MechSE

2025

MAGAZINE

Reef Rebirth

How engineering could save the world's coral

WALL-E like you've never seen before, p. 14
Crawlers go viral, back cover

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go.mechse.illinois.edu/magazine-2025

FROM THE DEPARTMENT HEAD

Anthony M. Jacobi
MechSE Department Head
Richard W. Kritzer Distinguished Professor

Dear alumni, students and friends of MechSE,

As we begin a new academic year, the MechSE department continues to be a shining star in The Grainger College of Engineering. In the last several issues of *MechSE Magazine*, I have talked about the unprecedented growth in all of our degree programs as well as our faculty ranks—and I'll repeat myself again this year because I'm happy to report that this progress endures! Our faculty ranks are growing, as are our highly sought-after undergraduate programs in engineering mechanics and mechanical engineering, and our graduate students continue to impact engineering research with their scholarly rigor.

As you will read starting on page 14, our research in the fields of robotics, autonomy and controls—areas of critical importance in the world—has reached new heights. We have hired several new faculty with expertise in these areas, and many more of our faculty and graduate students are making breakthrough discoveries that address wide-ranging problems.

Our alumni are also doing inspiring work. The department is incredibly grateful to the MechSE Alumni Board for surpassing their fundraising goal of $100K for scholarships and more to support first-generation MechSE students. Read about their achievement (page 34)—and a new named space in Lu MEB!—that will impact numerous students for years to come.

And finally, I encourage you to read our deeply reported cover story on the exceptional work being done to find new ways of supporting the reproduction and growth of the world's endangered coral reefs. Led by Professor Amy Wagoner Johnson, and joined by colleagues in Illinois Grainger Engineering, across the U.S., and in Curaçao, the project is an inspiring example of our ability to think big and to push the boundaries of the research paradigm. When you read the story and watch our eight-part film series that dives deep into the project, you will understand why Amy's cross-disciplinary vision earned one of the National Science Foundation's first Growing Convergence Research awards seven years ago. The award-worthy film series produced by MechSE's communications team is one that I promise you won't regret watching.

As always, you can check out all the extra content related to these stories and more at **go.mechse.illinois.edu/magazine-2025**

Reef Rebirth

How engineering could save the world's coral

BY TAYLOR PARKS

Over the last century and beyond, generations of observation and research have recorded significant changes in the world's reefscapes. Coral reefs are known to be very sensitive to environmental factors such as temperature, pollution, and pH and oxygen levels. They are also impacted by the levels of different forms of algae—while some have a symbiotic relationship with coral, other forms can overtake and suffocate them—which in turn are subject to the same oceanic factors. Indeed, a thriving coral reef represents a delicately balanced and finetuned ecosystem, which can easily be thrown off balance in the face of pollution, ocean acidification, and effects of overfishing. Yet, these complex organisms represent not only a critical component in the ocean machine, but also a resource for bio-inspired materials design. The call has sounded for engineers and marine experts to work together to learn from and preserve our reefs—and Illinois Grainger engineers have answered.

Watch the coordinating film series "Reef Rebirth"

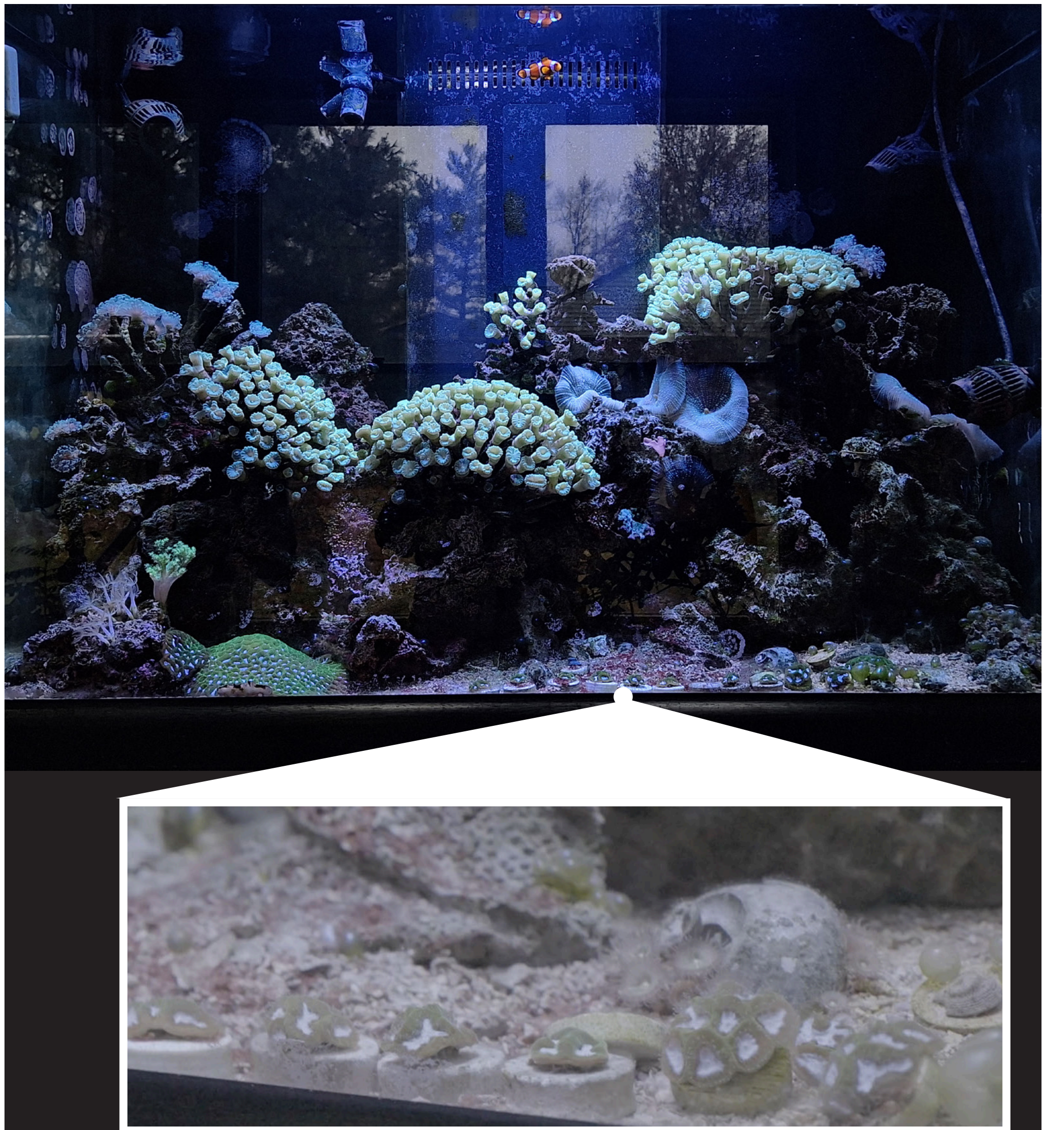
go.mechse.illinois.edu/ReefRebirth

An interdisciplinary research team led by MechSE faculty has been tackling this issue for over half a decade. First covered in 2018, the group's efforts have evolved over the years to encompass an international research team working both in U.S.-based labs and the "field,"—in this case, the Caribbean sea surrounding the island of Curaçao.

Amy Wagoner Johnson

Rosa Espinosa-Marzal

Principal Investigator and MechSE Professor **Amy Wagoner Johnson** leads the ongoing efforts alongside co-PIs former MechSE Assistant Professor Gabriel Juarez and Ivan Racheff Professor **Rosa Espinosa-Marzal** from the Department of Civil and Environmental Engineering at Illinois. Additional leading researchers on the team include Professor Forest Rohwer from San Diego State University, Associate Researcher Linda Wegley Kelly from the Scripps Institution of Oceanography and coral reef biologist Dr. Kristen Marhaver from the Caribbean Research and Management of Biodiversity (Carmabi) Foundation.



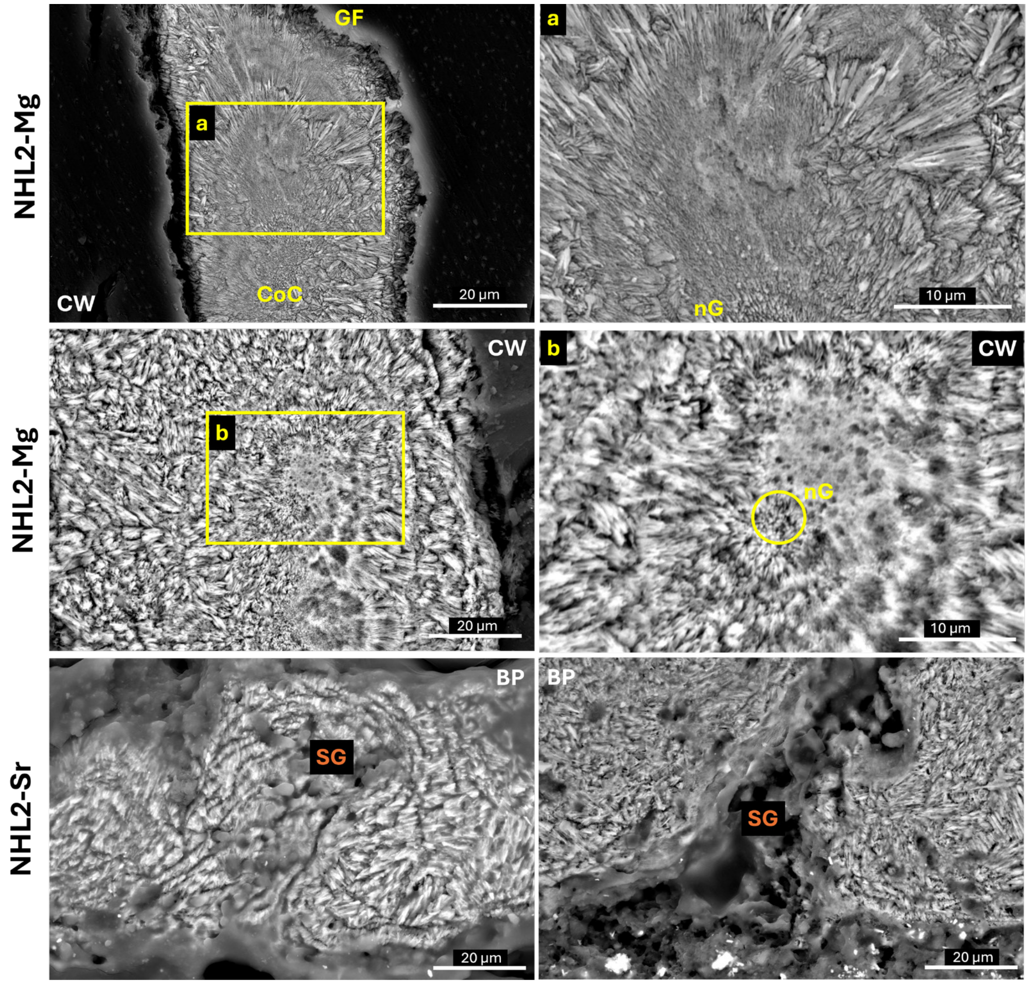
Jassim's home tank hosted some of the team's initial substrate experiments. The three types of substrates the team is experimenting with can be seen in the inset photo.

Understanding Coral Larvae

Within the animal kingdom, corals are classified as marine invertebrates that form compact colonies of individual polyps, or cylindrical shaped bodies with a mouth and tentacles that attach at the base to a substrate. In biology, "substrate" refers to any surface upon which a plant, fungus, animal, or other organism lives. Coral typically attach to submerged rocky shoals, often building upon themselves over time to form reefs.

Corals reproduce both asexually, in which a new polyp grows from a parent polyp to expand the colony, and sexually, in which eggs are fertilized by sperm, eventually maturing into larvae called planulae. These microscopic planulae drift in the ocean's current searching for a suitable surface to settle. Once settled, and having grown into juvenile polyps, they can lay down a calcium carbonate corallite—a cup-like skeleton that adds stability. When adult polyps reach maturity, they recommence the reproductive cycle so that a colony of coral develops over time.

While scientists have made significant progress in sustaining larvae reproduction and growth in a lab setting, transitioning lab-grown larvae to ocean conditions remains challenging. Limited knowledge surrounding the impact of different substrates on coral growth and the



Above: Vertical cross-section scanning electron microscopy images of coral samples growing on the NHL2-Sr substrate (bottom images) as well as a composite natural hydraulic lime and magnesium (NHL2-Mg) substrate (top and middle images). In these cross-sections, the growing front (GF), corallite wall (CW), center of calcification (CoC), substrate grain (SG), nongranular structure (nG), and basal plate (BP) are labeled. Image courtesy of Rosa Espinosa-Marzal.

larvae's inability to overcome currents when trying to attach have hindered efforts to regenerate reefs successfully. Thus, we need not only to understand how currents and other reef conditions impact larvae attachment, but also the role that substrates play in both their settlement and growth.

"Coral reefs are among the most diverse ecosystems on Earth, providing habitat and sustenance for a wide range of marine life," said Espinosa-Marzal. "From an environmental perspective, it's crucial to preserve these reefs for their immense ecological and global and local economic importance."

In the Beginning

Wagoner Johnson, who was featured on a two-part podcast earlier this year discussing the team's research, had attended a conference in Jamaica in 2016 with former MechSE faculty member Andrew Alleyne, now Dean of the College of Science and Engineering at the University of Minnesota. The pair's collaboration had focused on using 3D printing to fabricate bone scaffolds. However, the conference theme was coral.

"We were asked to present our work on printing 3D scaffolds," Wagoner Johnson recalled. "When I was talking to people [at the conference], I just found coral reproduction really interesting. Based on feedback from the coral biologists, I thought this was a place where we could have an impact—where people who know about materials could contribute to environmental efforts."

The experience led Wagoner Johnson to pair with Juarez and assemble an interdisciplinary research team focused on coral reef restoration. Wagoner Johnson works to develop new materials to encourage larval attachment at a reef's surface and Juarez studies larval swimming behavior in ocean-like fluid environments.

"It's really about keeping an open mind and allowing yourself to imagine big ideas that are outside of your expertise," Wagoner Johnson said of exploring how her scaffolding research could apply not only to the human body but also to corals. "Illinois is a great environment for moving across fields and using your expertise in different ways."

Quantifying Coral Growth

Espinosa-Marzal would later bring her materials science and engineering background to the project, helping to frame the group's understanding of coral growth.

"My group studies biomineralization, the process by which corals grow," she said. "From a materials science perspective, we can design new, sustainable and environmentally friendly materials that apply the principles of biomineralization."

As the team experiments with the substrates, Espinosa-Marzal employs advanced microscopic techniques to inspect the coral "skeletal" systems at very high resolution. "We try to connect the skeleton formation and properties with healthy coral growth," she said. "The coral living [in our tanks now] are healthier than those dying on ocean reefs. We want to translate this into substrate design to support healthier coral in the wild."

Similar to the impact of temperature on grain formation in metals, slower or faster growth rates influence the microstructure and properties of coral skeletons, which provide structural support and play a critical role in the corals' survival and function within marine ecosystems. At the microscale, the size and morphology of calcium carbonate crystals, which are secreted through coral polyps, determine the microstructure—including porosity—and ultimately shape the coral's overall morphology.

Espinosa-Marzal recognizes the opportunities in learning from coral biomineralization. "We aim to develop materials that grow like corals and exhibit


An interdisciplinary dive team including Yus collects samples in Curaçao.

self-healing properties," she explained, highlighting that corals also capture carbon dioxide during growth. "They offer the potential to create a living material that is both durable and capable of changing shape."

