MechSE

SUMMER 2023 MAGAZINE

WORLD DOMINATION

Illini Motorsports

National Champs
#1 in North America
#3 in the World

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MECHSE MAGAZINE • SUMMER 2023

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MechSE's on the 'Gram!
We may not be "Instagram famous" yet but you should still follow @illinoismechse

FROM THE DEPARTMENT HEAD

Anthony Jacobi
MechSE Department Head
Richard W. Kritzer Distinguished Professor

Dear alumni, students and friends of MechSE,

I hope this note finds you well. Our department has been very busy in the year since we last sent you the MechSE Magazine — millions more dollars in research funding won for our faculty, hundreds of high-achieving undergraduates completing their degrees and entering exciting new jobs, and many graduate students carrying the Illinois legacy into promising careers in academia and industry.

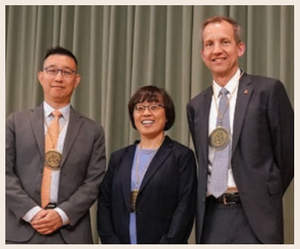
I might be biased, but I believe MechSE students and faculty are clearly among the best at Illinois – and I encourage you to read about all of their achievements in this issue. As you can see on the cover (and on the next page), our Formula SAE (Illini Motorsports) team has enjoyed the most successful period in their 44-year history – and we could not be more proud. Our undergraduate design courses are flourishing in creative ways (pages 8-11). MechSE's graduate programs are entering an unprecedented period of growth along with an incoming cohort of stellar students (pages 12-13).

This issue also includes two feature stories that you're the first to read! "Up in the Air" highlights the groundbreaking research our faculty are working on in the aviation and aerospace sectors as well as the rapidly expanding world of UAVs. "MechSE's 'Underground' Music Scene" is a fun read on the intersection of engineering, math and music. And be sure to check out the multitude of extra content – including several inspiring videos – on the MechSE website. Just scan the QR code below using your phone's camera.

As always, we would love for you to come visit the new Sidney Lu Mechanical Engineering Building, and I encourage you to stay in touch. Thank you for all you do to support MechSE.

go.mechse.illinois.edu/magazine-summer23

SIX FACULTY HONORED WITH NAMED PROFESSORSHIPS



In an historic first, six MechSE faculty received named professorships. This is the most the department has ever named at one time and reflects MechSE's excellence among peers.

A named professorship is one of the highest honors bestowed by the university. Faculty who hold one are celebrated for teaching, research, and the caliber of thinking that inspires both. Recipients use the endowments to initiate new areas of research, to support graduate student work, and to bring prestigious visiting scholars to the department, for example. Students, in turn, benefit from their association with top-notch faculty engaged in innovative research and teaching.

"Such distinguished named faculty appointments are based upon recognition of significant accomplishments and contributions to the department and the university over the years," said MechSE Department Head Tony Jacobi. "I am pleased that we can honor our colleagues in this way for their excellent and inspiring work."

Top image, from left:
Randy Ewoldt, Alexander Rankin Professor
Nenad Miljkovic, Founder Professor in Mechanical Science and Engineering
Gaurav Bahl, George B. Grim Professor

Bottom image from left:
Tonghun Lee, Bei Tse Chao and May Chao Professor of Mechanical Engineering
Elizabeth Hsiao-Wecksler, Grayce Wicall Gauthier Professor in Mechanical and Industrial Engineering
Harley Johnson, Founder Professor in Mechanical Science and Engineering

Illini Motorsports

National Champions #1 in North America #3 in the World

OVER THE LAST SEVERAL YEARS THE UNIVERSITY OF ILLINOIS Formula SAE (Society of Automotive Engineers) team has steadily established itself as the top team in the country and one of the best in the world. But the last 14 months in particular have been, hands-down, the best ever for any car team at the University of Illinois.

For the first time in its 44-year history, the team won both of the competitions that comprised the 2022 Formula SAE National Collegiate series—finishing as the national champions with a nearly clean sweep of first-place trophies.

At the final event – held at the Michigan International Speedway – the team dominated the approximately 60 teams from across North America. Their score of 954 points out of 1,000 was the second highest score in the history of the Formula SAE competition.

At the first event, facing competition from 89 other universities, the team, also known as Illini Motorsports, was named the top overall performer, finishing first in the Design and Endurance categories and second in Cost. The Illinois team – made up overwhelmingly of MechSE students – designed and built a high-performance race car with an outstanding level of engineering competence. With extremely capable drivers who were well practiced, they were able to handle the pressures of a highly competitive event.

“I have been doing this for many years and I have never before witnessed such an amazing performance. The weather was good and it was great fun to watch!” said MechSE Associate Professor Emeritus Michael Philpott, faculty advisor for the team.

In addition to first place overall, the Illinois team also boasted:

1st in Vehicle Design (a series of grueling assessments and evaluations of each team and their vehicle design decisions by leading industry experts)

1st in Acceleration (straight line hard-down 0-60)

1st in Endurance (22-lap race with one driver change and automatic disqualification for vehicle component failure, loss of fluids, etc.)

1st in Autocross (single lap, sharp twists and turns around cones, fastest lap time to win)

2nd in Skid Pad (behind Purdue University)

“Over the past 40+ years, Formula SAE has been a life-changing experience for thousands of students at Illinois. I cannot express how much of a role university support plays in providing the tools to the excellent student-engineers that comprise this team. It is thanks to university support that we can continue to represent the University of Illinois in a manner befitting of our reputation as a top engineering school.”

– Blaine Hesler, 2022-23 team captain

Just one year later, in May 2023, Illini Motorsports excelled yet again at the premier North America Formula SAE competition. With a highly competitive field of 120 collegiate teams from the U.S., Canada and Central America, they again achieved 1st place, dominating the rest of the pack – boasting a 75-point lead over the 2nd place finisher.

Of course, this win came on the heels of news of a 3rd place world ranking. Among more than 500 schools that compete in one of the most competitive formula racing competitions, the University of Illinois team established itself time and again as a top competitor. The team dominated competitions with an average score of 770 out of 1,000 points.

Points are earned at each competition for aspects like vehicle design, presentation, acceleration, endurance, auto-cross, and skid-pad. Rankings are computed using the average number of points earned over the prior six competition events.

“The Formula SAE series is the largest and most competitive formula race car series in the world with over 500 teams competing each year. For comparison, Formula 1 has only 10 teams. So, to be in the top 10 of the Formula SAE world rankings is always a huge achievement for us,” said Philpott.

Undergraduate News

1.

MechSE student is first in family to graduate from college

Jonathan Cifuentes Barrios dreamed of attending Illinois since his immigration to Chicago in 2015. The Guatemala native, who earned his BS in mechanical engineering this past December, is the first in his family to graduate from college.

Cifuentes started his college education at Wilbur Wright College and then transferred to Illinois. “I had all of my hope in U of I,” recalled Cifuentes, who is now in a rotational program in power systems at Eaton Corporation in Wisconsin. “I knew that if I could get here, I could do anything in my life.”

Jonathan Cifuentes Barrios, center front

Jaden Thompson

2.

Thompson named 2023 Knight of St. Patrick

Rising senior Jaden Thompson was one of 11 winners of the prestigious Knight of St. Patrick award, granted by The Grainger College of Engineering to students who embody leadership, excellence in character, and exceptional contributions within the college. This past academic year, Thompson served as Business and Administration Lead for Illini Motorsports as well as a leader for the Aerodynamics Project team, designing and optimizing wing orientations. He is interested in a career in the automotive or aerospace industries.

Watch Aaryaman’s video:
go.mechse.illinois.edu/magazine-summer23

3.

