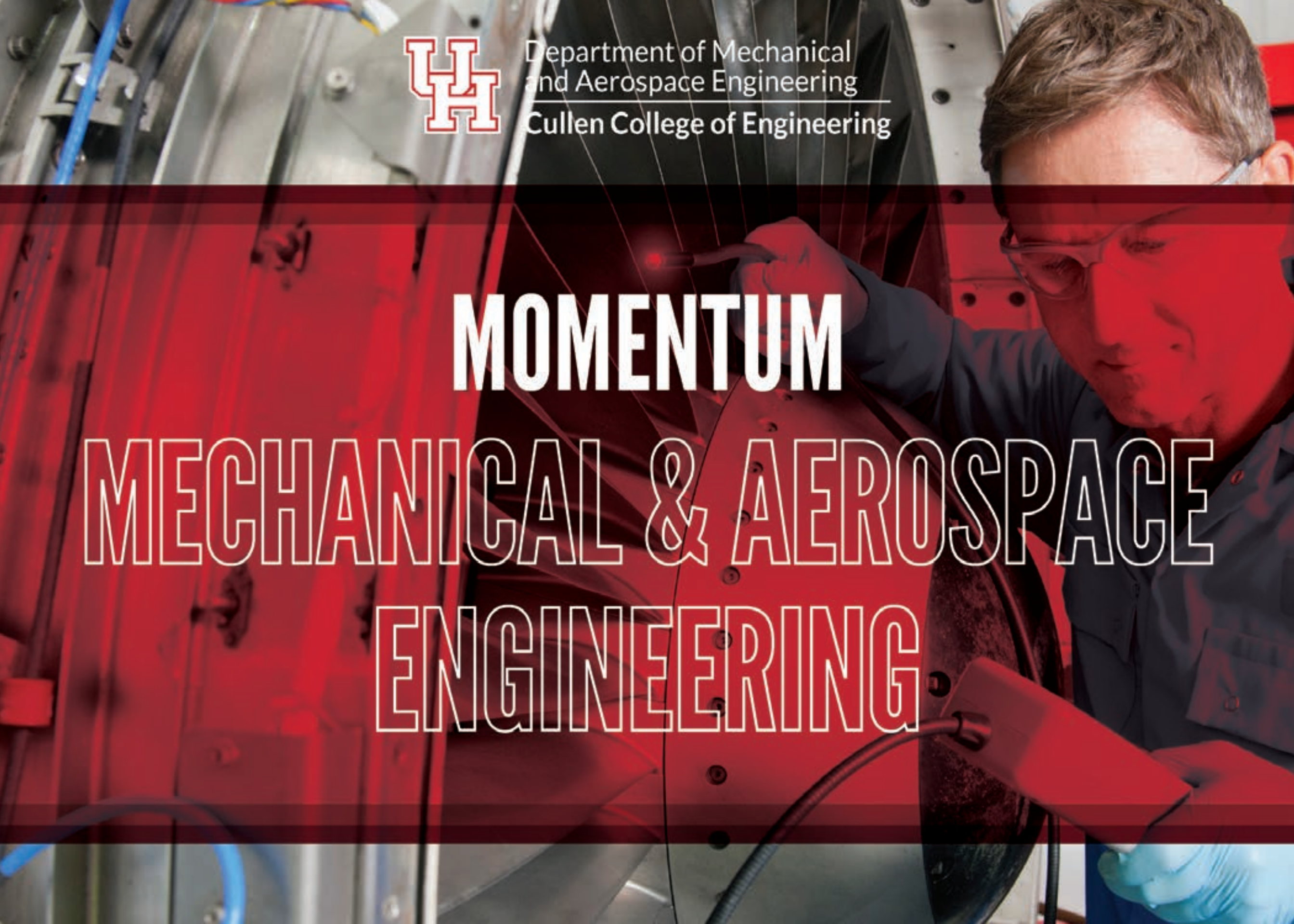


Department of Mechanical
and Aerospace Engineering
Cullen College of Engineering

MOMENTUM

MECHANICAL & AEROSPACE ENGINEERING

MAE'S SELVA SECURES $8M IN FEDERAL FUNDING FOR FUSION RESEARCH

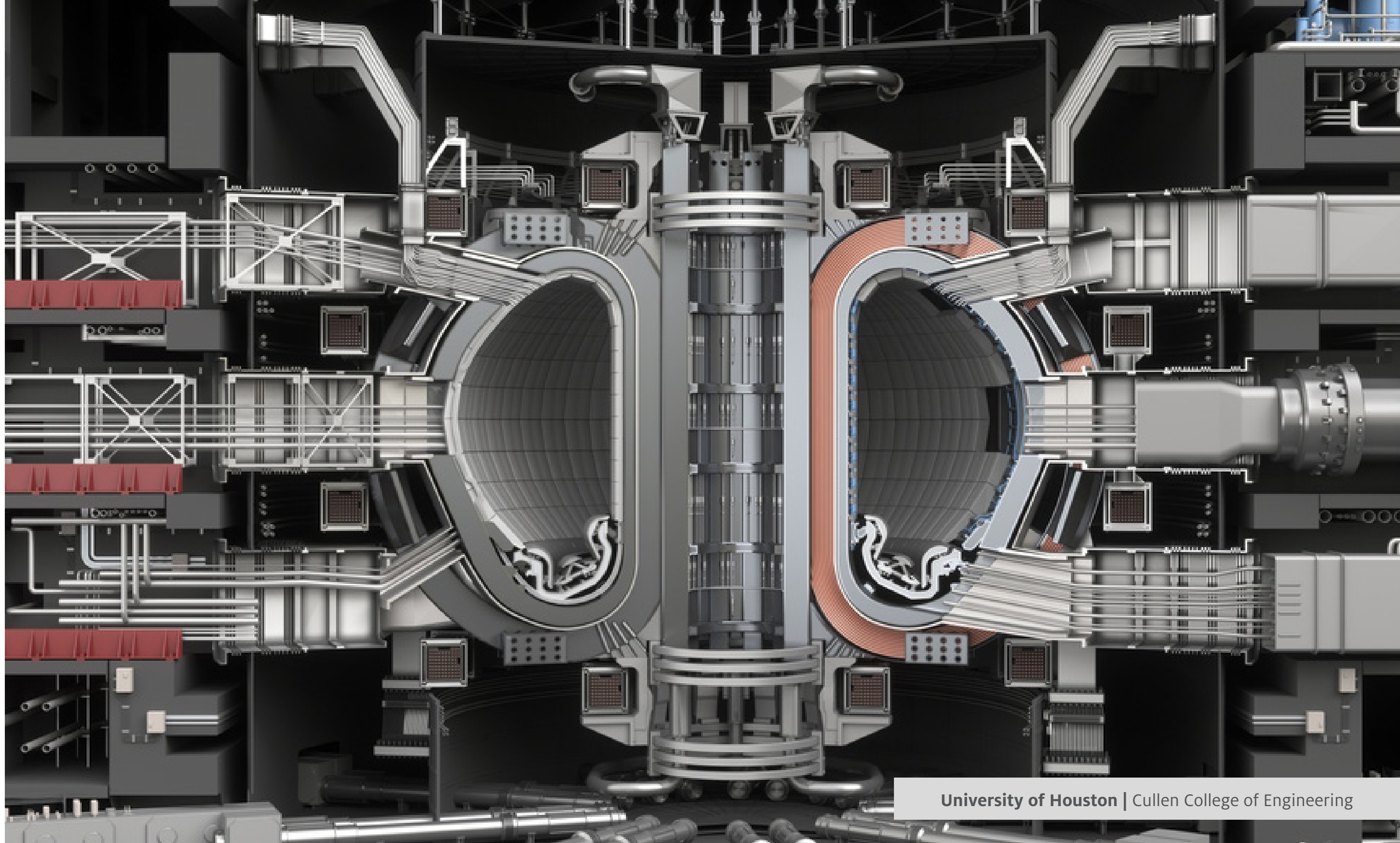
The University of Houston, a global leader in energy research and innovation, will receive $8 million in federal funding to help ensure the U.S. remains at the forefront of fusion technology.

UH is one of 23 institutions around the country, and the only one in Texas, that will share part of $134 million from the U.S. Department of Energy. **Venkat Selvamanickam**, M.D. Anderson Chair Professor of Mechanical & Aerospace Engineering and director of the Advanced Manufacturing Institute, will lead research on superconducting magnets. Selva said these make compact fusion reactors possible.