Investigating Coral Properties

Chemist and postdoctoral researcher **Joaquin Yus Dominguez** joined Wagoner Johnson's lab at Illinois after earning his PhD in materials science and engineering from Universidad Carlos III de Madrid.

"I was working with ceramic semiconductors," Yus said of his PhD research. "But the tolls and characterization process for these materials weren't that different from the approach we take to understand the coral settlement substrates."

Yus was also already certified as an open water diver, which made him a natural fit for a role on the team. Over the past few years, he has investigated the material properties of substrates for coral restoration and their influence on larval behavior and the skeleton of juvenile coral samples. He has also traveled to Curaçao to join the field researchers diving on the reefs.

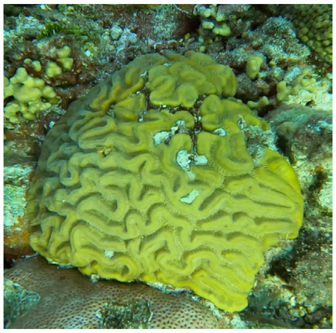
"When you introduce biological and ecological factors to the array of material properties, everything changes," Yus said of the complexity in working with a living material. "There are so many variables that can change the output of the same analysis, even down to minute differences in the coral's genome."

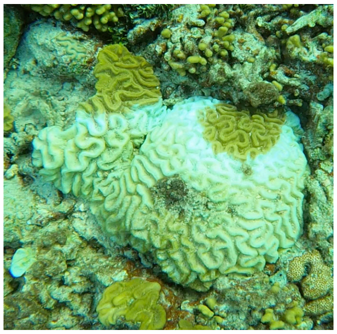
Yus has worked with both the substrate material as well as coatings that change the surface properties of the material itself. "We work with hard materials to create the substrate itself—the rock," he said. "And then we introduce additives to release ions and other chemicals into the surrounding water, and we work with substrate coatings to help attract larvae and promote settlement and attachment."

During experiments with substrate materials, Yus and others found that calcium carbonate alone did not hold up well when submerged in water long term—instead, the hydrophobic material would break apart over time, prohibiting successful larvae growth. To resolve this, the team added calcium silicate to the mix—a hydrophilic powder that activates when exposed to water. This combination gave the substrate the necessary strength to support growth over time.

Although field researchers located at Carmabi have been collecting gametes (i.e., reproductive cells) and caring for live larvae samples that swim or drift near the reef, due to import restrictions, the research team cannot transport live coral samples to Illinois from Curaçao. However, collaborating researcher Justin Zimmerman, currently the supervisor of the Florida Coral Rescue Center, has been able to send live samples from a reef in the Florida Keys that the team maintains in local

> "*When you introduce biological and ecological factors to the array of material properties, everything changes.*
>
> *- Joaquin Yus Dominguez*"





Above: Where healthy coral is vibrant and robust, sick coral becomes pale and brittle.

Li works with experimental substrates in Espinosa-Marzal's lab.

tanks. Moreover, larvae that have not latched have a short lifespan—whether in the wild or in captivity—and the Carmabi researchers routinely preserve any dead larvae, shipping them to Illinois for further study.

Fourth-year environmental engineering PhD student **Jingyu Li** works alongside Yus to experiment with the preserved larvae and juvenile corals. She prepares samples by affixing the larvae in epoxy on top of a manufactured substrate. She then monitors the larvae's crystalline structure and morphology to understand the substrate's influence. Although the corals are dead, chemical and mineral substrates can still have a measurable impact.

Li's personal connection to the project stems from experiences in her native China, where she would see coral reefs while diving in shallow water.

"Coral reefs are very important for maintaining marine life," Li said. "Due to overfishing and water pollution, the number of living reefs has significantly decreased. It's important to act."

Learning What Larvae Like

Alongside Juarez, postdoctoral researcher and physicist **Daniel Gysbers** (PhD ME 2024) focuses on understanding the hydrodynamics of larval transport.

"I look at how the flow of currents at the ocean floor interact with the topography so that we can create flow structures that assist larvae in attaching to reef surfaces," Gysbers said. "We perform experiments in a tank where we can generate the same currents as the ocean floor and use lasers to image the particle flow."

Collaborating researchers in the field at Curaçao send current data for Gysbers to implement. He also had the opportunity to travel to Curaçao to investigate the attractiveness of different substrate chemicals by placing local larvae in a fluid-filled channel and injecting the chemicals at one end. Gysbers observed whether the larvae would swim toward or away from the chemicals and used the data to inform simulations.

Biologist and postdoctoral researcher Jason Baer, who earned his PhD while working in Rohwer's lab, has also been focused on the ocean floor environment—from a microbial perspective. His doctoral research was on building coral reef arks—positively buoyant structures that could be tethered to the sea floor to provide a friendlier environment for larvae settlement.

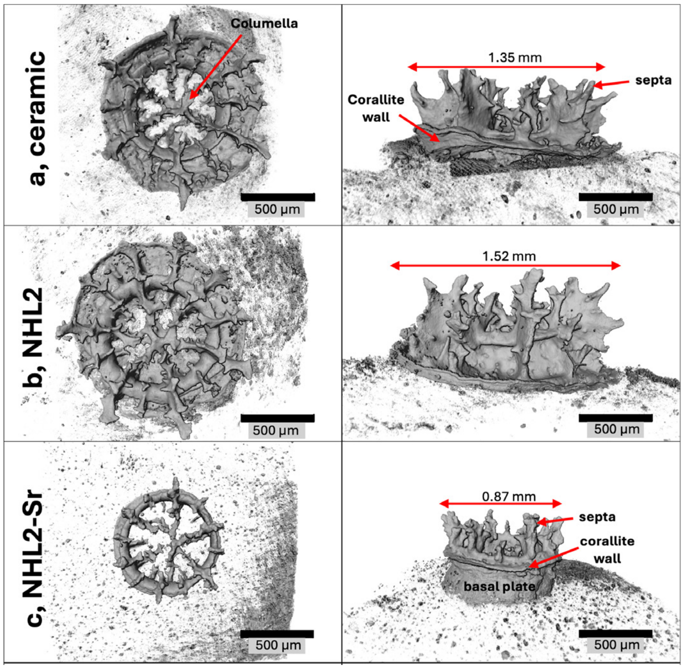
"The sea floor environment experiences a lot of change, which makes it a harder place for corals to live," he said. "We thought that by moving a coral reef community up into the mid-water, or off the sea floor, we might be able to enhance some of those environmental conditions and provide a better environment for corals and other organisms to live."

These efforts proved fruitful, opening the door to further investigations of ideal materials and methods for floating reef construction. "The corals and other organisms living on these structures were a lot happier than they were on the sea floor," Baer said.

Back at Illinois, now fifth-year mechanical engineering PhD student **Koumudhi Deshpande** worked with Gysbers to analyze the swimming patterns from field experiments and build an understanding of how the diffusion of chemical cocktails over a reef can impact larval settlement.

"We had some interesting findings where [the larvae] actually liked some chemicals and were swimming slower and circling more in the presence of them," she said. "Whereas with other chemicals, they would speed up or swim in a straight line to avoid them. We added these responses to our model to understand the impact on settlement."

"We found that calcium and strontium ions in certain concentrations can attract larvae, which was interesting because these ions are some of the building blocks for coral exoskeletons," Gysbers said.



X-ray images of 6-month-old coral samples growing on ceramic (top), natural hydraulic lime 2 (NHL2; middle), and a composite natural hydraulic lime and strontium (NHL2-Sr; bottom) substrates. Image courtesy of Rosa Espinosa-Marzal.

Caring for Coral

Mechanical engineering junior **Yusuf Jassim** had unique insight to contribute to the project—the care and keeping of coral.

"I'd read about the project," Jassim said of first learning about the coral study prior to coming to Illinois. "I contacted [the research team] because I already had a reef aquarium set up at home."

The process for Jassim to successfully start and maintain a home coral tank had presented its own challenges. "You start with deionized water and mix in sea salt," he described. "You allow the mixture to sit so that bacteria can grow. Then, you add live rock to introduce new nutrients, and then you can introduce fish and finally coral."

Jassim's tank's capability was a boon to the research team. Yus sent Jassim substrate samples upon which to grow coral fragments so they could investigate the impact of each substrate on growth rate. The samples included natural hydraulic lime (NHL), which hardens in water and consists of calcium silicate and calcium aluminate; 3D-printed biodegradable polylactic acid (PLA) coated with calcium carbonate; and blank PLA as a control. Fragments of coral were adhered to each substrate and monitored for growth rate using imaging.

"Coral are very interesting because they're actually animals, but they don't seem like it," Jassim said of the motivation to keep a home tank. "I think it's pretty cool to see these fascinating organisms up close."

With the project and its team expanding, Jassim later helped design the current tank configuration in Newmark Lab, where the Illinois team cares for and continues to monitor coral samples. The system includes multiple main tanks, heating and filtration equipment, and pumps to drive circulation.

Jassim continues to collaborate on the project through an independent study with Espinosa-Marzal. "Coral reefs are declining at an astonishing rate," he said. "It would be very nice to find materials that can help with larval settlement."

Looking Ahead

With the team looking hopefully to the future of coral reef regeneration, their ongoing efforts show no sign of slowing down.

"I think that if we're going to improve coral restoration outcomes, we have to not only really understand ecosystems at a high level, but also how different environmental conditions like temperature, oxygen level, and alkalinity interact with the geometry of coral reefs," Baer said. "Corals have a lot of structure and provide habitats for all sorts of biodiversity. [In pursuing restoration], we want to give corals a chance to create that structure."

"I envision that we will identify substrate compositions that allow coral larvae to settle and grow into mature corals with much more success," Espinosa-Marzal said. "We need to design substrates that promote higher success in larval recruitment and settlement, are affordable, and support the healthy growth of corals despite ocean acidification and rising temperatures." ◆

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The team's current five-year study, "From Molecules to Sustainable Reef Platforms: Engineering Ecosystems for Coral Recruitment and Survival," is funded through August 2026 by the National Science Foundation.

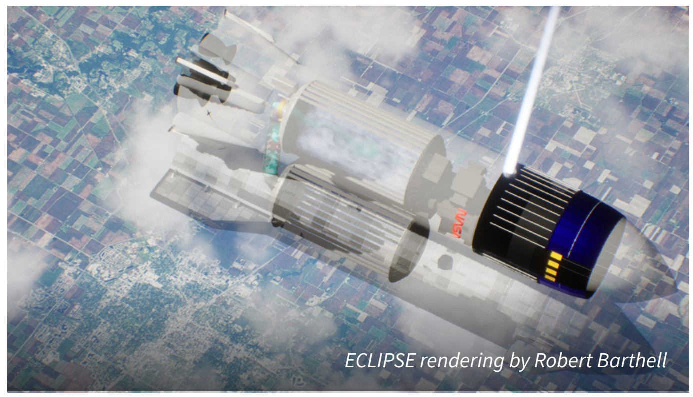
Jassim takes a reading at his home tank.

Undergraduate News

Student team named finalist in NASA Human Lander Challenge

An interdisciplinary team of Grainger College of Engineering undergraduates was selected as a finalist in NASA's 2025 Human Lander Challenge (HuLC). The students created the concept design "Efficient Cryogenic Low Invasive Propellant Supply Exchange" (ECLIPSE) in response to this year's theme—to develop innovative, systems-level solutions to understand, mitigate potential problems, and mature advanced cryogenic fluid technologies that can be implemented within three to five years. Cryogenic fluids, like liquid hydrogen or liquid oxygen, must stay extremely cold to remain in a liquid state. The ability to effectively store and transfer these fluids in space (i.e., from a depot to a spacecraft) is becoming increasingly vital for the future of long-duration missions.

"Our team is very unique in the sense that we have students from diverse majors," said faculty advisor Vishwanath Ganesan, a postdoctoral researcher in MechSE Professor Nenad Miljkovic's lab. "This enables each student to bring their own perspectives and strengths on various aspects of the design and development of innovative and holistic solutions to advanced engineering problems."



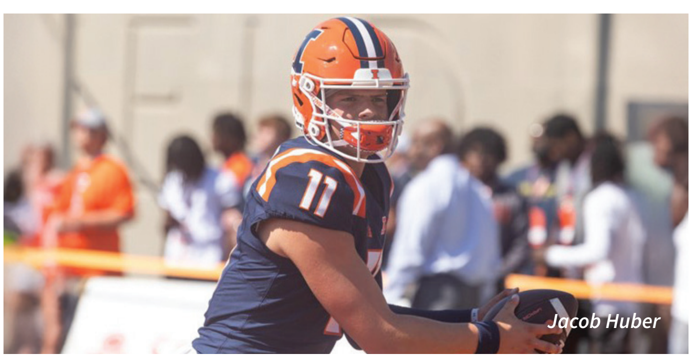
ECLIPSE rendering by Robert Barthell

The team presented at the final HuLC Competition Forum in June in Huntsville, Alabama, where they conducted critical design reviews with industry professionals to rigorously test the strength of their final design, and where they were awarded Best Technical Presentation.

For two Illinois football players, ME has always been the chosen career path

Although senior **Jacob Huber** comes from Spring Grove, a Chicago suburb, and junior **Henry Engel** hails from rural Lena, they both have the drive to excel in mechanical engineering while thriving as Division I student athletes. "I've wanted to go into mechanical engineering since I was fairly young and it was great to have an in-state school that was ranked so highly in that department," Engel said.

Being a student athlete is not for those who like things easy. To balance school and sports, students must make the often-difficult choice to prioritize athletics over other commitments. "I have to sacrifice a bit of my social life to excel in class," Huber said. He also takes a lighter courseload during football season. Engel said both school and football showed him that results don't come right away. Instead, success comes from consistent effort, whether in practice or on assignments. He added that football taught him how to work well on a team, which has been a huge help when tackling group projects in school. Huber's advice to future MechSE athletes relies on discipline. "Build a strong support system of teammates, classmates, and mentors," he said. "It's going to be tough, but the skills you gain from balancing sports and school will help in all parts of life."



Jacob Huber

Henry Engel

Electric boat team tests the waters at Naval competition

MechSE's Electric Boat Competition Team made waves this past semester with their senior capstone design project, the USS Illini. The team competed in the 2025 Promoting Electric Propulsion (PEP) Competition hosted by the American Society of Naval Engineers. The competition, which featured heats for crewed and uncrewed (i.e., remote controlled) boats, took place in Virginia Beach.

Advised by MechSE Professor Kelly Stephani, the team included seniors Matthew Bianchi, Noah Brody, Carter Eid, Sebastian Sanchez, Allan Zhu, Ethan Cho, Xiaorui Gu, Hongbo Nie, Kevin Ho, and Drew Stadelman.

The competition required the USS Illini to carry a 30-pound removeable payload while completing a two-mile course in less than 55 minutes. It was run in time trials, with each boat staggered in its start to avoid course collisions. Although the USS Illini fell short of the 2-mile mark, stopping at 1.4 miles due to an electronic speed controller failure, the boat team had already demonstrated reliability in many subsystems and recorded valuable data that will help guide future iterations of the boat.

"[Our] team was the first of [MechSE's] PEP electric boat teams to attend the competition with a functioning craft. We were able to research, design, manufacture, iterate, and compete with [our] boat within a 10-week time frame," said team member **Drew Stadelman**. Their goal was to use commercially available electric material to create a low-cost, environmentally friendly uncrewed boat design. Their prototype included design features such as a kayak-style hull, dual 3D-printed propellers, and water-based cooling. Their brushless propulsion system featured four 10,000 mAh lithium polymer batteries. They were sponsored by the Center for Power of Optimization of Electro-Thermal Systems and MechSE alumnus Bill Profilet (BSME 1984).