Mechanical Engineering at Illinois holds steady at #7

In the 2023 *U.S. News & World Report* the undergraduate mechanical engineering program at the University of Illinois maintained its No. 7 rank for another year. Since the 2021 reopening of the renovated Sidney Lu Mechanical Engineering Building, MechSE boasts one of the newest and most innovation-rich mechanical engineering educational facilities in the world.

“MechSE has its sights set on more innovative use of its resources, on enhancing its impact on undergraduate education, and on making this world-class education accessible to even more talented students. We hope that the many small steps we are taking toward improvement – some visible and others behind the scenes – will take us to new heights. The core reasons for our continued success are a dedicated faculty and the excellent staff in the Undergraduate Programs Office who provide outstanding service to our students,” said Sanjiv Sinha, Associate Head for Undergraduate Programs.

Aaryaman Patel

4.

Undergrad wins award for sustainable energy video

Aaryaman Patel won second place in the International District Energy Association (IDEA)’s Campus Energy Student Video Contest. The annual contest aims to spread awareness of campuses that are leading the way in sustainable energy. Patel rose to meet the challenge with the encouragement of Teaching Associate Professor Leon Liebenberg. Patel filled the role of writer, producer, actor, and director to create his video, which follows three students learning about Illinois’ energy systems while studying for their thermodynamics test.

5.

Clare Booth Luce Research Scholarship winners

Two of the eight students selected as the 2022-23 Grainger College of Engineering Clare Boothe Luce (CBL) Research Scholars were MechSE undergraduates Maya Grant and Charmaine Nieves.

The CBL award honors women undergrads who conduct research and intend to pursue graduate degrees in STEM. Scholars receive up to $12,000 for research in the summer, fall, and spring semesters and travel support to present their research at conferences – all while working closely with their research mentors.

Grant is a rising senior in mechanical engineering who intends to pursue a PhD in robotics. She is also a James Scholar, Lockheed Martin Scholar, Wentcher Scholar, Ron Brown Captain, and Grainger Engineering First-Year Experience (GFX) Scholar.

Nieves graduated this past spring with a degree in mechanical engineering and a minor in electrical engineering. She intends to pursue a graduate degree in mechanical engineering at MIT. She was a Hispanic Scholarship Fund (HSF) Scholar and a James Scholar as well as on the Dean’s list.

Maya Grant

Charmaine Nieves

6.

Human-centered design at heart of ventilator cart created for young patient

Seven-year-old Urbana resident Dominic lives with respiratory issues that require him to use a portable ventilator throughout the day, and one ME 470 Senior Capstone Design team was tasked with designing a pushcart that would provide Dominic with independence and mobility.

Requirements for the cart included an adjustable handlebar to accommodate Dominic's growth, a robust design that would allow the cart to maneuver over diverse terrain, and foldable, lightweight limbs to allow for easy storage and transportation. The team also included a custom pocket for Dominic to store his iPad when he walks. Their process, which was heavily influenced by human-centered design, allowed the team opportunities to collaborate directly with Dominic and his family, including his mother, Aurea.

"The students did an amazing job, taking notes of what we needed as a family and making sure those parts came through at the end of the project," Aurea said. "The team always kept me in the loop on changes and ideas they had. It was an amazing experience."

> *"The students did an amazing job, taking notes of what we needed as a family and making sure those parts came through at the end of the project."*

Above: Local resident Dominic can use the cart to transport his ventilator during daily activities.

RIght: Joshua Giffin, Ashley Kuhel, Jessie Nutter and Victor Cantet, with their ventilator cart design.

Justin Kao, Scott Altman and Ethan Moore

7.

NASA astronaut presents scholarship awards to MechSE undergrads

Illinois alumnus, NASA astronaut and U.S. Navy Captain Scott "Scooter" Altman (BS Aero 1981) was back on campus in February to present two of MechSE's undergraduate students with honors from the Astronaut Scholarship Foundation (ASF). Justin Kao and Ethan Moore were the 2022-23 recipients of ASF scholarships.

Kao, who graduated in May, has had extensive experience in the aerospace world, including internships at Stoke Space Technologies, United Launch Alliance, NASA Johnson Space Center, and Boeing, and an undergraduate research position in the CHESS Center at Illinois. He is a previous captain of the Eco Illini Supermileage team. Upon graduating in May, Kao began an internship at Relativity Space, working as a structural engineer on Terran R, a fully additively manufactured rocket, then he plans to enter a master's degree program in aerospace engineering. Kao aims to solve cutting-edge issues at space startups that enable greater access to space, for the benefit of humanity.

Moore also graduated in May and has conducted research on environmental monitoring and exploration robotics. He independently developed water quality sensing robots and machine learning algorithms that can predict future hazards in aquatic ecosystems. As an undergraduate researcher in the Augmented Listening Lab, he created robots for acoustic applications like underwater localization and completed six automation engineering internships at Tesla, Raytheon Technologies, and II-VI Marlow. Moore also leads WYSE IMAGINE Robotics – a free, accessible, and inclusive weekly program he founded two years ago to break down barriers of entry to competitive robotics for disadvantaged youth in his community.

8.

College's Engineering Pathways program expands statewide

The Grainger College of Engineering now offers greater access to its nationally ranked academic programs. Beginning this Fall, qualified students attending any Illinois community college can apply to participate in the two-year Engineering Pathways program, which provides a streamlined transfer experience and guaranteed admission into the college. "By addressing challenges in the transfer process, we expand the opportunity to earn a degree from The Grainger College of Engineering to a more diverse population of talented students attending our Illinois community colleges," said Keri Niehans, the program's director.

Left: Students from the Engineering Pathways Program.

UNDERGRADUATE NEWS

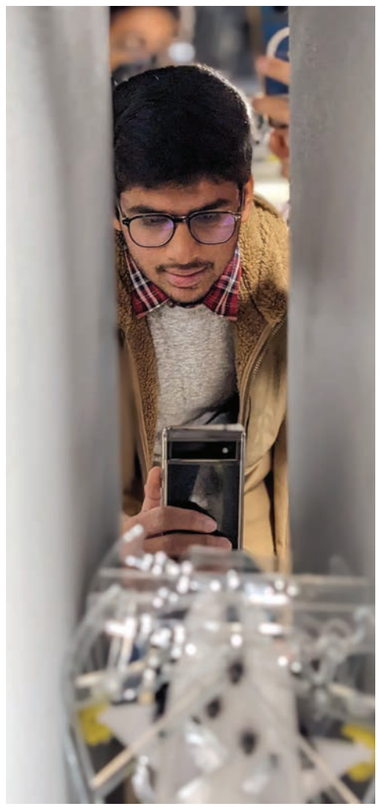
ME 370 GOES ★ AMERICAN NINJA WARRIOR

★ **MECHANICAL DESIGN I (ME 370),** a staple of MechSE's design curriculum, introduces students to machine design from a linkage and gear train perspective while incorporating a focus on user-centered design. Every semester the course challenges students with two design projects; this semester, they were tasked with designing a robot that took inspiration from American Ninja Warrior, the show where contestants often distinguish themselves with strong personalities, pithy names, and bright color schemes.

Their climbing robots had to complete two challenges moving between two parallel, narrowly spaced plates in different configurations—a horizontal army crawl and a vertical climb. Students earned significant bonuses for creativity and aesthetics.

Throughout the semester, teams took their robots from the concept stage, through design and prototyping, to iteration and optimization. Their designs were not constrained to emulating human motion and they were expected to draw from biomimetic design – i.e., chimney like a rock-climber, slither like a snake, hop like a spider, slide like a worm, climb like a monkey, or inch like a caterpillar.