"I've dedicated 38 years to advancing superconductor technology, and my goal is to unlock the full potential of this magical technology for society," said Selva, who secured UH's role in the research initiative. "Beyond fusion, superconductors can transform how we deliver power to data centers, enable highly efficient motors and generators and improve electric power devices. They also enable critical applications such as MRI and proton beam therapy for cancer treatment. I want society to experience the broad benefits this remarkable technology can provide."

The funding comes from the DOE's Fusion Energy Sciences division, which is tasked with developing an energy resource through fusion, the same type of energy the sun produces, Selva said.

The total funding is split across two initiatives: $128 million for the Fusion Innovation Research Engine and $6.1 million for the Innovation Network for Fusion Energy program.



UNIVERSITY OF HOUSTON ENGINEER CREATES A POSSIBLE REPLACEMENT FOR PLASTIC

In a world overrun with plastic garbage, causing untold environmental woes, University of Houston assistant professor of mechanical and aerospace engineering, **Maksud Rahman**, has developed a way to turn bacterial cellulose — a biodegradable material — into a multifunctional material with the potential to replace plastic.

Yes, it has the potential to become your next disposable water bottle, and so much more, like packaging material or even wound dressings — all made from one of the Earth's abundant and biodegradable biopolymers: bacterial cellulose.

"We envision these strong, multifunctional and eco-friendly bacterial cellulose sheets becoming ubiquitous, replacing plastics in various industries and helping mitigate environmental damage," said Rahman, who is reporting his work in Nature Communications.

"We report a simple, single-step and scalable bottom-up strategy to biosynthesize robust bacterial cellulose sheets with aligned nanofibrils and bacterial cellulose-based multi-functional hybrid nanosheets using shear forces from fluid flow in a rotational culture device. The resulting bacterial cellulose sheets display high tensile strength flexibility, foldability, optical transparency, and long-term mechanical stability," said M.A.S.R. Saadi, a doctoral student at Rice University, who served as the study's first author. Shyam Bhakta, a postdoctoral fellow in Biosciences at Rice, supported the biological implementation.

"This scalable, single step bio-fabrication approach yielding aligned, strong and multifunctional bacterial cellulose sheets would pave the way towards applications in structural materials, thermal management, packaging, textiles, green electronics and energy storage," Rahman said.

"We're essentially guiding the bacteria to behave with purpose. Rather than moving randomly, we direct their motion, so they produce cellulose in an organized way. This controlled behavior, combined with our flexible biosynthesis method with various nanomaterials, enables us to achieve both structural alignment and multifunctional

MAE'S FLORYAN EARNS AFOSR YOUNG INVESTIGATOR PROGRAM AWARD FOR ENERGY EFFICIENCY RESEARCH

Daniel Floryan, Kalsi Assistant Professor of Mechanical & Aerospace Engineering, has been selected for the 2025 Young Investigator Program Award by the Air Force Office of Scientific Research.

His research proposal, "Breaking Energy Efficiency Limits in Unsteady Wall-Bounded Flows," was chosen from more than 150 proposals. The total award amount is $450,000, spanning three years.

When airplanes fly through air, they expend tremendous energy cutting through the friction of the air. There is a long-standing interest in manipulating the airflow close to the airplane to reduce the required energy. Unfortunately, despite devoted research efforts to it over the years, net energy savings have plateaued around 10 percent.

"Our ability to surpass this level of energy savings is ultimately limited by energy bounds that derive from the governing dynamics of fluid flows," Floryan said. "We seek to develop a new class of flow control strategies that can break the established energy savings limits. This effort is guided by our theory that suggests that multi-modal control has great potential for energy savings."

Once the new flow control strategies have been developed, his research will attempt to combine newly understood physical mechanisms with methods from optimal control theory to refine control strategies, resulting in a step-change in the energy-savings capabilities of flow control.

Daniel Floryan
Assistant Professor

MAE'S ZHAO RECEIVES NSF CAREER AWARD

Mechanical and Aerospace Engineering's Assistant Professor **Bo Zhao** has been awarded $549,770 for his NSF CAREER proposal, "Understanding and Controlling Nonreciprocal Thermal Radiation Exchange Between Surfaces."

The project seeks to challenge a centuries-old law, which would fundamentally change our understanding of the characteristics of light transport and potentially have a significant impact on the efficiency of solar energy harvesting and thermal management systems.

"Water flows because water at a higher elevation has more potential energy than water at a lower elevation; the flow is driven by this potential energy difference. What I do is another energy flow: not water, but sunlight," said Zhao.