Captured on Camera

Epic builds, late nights and unique solutions—watch what our students are creating

Teams shine at Cornfield Clash Jr.

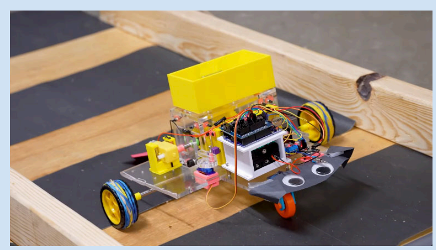
In addition to competing against other universities from around the world, registered student organization Illini VEX Robotics offers an important robotics competition—called the Cornfield Clash Jr—for high school students, especially those from central and southern Illinois. This year, 36 teams from 12 high schools across Illinois and Indiana faced off.

Watch the video and read the story!
go.mechse.illinois.edu/cornfieldclash

If you have arachnophobia, look away!

The Illinois student chapter of ASME's creation of an Arachnobot centers around the body and legs, all of which were 3D printed on campus. With only six legs, Arachnobot takes advantage of the tripod gait observed in many hexapod insects, and its software features code that programs each servo to execute that gait into fun dance moves. Arachnobot even won the 1st place Distinguished Technology Award at EOH!

Watch the video:
go.mechse.illinois.edu/arachnobot



Robots, start your engines!

MechSE students taking ME 371 (Mechanical Design II) were tasked with designing and building robotic cars that could compete in a series of challenges to test speed, agility and more. The teams were also judged for the creativity and quality of their robots. With a range of unique designs including some familiar characters (Tow Mater, anyone?), they did not disappoint!

Watch the video:
go.mechse.illinois.edu/robotcars

Immersed in Japanese culture: A MechSE student's internship at Japan House

Mechanical engineering senior **Eungi Youn** served as a Japan House intern during the 2024–25 academic year after seeing a flyer posted in the Sidney Lu Mechanical Engineering Building. Youn studied Japanese in high school and was eager to learn more about Japanese culture and experiences. “I thought that the internship would be interesting,” he said. “It’s not something that everyone can do… and I wanted to try something outside my bubble.”

As an intern, Youn assisted with tea ceremonies, provided tours, maintained the gardens, and promoted Japanese culture. He was immersed in many Japanese arts and aesthetics including Chado, Origami, Calligraphy, and even learning how to properly wear a kimono. Through the experience, Youn said he was able to develop strong social skills in a kind and positive environment. His internship is also significant to his future engineering career, for which he plans to focus on robotics. Having visited Japan multiple times, he is considering pursuing a job there.

“I think engineering students sometimes forget about the social aspects of their career development,” Youn said. “Sometimes they lack public speaking, elevator pitching, or having interaction with other human beings. Working at the Japan House helped me with that because we have a lot of interactions with visitors—sometimes we are the ones explaining Japanese culture and the tea room history to the public.”

MechSE undergrad brings health food store to Green Street

Mechanical engineering junior **Vidhi Chavda** is now a full semester in with her own brick-and-mortar business—a shop selling healthy shakes, refreshers and more. Her store, Elite, is located at the intersection of Second and Green, and promises to offer healthy food options that incorporate nutritional supplements. The shop operates during daytime business hours so that students can easily grab a shake or other quick meal on their way to class.

As a freshman at Illinois, Chavda struggled to find healthy food options on Green Street. She thought back to a health café in her hometown that offers a menu with the kinds of quick but healthy options she was looking for. “I went back home during winter break and I walked into [the café] and thought, ‘What’s stopping me from doing this?’” she said. “The café owner mentored me and taught me everything—not just the business side but also making the menu and the recipes.”

Chavda, who is also a double-major in the Innovation, Leadership & Engineering Entrepreneurship (ILEE) program, has a team of part-time workers and a full-time manager, but works in the shop whenever she doesn’t have class or other commitments. “The U of I is the ideal little world,” she said of leveraging the skills of so many talented people, which has helped enable her to make her small business a reality. “You have everyone from every expertise. It’s amazing.”

Knights of St. Patrick

Recent mechanical engineering grads **Jon Coonley** and **Rene Mohammadi** were two of 10 engineering students to be named 2025 Knights of St. Patrick, an honor awarded to students who demonstrate leadership characteristics, excellence of character, and exceptional contributions to The Grainger College of Engineering.

During Coonley’s time in MechSE, he served as VP of technical affairs for the student chapter of ASME; a drop-in tutor for the Center for Academic Resources in Engineering (CARE); a facilitator for the PHYS 211 Peer Led Tutoring (PLT) program; a research assistant in Professor Jie Feng’s lab; and the ASME Special Projects Committee co-director, navigating teams through five EOH projects. Coonley will begin his career at Sargent and Lundy as an analyst for nuclear power systems. “If there’s one quote that summarizes my whole college experience it is this: ‘It’s not about how you did; it’s about what you do.’ And now, I am beyond excited to start my career and apply my education and knowledge to advancing the field of energy systems,” Coonley said.

Mohammadi worked in Chemical and Biomolecular Engineering professor Brendan Harley’s lab; served for two years as an Engineering Learning Assistant (ELA) for Grainger’s First Year Experience; was president of the nonprofit Engineers in Action Bridge Program; was active in Engineering Council’s Engineering Outreach Bureau; worked as a student co-director to welcome new classes of Grainger engineers to campus; and won a Mayo Clinic Summer Undergraduate Research Fellowship, where she conducted endometrial cancer microbiome research. She plans to continue her research in women’s health and aims to pursue a PhD to advance the field through holistically innovative bioengineering solutions.


Jon Coonley


Rene Mohammadi

MechSE student researchers boast award-winning visuals

Both graduate and undergraduate researchers, working in a wide variety of faculty labs in MechSE, were named winners in this year's Graduate College Image of Research Competition and Image of Research Undergraduate Research Competition, respectively.

Engineering mechanics undergraduate **Sawyer Eaton** won first place for his image, "Surprising Dynamics of Hollow Droplet Impact on Solid Surfaces," which illustrates the post-impact bouncing dynamics of hollow droplets with viscoelastic shells. Eaton is an undergraduate researcher in Professor Jie Feng's Fluids, Interfaces and Transport (FIT) Lab, where he began working in summer 2024. Alongside a graduate student mentor, he helped iteratively design their research methods and apparatus.

"While I have learned a lot about the science relating to the project, I think the more important things I have learned pertain to the broader topic of how to conduct research. I am starting grad school in the fall, and familiarizing myself with this experience has made me much more comfortable and excited about conducting research in the future," Eaton said.

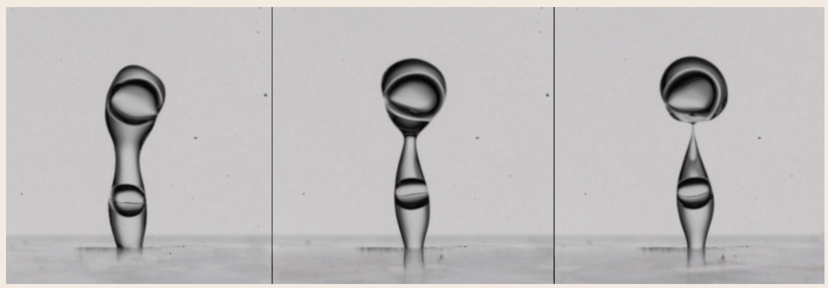
Additionally, when the University of Illinois Graduate College announced the semifinalists for their competition, graduate students from MechSE represented a significant percentage, with three out of 24:

"Serendipity in Science: Biomimicry in Copper Electroplating" by **Arielle Gamboa** (advisor Nenad Miljkovic)

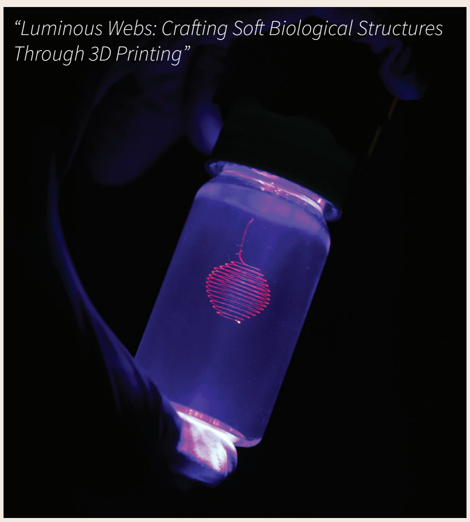
"Luminous Webs: Crafting Soft Biological Structures Through 3D Printing" by **Tanver Hossain** (advisor Randy Ewoldt)

"Helix of Growth" by **Yun Seong Kim** (advisor Sameh Tawfick)

Aerospace engineering graduate student Sainath Barbhai, who is advised by MechSE Professor Jie Feng, was also one of the finalists, with "Beads-on-a-String Structured Jets Produced by Bursting Bubbles with a Viscoelastic Compound Layer."

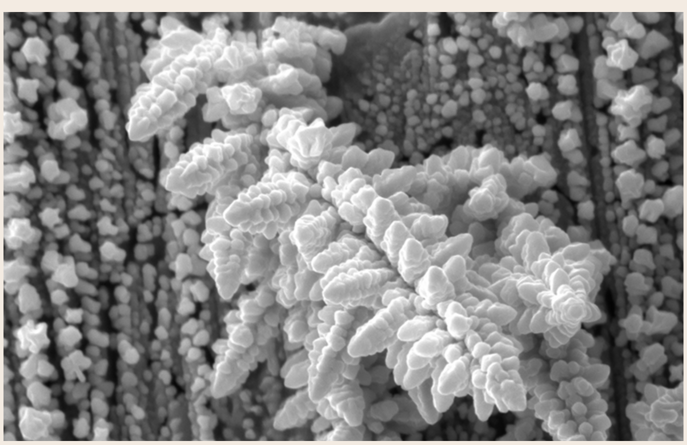


"Surprising Dynamics of Hollow Droplet Impact on Solid Surfaces"

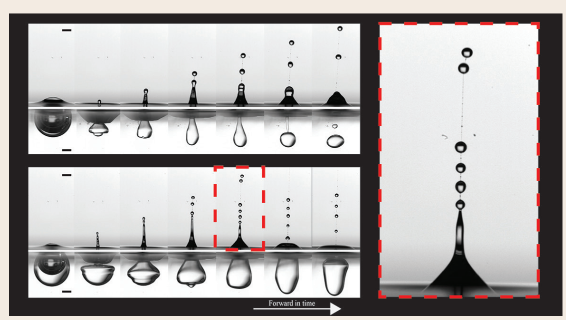


"Luminous Webs: Crafting Soft Biological Structures Through 3D Printing"

"Helix of Growth"



"Serendipity in Science: Biomimicry in Copper Electroplating"



"Beads-on-a-String Structured Jets Produced by Bursting Bubbles with a Viscoelastic Compound Layer."

Graduate News

Modi's journey to success

Modi with his parents on the Main Quad

Vatsal Modi (M.Eng.ME 2024) has put his career plans into action. As a Remanufacturing Technician III at Tesla, Modi runs analyses on damaged products and works to understand the reason behind the damage or the error in the diagnostics. He emphasizes the significance of problem-solving, adaptability, brainstorming, and analysis when completing tasks and projects in his role. He credits the resources and support from M.Eng.ME program staff with helping him on his journey. “The period of time that I was attending Illinois was filled with some of the best moments of my life,” Modi said. “The M.Eng.ME program helped to further develop my technical knowledge, as well as improve my communication and networking skills. I don’t know where I would be if I never came to this university, but I know that I wouldn’t have had as many opportunities as I have now.”

MechSE's graduate programs still strong at #7

U.S. News and World Report has ranked the University of Illinois as the #7 best graduate program in mechanical engineering for 2025. MechSE’s research-based MS/PhD program consistently ranks in the top ten in the country.

Additionally, The Grainger College of Engineering moved up two spots to #7 and now boasts 10 graduate degree programs ranked in the Top 10.

Online master's in ME climbs to #3

MechSE's online mechanical engineering master's degree program is now ranked #3 in the nation, moving up one spot from last year. The University of Illinois Urbana-Champaign shares the #3 spot in a three-way tie with Johns Hopkins University and Penn State University. The program has become known for the highly personalized support students receive from day one, no matter how they are enrolled. Students also enjoy a close-knit, diverse community of their peers. "The flexibility in how our program serves the needs of a variety of students—both professional part-time and full-time academically oriented—is incredible," said Quinn Brewster, M.Eng.ME Faculty Director. "Personally, I have always been glad I chose to earn an M.Eng. degree many years ago, and I am continually inspired by the students who come through our program here in MechSE."

Learn more about our M.Eng.ME program!

mechse.illinois.edu/graduate/MEngME

Zhang recognized with prestigious award from Materials Research Society

Mechanical engineering doctoral student **Yue Zhang** was named a Materials Research Society (MRS) Graduate Student Award winner, as a Silver Award recipient. He was formally recognized at the MRS 2024 Fall Meeting and Exhibit in Boston, where he also presented his research. The prestigious and competitive award honors graduate students whose academic achievements and current materials research display a high level of excellence and distinction. Zhang works alongside associate professor Arend van der Zande (Departments of MechSE and Materials Science and Engineering) to engineer new electronic, photonic and mechanical devices using 2D materials as molecular building blocks. "Receiving this award is a great recognition of my research. It is also a great inspiration for me because I hope to become a professor, and many of the past winners of this award now work on the faculty at the best universities and perform really well in academia," said Zhang.

What is Theoretical and Applied Mechanics at the University of Illinois?

As one of the oldest degree programs on campus and one of the few of its kind remaining in the U.S., our Theoretical and Applied Mechanics degree is a hidden gem that brings together some of the main foundations that engineering is built on.

"Having a TAM degree allows you to pivot into new areas and new places with that solid foundation of applied mechanics. A lot of my colleagues in the TAM degree program who moved into industry had a lot of experience to pull from to transition between fields," said Meg Grady (MS TAM 2011, PhD TAM 2014), professor of mechanical and aerospace engineering at the University of Kentucky. "Additionally, the prestige of that alumni network is one of the great benefits of the TAM program."

MechSE professor and associate head for graduate programs and research Elif Ertekin agrees. "TAM alumni are known worldwide. Our program is historically very prestigious, very well-known, and very revered. I think if people hear that you have a degree in TAM from the University of Illinois, immediately they will know what kind of background you have, what kind of grounding you gained, what kind of culture you're coming from."

Watch the video to learn more about MechSE's revered TAM degree program!

go.mechse.illinois.edu/Illinois-TAM

WALL-E like you've never seen before

Our research in robotics and autonomy seeks to change the world

BY TAYLOR PARKS

MechSE's faculty are working toward a future in which human productivity is augmented by robotic support and autonomous control systems work tirelessly in the background to further human endeavors. They are contributing a plethora of research toward this revolution, with investigations ranging from penny-sized automated wearables to dynamic educational prosthetics. Some are also involved with The Grainger College of Engineering's Center for Autonomy, a shared research facility housed at the Coordinated Science Laboratory that seeks to enable high-impact research to design innovative autonomous systems. The center also offers professional development opportunities to graduate students through its M.Eng. degree that focuses on autonomy and robotics.

