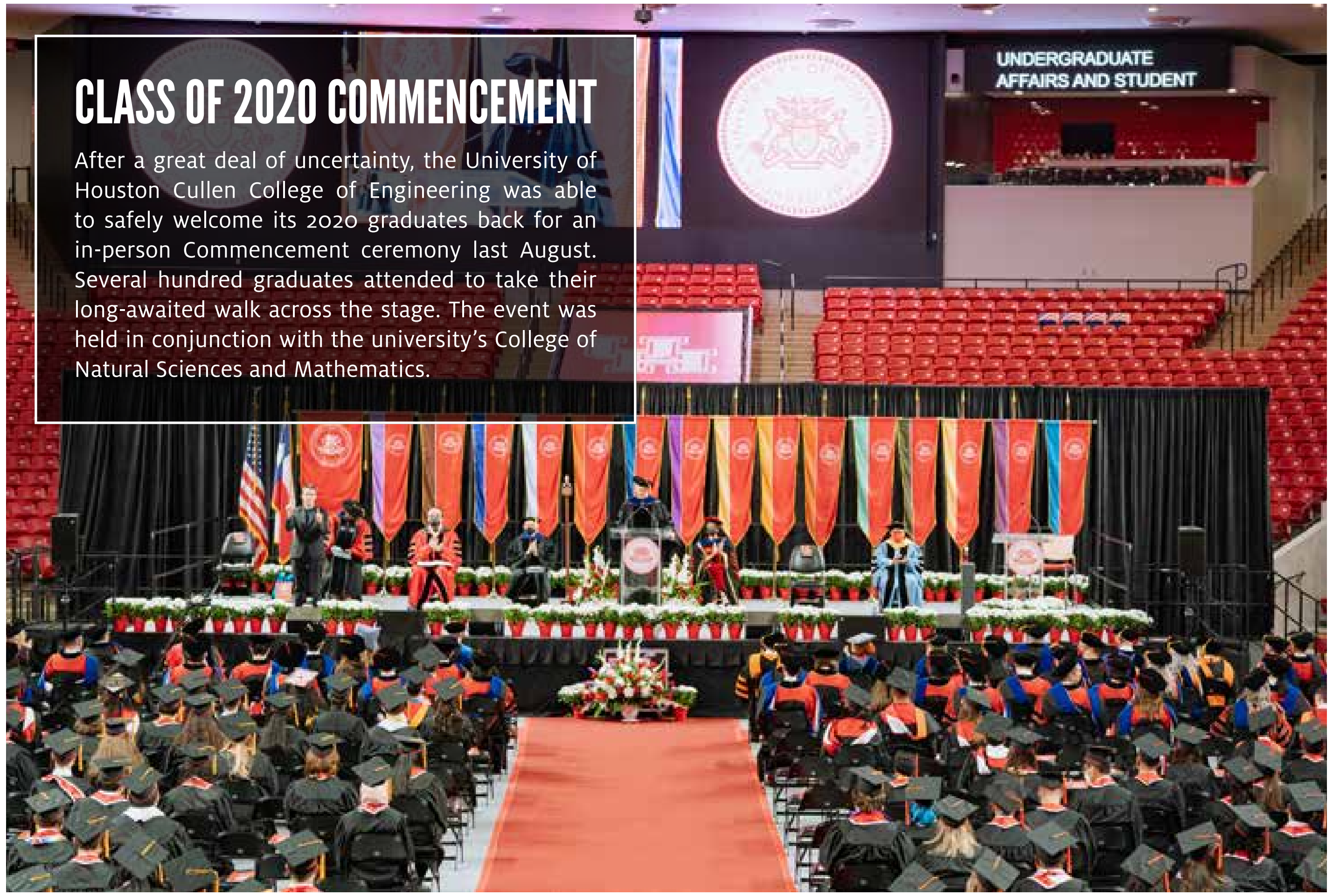
Workplaces have become public art museums. Here in Houston, the walls of an XL Auto Parts store display astonishing murals. The walls of the St. Arnold Brewery warehouse offer lovely images. Serious art now lights up walls in scores of local workplaces.

And, as I open my eyes to this urban art, I realize we're seeing its evolution in midstream. Look at graffiti on railway cars. People paint it furtively, and in haste. Only now and then does it reach a level we'd call beautiful.

Or look inside the gun turrets on Peaks Island: They once held huge 16-inch guns in the Portland, Maine, harbor during WWII. Artists have since gone to work in limited light and made art in those concrete caverns. But now … vandals have scribbled over that art – come full circle and reclaimed the nasty original sense of the word graffiti.