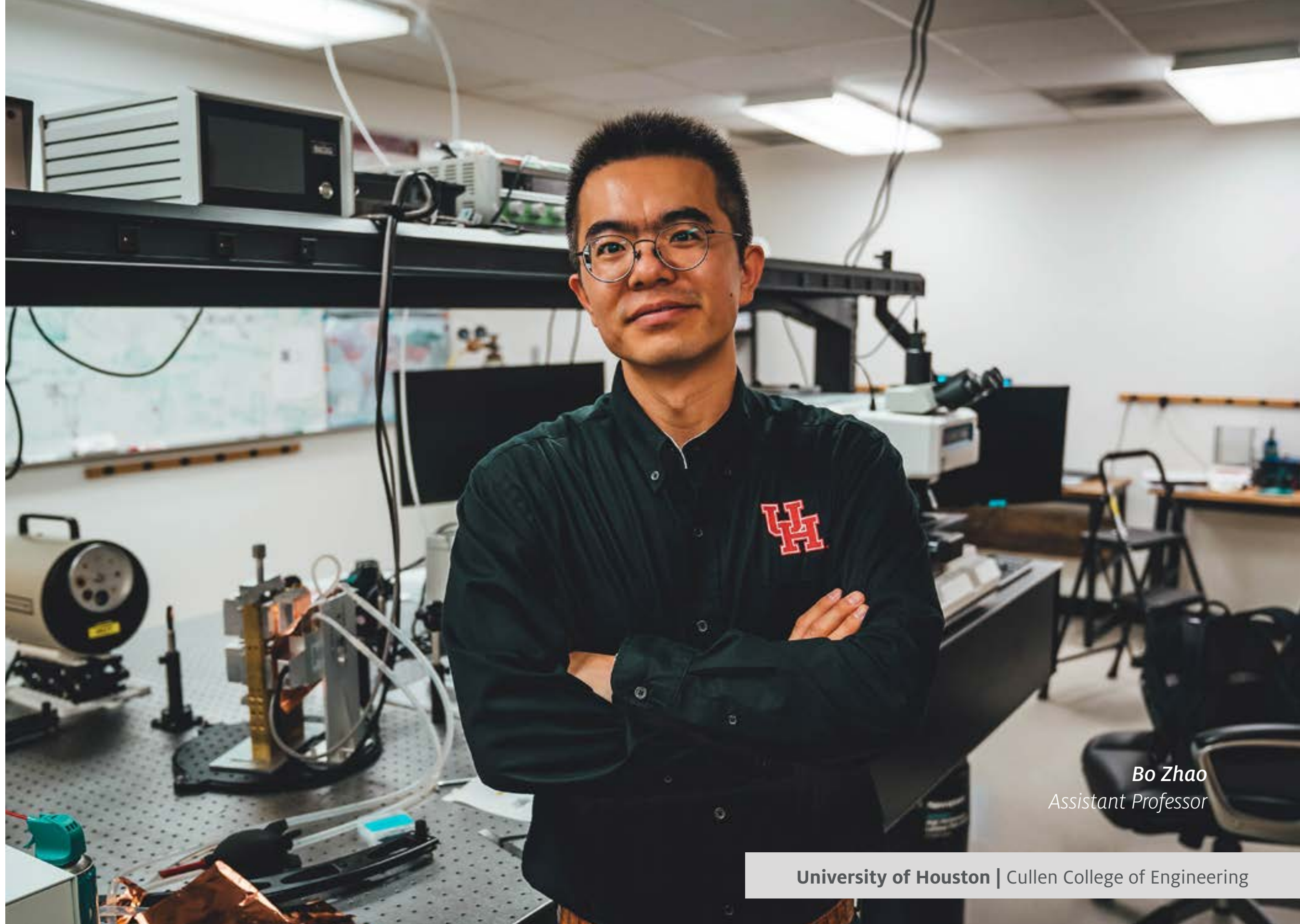
Sunlight also carries energy in its waves — electromagnetic waves — but flows in a slightly different way.

"Usually a high-potential object emits energy outwards, but for sunlight or other similar radiation or electromagnetic waves, the reverse can happen: something cold can also transport [energy] back to the hotter high-potential object. My research is trying to remove this constraint for light transport," he said.

One of many reasons that this research is of interest is the potential for increased efficiency in solar energy capture. If sunlight could be made to only flow unidirectionally, without transporting any energy back toward the sun itself, then cascaded energy harvesting devices could allow for more complete and more useful collection of solar energy without waste due to reemission.