With a shared dedication to collaborate and a passion for innovation, MechSE is seizing opportunities in the areas of autonomy, robotics and controls to change the world in unprecedented ways.

Mickey Clemon

With a background in manufacturing, Teaching Assistant Professor Mickey Clemon has developed meaningful collaborations with roboticists in two broad areas—field work, which is pertinent for agricultural applications, and collaborative 3D printing, in which robotic arms work together to overcome traditional printing constraints.

Typically, 3D printers print one layer at a time, with each subsequent layer relying on the previous for structure. The volume of the printed part is constrained to fit within the print bed and gantries.

"We've made the 3D-printing process faster by deconstructing these constraints and figuring out what can be printed in what order," Clemon said. "We've expanded into multiple print arms to print multiple layers simultaneously. Our framework is a sequencing plan that is platform-independent."

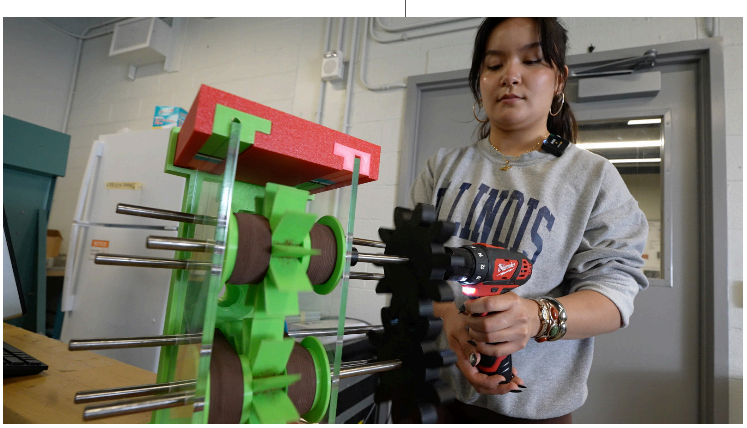
Clemon and collaborators are now exploring other constraints, such as material properties and the energy consumption associated with printing each part. While the overwhelming majority of 3D-printing efforts have historically focused on prototyping, the field is experiencing a shift toward more finalized 3D-printed products.

"The long-term performance of these products is starting to become very relevant," he said. "Consideration of the material properties is going to be very valuable as the additive manufacturing community moves into printing final products."

At the same time, Clemon and others have been collaborating with researchers from the University of Technology Sydney to improve efficiency, and safety, in a very different application—wool harvesting.

"Shearers can injure themselves or age out of the job quite quickly—the job lifespan of a professional sheep shearer is often very short," Clemon said of the ongoing challenge posed by the wool industry's traditional harvesting methods.

One current state-of-the-art method still under investigation—an injection that weakens wool at the follicles—shows promise. Weakening the wool follicles prior to harvest allows harvesters to pluck the wool from the sheep without the need for shearing devices, which reduces both the risk of injury and the required skill level. Clemon's interest in supporting these efforts led him to sponsor a Senior Capstone Design (ME 470) team to develop a prototype automated device for collecting the loosened wool from the sheep.



Undergraduate Rene Mohammadi demonstrates her ME 470 team's prototype of a wool plucking device.

"Now that robotics and microcontrollers are much cheaper than they were 20 years ago, I think there's a real opportunity to bring automation and clever mechanical design into more farming practices," Clemon said. "There are lots of jobs that people do because they're impractical for robots—the job requires the adaptability and insight of people, and it's done in a dirty, sometimes dangerous environment. There's an opportunity for students to explore how to bring automation to these sorts of jobs and make them faster and easier for people to accomplish."

Nazanin Farjam

Assistant Professor Nazanin Farjam's research focuses on developing innovative modeling frameworks and intelligent control strategies to enhance the flexibility, robustness, and efficiency of complex dynamical systems.

"My passion lies in pushing the boundaries of manufacturing and venturing beyond traditional domains into the realm of cutting-edge, complex systems," Farjam said of her work, which includes enabling the creation of flexible, lightweight, and cost-effective components that seamlessly integrate into advanced technologies—even in harsh environments like space or remote areas (for example, imagine a swarm of robots manufacturing semiconductor chips on Mars). This approach supports scalable and sustainable manufacturing processes, minimizing material waste and production costs.

"What truly excites me is the potential to make manufacturing smarter, more adaptive, and future-ready," she said. "By leveraging advanced modeling and AI-driven control strategies, we can create systems that dynamically adjust to changes and operate at peak efficiency."

Farjam is particularly excited about her work's potential to impact industries such as advanced electronics, biomedical devices, space manufacturing, and robotics.

"Printed electronics offer lightweight, customizable circuits for applications like wearable and biomedical devices," she said. "Combined with development of intelligent control systems, these technologies will enhance fabrication process efficiency and adaptability. Ultimately this will lead to agile, automated manufacturing systems capable of on-demand, customized production, aligning with Industry 4.0 and smart manufacturing trends."

Naira Hovakimyan

Professor Naira Hovakimyan's high-flying efforts regularly make the news.

She serves as Director of the Center for Autonomous Vehicles in Air Transportation Engineering (AVIATE) at Illinois—a NASA-funded university leadership initiative that integrates

Hovakimyan's graduate students test one of their UAVs in the lab.

efforts from researchers at the Georgia Institute of Technology, Massachusetts Institute of Technology, University of Nevada, Reno, and Noth Carlina Agricultural and Technical State University as well as industry partners Lockheed Martin and Sierra Nevada Corporation. The center is focused on enabling safe and efficient advanced air mobility through the development of a robust and resilient autonomy framework.

Hovakimyan noted that the team has already developed scaled, operational prototypes of aerial taxis. "For example, these are the so-called flying cars that can facilitate easy transportation between small towns."

The multidisciplinary team develops, tests and validates algorithms for the safe integration of learning-enabled components, or AI modules, in flying unmanned aerial vehicles (UAVs). Earlier this summer, they hosted their first Autonomy Fest, showcasing their progress with UAV component development and giving talks on relevant topics such as flight safety, fault diagnosis, and outreach. Safety, in particular, is high on Hovakimyan's priorities for the future of UAVs.

"When you remove the human operator, the autonomous system has to be able to make decisions and avoid all kinds of crashes," she said, noting the ongoing need for developments to these systems. "The challenging cases are the ones in which obstacles, collision paths and failures are introduced. We are working on these cases to develop additional safety features through autonomous solutions."

As she looks to the future, Hovakimyan is most excited by what the team collectively can accomplish.

"The best is yet to come," she said. "With the help of NASA funding a team of exceptional scholars, and through exemplary leadership, global outreach, and industrial partnerships, we are very excited to contribute to the science of autonomy."

Elizabeth Hsiao-Wecksler

Professor Elizabeth Hsiao-Wecksler currently leads multiple robotics efforts geared toward improving mobility and quality of life for people with physical challenges. On the one hand, her team has been working on a personalized, unique rolling experience (PURE) ball-based mobility device that can be used in place of a traditional wheelchair.

The previous generation of their device could carry a person up to 130 pounds at four miles per hour. "We're hoping to be able to support people up to 200 pounds and at six miles per hour," Hsiao-Wecksler said. "Our Gen3 prototype is also being made modular so that we can separate the drive train from the upper module."

Hsiao-Wecksler hopes that Gen3's modularity will increase the breadth of its working abilities—such as swapping out a chair for a robotic arm or adapting for a non-human payload.

"The cool thing about ball bots is that they ride on a single spherical wheel, which makes them self-balancing," she said. "You can move forward and backward, slide left and right, and spin. And we've added a vision system to achieve fully autonomous driving."

Her group is also investigating robotic limbs that can provide haptic feedback to medical students who are training to perform neurological exams. The project, which represents more than ten years of iterative design, is funded by the Jump ARCHES program, a collaboration among OSF HealthCare, the U. of I., and University of Illinois College of Medicine Peoria.

Clinicians will often attempt to diagnose neurological injuries or disorders by manipulating the patient's limbs, which can reveal two muscle stiffness characteristics indicative of these disorders—spasticity, which is velocity-dependent during passive movement, and rigidity, which is constant.

"[With our prosthetics], we want to mimic spasticity, which is often seen in people with a stroke, cerebral palsy, or spinal cord injury, and rigidity, which is often seen in people with Parkinson's," Hsiao-Wecksler explained. The team has developed a working prosthetic arm prototype that is currently being used for student training, and are developing a prosthetic leg for the same.

Most recently, she embarked on the development of a soft robotics cushion, also funded by Jump ARCHES, that ameliorates pressure ulcers for people who are wheelchair bound.

"We've been working to understand air bladders—how to design and fabricate them," she said. "We want to be able to actuate the amount of support provided to the individuals sitting on them."

"The hope is that this will become an automated system where the chair can detect pressure points and modulate pressure to relieve them," she said. "It should modulate the behavior of the cushions so that

The PURE ball-based mobility device (Gen3 seen here) can carry payloads over diverse terrain, setting the stage for more adaptive transport for patients experiencing limited mobility.

it can change where loading is experienced over time. And it should be fully contained so that the unit can be transferred from chair to chair depending on where the individual is."

In all of her projects, Hsiao-Wecksler is excited by the prospect of helping more and more people. "I have a deep interest in helping people with disabilities and being able to improve their quality of life," she said.

Hsiao-Wecksler's medical education task trainers - in this case, robotic limbs that can provide haptic feedback to medical students who are training to perform neurological exams.

Prashant Mehta

Professor Prashant Mehta looks eagerly to the future of AI as it pertains to applications like robotics and control. "It's a great time to be alive," he quipped, with so many opportunities to explore AI technology while it's still young.

In previous work, one of Mehta's former PhD students developed the mathematics for a particular type of control theory that proved to be very relevant to understanding how AI technologies, such as the generative chatbot ChatGPT, function.

"We hope to use that background to understand how ChatGPT and other models work," said Heng-Sheng Chang, a postdoctoral researcher and former student in Mehta's lab.

"You can't help but be amazed by how well it works—which is a surprise," Mehta said of technologies like ChatGPT. "As a community, we did not really expect that something like this would be possible based on the mathematics that exist. Yet, it is there—it demonstrably works. Our goal is really to try to understand the mathematical foundations for this technology."

Chang's perspective on understanding AI for future implementation in soft robotics echoes Mehta's sentiment. "At first, we try to understand and model AI, and then we work to control it," he said of the team's process going forward. "How do we orient AI behavior toward our desired goals?"

Mattia Gazzola

Mehta, Chang, Associate Professor Mattia Gazzola, and other collaborators have also developed an unprecedented computational octopus arm model (see page 28 for more on this work).

"The foundational work began with understanding what happens in an octopus's biological system," Mehta recalled of the years-long ongoing study. "Then it quickly transitioned to applying [the octopus's] inspiration to real engineering systems."

"Our theoretical understanding is still an intuitive approach," Gazzola said of ongoing work.

"We want to develop an automated framework so that our octopus model can learn to perform tasks on its own."

Following his efforts to model the arm, Chang also worked to develop a test bed for physical prototypes. Findings from the octopus arm have implications for applying soft robotics to industries like agriculture that rely heavily on physically laborious processes.

"We started with some mathematical backgrounds to understand the math behind it," Chang said of the process of modeling complex systems for soft robotics applications. "Then we got to learn from a physical arm, and then we developed simulations. It has been very rewarding for me, being able to understand real things that are happening."

> *To my knowledge, this is the first time anyone has demonstrated long jumping in insect-scale robots. This is significant because it gives the robot planned mobility, where it can now jump from A to B, traversing terrain [with obstacles larger] than its own size.*
>
> \- *Sameh Tawfick*

Sameh Tawfick

Professor Sameh Tawfick has been working to develop jumping capability in 3D-printed insect-scale robots.

"To my knowledge, this is the first time anyone has demonstrated long jumping in insect-scale robots," Tawfick said of his lab's accomplishment. "This is significant because it gives the robot planned mobility, where it can now jump from A to B, traversing terrain [with obstacles larger] than its own size."

Jump performance in insect-scale robots was previously hindered by small-scale manufacturing processes and limited availability of materials and miniature actuators. Tawfick's team used coiled artificial muscle actuators and projection 3D printing to produce a monolithic elastomeric robot design inspired by a locust's jumping mechanism.

"We used a four-bar linkage design for jumping, inspired by the locust, which is an outstanding jumper," said Tawfick, explaining that while a locust's four legs are not linked, allowing it to both walk and jump, the robot in their study relies on a single muscle serving a linkage system.

Their insect-scale prototype has a lightweight elastomer body and an artificial muscle made from coiled, heat-treated nylon fishing line. Tawfick's lab previously developed machines to produce these miniature coils. The researchers designed and tested 108 robot iterations produced through additive manufacturing, with the smallest having a mass of 0.216 grams and the ability to jump 60 times its body size in horizontal distance.

"Our dream for the future is to have a small mission in which the robot executes multiple jumps until they reach a target," he said.

Siyi Xu

Imagine if muscle performance could be tracked during real-time training—this is what Assistant Professor Siyi Xu hopes to achieve.

Xu works to develop wearable actuators that can give tactile feedback in real time as the wearer performs certain tasks or exercises. This is especial-

Xu's penny-sized wearables will safely adhere to the skin to track muscle movement.

ly pertinent for athletes and patients in physical therapy, where haptic feedback could impact their training or recovery on the spot.

"We're hoping to use the actuators to sense the biomechanical performance of muscles," Xu explained. "For example, how well the muscles are being trained or activated during certain motions, and whether they are meeting targeted requirements."

Current technologies, such as ultrasound or specialized handheld devices, are capable of tracking muscle mechanical properties. However, fully untethering these technologies so that they become wearable, mobile devices is challenging. Xu seeks to address this gap by developing lightweight, waterproof wearables that safely adhere to the skin. Her current prototypes are on the scale of a penny.

"I'm hoping to improve the performance of these actuators and use them as wearables to untether them from electronics. That's a very exciting contribution we could provide to the field," Xu said.

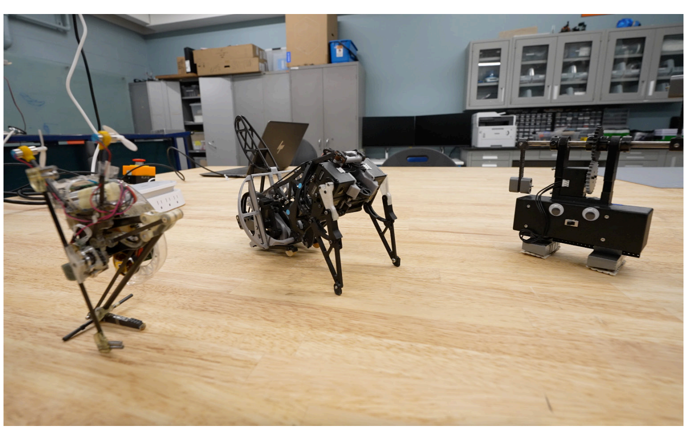
The real-time feedback is also pertinent for robotics design. With in-depth feedback from human performance during a task, robots that collaborate with the human to complete the task more efficiently could be adapted to the specifications defined in these metrics.

"I'm excited to investigate the possibility of improving collaboration between humans and robots."

Justin Yim

"Our lab works on a lot of robots that move around in unconventional ways," said Assistant Professor Justin Yim. "We're really excited about exploring the different ways that robots can move around in the world—walking, rolling, jumping, maybe even slithering."