Robots had to be fully autonomous, with no external control; stable and self-contained with a gear motor and batteries to drive it; and able to walk, swing, slide, or leap between the plates using grippy legs, pincers, body, or feet. ◆



Watch the robots in action!
go.mechse.illinois.edu/magazine-summer23

ME 200 MIXES ART WITH THERMODYNAMICS

ASSOCIATE TEACHING PROFESSOR LEON LIEBENBERG FREQUENTLY LEADS MechSE's introductory thermodynamics course (ME 200). While he always incorporates creative aspects in his courses, in the spring semester he asked something new of his students, and they rose to meet the challenge.

The final project, titled "ART + THERMODYNAMICS to Promote Sustainable Energy Solutions," tasked students to utilize an art form to convey thermodynamics ideas and sustainable energy alternatives in an engaging way. Having already completed a mandatory visit to the nearby Abbott Power Plant and with a few weeks of thermodynamics knowledge under their belt, Liebenberg's students shared what they learned in transformative ways.

From board games to large-scale models of the Rankine cycle, students let their creativity shine. Top projects included two interpretive dances, a CNN dupe video, a graphic novel, an animated video and a comic book.

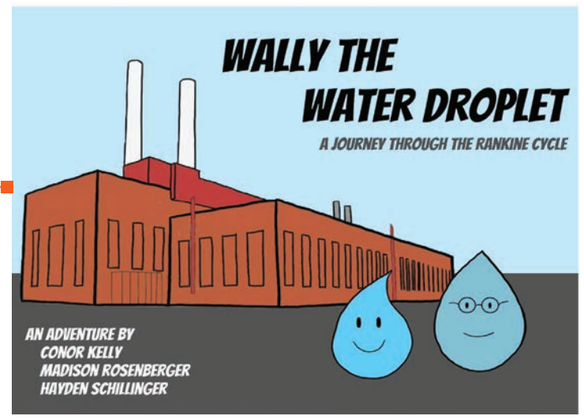
Sophomores Marit Ley (front), Olivia Hunsberger, Kaitlyn Uhlman and Marshall Tenzer won first place by combining spoken word poetry and dance. The idea stemmed from a joke, as Ley mentioned to her team that she has danced all her life. One thing led to another, and Ley ended up choreographing a dance in her hometown studio to Tenzer's original spoken word poem. "The biggest take away was the fundamental ideas – the various cycles, it's all very basic in terms of analysis," Tenzer reflected. "Thermodynamics is simple, but how do you make energy clean? Analyzing this aspect and how to pursue a better alternative is what's most important for the future."

A funny and informative "CNN dupe" follows a news reporter through their segment, starting at the Abbott Power Plant and moving to a local interview. The team's biggest take away from the project "was how to simplify thermodynamics ideas," said team member Joseph Symanski. "With a three-minute limit, the team "learned how to think about engineering outside the box."

Team 33 illustrated the Rankine cycle using a comic book that tells the story of Wally the Water Droplet, who goes through the Rankine cycle and must fight emissions particles.

"A Day in Walter's Life" focused on the Rankine cycle by painting the story of Walter Rankine. Walter gets a ride from Arnold Schwarzenegger to represent work going into the cycle, then eats a jalapeño to represent heat, and so on. The team's story even offered ways to improve Walter's life and the Abbott Power Plant to make the plant cleaner.

Watch a video of the final projects: go.mechse.illinois.edu/magazine-summer23



Graduate News

M.ENG.ME PROGRAM SETTING NEW RECORDS

NOW HEADING INTO ITS NINTH academic year, the highly ranked Master of Engineering in Mechanical Engineering program (M.Eng.ME) has become a firmly established and successful professional, non-thesis graduate degree program. For the second year in a row, the online M.Eng.ME is ranked in the top three programs in the country.

Showing significant growth over the last several years, the program is on track to welcome as many as 100 students in Fall 2023 – a dramatic increase from approximately half that number just three years ago. MechSE has seen an impressive 205 students graduate from the program since its inception in Fall 2015.

The program has enabled its alumni to launch exciting careers at companies including SpaceX, Lockheed Martin, Boeing, Tesla, Microsoft, Navistar and Abbott Laboratories, to name just a few. M.Eng.ME graduates are also more likely to be hired in or promoted to leadership and/or senior engineering positions.

"We are so proud of our students," said Dr. Jiajun He, the program's Faculty Director. "Clearly, our M.Eng.ME program has had a tremendous impact on many careers and on emerging technology." ◆

Giants of industry: Dr. L. Winston Zhang (PhD ME 1996) joined the M.Eng.ME faculty last fall, teaching Electronics Cooling in ME 598. In 2004, Zhang founded thermal management company Novark Technologies in Shenzhen, China, and his decades of industry expertise has proved to be an invaluable asset to the program and its students.

> The M.Eng.ME program has been a turning point for me. It has allowed me to learn invaluable skills while working on a variety of projects and helped further my understanding of topics I learned as an undergraduate. I have also been able to witness how each student is important within the M.Eng.ME community and how staff and professors are supportive of us through this rigorous but fruitful journey.
>
> *- Saba Setayeshi, on-campus student*

Learn more about Professor Winston Zhang.
go.mechse.illinois.edu/magazine-summer23

MechSE lands top cohort of students

THE DIVERSE GROUP OF graduate students set to arrive in MechSE this fall is one of impressive talent. More than 80 new MS and PhD students have accepted their offer to join MechSE to study mechanical engineering and theoretical and applied mechanics. This is a 71 percent increase from graduate enrollment last year – with 25 percent of them women or underrepresented minorities.

Associate Head for Graduate Programs and Research Petros Sofronis credits this successful round of applications and enrollments to Professor Arne Pearlstein, chair of the Graduate Programs Committee, and Joann Pyon, Graduate Admissions Coordinator.

"Our staff and admissions committee did an excellent job selecting an outstanding group of students who are competitive young researchers in their fields. They are all really strong students who received some of the most prestigious fellowships available," he said.

A few of the fellowship recipients include:

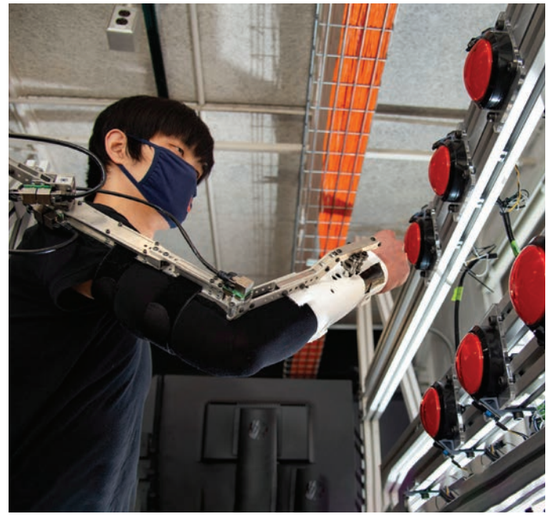
Fatemeh Cheraghi Pouria
Illinois Distinguished Fellowship / research interest in robotics and controls

Derrick Sanders
Graduate College Fellowship (PhD), SURGE Fellowship, Sloan Scholarship / research interest in manufacturing, nanomechanics and nanomanufacturing

Marcos Figueroa
Graduate College Fellowship (PhD), Sloan Scholarship / research interest in dynamics and fluid mechanics and thermal sciences

Katherine O'Reilly
Graduate College Fellowship (MS), GEM Fellowship / research interest in robotics and manufacturing

John Golden
Graduate College Fellowship (MS) / research interest in robotics and biomechanics



"MechSE will continue to support the growth of our amazing candidates, especially those from underrepresented populations, in all areas of mechanical engineering and theoretical and applied mechanics. This will continue through scholarships from a variety of areas, including but not limited to our generous emeriti, alumni, industry partners, and by working with The Grainger College of Engineering to secure such excellent fellowships as the SURGE Fellowship," said Kathy Smith, Assistant Director of MechSE Graduate Programs. ◆

Incoming students awarded Dantzig Scholarships

MECHSE HAS SELECTED TWO mechanical engineering graduate students, Catalina Bastias and Thomas Livesay – both of whom will start in the fall – to receive the Jon and Anne Dantzig Graduate Scholarship.