"From a fundamental perspective," said Zhao, "what I do is try to break the so-called reciprocity of this transport process. I want to make light transport as one-way as possible."

In other words, if reciprocity is currently a window through which light can travel in either direction, Zhao is working to create a one-way window, transparent only in one direction.



Bo Zhao
Assistant Professor

UH RESEARCH CHALLENGES CONVENTIONAL THEORIES OF HOW CELLS DETECT ELECTRICAL FIELDS

Research Could Impact Development of Next-Generation Medical Devices, Biosensors, Therapies

The human body is a veritable cellular highway with up to 37 trillion cells traveling about and carrying out all essential life functions, from taking in nutrients and converting them to energy, to repairing a skinned knee. In large part, cells get their marching orders from electric fields influencing their functions.

In fact, new evidence from the University of Houston suggests that cells are incredibly sensitive to electrical fields, much more so than older scientific theories suggest.

“Our research challenges long-held assumptions about the limits of cellular electrical sensing and explains how cells detect electric fields with remarkable sensitivity,” reports **Yashashree Kulkarni**, Bill D. Cook Professor of Mechanical and Aerospace Engineering at UH in Proceedings of the National Academy of Sciences.

Kulkarni supervised the work of graduate student **Anand Mathew**, who led the research.

For decades, scientists thought cells couldn’t detect very weak electric fields because of “thermal noise” — tiny random movements caused by heat. It’s like trying to hear a whisper during a loud rock concert: the background noise drowns it out. Scientists believed this “noise floor” set the limit for what cells could possibly sense.

Kulkarni and Mathew’s study presents a compelling new explanation: active matter within the cell membrane can push the system out of equilibrium, enabling heightened electrical sensitivity.

The researchers created a new theoretical model using nonequilibrium statistical mechanics — a type of science that studies systems always using energy. The new model helps explain how electromechanical membranes in cells move and change in their active, energy-filled environment.


***From left to right:** Yashashree Kulkarni and Anand Mathew*

MAE'S RAHMAN, THAKUR REINVENTING CERAMICS WITH ORIGAMI-INSPIRED 3D PRINTING

In a breakthrough that blends ancient design with modern materials science, researchers at the University of Houston have developed a new class of ceramic structures that can bend under pressure — without breaking.

Potential applications for this technology range from medical prosthetics to impact-resistant components in aerospace and robotics, where lightweight — but tough — materials are in high demand.

Traditionally known for their brittleness, ceramics often shatter under stress, making them difficult to use in high-impact or adaptive applications. But that may soon change as a team of UH researchers, led by **Maksud Rahman**, assistant professor of mechanical and aerospace engineering and Md Shajedul Hoque Thakur, postdoctoral fellow, has shown that origami-inspired shapes with a soft polymer coating can transform fragile ceramic materials into tough, flexible structures. Their work was recently published in Advanced Composites and Hybrid Materials.

"Ceramics are incredibly useful — biocompatible, lightweight and durable in the right conditions— but they fail catastrophically," said Rahman. "Our goal was to engineer that failure into something more graceful and safer."

TWO UNIVERSITY OF HOUSTON PROJECTS NAMED FINALISTS FOR **THE $50 MILLION GULF COAST CHALLENGE**

Two University of Houston projects were named finalists in the $50 million Gulf Futures Challenge, highlighting UH's growing role in solving real-world challenges and creating solutions that benefit Texas and inspire coastal communities worldwide.

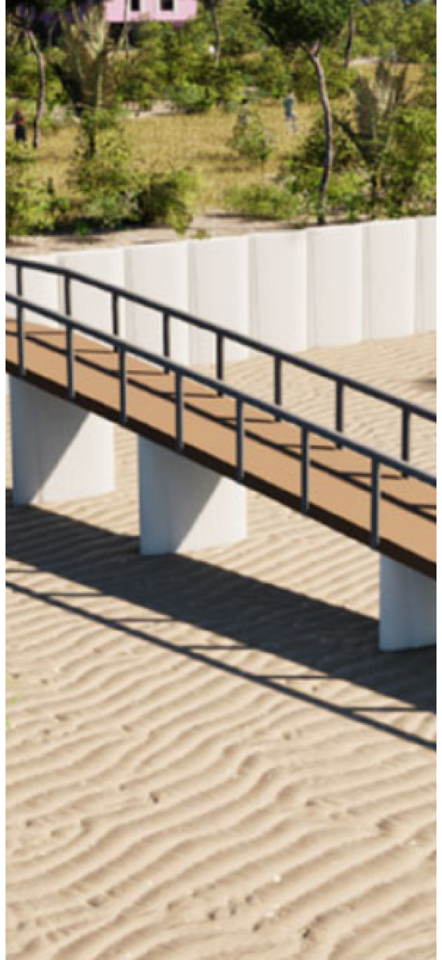
The prestigious competition, sponsored by the National Academies of Science, Engineering and Medicine's Gulf Coast Research Program and Lever for Change, seeks bold solutions for critical issues facing the region. The 10 finalists were selected from 164 entries, and all share a common goal of creating safer and more resilient communities where people along the Gulf Coast can live, work and thrive.