As a PhD student at University of California, Berkeley, Yim developed Salto, a one-legged jumping robot inspired by the biomechanics of the squirrel-sized lesser bushbaby. With Salto, he demonstrated the ability to direct accurate leaps onto narrow targets and stick the landing gymnast-style. More recently, he has turned his focus to outer space, investigating the ability to jump on Saturn's icy moon Enceladus with Phase 1 funding from the NASA Innovative Advanced Concepts (NIAC) program.



Yim's robots move around in a variety of unconventional ways.

"The gravity on Enceladus is roughly 1/80th the strength of that on Earth, so a robot that can jump four feet high [on Earth] might be able to cover the length of a football field in a single bound, allowing it to cover crevices and canyons and other rough terrain," Yim explained. "We're also looking at combining jumping with rolling locomotion so that we can take advantage of wheels on flat terrain and jumping on rough surfaces. If we can do both, the robot will be more flexible and more adaptable to situations that we might not have predicted at launch time."

Yim's lab is also developing robots that can emulate squirrels' ability to jump into a climbing motion as well as both walking and wheeled robots that use minimal motors for locomotion—not to mention a rock-shaped robot that uses an internal pendulum to literally rock and roll.

Yim credits nature with the inspiration for his work, which has garnered accolades such as a Faculty Early Career Development Program (CAREER) Award from the National Science Foundation.

"Animals serve as a really great example for how small or big things can get around on our planet," he said. "When we try to build engineered systems, we don't always have to start from scratch, trying to figure out every possible way we might solve the problems that we face."

Over the next few years, Yim is excited to contribute to the evolution of robots' animalistic capabilities. "I'd love to see robots that explore new ways to move that can be better than how robots move now," he said. "And maybe even better in some ways than how animals and humans move. That would open up new abilities for robots to do things that humans and other animals can't." ◆

> *Animals serve as a really great example for how small or big things can get around on our planet. When we try to build engineered systems, we don't always have to start from scratch, trying to figure out every possible way we might solve the problems that we face.*
>
> *- Justin Yim*

Watch the coordinating videos featuring several of these faculty and their inspiring work!

go.mechse.illinois.edu/robotics-autonomy

Johnson named Executive Director and CEO of Illinois Quantum and Microelectronics Park

MechSE professor Harley Johnson is now Executive Director and Chief Executive Officer for the recently announced Illinois Quantum and Microelectronics Park (IQMP).

The project, a quantum-focused research and development campus on the south side of Chicago, will be managed by a University of Illinois-led organization on behalf of the State of Illinois and Governor J.B. Pritzker. The IQMP will propel development of a quantum market that has a predicted worth of $2 trillion in the next decade by closely aligning entrepreneurial activity with research firepower. Advances in quantum information science and engineering, together with next-generation microelectronics, promise to transform computing, which underpins much of how our modern society operates.

“We are proud to have been called to lead the effort, and I’m personally thrilled to have an opportunity to help shape this historic project,” Johnson said. “The potential for our work in the park to change the world is drawing comparisons to historic tech initiatives like the Manhattan Project or the development of Silicon Valley. Due to the unique nature of this public-private partnership, we have a once-in-a-generation opportunity to make the world better through advancements in quantum computing and microelectronics."

Alva L. and Sandra R. Addy Head of the Department of Mechanical Science and Engineering

In September 2024, MechSE was thrilled and humbled to announce the first named department headship in The Grainger College of Engineering—the Alva L. and Sandra R. Addy Head of the Department of Mechanical Science and Engineering.

A passion for higher education and a desire to continue their legacy led alumnus Alva “Tad” Addy (PhD ME 1963) and his wife Sandra Addy to establish this historic gift. Tad, who passed away in 2018, was a pioneering fluid mechanics researcher and a beloved professor. He led MechSE (then Mechanical and Industrial Engineering) from 1987 to 1998 and had a profound impact on the quality of MechSE’s education, research and public service. Sandra (BS 1963, MS 1967, PhD 1974 Edu), worked for a time in alumni relations and fundraising for the department and was also a schoolteacher.

The Addys’ gift is an unrestricted bequest expectancy, meaning the funds have been left in a will and can be used for any purpose, in this case at the discretion of the department head. The Addys knew first-hand the value of unrestricted funds.

“Tad and I worked hand in hand, but he was the driving force, and this gift reflects his intentions. It is a very rewarding thing for me to be able to do this,” said Sandra. “I was delighted to find out that this is the first named department headship in the college. I hope that department headship endowments will follow for other departments in The Grainger College of Engineering because I know first-hand what a powerful tool this endowment will be for the Department of Mechanical Science and Engineering.”

Watch the video and learn more about the inspiration behind the gift:

go.mechse.illinois.edu/Addy

In Memoriam: Lambert “Ben” Freund

Alumnus and professor Lambert “Ben” Freund passed away October 3, 2024, at the age of 81. Freund is an alumnus of MechSE (BSEM 1964, MS TAM 1965) and served as an adjunct professor in the Department of Materials Science and Engineering. After earning his PhD in theoretical and applied mechanics from Northwestern University, he arrived at Brown University as a postdoctoral fellow in 1967 and rose through the ranks to become professor of engineering in 1975, where he worked until his retirement in 2010.

Freund was known both as an outstanding teacher and a pioneering researcher. His papers and books defined subfields of mechanics, and his work contributed significantly to the world’s basic understanding of the mechanical behavior of engineering materials. He was a member of the National Academy of Engineering (1994) and the National Academy of Science (1997), to name a few. He served as a member of the U.S. National Committee for Theoretical and Applied Mechanics and a U.S. delegate to and president (2004) of the International Union for Theoretical and Applied Mechanics. Even with his many recognitions, Freund delighted most in the accomplishments of his students and mentees.

After retiring from Brown University, he moved to Champaign to be closer to his son, Department Head and Willett Professor of Aerospace Engineering Jonathan Freund, and his family.

From Defense to Disease:
King's Deep Dive into Manufacturing

To say the least, MechSE Professor **Bill King** has had a busy year. His advanced manufacturing research, which garnered early accolades such as the Presidential Early Career Award for Scientists and Engineers and many other awards for engineering achievements, has paved the way for multiple innovative opportunities that could benefit society in potentially groundbreaking ways.

In Fall 2024, The Grainger College of Engineering launched the Illinois Manufacturing Institute (IMI), which King directs. The IMI is dedicated to pushing the envelope in industry to create the next generation of manufacturing infrastructure. King's leadership is informed not only by his career exploration of advanced manufacturing concepts but also by his industry experience as founding chief techology officer at the Digital Manufacturing and Design Innovation Institute (now MxD) and co-founder and chief scientist at the cutting-edge digital factory Fast Radius.

"Grainger Engineering has over 50 faculty members working on different aspects of advanced manufacturing such as additive manufacturing industrial internet of things machine networks, human-robot interfaces, advanced materials, and supply chain management, and the IMI will bring them all together to better collaborate and present their expertise to the world," King said.

Indeed, King's vision for communal manufacturing extends beyond the Illinois campus. During the same year, he led the formation of the University of Illinois' Quad Cities Manufacturing Institute (QCIM) to foster collaboration between the U.S. Army Arsenal in Rock Island, Illinois, and businesses in the Quad Cities area.

As if directing one center and leading the development of another was not enough, King and fellow MechSE Professor Sameh Tawfick began working with the U.S. Army earlier this year to launch the world's first university research center focused on developing large metal additive manufacturing. They seek to develop industrial processes that will allow the military to quickly manufacture large parts on demand for its ground vehicle fleet.

King's investigations include not just large-scale parts manufacturing but also more granular inspection of the manifest of individual parts. His research team found that parts made by 3D printing carry a unique signature from the specific machine that made them. Their discovery inspired the development of an AI system that can detect each signature, or "fingerprint," and identify the origin.

"We are still amazed that this works: we can print the same part design on two identical machines—same model, same process settings, same material—and each machine leaves a unique fingerprint that the AI model can trace back to the machine," King explained. "It's possible to determine exactly where and how something was made."

King has also found opportunity to apply ideas from advanced manufacturing to benefit the field of cancer research. In his Advanced Research Projects Agency for Health (ARPA-H) project, "Manufacturing Agile and SCalable Organoid Tumor models (MASCOT)," King is working to develop a platform for manufacturing tumor cultures to replicate cancer outside the body.

"The goal is to have consistent size, shape and chemical composition across tumors, and this is something that digital manufacturing can do very well," King said. "Instead of individual models hand-grown in a lab, you can reliably produce hundreds of identical models at once, and now you can systematically study things like the effects of different drugs on the same tumor." ◆

Read more about all of these exciting initiatives: **go.mechse.illinois.edu/magazine-2025**

Welcome New Faculty

Seven remarkable new faculty—three of whom are Grainger College of Engineering alumni!—joined the MechSE department during the past academic year. Two specialized teaching faculty and five tenure-track faculty are strengthening our expertise in the fields of soft robotics, manufacturing, thermal system optimization, nuclear materials, innovative engineering education and more.

Associate Professor **Craig Bradshaw** joined MechSE from Oklahoma State University. His research area is in thermal systems, compressors, heat pumps, air-conditioning, refrigerant and lubricant properties, model-informed design optimization, model development, fundamentals of heat and fluid flow in thermal systems, waste-heat recovery, thermodynamics, and heat transfer. He also serves as Executive Director of the Air Conditioning and Refrigeration Center (ACRC) at Illinois.

The research of Assistant Professor **C. Ricardo Constante-Amores** focuses on fluid mechanics related to multiphase flows, data-driven turbulence modeling from a dynamical system point of view, and Koopman theory for high-dimensional systems. He has developed a modeling framework that accounts for the presence of surfactants in multiphase systems; created low-dimensional models for canonical turbulent systems such as pipe flow and plane Couette flow; and studied the role of kidney stones in renal pelvis using patient-specific CFD models.

Nazanin Farjam is an Assistant Professor who studies process modeling and control, advanced manufacturing, printed electronics and electrohydrodynamic jet printing (EHD). She focuses on enhancing the flexibility, robustness, and efficiency of complex dynamic systems by developing modeling frameworks and intelligent control strategies to push the frontier of advanced manufacturing and optimize the behavior of systems and their components.

Teaching Assistant Professor **Kellie Halloran** earned her BS, MS and PhD from MechSE, where her doctoral work under Mariana Kersh focused on shoulder biomechanics during and after handcycling exercise, inverse musculoskeletal modeling, injury prevention during exercise for manual wheelchair users, and engineering education. She is already making her mark bringing innovative new ideas to the department's design course curricula.

Kevin Wandke joins MechSE as a Teaching Assistant Professor after earning all three of his degrees from Illinois. His doctoral research was in machine learning for solving coupled partial differential equations (PDEs) as well as simulation and modeling of soft robots. He developed a method for correcting energy drift in long timescale machine learning simulations of dynamic systems. Wandke has also collaborated alongside Halloran and colleagues to improve MechSE's undergraduate design courses.

Professor **Janelle Wharry** brings expertise in structure-property-functionality relationships of materials in mechanical, irradiation, electrochemical, and corrosive extreme environments. She has developed theories explaining phase transformations in steels under mechano-irradiation extremes, and her work is enabling code-qualification of advanced manufacturing methods for nuclear structural alloys. She joins MechSE from the School of Materials Engineering at Purdue University.

Assistant Professor **Siyi Xu** studies soft robotics, wearable and implantable sensors, electrically responsive soft actuators and fluidic systems. She has developed biocompatible soft sensors and power-dense transducers for the actuation and control of soft robots, and has demonstrated the potential of compliant, lightweight, and compact wearable robotic systems for daily assistive and therapeutic purposes. Xu has come full circle, having earned her undergraduate degree in materials engineering from Illinois. ◆

Faculty and Staff Abroad

The role of culture and community in the student experience

The belief that students benefit from the diverse perspectives of instructors with first-hand experiences in global travel and service learning was behind a recent trip to Jamaica aimed at training faculty and staff to incorporate more global learning into their courses.

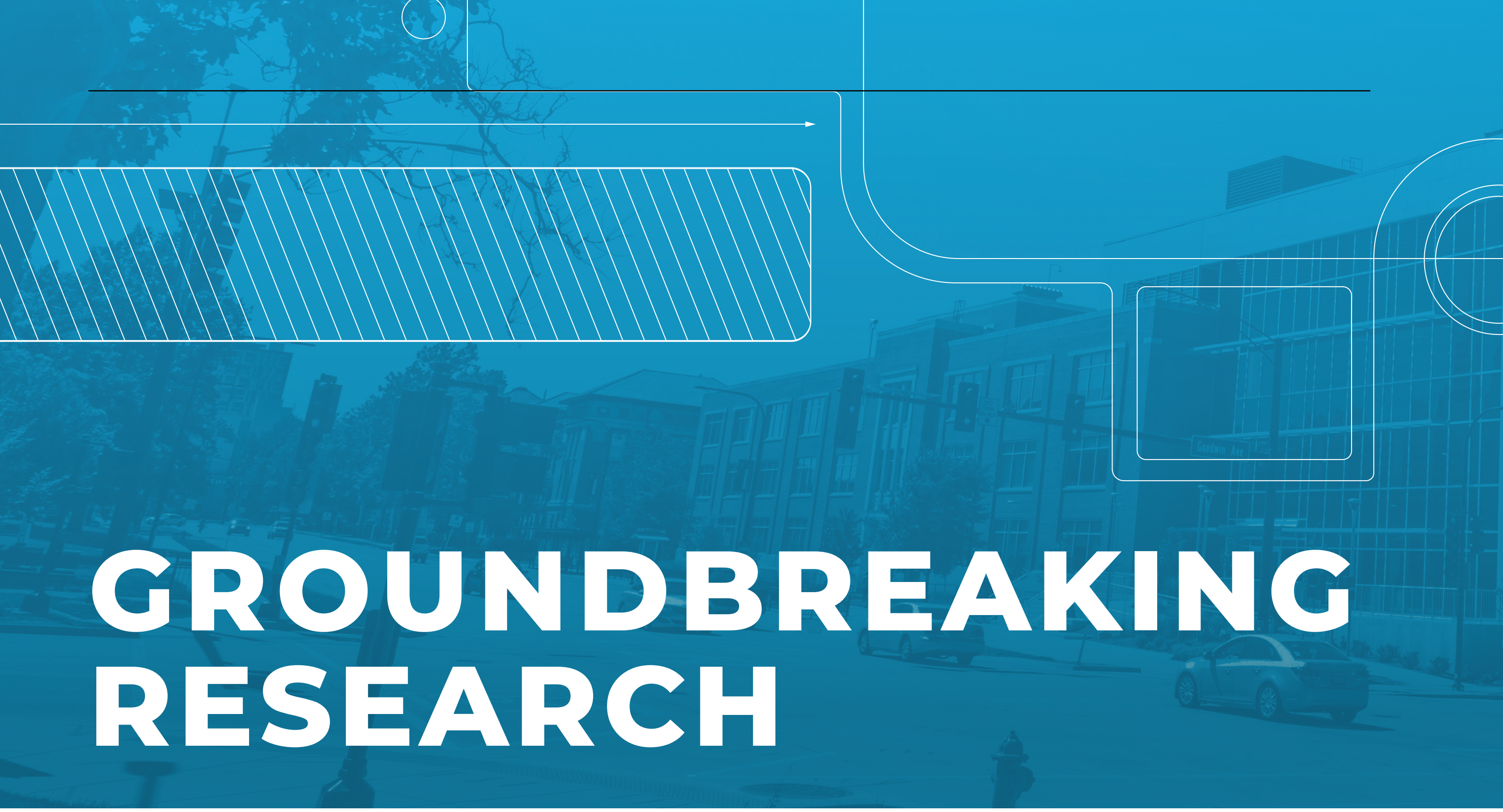
This spring, a dozen Grainger College of Engineering faculty and staff traveled to Jamaica as guests of the Petersfield Galloway Benevolent Society (PGBS), including MechSE's **Kellie Halloran**, **Brian Mercer**, and **Stephanie Ott-Monsivais**. During the retreat, they were immersed in culture and global service learning as well as preparations for leading future student experiences.