Bastias, who earned her undergraduate degree from the University of Colorado Boulder, will work with Assistant Professor Callan Luetkemeyer. As an undergrad, she conducted research into the effects of exercise on medial collateral ligament mechanical behavior and studied the effects of pregnancy on the mechanical injury criteria of murine uterosacral ligaments (i.e. those in mice).

Livesay, a graduate of Duke University, will work with Professor Randy Ewoldt. One of his research highlights includes developing a new method of mechanically deploying sound and camera traps in tropical rainforests using drones with the intent to observe and measure biodiversity without disturbing the rainforest.

"Catalina and Thomas embody exceptional incoming students that pave the way for Latinx students like themselves to push the boundaries in their fields. I am thankful that former professor Jon Dantzig and his wife Dr. Anne Dantzig can support their academic development and research opportunities," said Joann Pyon, Graduate Admissions Coordinator in MechSE.

UP IN THE AIR

Watch the coordinating film "Up in the Air"
go.mechse.illinois.edu/magazine-summer23

By Taylor Tucker

Hypersonic systems. Sustainable jet fuels. Personal autonomous drones. Adaptive aircraft control. Improved combustion technology. Enhanced aerodynamics and turbulence control. Aircraft de-icing. These are just some of the ways MechSE researchers are contributing to the broad fields of aviation, aeronautics and similar areas.

FOR HOVAKIMYAN, SAFE PERSONAL AVIATION IS THE ULTIMATE GOAL

W. Grafton and Lillian B. Wilkins Professor Naira Hovakimyan has manifested her passion for aviation in a number of diverse projects.

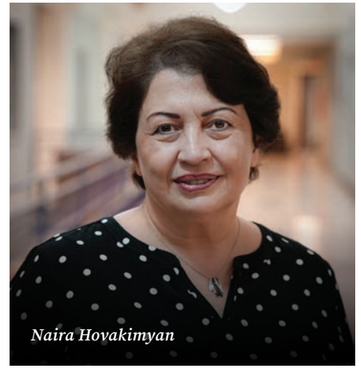
Over the last 20 years, she has worked to develop the L1 adaptive control system. As the only controller cleared by pilots for stall and post-stall fight regimes in NASA's Aviation Safety program from 2007 to 2010, hers was the *first* adaptive controller to be tested on manned aircraft – which she did several times between 2015 and 2018, including on both Learjet and F-16 platforms at Edwards Air Force Base. The controller's performance was always verified according to its theoretical predictions, making it an invaluable approach for safety-critical systems.

"As a team, we are now working on advancing the L1 adaptive controller through technology transition and maturation phases," said Hovakimyan, who noted that researchers from MIT, Georgia Tech, University of Nevada, Reno, and North Carolina Agricultural and Technical State University collaborate with her group on the NASA University Leadership Initiative – alongside industry partners Lockheed Martin and Sierra Nevada Corporation – to enable the technology transition to urban aerial vehicles (UAVs).

"We are focused on the verification and validation tools and frameworks for the L1 adaptive controller, augmented with robust perception and learning-enabled components, that can safely and securely fly humans in urban areas. Ideally, one should be able to continue living in their affordable house in Urbana-Champaign, have a fancy dinner in Chicago and maybe consider working in Ohio. With UAVs this should be easy to do."

Some of Hovakimyan's past projects include parcel delivery with drones and at-home elderly care using small aerial vehicles. She is also cofounder and chief scientist of Intelinair. Her vision for the future of her work centers around the idea of personal aviation. With the L1 adaptive control framework's capability to support the development of autonomous solutions for a broader class of airborne vehicles, she anticipates that flying cars will become a reality—and with them, improved accessibility for housing, transportation, and job opportunities. She now co-directs the Center for Autonomous Vehicles in Air Transportation Engineering (AVIATE), supported by NASA.

Hovakimyan is also excited about her growing number of PhD students and graduates. "In the next 5-7 years, I will have graduated 50 students," she reflected. "That's 50 models of this research going out into the world and carrying on the legacy."



Naira Hovakimyan

Shown is the M1 combustor, a laboratory-scale single-sector combustor designed to replicate a single swirl cup of a gas turbine engine. The M1 combustor has up to 4-side optical access for implementing a wide array of advanced laser and optical diagnostics. It has been utilized to study various aspects of swirl-stabilized spray flames including spray breakup, spray droplet distribution, flame structure and flame dynamics.

NOVEL UAV TECHNOLOGIES FOR A SECURE FUTURE

The Center for UAS Propulsion (CUP), a research cohort established to advance the next generation of Unmanned Aircraft Vehicles (UAVs) and systems, has been steadily expanding since its advent in 2018.

Led by Bei Tse Chao and May Chao Professor Tonghun Lee, CUP's research thrusts are primarily focused on ignition, surface materials, battery technology, and power management for UAVs at subsonic and supersonic speeds in variable atmospheres, with projects such as extreme fuel ignition characterization, tribological materials for extreme low viscosity, and high-pressure compact air management. At Illinois, roughly 10 students and two postdocs work on various aspects of CUP projects in Lee's Advanced Propulsion and Energy Laboratory.

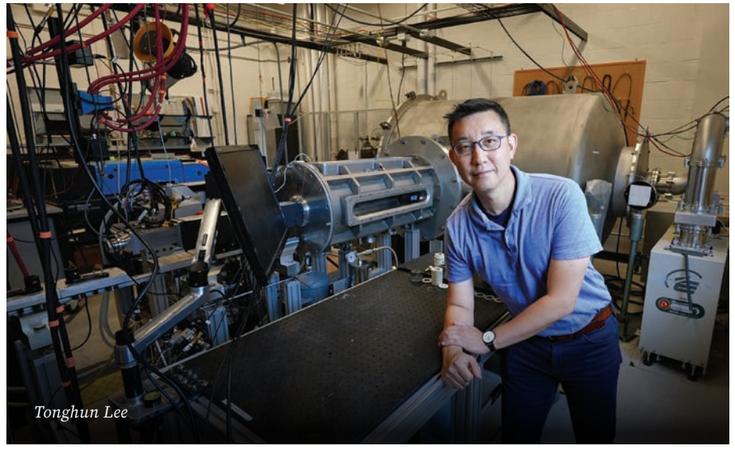
"We're developing new combustors to look at different types of combustion strategies for the Department of Defense, and also contributing to alternative fuel integration within the Federal Aviation Administration," Lee said of his group's current work.

Lee's team visited Argonne National Laboratory this past April to collect experimental data from a combustor built specifically to test a range of fuels intended for turbine engines. They used the lab's advanced photon source, a high-energy X-ray source facility, to resolve droplet formation and break down processes occurring inside the combustor during fuel injection.

The data will be used to inform computer-simulated visualizations developed by collaborating researchers from Argonne. Accurate depictions of the fuel's behavior throughout the combustion process will better inform the development of engines that can accommodate a different range of aviation fuels, including new, sustainably sourced fuels supported by the FAA.

The center includes collaborators from Illinois, University of Illinois Chicago, Northwestern University, University of Wisconsin-Madison, University of Minnesota, University of Michigan, Texas A&M University, and University of North Texas, and is also partnered with the Office of Naval Research, the Air Force Office of Scientific Research, and the Army Research Laboratory's Vehicle Technologies Directorate, which serves as the government lead and primary funder for the cohort.

"Managing a multi-university effort has been challenging in terms of time and effort," Lee said. "But it has been rewarding to see continued support from the Department of Defense as well as Congress, and to be part of novel technical breakthroughs in our first five years."