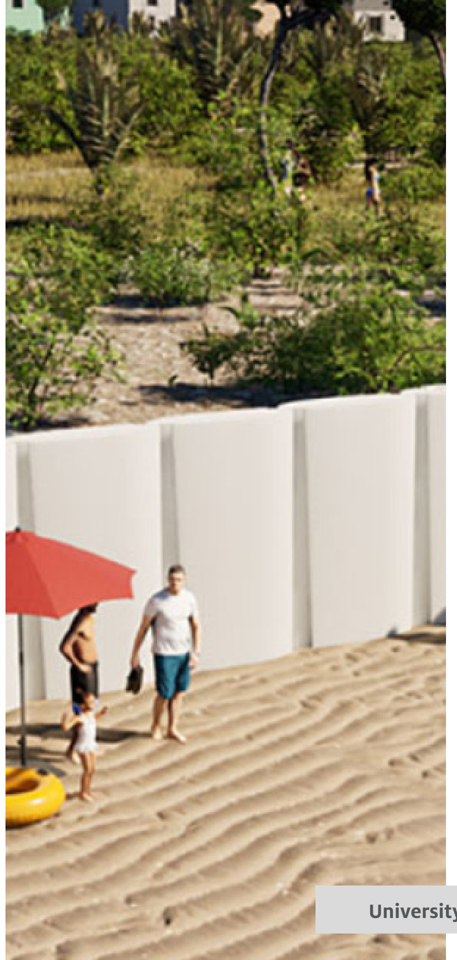
"Being named a finalist for this highly competitive grant underscores the University of Houston's role as a leading research institution committed to addressing the most pressing challenges facing our region. This opportunity affirms the strength of our faculty and researchers and highlights UH's capacity to deliver innovative solutions that will ensure the long-term stability and resilience of the Gulf Coast." — **Claudia Neuhauser,** vice president for research at UH.

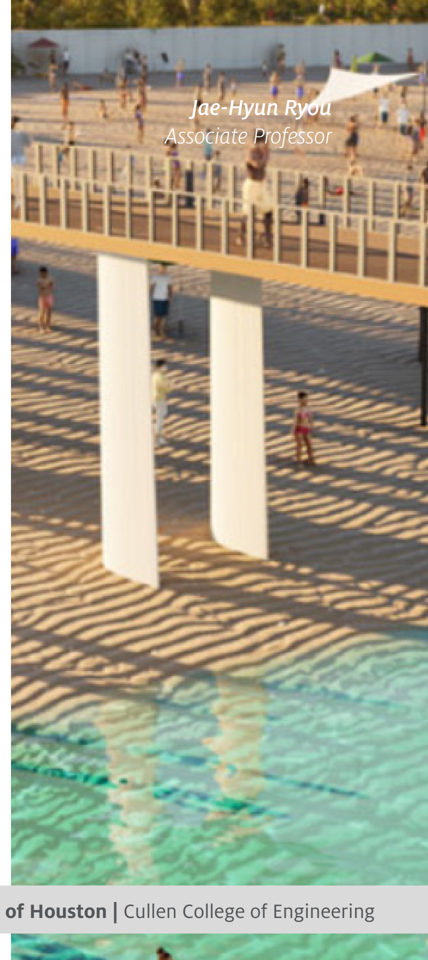
Turning Old Oil Platforms into Clean Energy and Marine Habitats

The first project, titled "Repurposing Petroleum Infrastructure for Sustainable Energy, Food and Critical Minerals," explores how unused offshore oil and gas platforms can be transformed into tools for environmental and economic benefit. UH's ROICE program (Repurposing Offshore Infrastructure for Continued Energy) is partnering with the Gulf Offshore Research Institute to demonstrate the effectiveness of repurposing these idle structures to support clean hydrogen production, open ocean aquaculture, continuous data acquisition and critical mineral harvesting.