In collaboration with AllPeopleBeHappy and PGBS and funded by the college's Strategic Instructional Innovations Program (SIIP) and International Programs in Engineering (IPENG), the project's goal is to expand students' global engagement opportunities by training faculty and staff to offer courses that incorporate global learning components. By reflecting on their own personal experiences during this program, instructors may be better equipped to connect with students and lead programs with greater empathy and insight.

Ott-Monsivais, director of undergraduate programs for MechSE, said program leaders and the community stressed the significance of Americans going to Jamaica to better understand their culture and life. "There were many things I encountered during our program that made me reevaluate my assumptions," Ott-Monsivais said of her experience. "It made me reflect on my privilege and reinforced the importance of learning from others, especially those with backgrounds different from my own."

While this program focused on culture and community, it also showed Ott-Monsivais how global learning and service elements could enhance engineering courses. "Being in an unfamiliar environment challenged me while promoting a growth mindset, which will help me relate to my students and better understand their experiences. It has provided me some insight into the issues students may face when studying abroad and has supplied me with strategies to help them overcome key obstacles." ◆

Learn more and see photos from their experience: **go.mechse.illinois.edu/facultyabroad**



GROUNDBREAKING RESEARCH

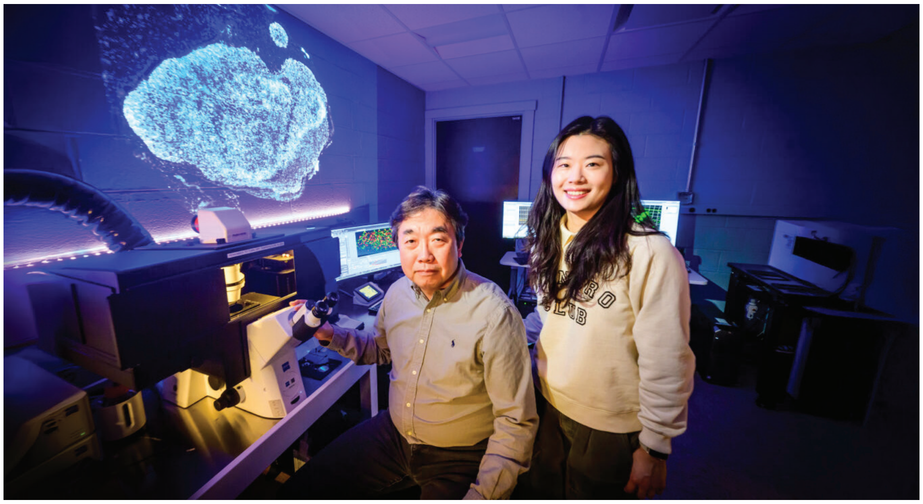
DNA ORIGAMI GUIDES NEW POSSIBILITIES IN THE FIGHT AGAINST PANCREATIC CANCER

One of the challenges of fighting pancreatic cancer is finding ways to penetrate the organ's dense tissue to define the margins between malignant and normal tissue. Professor **Bumsoo Han** and colleagues have found that specially engineered DNA origami structures carrying image dye packets can specifically target cancerous mutations in the human gene KRAS—mutations that are present in 95% of pancreatic cancer cases.

"This research highlights not only the potential for more accurate cancer imaging, but also selective chemotherapy delivery, a significant advancement over current pancreatic ductal adenocarcinoma treatments," Han said. "The current process of cancerous tissue removal through surgical resection can be improved greatly by more accurate imaging of tumor margins."

The team developed pancreatic cancer models using 3D-printed "tumoroids" and microfluidic systems that mimic the complex tumor microenvironment to reduce the reliance on animal tissue and accelerate translation to clinical use in humans. They added the dye-packed DNA structures to the tumor models to track their movement before administering the structures to mice to explore distribution in more physiologically relevant conditions. They also experimented with the shape and size of the origami molecules.

The next step is to explore the use of origami-folded DNA molecules with chemotherapy drugs for selective delivery to cancer cells without affecting normal cells. "Doing so with engineered tumor models to reduce animal use and accelerate translation in drug discovery is another direction we are very proud of," Han said.



Han, left, and postdoctoral researcher Sae Rome Choi are authors of a new study exploring the use of DNA origami for better imaging of dense pancreatic tissue for cancer detection and potential treatment. Photo by Fred Zwicky.

NEW BRAIN MODELING AIMS TO BETTER UNDERSTAND THE MECHANICS OF TRAUMATIC BRAIN INJURY

Assistant Professor **Callan Luetkemeyer** won a three-year Early Career Program grant from the Army Research Office to develop material models of the human brain in collaboration with researchers from the Biomedical Imaging Center at the Beckman Institute at Illinois.

In terms of material behavior, a healthy human brain roughly resembles Jell-O. Brain matter contains numerous neural pathways that are constructed from nerve cells coated in a myelin sheath and resemble fibers mechanically. The brain contains regions of grey matter and white matter, each of which have their own densities and stiffnesses. Thus, modeling the brain as a complete system is nebulous and complex.

However, accurately modeling the brain's material behavior is crucial for understanding the impact of traumatic brain injuries, particularly those that occur repeatedly over time, resulting in chronic traumatic encephalopathy, or CTE. Unlike conventional modeling techniques, which rely on expensive computational tools and data from magnetic resonance elastography to produce, Luetkemeyer's method leverages inversive mechanical modeling to produce the same model in a matter of minutes.

"We use specialized MRI pulse sequences to measure how the brain deforms in response to shear waves propagating through it," Luetkemeyer said. "Modeling the brain as linear and isotropic—effectively, like a metal—isn't very predictive. Over the next three years, we're focused on developing better models that treat the brain as having nonlinear and anisotropic properties."

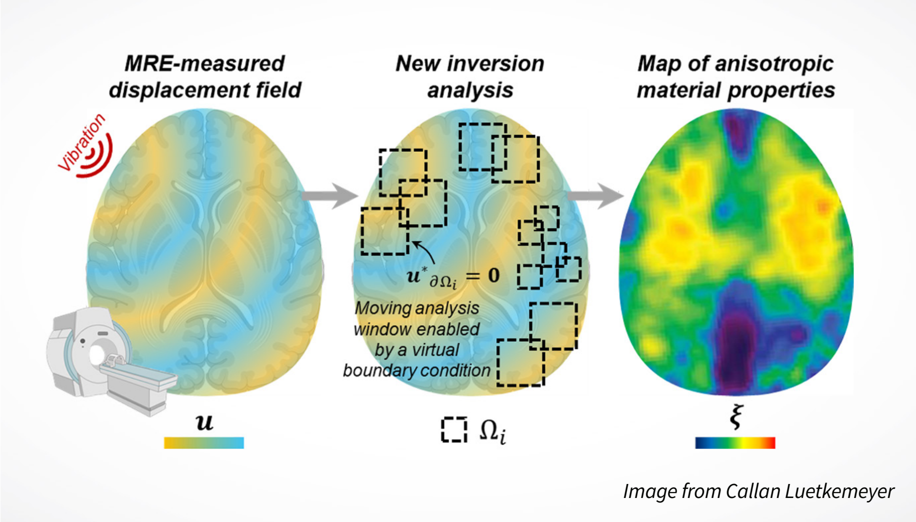
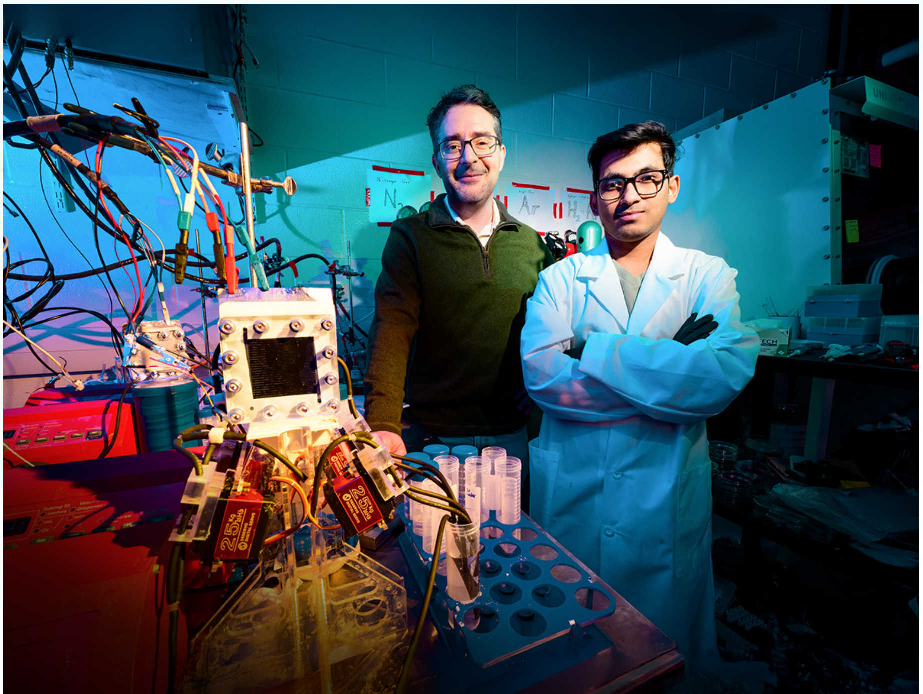


Image from Callan Luetkemeyer

> *"Modeling the brain as linear and isotropic—effectively, like a metal—isn't very predictive... We're focused on developing better models that treat the brain as having nonlinear and anisotropic properties."*
>
> *- Callan Luetkemeyer*

> *...The technique could require less energy to push the water through and eventually become more efficient than what is commonly used in the reverse-osmosis process.*
>
> *- Kyle Smith*



Kyle Smith, left, and graduate student Habib Rahman are leading the charge toward wide-scale implementation of water desalination. Photo by Fred Zwicky.

NEW RESEARCH HELPS ELIMINATE DEAD ZONES IN DESALINATION TECHNOLOGY AND BEYOND

Associate Professor **Kyle Smith** and his research team have found a way to eliminate the fluid flow “dead zones” that plague the types of electrodes used for battery-based seawater desalination.

To date, technical hurdles have prevented the wide-scale implementation of desalination technology. Reverse osmosis, which pushes water through a membrane that filters out salt, is costly and energy-intensive. Using electricity to draw charged salt ions out of the water also incurs an energy cost. Smith found that using a physics-based tapered flow channel within electrodes can move fluids quickly and efficiently, potentially requiring less energy.

“Traditional electrodes still require energy to pump fluids through because they do not contain any inherently structured flow channels,” Smith said. “However, by creating channels within the electrodes, the technique could require less energy to push the water through and eventually become more efficient than what is commonly used in the reverse-osmosis process.”

Although the team faced some manufacturing challenges while preparing the electrodes for experiments, they are confident these can be overcome for long-term, scaled-up production.

“Beyond its impact toward electrochemical desalination, our channel-tapering theory and associated design principles can be applied directly to any other electrochemical device that uses flowing fluids, including those for energy storage conversion and environmental sustainability like fuel cells, electrolysis cells, flow batteries, carbon capture devices and lithium recovery devices,” Smith said.

Ewoldt and Tawfick used their new "growth printing" technique to fabricate a pinecone, raspberry and squash.

NEW 3D PRINTING METHODS REPLICATE NATURE'S FINEST FIBERS AND MIMIC TREE TRUNKS' OUTWARD EXPANSION

Professor **Sameh Tawfick** is leading a collaborative effort with Professor **Randy Ewoldt** and researchers from the Beckman Institute at Illinois to develop "growth printing," which mimics tree trunks' outward expansion to print polymer parts quickly and efficiently without the molds and expensive equipment typically associated with 3D printing.

"Completely new manufacturing processes are hard to find. Growth printing is entirely new, which is thrilling," said Tawfick.

To perform a growth print, the researchers pour liquid resin, called dicyclopentadiene, into an open glass container submerged in ice water and heat a center point in the resin to 70 degrees Celsius. Any resin the heat touches as it radiates hardens so that the process produces a growing sphere. The final shape of the object can be altered through manipulation—as the liquid-to-solid reaction only happens below the surface, the researchers can lift, dip, or spin the solid part like blown glass to change its appearance.

Using their new method, the team fabricated everyday items such as a pinecone, raspberry, and squash. These are all axisymmetrical shapes, or symmetrical around a vertical axis. Non-symmetrical shapes are more difficult, but possible; for example, the team sculpted a kiwi bird by allowing the spherical body to expand below the surface before pulling it up just in time to create a diminutive head and minute beak.

Separately, Tawfick and Ewoldt also collaborated on the development of a cutting-edge embedded 3D-printing technique for the rapid printing of fine fibers in gel. Similar to growth printing, where the object is produced primarily beneath the surface of the resin, the team's method allows for complex shapes, such as helical springs, to be printed and cured within a reservoir of gel.

To achieve the unprecedented printing resolution of 1.5 microns per fiber, the team employed a method of solvent exchange to inhibit capillary breakup from surface tension, which allowed the fiber filament to cure instantaneously in the gel and thus prevented manufacturing defects like snapping.

"The significance of this method is to produce many geometries of hairs while not having to deal with the downward force of gravity on such fine and flexible hair," Tawfick said.

"This study relates to the broader research vision of my group—to enable novel engineering functionality by using the complex mechanical behavior of non-Newtonian fluids and soft solids," Ewoldt said. "This perspective integrates across foundational areas of mechanics, from fluid mechanics to solid mechanics and behavior in-between."

> *It was almost like working with a little kid. You have to know how to approach [the octopus] and keep it engaged."*
>
> *- Mattia Gazzola*

The team's modeling approach is significant to advancements in robotics, dynamics and control systems.

A NEW MILESTONE IN THE STUDY OF OCTOPUS ARMS

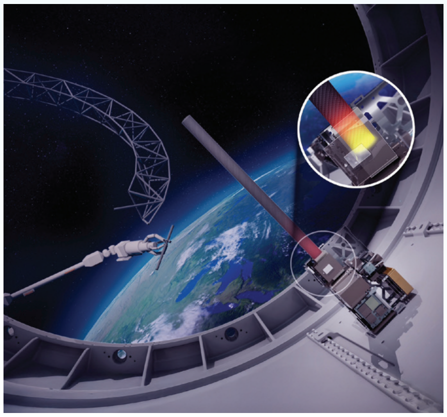
Professor **Prashant Mehta** and Associate Professor **Mattia Gazzola**, alongside several collaborators, have developed an unprecedented computational octopus arm model.

The model, which demonstrates an octopus's intricate muscular architecture, is used to explain how structural mechanics dramatically simplify the control of the arm by automatically orchestrating complex three-dimensional recurrent motions out of simple muscle contraction patterns—a milestone both in biology and engineering. "The computational model is a useful testbed for roboticists to test their algorithms," Mehta said.

The researchers have collaborated on this work since 2019 with the overarching goal of developing "cyberoctopus" capability—in other words, creating robotic control systems that can replicate the complex movements of octopus arms, with many degrees of freedom.