Tonghun Lee

> "I think CUP will leave two legacies. It will have pioneered many of the key technologies that will power the next generation of UAVs for our military, many of which may trickle down to the civilian sector. Equally important is that we will have contributed to establishing a domestic infrastructure for production of these technologies for a secure future."
>
> *- Tonghun Lee*

SUSTAINABLE AVIATION FUELS

Alternative fuels are one method scientists are exploring in the quest for greater sustainability. Alex Solecki, a graduate student in Lee's lab, is using the FAA's Alternative Jet Fuels Test Database to compile, track and analyze trends in sustainable fuels, with the goal of accelerating their certification, scaling and adoption.

She said sustainable fuels present significant potential for supplementing the use of conventional petroleum-derived jet fuel in the commercial aviation sector and, in fact, are already doing so in small volumes. While these alternative fuels are chemically diverse, they can achieve the same standards as conventional Jet A fuel (a kerosene civil aviation fuel). However, it will take more research and analysis before these synthetic fuels – which are currently certified at blending ratios of 50% or less with conventional kerosene – are accepted by governing bodies, aviation companies and consumers.

"The aviation sector is highly safety oriented. Large-scale changes to something as influential as fuel type will not be seen until an overwhelming amount of scientific support is presented for its suitability," Solecki said.

STEPHANI AND THE FUTURE OF HYPERSONICS

Associate Professor and Kritzer Faculty Fellow Kelly Stephani continues to lend her voice to the field of hypersonics. As a recognized expert, she spoke last fall on a panel regarding the future of hypersonic technology and was appointed to the National Academies of Sciences, Engineering, and Medicine Board on Army Research and Development in April of 2022. She also participated in an experts panel that discussed hypersonic weapon capabilities.

"Once we get students trained in areas of facility operations, instrumentation, diagnostics, and analysis, [then] when they are ready to enter the workforce, they bring that to bear and can help transition academic innovations to enable new capabilities and hypersonic systems," she said, of preparing new generations of engineers to contribute to the field.

Stephani serves as associate director of the Center for Hypersonics and Entry Systems Studies (CHESS), which has project thrusts such as aerothermodynamics, gas-surface interactions, material response, thermal protection systems, and hypersonic environments. She also co-directs the University Consortium for Applied Hypersonics (UCAH), a collaborative network of universities that work with public and private entities to advance hypersonic systems.

This summer she was a visiting fellow at Stanford University's Hoover Institution, an interdisciplinary public policy think tank.

Stephani's research in hypersonics focuses on material behavior—specifically, the quality of response to hypersonic conditions. Her group is particularly interested in materials that can be made to resist forms of degradation, such as oxidation, face transformation, and warping, commonly experienced in high-temperature environments.

"We need to think about how our own developments and innovations finally play out in how policy is formed and how states decide to maneuver," she said. "We're learning a lot from observing what the U.S. is doing with other world leaders and from how those leaders are responding."

Kelly Stephani

Electric aircraft

AN ENERGY-EFFICIENT – AND FAST – DEICING METHOD FOR ELECTRIC AIRCRAFT

New research from Founder Professor Nenad Miljkovic shows promising findings for the future of electrified aircraft capability.

Snow and ice removal is crucial for maintaining aerodynamic lift and energy efficiency. Ice buildup on the wings' edges can disrupt lift while creating additional drag, potentially causing the aircraft to stall. Similarly, ice buildup on propellers can imbalance the blades, leading to excess vibration and reduced thrust.

Internal combustion engine (ICE) aircraft are typically equipped with rubber boots that inflate and deflate pneumatically to break up snow and ice accumulation on critical surfaces. Some ICE aircraft also route engine heat to prevent ice from forming. However, electrified aircraft do not have the same onboard mitigation strategies.

One deicing method Miljkovic is pursuing for electric aircraft – called pulse interfacial deicing (PID) – involves a localized "pulse" of thermal heat applied directly to the interfacial layer adhering to the ice and frost.

His team is also developing a coating that synergistically combines PID with surface wettability to accelerate ice, frost and snow removal. The combination of these fundamentally different removal mechanisms proved to be ultraefficient, using 50% less energy input and taking less than five seconds to complete. They plan to scale their strategy to full-sized electrified aircraft.

METAMATERIALS COULD REVOLUTIONIZE HOW AIRCRAFT RESPOND TO TURBULENCE

Researchers from Illinois, CalTech, University of Pennsylvania, and Boston University are embarking on a new study to determine how various mechanical metamaterials interact with the dynamics of turbulence. Their findings are expected to result in transformative changes to the energy requirements and flight envelope of air vehicle operation.

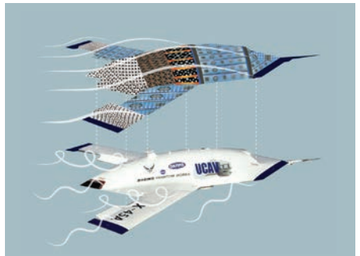
Mechanical metamaterials are engineered structures with unique properties that are not present in natural materials. However, their effects on turbulent flows around air vehicles is currently unknown.

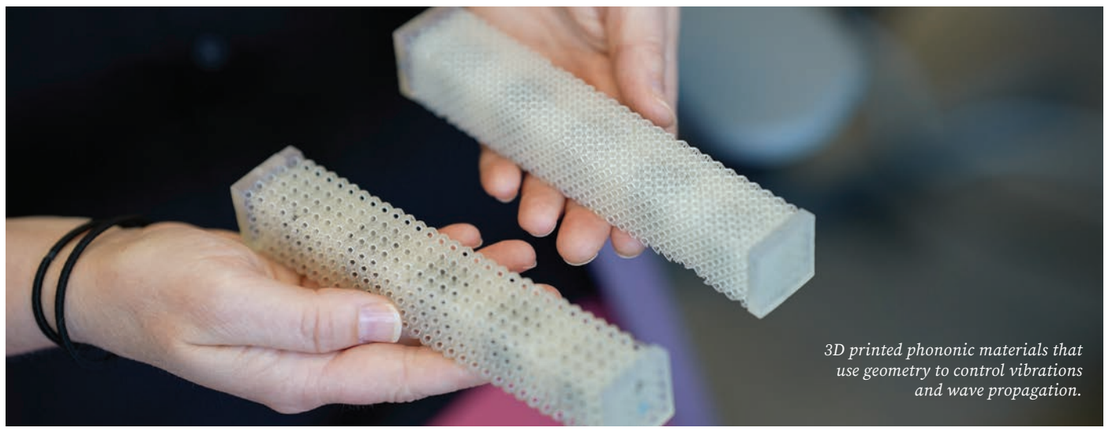
Associate Professor Katie Matlack is the PI on the project, which was awarded a highly competitive Multidisciplinary University Research Initiative (MURI) grant from the Air Force Office of Scientific Research (AFOSR).

"Many mechanical metamaterials exhibit mechanical and dynamic properties that actually have quite complementary features to fundamental challenges in passive flow control. But this is a highly complex domain that involves many disparate disciplines, so there's been very few efforts to push that forward until now," Matlack said.

In the process, her team will also establish a new multidisciplinary field – fluid-metamaterial interaction (FMI) – and aim to discover new fluid-structure coupling between innovative materials and critical aerodynamic flows to enable passive control of transition delay, drag reduction, and separation.

Their work will enable vehicles that can safely and efficiently maneuver through complex environments, and the researchers ultimately aim to jumpstart the FMI field to enable novel aircraft designs. For the Department of Defense, this research will result in surface/subsurface structural systems to make passive, dynamic flow control within next-generation air vehicles a reality.


Concept of FMI of bespoke materials to enable optimal aircraft performance.


3D printed phononic materials that use geometry to control vibrations and wave propagation.