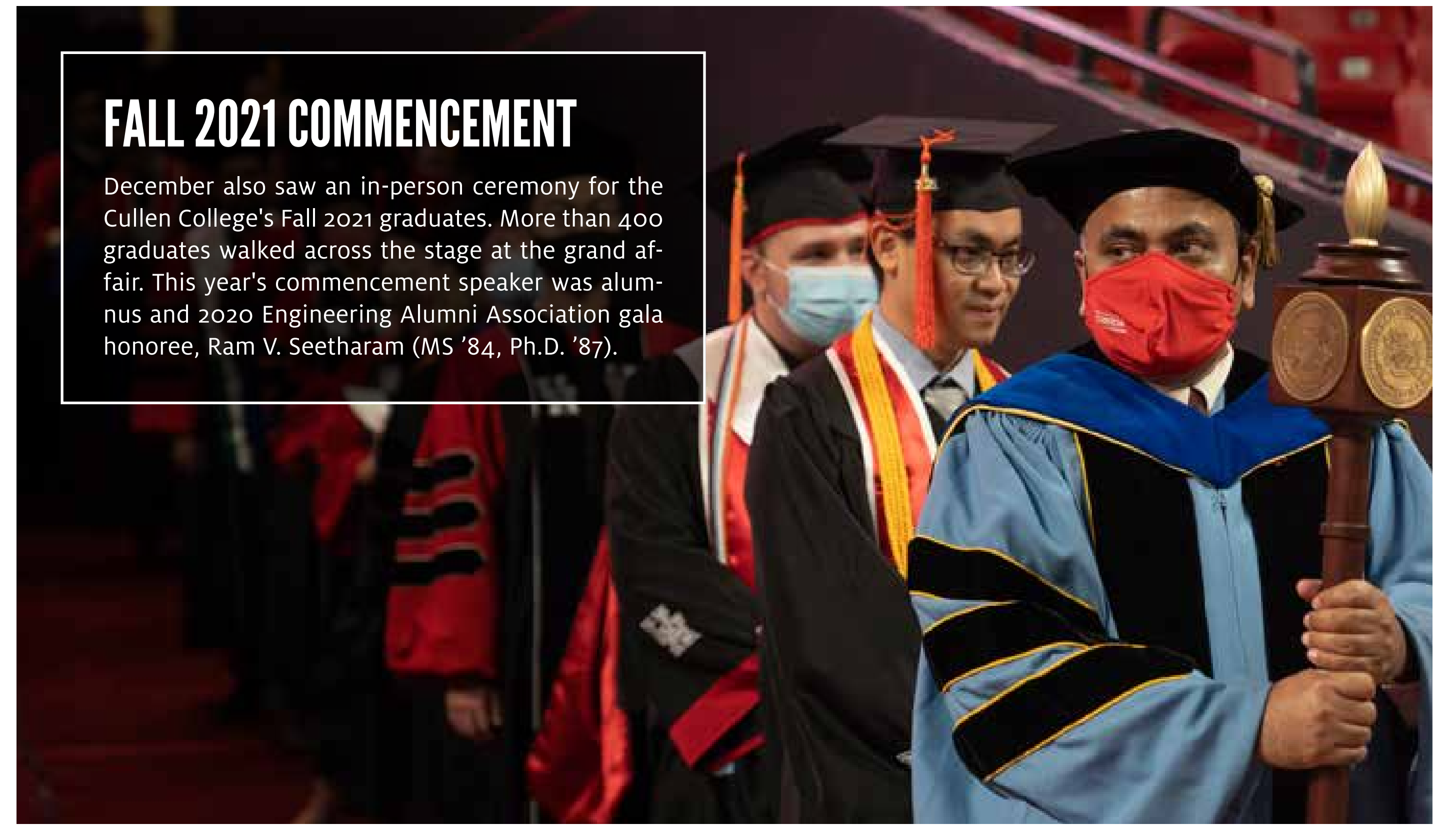
Maybe that's what it means to have made it in the art world: Maybe having your murals defaced with graffiti marks you as having arrived. And we're back to invention: We create new media – radio, TV, Internet. Then others come along and use those media to spread hate and lies. We build, then we sully what we've made. Then we build again.

So urban murals, born in graffiti, now recognized as art, reach fine levels of both beauty and intensity. Go out and look at these uncelebrated open air museums in your city or mine. Wondrous and unexpected, they leave us moved by what we see.



CLASS OF 2020 COMMENCEMENT

After a great deal of uncertainty, the University of Houston Cullen College of Engineering was able to safely welcome its 2020 graduates back for an in-person Commencement ceremony last August. Several hundred graduates attended to take their long-awaited walk across the stage. The event was held in conjunction with the university's College of Natural Sciences and Mathematics.