The team used image tracking to record the movements of a live octopus as it performed tasks in a tank. The octopus was placed on one side of a Plexiglas sheet with a hole through which only one arm could reach. In the experiments, a tempting object was placed on the opposite side of the sheet so that researchers could video-capture the octopus reaching for and manipulating the object.

"It was almost like working with a little kid," Gazzola said of the octopus. "You have to know how to approach [the octopus] and keep it engaged."



ILLINOIS RESEARCHERS KICK OFF NEW PHASE OF PROGRAM TO EXPLORE SPACE-BASED MANUFACTURING

A new space manufacturing project led by Professor **Sameh Tawfick** kicked off late last year. “Mission Illinois” aims to send a specialized construction apparatus to the International Space Station during the summer of 2026 to demonstrate space-based manufacturing.

“The goal of this project is to test an energy-efficient chemical process that transforms a liquid material into a solid material—known as curing—to enable on-orbit manufacturing and construction of large space structures such as new space telescopes, radio frequency antennas and other sensors with high-dimensional and mechanical precision and mass efficiency over massive sizes, some more than 300 meters in diameter,” Tawfick said. “We manufacture carbon fiber composite tubes that can then be assembled into space trusses on-demand, rapidly and with minimal energy use.”

The multiphase study, now in phase 3, is part of the Defense Advanced Research Projects Agency’s (DARPA) Novel Orbital Moon Manufacturing, Materials, and Mass Efficient Design program.

“This will be the first demonstration of manufacturing in space,” Tawfick said. “Realizing such structures will enable the next stage in humanity’s space utilization and a future beyond our imagination.” ◆

MORE BREAKTHROUGHS

Taher Saif aims to understand and manipulate the tumor microenvironment to improve the efficacy of pancreatic cancer treatment—by examining the mechanical stiffness of the cells in the tumor microenvironment. Typically, in cancer microenvironments, chemotherapy drugs are prevented from reaching the tumor due to the stiffness of the cancer-associated fibroblasts, the cells surrounding the tumor. Saif is developing and testing advanced instrumentation to soften the fibroblasts—and has already seen a remarkable increase in drug efficacy, paving the way for more personalized cancer therapies.

A multi-institution team led by **Janelle Wharry** has received $2.5M from the Department of Energy to design new materials that could make nuclear fusion power plants a reality. The team is exploring alloy design spaces and manufacturing processes to develop next-gen materials for the “first wall” that surrounds the fusion core of nuclear fusion reactors. For the U.S. to move from producing energy via nuclear fission to the more renewable (and less controversial) nuclear fusion method, new materials are needed that can withstand the immensely high temperatures and pressures generated during the fusion process. Wharry and colleagues, including **Huseyin Sehitoglu** and other Grainger engineers, aim to do just that.

MechSE’s **Bumsoo Han, Taher Saif** and **Amy Wagoner Johnson** are among the 16 Illinois researchers who were selected as part of the inaugural cohort of Chan Zuckerberg Biohub Chicago investigators. The 48-member group, which will focus on instrumented tissues, inflammation, and the functions of the immune system, also includes investigators from Northwestern University and University of Chicago.

Visit ***mechse.illinois.edu/news/CZBiohub*** to learn what the researchers are working on.

New work from **Bill King** and **Nenad Miljkovic**, with the U.S. Navy, is bringing some much overdue innovation to the design of heat exchangers—billions of which are used around the world in HVAC systems, refrigerators, cars, ships, aircraft, cell phones, data centers and more. Crucially, using 3D printing, they designed and made a new two-phase heat exchanger with complicated 3D geometries that would not have been conventionally manufacturable. Testing shows their device outperformed traditional designs by 30% to 50% for the same amount of power.

The exposure of biological cells to stressors such as radiation, pollutants, and heavy metals can cause lipids (fats) in the body to oxidize. Oxidation can drastically change the lipids’ physiochemical properties to the point of impeding homeostasis and can even result in explosion of vesicles, the tiny, naturally occurring compartments that store enzymes. **Jie Feng** is studying the use of controlled, light-induced vesicle explosion to potentially package and deliver small amounts of materials in the human body. For example, drugs that are cytotoxic, like cancer drugs, could be packaged in a vesicle that is harmless to the body and delivered to cancerous tissue without killing healthy cells along the way.

Alumni News

Reducing methane emissions one well at a time ▲

Last year, **Kapilan Tamilselvan** (BSME 2018) joined Tradewater, a mission-based benefit company that primarily focuses on non-carbon dioxide gases such as refrigerants and halons. Tamilselvan's team works on its more recent program to capture methane emissions, targeting the roughly 100,000 documented orphaned wells in the U.S.—i.e. those without solvent owners. Tradewater works with state registries and landowners to find these wells and evaluate whether they are still emitting potent methane gas. Over the next few years, Tamilselvan and the team hope to increase plugging efforts both across the U.S. and internationally. Currently, federal carbon credits fund Tradewater's plugging projects, but properly plugging one well can cost anywhere from $10K to $100K. "The existing federal funding that we have would not nearly be enough to plug every orphaned well. We need private companies to come in with climate finance and do this work too," said Tamilselvan.

Transforming and optimizing threads

Hardy Komandiwirya (BSME 2002, MSME 2004) has undergone a unique journey, developing from a MechSE student to his current role as a successful general manager and entrepreneur in China's garment industry. A native of Indonesia, he worked his way up to the role of general manager of a garment factory in China named Koon Fat Garments Limited (KF Garments).
In this role, he develops the business, streamlines production lines, increases production capacity, and works with a staff of about 1,000. Garments from his factory are shipped to the U.S., with current clients including Urban Outfitters, PacSun, and Abercrombie, to name a few. Komandiwirya also started several of his own businesses, including a garment trading company, Creative Textile Limited, which caters more to high-end customers, and an Amazon side-hustle, Tuan Yuan Electronics, which sells small home appliances.

Tilton's journey continues to gain ground

Adam Tilton (BSME 2010) recently announced the successful seed funding of his latest start-up, Driver. Featured in TechCrunch, Driver's generative AI-powered platform can both translate complex technical documentation into concise, actionable explanations and generate comprehensive documentation quickly for new products. This is a boon for the semiconductor industry in particular, where technical documentation for a single chip can be thousands of pages long—resulting in long, tedious hours of study for engineers to understand how to implement the chip in a system or product.

"

The value of an engineering education is learning how to think and how to teach yourself... The learning experience that I had [at Illinois] really put things in perspective for me.

- Eduardo Torrealba

"

From FSAE to the fast lane ▲

In his role as a Sportscar Racing Simulation Engineer at Cadillac Racing, **Brian Smith** (BSME 2019) performs offline lap simulations for the Cadillac V-series R racecar to generate valuable data that teams can use to make quick decisions during races. He also performs studies to analyze potential improvement areas and evaluate how the car will behave if one component or another is changed. Smith's involvement in Illini Motorsports (IM) Formula SAE (now Illini Electric Motorsports) helped lay the foundation for his career path. He was a member of the IM team throughout his time at Illinois and ultimately became the suspension subsystem lead in 2018. "The Formula SAE team gave me tons of applicable experience both in terms of design and manufacturing," he said.

Mohammed leverages nonlinear mindset to lead the way in clean waste industry

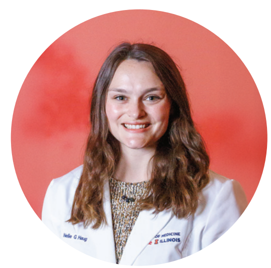
Azeez Mohammed (MSME 1995, PhD ME 1998) was named the CEO of Covanta Holding Corporation, now known as Reworld, in 2021, and has shaped his career from the nonlinear mindset he developed under Professor Alex Vakakis at Illinois. The company, which partners with businesses and communities to create smarter waste solutions with positive environmental impacts, has seen significant transformation under his leadership, moving from public to private and becoming a profitable business leader in the waste solutions industry. Reworld is one of just a few carbon-negative companies in the U.S. "What we do here at Reworld is ten times cleaner than anything I've done in my career, including previous efforts like solar," Mohammed said.

Dwivedi, Cache Energy race to find inexpensive ways to store renewable energy

Scientists and engineers have been racing to find inexpensive ways to store an overabundance of wind and solar power for later so that, ultimately, it's available 24/7. Alumnus **Arpit Dwivedi**'s (PhD ME 2022) company, Cache Energy, is storing it in chemical bonds inside pellets made of lime derived from limestone. Dwivedi said the pellets can be stored almost anywhere and will hold their charge "almost forever." The startup raised $8.5M in seed funding last year and as of August 2024, has one pilot reactor currently with a customer.

Torrealba continues his success in the manufacturing industry

Eduardo Torrealba's (MSME 2013) company, Lumafield, founded in 2019, recently announced $75 million series C funding, which acknowledges its leadership status within the manufacturing industry and opens opportunities for more expansion. Lumafield utilizes X-ray CT scanners and advanced engineering software to upgrade manufacturing in a variety of industries. In his position as CEO, Torrealba places importance on creating new ideas and advocates for engineers to look for opportunities for growth in their career. "The value of an engineering education is learning how to think and how to teach yourself," Torrealba said. "While there are concepts from past courses that I don't tend to use on a regular basis, the learning experience that I had [at Illinois] really put things in perspective for me."



CI MED team's labor onset detection system wins top prize in pitch competition

Last fall, a Carle Illinois College of Medicine student team—including MechSE alum **Nellie Haug** (BSME 2022)—won the top prize, including $25K, in the TechRise Startup Pitch Competition for their solution to help detect onset of labor. AmnioAlert is a non-invasive underwear liner designed to provide an objective and cost-effective indication of labor onset, preventing unnecessary trips to the hospital for "false alarms." Haug and the team said their device could be especially important for expectant mothers in rural settings who must drive long distances to deliver their babies. The same student team won $10K in investments by advancing to the finals of the spring 2024 Cozad New Venture Challenge at the University of Illinois. ◆

GAINING A SECOND WIND

GRAINGER ENGINEERING ALUMNI COLLABORATE TO RESTORE WWI RELIC

Bruce Ernt, left, and Arnie Taube

MechSE alum **Arnie Taube** (BSME 1975) and aerospace engineering alum Bruce Ernt (BSA&AE 1965) have found an outlet for their shared passion for aviation: restoring a World War I-era DH-4 light-bomber/observation aircraft to flyable status.

"I am very enthusiastic about airplanes and history, so it was a natural fit," Taube said of volunteering for the project.

The two alumni, both retired, are volunteering alongside a dozen or so dedicated craftsmen in partnership with the Bleckley Airport Memorial Foundation in Wichita, Kansas. The Bleckley Foundation honors Wichita local Second Lieutenant Erwin Bleckley, an artillery observer who flew in an identical DH-4 with Chicago native Lieutenant Harold Goettler on two missions during WWI.

The AirCo DH-4 light day bomber biplane, designed by British aerospace engineer Geoffrey de Havilland, is memorialized as a widely successful WWI day bomber. U.S. manufacturers produced nearly 5,000 of the 6,000+ total biplanes that saw combat during the war.

"The [DH-4] was a very high-performance aircraft at the time," said Taube, who has been working on the restoration project for more than a year. "It was fast enough and could fly high enough that German fighters had a really hard time being able to fight it or shoot it down."

As part of the 50th Aero Squadron, Bleckley and Goettler were given a mission to attempt to locate the Lost Battalion—nine companies of the U.S. 77th Division who were isolated by German forces in the Argonne Forest in October 1918. Such an attempt—to locate and assist lost soldiers stranded in enemy territory, all from up in the air—was the first of its kind in U.S. military history.

Both men died during the mission, and were awarded the Congressional Medal of Honor posthumously for their heroic attempt.

The restoration project, slated to finish in 2026, involves fabricating new wooden parts as well as cleaning originals. This particular DH-4 was manufactured near the end of the war and never assembled for combat. It was first assembled by a group based in Bowling Green, Kentucky, who displayed the project at EAA AirVenture Oshkosh in 2018. Unfortunately, the DH-4 crashed during an attempted test takeoff two years later, sustaining heavy damage to its fuselage and wings. This project marks its second restoration.

Taube has been helping with assembly of existing parts, such as the joystick and other controls, as well as varnishing new parts and cleaning originals. Ernt has been helping to fabricate wing sections. He will also contribute to control surfaces such as the horizontal stabilizer.

"We have the full set of engineering drawings for the aircraft from the Dayton-Wright Company, so we fabricate parts as needed," Taube said.

Although ten years apart in their programs, the two alumni have led similarly rich careers and both moved to the Wichita area as retirees to be closer to their respective children. Ernt, who grew up in Rantoul, Illinois, worked his way through school and completed what was then a five-year aerospace program in four and a half years. He would eventually settle in southeast Kansas, working for M-E-C Company for 25 years before retiring as vice president.

Taube had also intended to apply to Illinois' aerospace engineering program, but life brought other opportunities.

"When I was entering college, the Apollo program was shutting down and aeronautical engineers were being laid off," Taube recalled. "I decided that I was going to become a mechanical engineer instead because there are mechanical systems in airplanes."

Taube had an uncle who worked as a product engineer at John Deere, a connection that resulted in Taube applying to the company for a cooperative education position. He was accepted into the program and alternated between school semesters and internship positions during his time on campus. He would go on to have a 45-year career at John Deere.

Within the volunteer community, the pair enjoy a kinship from their connections to Illinois. "We're the tag team for following U of I sports so we can brag about how our teams are doing to all the Kansas kids," Ernt joked.

The group hopes to place the finished aircraft, along with a bronze statue of Second Lt. Bleckley, on permanent display in the passenger terminal of Wichita Dwight D. Eisenhower National Airport. ◆

Korder at Penrose Brewery 10 years ago.

TEN YEARS AND COUNTING FOR THESE ENGINEERS TURNED BREWERS

Going from studying mechanical engineering to hitting the ten-year anniversary of running your own brewery is not something most people have in common, but MechSE alumni **Brent Schwoerer** (BSME 2001) and **Tom Korder** (BSME 2005) have both done exactly that.

The two central Illinois natives—Schwoerer grew up on his family's farm in the Bloomington-Normal area; Korder is a townie from Urbana—have expressed the value of an engineering background in endeavors both within and beyond the field.

"You can take what you learn in engineering school anywhere you go," Korder said. "What got you through the program, the way you learn and the way you process things, will get you through the rest of your career, no matter what it is."

Although their companies recently hit a shared milestone, these engineers' pathways to brewing success tell different stories.

Korder's path took shape when he began working for Anheuser-Busch right out of college, following recommendations from satisfied friends who had done the same. "It wasn't my lifelong dream to be a brewer, but once I got the position and started learning the intricacies of everything beer could be, my passion began," he recalled.

He later worked as a manager for Goose Island in Chicago before founding Penrose Brewing Company in Geneva with former Goose Island colleague Eric Hobbs.

"We were inspired by the tiling pattern," he said of the name. "The pattern looks beautiful because of the math and science behind it. We relate that to brewing—at the end of the day, most people just care about the beer in the glass and the way it tastes. But the reason it turned out that way is because of all the math and science and engineering effort that we put into it before it reached the glass."

Penrose has experienced an impressive evolution over its first ten years, starting out with Belgian brews and foraying into IPAs before expanding to include hard seltzers. In 2024, the company scaled its distribution to include Wisconsin in addition to Illinois.

"Running a business is a totally different beast than just brewing," he reflected. "But as long as I can learn and grow, that's how to succeed."

Continuously learning and growing is also what drives Engrained Brewing Company founder Schwoerer, who rediscovered his passion for engineering in brewing.