Faculty News

Gaurav Bahl was elected a 2023 Fellow of Optica. The society also named a publication from Bahl one of 2022's top breakthroughs in optics.

Lili Cai won a 2023 NSF CAREER award, for which she will explore a novel approach to fabricating nanoscale diamonds, which are used in semiconductor, energy and biomedical applications.

Leonardo Chamorro was part of a team that improved upon the design of their flying microchips with bioresorbable materials and colorimetric characteristics and enhanced aerodynamics – a major breakthrough in distributed monitoring technology. Chamorro will also represent The Grainger College of Engineering at the national convention for the Society of Hispanic Professional Engineers (SHPE) this year.

Alison Dunn is a recipient of the 2023 Frontiers of Materials Award from The Minerals, Metals & Materials Society (TMS).

Randy Ewoldt won the 2023 Everitt Award for Teaching Excellence, an honor selected by Grainger Engineering students.

A study by **Jie Feng** that modeled bursting bubble aerosols could more accurately model water-to-air pollutant and disease transmission, impacting public health and the global climate. In another study, he found that bursting bubbles coated by a thin oil layer produce drops with smaller sizes, greater overall number of drops, and are ejected at a higher velocity, compared to bubbles generated in clean water. Understanding the characteristics of contaminated aerosol droplets is crucial to designing effective tools and implementing appropriate guidelines related to weather, climate and human health.


Lili Cai

Mattia Gazzola won The Grainger College of Engineering Dean's Award for his research achievements as an assistant professor. He was also named a 2023-24 Fellow of the campus' Center for Advanced Study.

As an explosives expert, **Nick Glumac** was asked on several occasions by the *New York Times* last year to review imagery and provide expert feedback on the bomb that severely damaged the Kerch bridge, which connects Russia to Crimea.

Naira Hovakimyan has been named a Senior Member of the National Academy of Inventors (NAI).

Cutting-edge research from MechSE and NCSA, including **Iwona Jasiuk** and **Seid Koric** – at the intersection of artificial intelligence and classical numerical methods in computational mechanics – demonstrated an important step toward AI-driven modeling and design in complex engineering phenomena.

A new manufacturing achievement award from ASME – the DeVor-Kapoor Manufacturing Medal – was created in honor of the discoveries of MechSE's own **Shiv Kapoor** and the late **Richard DeVor.**

William King was named a Fellow of SME for his contributions to the manufacturing engineering profession. He was also one of just two faculty from Illinois elected a Fellow of the National Academy of Inventors (NAI).

Seid Koric and colleagues published a paper, "Meshless Physics-Informed Deep Learning Method for Three-Dimensional Solid Mechanics," that was among the top 10% most downloaded articles from Wiley's International Journal for Numerical Methods in Engineering. Koric was also the recipient of a 2022 HPC Innovation Excellence Award from Hyperion Research.

Leon Liebenberg won the 2023 Two-Year Alumni Effective Teaching Award.

In a first-of-its-kind study, **Moshe Matalon** presented physical insight into the mechanisms governing flame-turbulence interactions and explored the impact of the ubiquitous Darrieus–Landau instability on the propagation.

Katie Matlack's early-career achievements earned her the ASME C.D. Mote Jr., Early Career Award and the 2023 Grainger College of Engineering Dean's Award.

In 2022, **Nenad Miljkovic** was named an ASME Fellow. Additionally, a team including Miljkovic and **William King** developed a scalable surface nanostructuring strategy that allows for the formation of unique two-tier nanoscale 3D-printed architectures that enable superhydrophobicity, low droplet adhesion, resistance to condensation flooding, and enhanced liquid-vapor phase transition. Their technique achieved a 600% improvement in condensation heat transfer coefficient even at elevated vapor pressures and cooling temperatures.

Martin Ostoja-Starzewski was appointed a Rothschild Distinguished Visiting Fellow at the Isaac Newton Institute for Mathematical Sciences at the University of Cambridge.

The late **Curt Pedersen** was inducted into ASHRAE's Hall of Fame for his career-long contributions to ASHRAE-related technology.

Taher Saif was one of just seven faculty from Illinois elected as a Fellow of the American Association for the Advancement of Science (AAAS).

Huseyin Sehitoglu has been honored by the University of Illinois for his sustained mentoring with the 2023 Campus Award for Excellence in Faculty Mentoring. He was also selected last fall as an Honorary Member of ASME.

Chenhui Shao, along with **Seid Koric**, served as undergraduate research mentors at NCSA. The NSF-sponsored program they were part of was later selected for a Workforce Diversity & Inclusion Leadership Award. Shao also developed a federated deep learning method for defect detection in additive manufacturing, an important step in enabling manufacturers to monitor and improve the quality and mechanical properties of 3D printed components and products.

The Office of Naval Research awarded **Kyle Smith** significant funding to investigate increasing energy efficiency – by leveraging battery-like electrodes that use microfluidics – for desalinating seawater to potable levels. Additionally, Smith and his student Md Abdul Hamid presented a new theory of convection for understanding fast charging of batteries.

Sameh Tawfick was a recipient of the 2023 Grainger College of Engineering Dean's Award for Excellence in Research. He won in the associate professor category, which recognizes the previous five years of research accomplishments.

A new book from **Charles Tucker III** describes the now-ubiquitous development of the models used to predict fiber orientation – an important part of the process of molding plastics. The models, which are used all over the world, were developed by Tucker and his graduate students in MechSE more than 40 years ago.

The Grainger College of Engineering recognized the career accomplishments of **Alex Vakakis** with the prestigious Tau Beta Pi Daniel C. Drucker Eminent Faculty Award.

Arend van der Zande was named to the 2022 Clarivate Analytics Highly Cited Researchers List for the fourth time since 2018. The list recognizes those who have had exceptional influence as reflected through their publication of multiple papers frequently cited by their peers during the last decade.

Ning Wang and colleagues have discovered that cell nuclei have mechanical memory—that is, they remember a force that was applied to them earlier. This finding could serve as a knowledge baseline in understanding the effect of forces on proteins that participate in gene regulation. In a separate study, Wang developed a tiny mechanical probe that can measure the inherent stiffness of cells and tissues as well as the internal forces the cells generate and exert on one another.

Matt West won the 2023 Five-Year Alumni Effective Teaching Award. ◆

Each year, Grainger Engineering students nominate faculty and staff who exemplify excellence in and dedication to advising. Recognized as the top 10% of engineering advisors selected by their students, the group typically includes a handful from MechSE – for instance, five in 2020, six in 2021, and six in 2022. This year, however, an incredible 18 of the 25 Outstanding Advisors for 2023 are MechSE faculty and staff. They were honored at the college awards banquet in April. The winners included **Missy Biehl, Lili Cai, Alison Dunn, Stefan Elbel, Randy Ewoldt, Placid Ferreira, Naira Hovakimyan, Blake Johnson, Gabriel Juarez, Leon Liebenberg, Moshe Matalon, Katie Matlack, Nenad Miljkovic, Stephanie Ott-Monsivais, Arne Pearlstein, Susan Roughton, Taher Saif and Sam Tawfick.**

Welcome New Faculty

MechSE recently welcomed two new faculty to the department, enhancing our expertise in both soft tissue image-based modeling and in robotics.

> *My next goal is to predict injury computationally. But the long-term goal is to use the methods I've developed to actually detect damage and tissue microstructure non-invasively.*
>
> *- Callan Luetkemeyer*

Assistant Professor **Callan Luetkemeyer** arrived at Illinois from the University of Colorado Boulder, where she held a two-year postdoctoral fellowship, combining her background in image-based modeling with techniques from extracellular matrix biology to understand damage in soft tissues, which could help predict injuries. She earned her PhD in mechanical engineering from the University of Michigan in 2020.