FALL 2021 COMMENCEMENT

December also saw an in-person ceremony for the Cullen College's Fall 2021 graduates. More than 400 graduates walked across the stage at the grand affair. This year's commencement speaker was alumnus and 2020 Engineering Alumni Association gala honoree, Ram V. Seetharam (MS '84, Ph.D. '87).

ENGINEERING ALUMNI ASSOCIATION GALA

The Engineering Alumni Association (EAA) welcomed honorees, alumni and faculty back for an in-person Gala last November. The annual event celebrates the professional achievements and contributions of college alumni and faculty. Honorees included Carlos de Aldecoa Bueno (BSIE '97), Vikrant Lakhanpal (MS PETR '16), Erick C. Jones (MSIE '96, Ph.D '03), Charles Roxburgh, P.E. (BSPE '62, MSPE '63), and professors Frank J. "Fritz" Claydon and Haleh Ardebili.

ENGINEERING ALUMNI ASSOCIATION ANNUAL MEETING AND NETWORKING SOCIAL

The Engineering Alumni Association (EAA) held its annual meeting last October at the Powder Keg. The event furthers the EAA's mission of championing, supporting and uniting the Cullen College's students, faculty and alumni.

To learn more about events and outreach at the Cullen College,

visit **www.egr.uh.edu/events** or follow us on social media!

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View more photos online at

www.flickr.com/photos/cullencollege/albums

ENGINES OF OUR INGENUITY

NO. 802: BLUEPRINT

Today, eerie drawings bind concept to reality. The University of Houston's College of Engineering presents this series about the machines that make our civilization run, and the people whose ingenuity created them.

The word "blueprint" is a little like the word "coach." The old name carries into so many modern technologies that we forget that the original is gone. Once we made working drawings on a hard translucent paper called vellum. Then we laid the vellum on light-sensitive paper and ran it by a bright light. The exposed paper turned deep blue. The lines stayed white.

Now here's the catch: The last time I made a real blueprint from one of my drawings was 1949. So I've been asking friends, "When was the last time you saw a blueprint?" Most of them tell me, "The day before yesterday." Most people know exactly what blueprints are and think they're still in use.

If you really have seen one lately, it had to be in an old archive. Blueprints died out during the '50s. They were replaced by related processes like Ozalid and blueline.

John Herschel, son of astronomer William Herschel, invented blueprinting in 1842. He too was a great astronomer. He was a mathematician, chemist, and inventor as well. Herschel was the first Englishman to take up photography. After Herschel, blueprinting changed little for 120 years. Maybe, as a child, you photographed leaves by laying them on blueprint paper in the sun.

But by 1960 those ghostly negative images, white on blue, gave way to more obvious pictures with dark lines on a white field. Machinists no longer had to invert images in their minds before they carved them into wood and steel. Still, the people I talk to cannot quite forget those ectoplasmic negative realities.

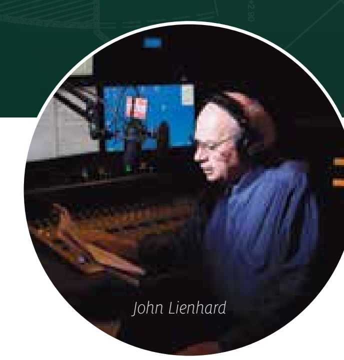
A friend recently handed me a remarkable book of 26 designs along with their blueprints. Grand Central Station and the Spirit of St. Louis. The Volkswagen Beetle and Washington Cathedral.

Look at the plans for Hoover Dam. They reveal a massiveness we cannot see in Arizona. The dam is as thick at its base as it is high. In Arizona we see the tips of its intake towers floating like water lilies behind the dam's delicate lip. The feathery mass of the white on blue plan is barely kin to the porcelain appearance of the real thing.

So blueprint has become more than a word -- more than an apt icon for a plan, or an intent, or a hope for the future. Those eerie negative images remind us that, when we invent, we see darkly -- as through a glass.

The thing in the mind and the thing in the world are curiously disjunct. But that's where genius enters. Great designers create two realities at once. Good design is hard just because it means building a blueprint in the mind -- for an engine that must one day live and act in the corporeal world.

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



John Lienhard

The Engines of Our Ingenuity is a nationally recognized radio program authored and voiced by John Lienhard, professor emeritus of mechanical engineering and history at the University of Houston and a member of the National Academy of Engineering. The program first aired in 1988, and since then more than 3,000 episodes have been broadcast.

FOR MORE INFORMATION ABOUT THE PROGRAM, VISIT:
www.uh.edu/engines

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