Launched in 2022, ROICE began as a thought experiment and has grown into an incubation space for researchers to explore ways to repurpose thousands of inactive wells, pipelines and platforms in the Gulf. The goal is to bring significant environmental and economic benefits to coastal communities.







Jae-Hyun Ryou
Associate Professor

UH JOINS AXIOM SPACE UNIVERSITY ALLIANCE

The University of Houston Cullen College of Engineering's Department of Mechanical & Aerospace Engineering (MAE) has joined the Axiom Space University Alliance, a global initiative created to expand scientific opportunities in microgravity research, technology development, R&D and commercial innovation in low Earth orbit (LEO).

UH is among 15 current partners across the United States, Europe and Australia in the Alliance's inaugural cohort. The Alliance is designed to help preserve and expand access to microgravity for research and innovation as the world transitions from government led to commercially owned and operated space stations.

The Alliance will serve as a global coalition for microgravity research and technology development, identifying research gaps and opportunities, aligning national and international research priorities, and providing a venue for international cooperation and resource sharing that benefits life on Earth and human exploration. Axiom Space, builder of Axiom Station, the world's first commercial space station, is convening universities to foster collaboration, resource sharing, shared access pathways to LEO platforms and flight opportunities, and capacity building for new and seasoned space researchers.

"Joining the Axiom Space University Alliance positions UH to contribute to the next chapter of LEO research and technology commercialization," said **Karolos Grigoriadis**, Hugh Roy and Lillie Cranz Cullen Endowed Professor & Chair of Mechanical & Aerospace Engineering. "This alliance opens pathways for our faculty and students to design, test, and fly microgravity experiments, connecting our labs with industry partners and commercial LEO platforms."

The UH MAE Department hosts the NASA Inflatable Deployable Environments and Adaptive Space Systems (IDEAS^2) Center, a five year, $5 million initiative advancing novel space infrastructure and adaptive technologies. The Axiom Space University Alliance will connect this program to commercial LEO platforms, creating a pipeline to payload development, on orbit demonstrations, shared resources, and industry partnerships.

MAE CAPSTONE GROUP DESIGNING ADAPTER FOR NASA

For their capstone project, a group of students in the Mechanical and Aerospace Engineering Department at the University of Houston's Cullen College of Engineering is designing, fabricating and testing a dynamic adapter that attaches to a device being developed by NASA's Marshall Space Flight Center (MSFC).

According to the group, H.O.R.I.Z.O.N.S. aims to deliver a dynamic connection between NASA's experimental Domed-Shaped Device (DSD) and an UR-series robotic arm that will allow the DSD to dynamically tilt 30 degrees circumferentially to account for irregular terrain.

The team consists of **David Whaley**, **Cory Crow**, **Ashton West** and **Charity Golleher**. All four are MAE students at Cullen. Their advisors for the project are Karolos Grigoriadis, Hugh Roy and Lillie Cranz Cullen Endowed Professor & Department Chair, and the Director of the Aerospace Engineering Graduate Program; **Farah Hammami**, Instructional Assistant Professor in Mechanical Engineering; and Brandon Phillips, the team lead for the NASA MSFC Electrostatic Levitation Lab.

As part of the Capstone Experience, students are tasked with identifying problems and designing a viable solution. Funding isn't provided, so students are heavily encouraged to network with external groups and companies to secure support for their projects.

H.O.R.I.Z.O.N.S. was able to pursue this opportunity by leveraging the connections that Whaley made with his previous NASA internships. Thanks to the support of Grigoriadis and Phillips, the team was able to receive sponsorship for this capstone project and the opportunity to test it at MSFC's Lunar Terrain Field.

The objective of the capstone project is to develop an adapting mechanism between the UR-Series arm and DSD to deliver circumferential actuation by utilizing Shape Memory Alloys (SMAs). This technology was chosen in collaboration with our advisors.

Left to right: *Brandon Phillips — NASA MSFC ESL Lab Lead, Charity Golleher, David (Ben) Whaley, Ashton West, Cory Crow and Irene Prado — NASA MSFC ESL Technician*

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