"Most of my doctoral research was focused on mathematically modeling the relationship between stress and strain in ligaments," Luetkemeyer said. "I detailed out the reasons why traditional methods weren't giving us quantitatively predictive models and then got into image-based modeling."

"My next goal is to predict injury computationally," she said. "But the long-term goal is to use the methods I've developed to actually detect damage and tissue microstructure non-invasively. I want to work toward diagnostic imaging platforms that are mechanics-based."

Luetkemeyer also hopes to bring more of an inclusive focus to rural communities like her own hometown. "I want to do some rural outreach and I think Illinois is a great place to do this," she said.

Bringing with him exciting and novel work in dynamics and bioinspired robotics locomotion, Assistant Professor **Justin Yim** is interested in making robots that are "more effective at getting around where humans go, and maybe even going places that are difficult for humans to travel. Robots are great in factories, but if they don't get out, they can't do things elsewhere—for instance, helping people in homes, helping to fight fires, or exploring."

Yim earned his PhD in electrical engineering at the University of California, Berkeley in 2020 before completing a postdoctoral fellowship at Carnegie Mellon University.

For his doctoral work he developed mechanical principles for high-power control algorithms for precise maneuvering of a one-legged jumping robot—inspired by the Senegal bushbaby, a small, nocturnal primate with very powerful, springy legs.

"Even though one leg seems like it'd be a really tough balance problem, you can still run and cover large obstacles and get a robot that is precise, powerful, and fast," he said.

Yim now hopes to use his design strategies to improve the movement of multi-legged robots. He also collaborates with biologists to use robots to answer biological questions.

"I'm currently using our robot to investigate other types of animals, like squirrels, that do similar types of jumps," he said. "If we build a robot that we understand and can experiment with, we can use our understanding of its locomotion to better understand how animals move. ◆

See Justin's robots in action! go.mechse.illinois.edu/magazine-summer23

GROUNDBREAKING RESEARCH

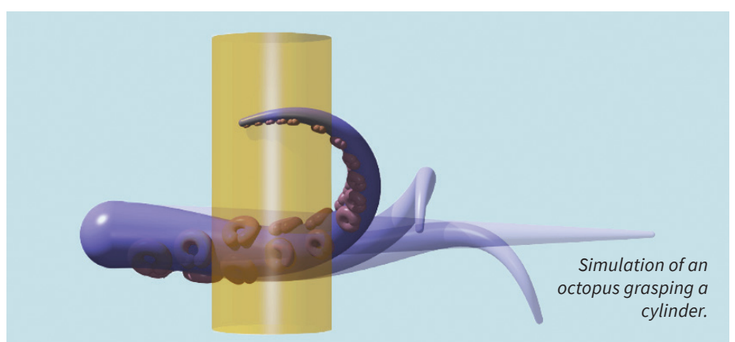
REACHING LIKE AN OCTOPUS:
Biology-inspired model opens the door to soft robot control

Octopus arms coordinate nearly infinite degrees of freedom to perform complex movements such as reaching, grasping, fetching, crawling, and swimming. How these animals achieve such a wide range of activities remains a source of mystery, amazement, and inspiration. Part of the challenge comes from the intricate organization and biomechanics of the internal muscles.

This problem was tackled in a research project led by MechSE professors **Prashant Mehta** and **Mattia Gazzola**. As reported in *Proceedings of the Royal Society A*, the two researchers and their groups have developed a physiologically accurate model of octopus arm muscles. “Our model, the first of its kind, not only provides insight into the biological problem, but a framework for design and control of soft robots going forward,” Mehta said.

The impressive capabilities of octopus arms have long served as an inspiration for the design and control of soft robots. Such soft robots have the potential to perform complex tasks in unstructured environments while operating safely around humans, with applications ranging from agriculture to surgery.

> *“Our model, the first of its kind, not only provides insight into the biological problem, but a framework for design and control of soft robots going forward.”*
>
> *- Prashant Mehta*



Simulation of an octopus grasping a cylinder.

HOW A BIRD’S NEST BECOMES A METAMATERIAL

When a bird selects a stick to add to a nest, it instinctively relates the properties of the stick to the overall nest that’s taking shape. As the bird adds new materials, the nest gradually becomes much more than just the sum of its parts: it becomes a “metamaterial” – a material with unique mechanical properties that can’t be found in any one naturally occurring material by itself. Such metamaterials can have a range of valuable applications for humans, too. However, before any new metamaterial can be applied usefully, its mechanical properties must be understood.

For this reason, researchers at the University of Akron and Illinois, including **Mattia Gazzola**, have been studying what happens when metamaterials are compressed, akin to what happens when birds pack down the materials of a nest.

They leveraged granular physics – the study of extracting bulk behaviors from individual behaviors – to learn how a material’s properties change when it’s compressed versus when it is released from compression. The ability to tune that mechanism would be a crucial parameter for some applications, such as ones involving shock absorption and toughness.

A photo of nest-like materials, taken in the lab of Hunter King, University of Akron.

GROUNDBREAKING RESEARCH

> *...It behaved exactly as we were intending, in that you could just sit in it, feel the organic motion, and drive it with your body.*
>
> *- Elizabeth Hsiao-Wecksler*

Watch the inspiring video!
go.mechse.illinois.edu/magazine-summer23

Adam Bleakney walks with his wife.

HANDS-FREE WHEELCHAIR PROTOTYPE ACHIEVES MAJOR MILESTONE

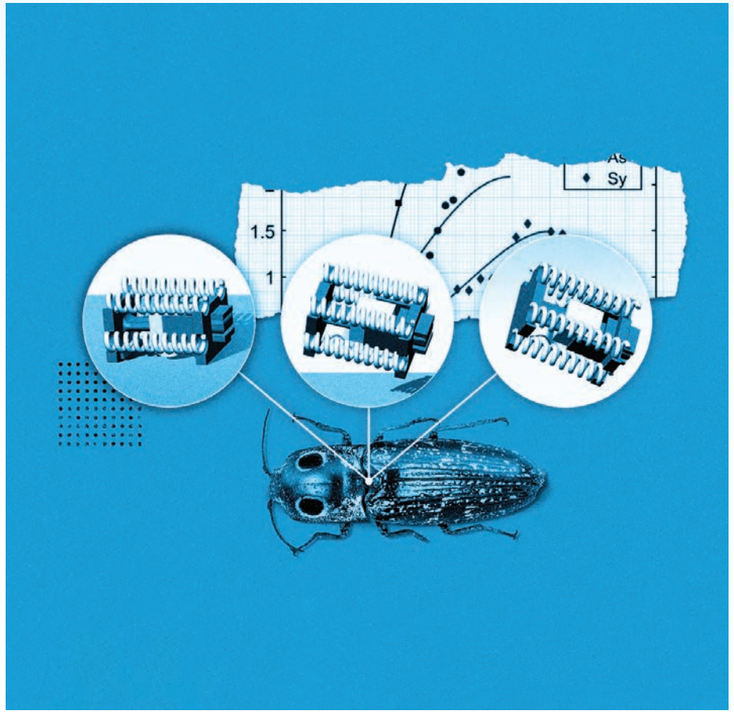
In 2020, collaborators from nearly a dozen units across the Illinois campus received a $1.5 million grant from the National Science Foundation to develop a robotic wheelchair that provides a novel mode of mobility to individuals with physical disabilities. Now two years in, the project has a working prototype and a patent pending.

The design for wheelchairs has not changed much since the first patent in the 1800s. "Manual wheelchair users, due to this traditional design, have a lot of issues," said **Elizabeth T. Hsiao-Wecksler**, MechSE professor and project PI. "It's difficult to fit in tight spaces, requires both hands to propel, and 70% of manual wheelchair users will experience upper extremity overuse injuries that may lead to inability to use a manual wheelchair. Powered wheelchairs address some of these issues, but they're generally really heavy, very large, expensive, and can be difficult to maneuver; most people who are able to would use a manual wheelchair."