The former product development engineer had known since his time in MechSE that he was most passionate about hands-on projects.

Schwoerer started working in new product development at Caterpillar after earning his master's degree in human resource education from the College of Education at Illinois. Over the course of ten years with the company, he gradually spent less and less time out in the field as he moved up the ranks.

"Corporate America wasn't where I was finding the passion I'd had when I started out, and I was looking for something that would get me back to my roots," said Schwoerer.

The idea to start a brewery first took root when Schwoerer's wife and fellow Illinois alum gifted him a homebrewing kit. "Homebrewing was very technical, which was great for my engineering mind, but it also had the artistic element of melding flavors together."

The blend of technical and artistic aspects combined with the hands-on nature of brewing presented the business opportunity Schwoerer had been looking for. He began planning a micro-brewery in 2010 and opened the brewpub three years later. His family's roots in farming and desire for clean eating inspired Engrained's farm-to-table menu.

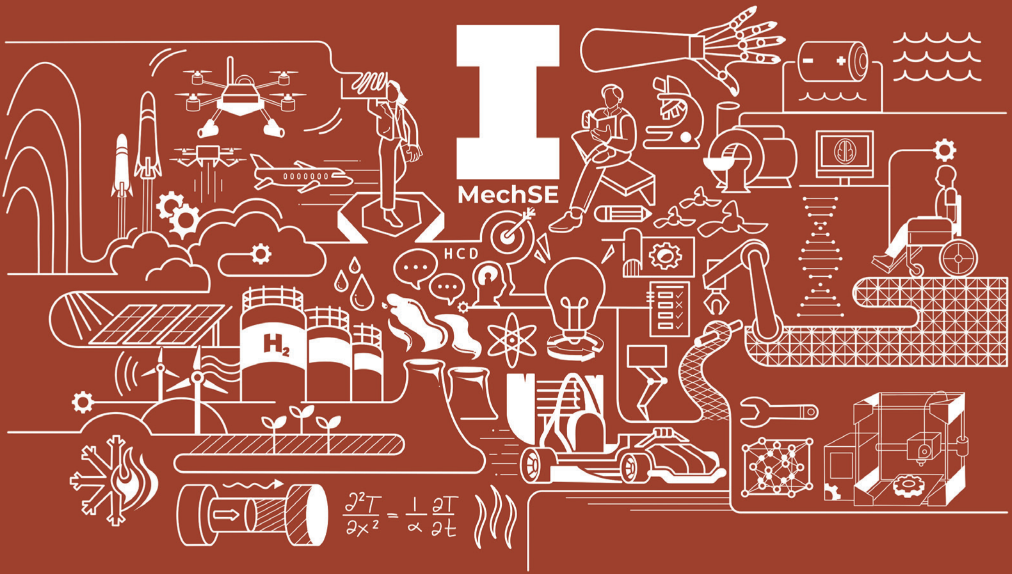
His business plan prioritizes local farmers, with 60% of Engrained's kitchen ingredients sourced from within an 85-mile radius and 100% of its pork bought from the family farm. Indeed, this model embodies Engrained's core values.

More recently, Engrained contracted to provide alcohol concessions and a beer garden for the new SCHEELS Sports Park, set to open this year. Within the past few years, the company also started canning popular brews for local distribution.

"It might not be the same as the manufacturing line at Caterpillar, but the brewery is very technical and I continue to learn as I go," Schwoerer reflected. "There's all kinds of cool ways to apply engineering to any kind of business."

For both brewers, cheers to the next ten years! ◆

Schwoerer at Engrainged Brewing Company.



Jacobi, left, and Woodmansee cut the ribbon at a celebration event in April.

Alumni Board exceeds funding goal, names student space in Lu MEB

Just over a year since announcing their effort, under the leadership of alumni board president Mark Woodmansee, the MechSE Alumni Board has surpassed their goal of raising $100K towards scholarships and other efforts that support first-generation MechSE students.

Their combined personal and company gifts currently total more than $101K, supporting specific initiatives that include scholarships and mentoring programs for first-generation students, inclusive academic seminars, and other efforts to provide and support educational equality for all students. The funding will help bring an Illinois education and improved opportunities to more deserving students.

In celebration, the board now sponsors a space on the second floor of the Sidney Lu Mechanical Engineering Building to highlight the connections between students and alumni. The MechSE Alumni Board Collaboration Space features a large, illustrated mural as the centerpiece, a plaque identifying the space, and rotating digital slides showcasing notable alumni.

The mural was designed by U. of I. graphic design undergrad Andrea Marquez and represents a variety of the research areas and fields of study MechSE alumni, students, and faculty are engaged in.

MechSE Department Head Tony Jacobi, faculty and staff, and many members of the board were on hand to dedicate the new space at a ribbon-cutting event on April 11.

"This is a momentous day. Thank you to the donors who helped make this space a possibility and a reality," said Woodmansee (BSME 1994, MSME 1997, PhD ME 1999). "I've had the pleasure of hiring many different people in my career who have gone on and been successful, but I think one of the things that separates MechSE grads from their engineering peers at other universities is their ability to stand up during interviews and go to a white board and visually articulate their thoughts for others, creating pictures, concepts, and ideas that are not too unlike this mural. The creative nature of MechSE grads is bar none. Additionally, this space features various alumni who have forged a career, taken the same classes that we've taken, but their careers have gone in many, many different directions, and my fellow board members and I hope that as people come through the building, they see this and recognize that when you become a MechSE student and graduate, you don't become an engineer. You become a problem-solver.

"I hope this is just the beginning. The board would like to build on this, to build other tangible venues to help MechSE become, in whatever way possible, the best it can be. The collaboration between our alumni and our students is really a powerful tool to have." ◆

Make a gift to support MechSE's first-generation students:

go.mechse.illinois.edu/magazine-2025

2025 Alumni Awards

MECHSE DISTINGUISHED ALUMNI AWARD

Since 1968, this award has recognized alumni who have established careers and have served in a professional and technical capacity to honor the department and the university. To date, nearly 200 MechSE alumni have received this award.

Stephen Blakely
(BSME 1969), *Chief Technology Officer; Principal; and member of the board of directors, Neurovision Medical Products, Inc.*

Natasha Childs
(BSME 1999), *Senior Project Engineer, U.S. Nuclear Regulatory Commission*

Patrick McAuliffe
(BSME 1987, MSME 1996 Southern Illinois University), *Vice President of Engineering, ProDrive Global Brands*

MECHSE OUTSTANDING YOUNG ALUMNI AWARD

Initiated in 2015, this honor recognizes alumni who graduated from MechSE less than 10 years ago and who have embodied the department and university's values in their professional careers.

Kenneth Cooley
(BSME 2018), *Director of Engineering, ATS Life Sciences Systems, Chicago*

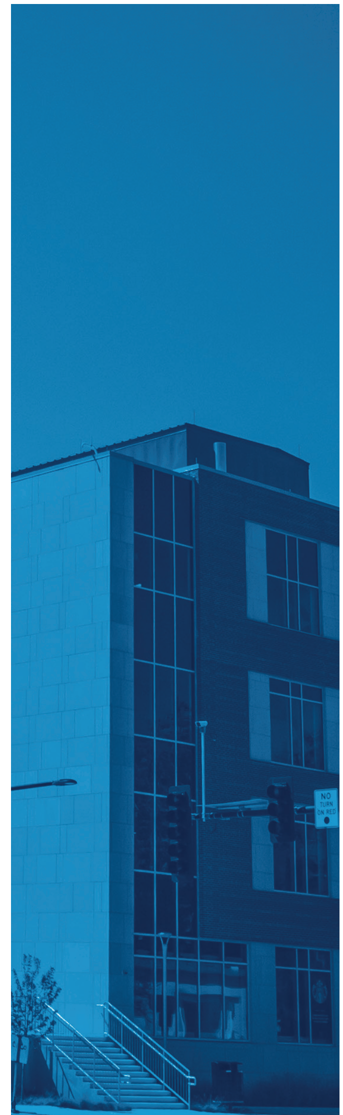
James Delacenserie
(BSME 2017, JD, Harvard Law School 2021), *Associate, Technology & IP Transactions, Kirkland and Ellis LLP, NYC*

Shantanu Shahane
(PhD ME 2019), *Software Engineer, Google Research*

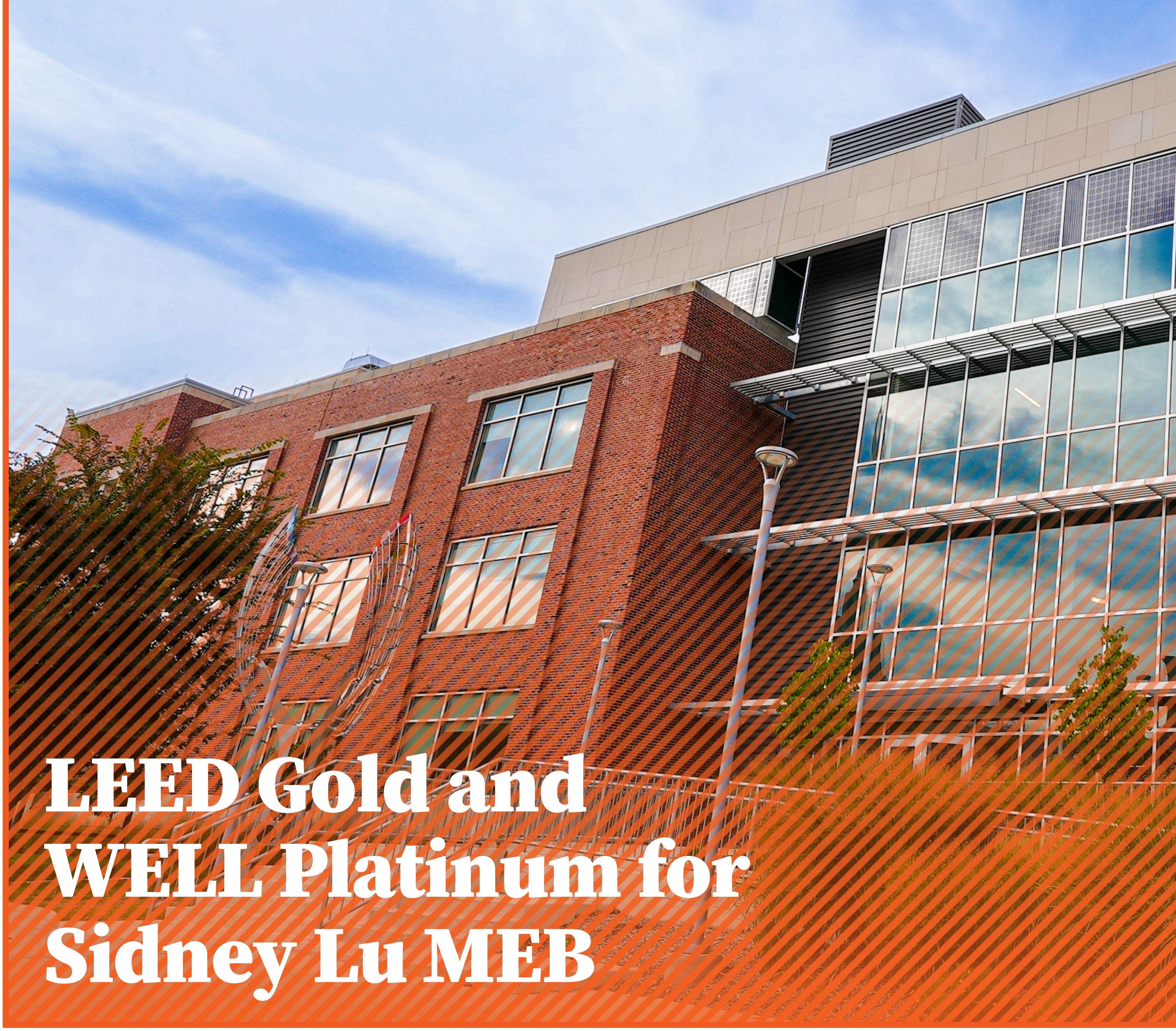
GRAINGER COLLEGE OF ENGINEERING ALUMNI AWARD FOR DISTINGUISHED SERVICE

Jigar H. Shah
(BSME 1996, MBA 2001 University of Maryland, College Park)
Serial entrepreneur, investor and energy strategist; recent Director of the Loan Programs Office at the U.S. Department of Energy

Shah was awarded for his tireless, career-long efforts to advance clean energy and his visionary leadership and innovation in the field of sustainable infrastructure.



Read more about the career achievements of our award winners



LEED Gold and WELL Platinum for Sidney Lu MEB

The MechSE Department is proud to announce that the Sidney Lu Mechanical Engineering Building renovation and expansion project has been awarded LEED Gold certification. LEED (Leadership in Energy and Environmental Design), developed by the U.S. Green Building Council (USGBC), is the most widely used green building rating system in the world and an international symbol of excellence.

The building also achieved WELL certification at the Platinum level. Lu MEB is the first facility on any University of Illinois campus to attain WELL certification, underscoring MechSE's efforts to steward and promote wellness in the department.

WELL certification is based on the 10 concepts developed by the International WELL Building Institute: Air, Community, Light, Materials, Mind, Movement, Nutrition, Sound, Thermal Comfort and Water.

Both recognitions were given for implementing practical and measurable strategies and solutions in areas including sustainable site development, water savings, energy efficiency, materials selection, indoor environmental quality, and more. LEED- and WELL-certified buildings have been shown to operate more sustainably and give the people inside them a healthier, more comfortable space in which to work.

“LEED is a transformative tool that ensures a building is designed and operated to achieve high performance, improve human health, and protect the environment,” said Peter Templeton, president and CEO, USGBC. “By prioritizing sustainability, MechSE, with the Sidney Lu MEB, is leading the way in their industry and helping USGBC continue towards our goal of green buildings for everyone within this generation.”

Led by architecture and engineering firm HED, the Lu MEB project was rooted in a vision that integrated sustainability, health, and adaptability into every design decision, structured around three main categories:

Environmental Performance and Energy Strategy

- Illinois' first installation of building-integrated photovoltaic (BIPV) glass, generating renewable energy
- Full mechanical system upgrade, improving indoor air quality and reducing the carbon footprint
- Restoration of the historic façade, high-performance glazing on the windows, and insulation decreased energy use and improved thermal comfort—all while respecting the building's architectural heritage
- 45% energy savings (32% energy cost savings) from the ASHRAE 2010 baseline

Occupant Wellness and Biophilic Design

- Prioritization of daylight, natural materials, and biophilic patterns and textures
- Promotion of healthy lifestyles and movement and the connections between design, sustainability, and wellness
- Partnership with on-site Starbucks to promote health-conscious food choices

Sustainable Stewardship of Resources

- Leveraging and improving upon the building's positive aspects, rather than abandoning an outdated facility
- Highly flexible areas and light-filled spaces for adaptability to pedagogy and integrative teaching

Grainger College of Engineering

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Department of Mechanical Science and Engineering
1044 Sidney Lu Mechanical Engineering Building
1206 W. Green Street
Urbana, IL 61801-2906

Have you watched it yet?

We previously reported on a video our team created featuring MechSE students' ME 370 inverted crawlers, which at the time had garnered 1.7M views on Instagram.

Eight months later its reach is still growing, with an incredible **2.7M views, making it one of the most watched videos across the entire university!**

Check it out on Instagram (**@illinoismechse**) and follow us to stay in the know on our elite program and latest achievements—and see ALL of our fun media!

go.mechse.illinois.edu/viralcrawlers