The team created PURE, Personalized Unique Rolling Experience, a hands-free wheelchair that operates similarly to a Segway where the rider leans in a desired direction. Based on the concept of a dynamically stable ball-based robot (ballbot) and using an omniwheel system to drive and control the spherical wheel, PURE automatically transitions between three driving behaviors: Steer, Spin and Slide.

Last summer, a round of users tested the prototype in the Center for Autonomy's high-bay testing area, which Hsiao-Wecksler said was a success. "[One tester] hopped into the prototype and started driving it right away. We didn't even have it fully calibrated to her—it was still calibrated to someone who had less range of motion," she said, "... but it behaved exactly as we were intending, in that you could just sit in it, feel the organic motion, and drive it with your body."

"Standard ultra-light, manual wheelchairs are no doubt outstanding in many respects and provide an increased level of independence during daily life. At the same time, the act of pushing a manual wheelchair prevents the hands from engaging in other more meaningful activities while moving – such as holding hands with a loved one on a walk, carrying a cup of coffee, holding a toddler while moving around the house. Each of these is possible with PURE," said Adam Bleakney, Head Coach of Illinois' Wheelchair Track and Field teams.



CLICK BEETLE-INSPIRED ROBOTS JUMP USING ELASTIC ENERGY

Researchers have made a significant leap in developing insect-sized jumping robots capable of performing tasks in the small spaces often found in mechanical, agricultural and search-and-rescue settings. A study led by **Sameh Tawfick** demonstrates a series of click beetle-sized robots small enough to fit into tight spaces, powerful enough to maneuver over obstacles and fast enough to match an insect's rapid escape time.

A 2020 study found that snap buckling – the rapid release of elastic energy – of a coiled muscle within a click beetle's thorax is triggered to allow them to propel themselves in the air many times their body length, as a means of righting themselves if flipped onto their backs. Tawfick and his colleagues from Illinois and Princeton University used tiny coiled actuators – analogous to animal muscles – that pull on a beam-shaped mechanism, causing it to slowly buckle and store elastic energy until it is spontaneously released and amplified, propelling the robots upward.

"Scientists and farmers currently use drones and rovers to monitor crops, but sometimes researchers need a sensor to touch a plant or to capture a photograph of a very small-scale feature. Insect-scale robots can do that," Tawfick said. ◆

MORE BREAKTHROUGHS

Leonardo Chamorro has embarked on a new study to investigate the mechanics of dust devils. Similar in appearance to tornados, dust devils are produced from bouts of turbulent flow and convective vortices that entrain dust.

A team led by **Joseph Bentsman** has solved a longstanding problem in steel casting control, showing what is fundamentally achievable if corresponding sensors and actuators are put into place.

Taher Saif and colleagues have discovered that biological robots made of human tracheal cells (called anthrobots) can promote the repair of wounded neural tissue by aggregating into larger "superbots." While the research is still in its early stages, the findings suggest the robots could one day treat the cellular damage that can occur after a stroke or with paralysis.

Randy Ewoldt and **Sameh Tawfick** are part of a Grainger Engineering and Beckman Institute team that received a $10.65 million grant from the U.S. Department of Energy. They will lead the Center for Regenerative Energy-Efficient Manufacturing of Thermoset Polymeric Materials to help meet President Biden's goal of reaching a net-zero emissions economy by 2050.

A team of researchers including **Taher Saif** are exploring how the regenerative power of cells can be used to replicate the restorative effects of exercise in space. Their work, funded by a $1M grant from NASA, will directly impact astronauts aboard future Artemis missions to the moon and eventually Mars.

Lili Cai has developed a new reflective coating that can be used in counter-surveillance military applications to provide camouflage under the scrutiny of thermal imaging cameras. Their tests of the thermal camouflage effect were so promising that it could successfully be used for both daytime and nighttime cloaking.

Nenad Miljkovic will lead a $2.5M project in an effort to lower the carbon footprint associated with powering and cooling data centers, considered among the country's critical infrastructure. MechSE's **Bill King** is also on the research team.

MECHSE'S "UNDERGROUND" MUSIC SCENE

By Taylor Tucker

The relationship between math and music has been the subject of numerous research studies, and it isn't uncommon to find that people who excel in one also excel in the other. Indeed, music itself has a rigorous mathematical structure and is rooted in patterns, fractions and mathematical divisions of time. Furthermore, musical sounds are produced through engineering means – mechanical, electrical and computational.

With all of the fascinating connections between the two, it may have been inevitable that we found many members of our MechSE community who share a common interest in both engineering and music. Even in this small sampling of musicians in MechSE, we see the manifestations of their shared passion playing out (pun intended) in wonderfully different ways.

Watch the coordinating film "MechSE's 'Underground' Music Scene" and find other fun content!
go.mechse.illinois.edu/magazine-summer23

> "Engineers are known as problem solvers, but we're also constantly looking for problems."
>
> *- Anjali Rangaswamy*

ANJALI RANGASWAMY, ALUMNA

The MechSE alum (BSME 2001) and singer-songwriter first began taking piano lessons as a four-year-old in India, followed by northern Indian classical vocal training. She picked up the guitar ten years later.

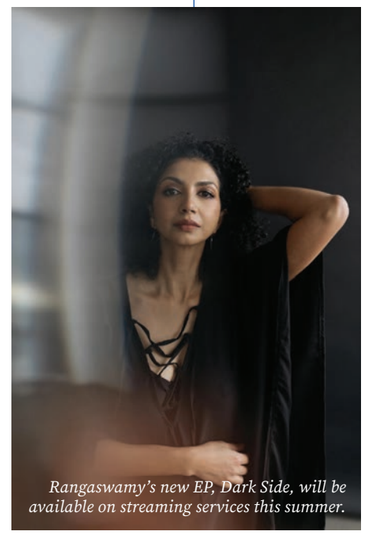
"I moved to the United States when I was ten years old and being able to sing and play really helped me develop an identity and confidence," Rangaswamy said. "Music has continued to be there for me through many challenging times, even in adulthood."

While studying mechanical engineering at Illinois, Rangaswamy amassed a catalog of original songs and began recording some on her own. "I realized that I needed professional guidance to produce a record with the level of polish I desired," she recalled. She connected with Champaign's Pogo Studio and was able to release her first full-length album, Offering, while still in college. "The process of having a song grow from a simple demo into a finished product with incredible musicians contributing is the drug I keep coming back to," she said.

Indeed, Rangaswamy, whose stage name is Anjali Ray, released her second full-length album, Indigo, in 2016, followed by the EP Giant in 2018. She performs several times a year with her LA-based Indian fusion band and has a new EP, Dark Side, which explores the experience of being a woman in her forties, coming out later this summer.

As chief engineer and technical fellow within the space division of Raytheon Intelligence & Space, Rangaswamy leads multi-disciplinary engineering teams in developing space sensors for both civilian and defense applications.

"I use every single inch of what I learned [at UIUC] right now," she said. "I don't dig too deep as a chief engineer in any one area, but I have to have proficient experience and aptitude in all of them to build teams that solve problems and identify vulnerabilities in our hardware. Engineers are known as problem solvers, but we're also constantly looking for problems."



Rangaswamy's new EP, Dark Side, will be available on streaming services this summer.

LARRY LISTER, ALUMNUS

In similar fashion, Larry Lister (MSME 1986), who currently works as a senior mechanical engineer at Facility Dynamics Engineering, is the drummer for the Champaign-based band The Boat Drunks. He joined the group shortly after starting with Facility Dynamics 22 years ago.

The group, which now has five studio albums and one live album, began as a Jimmy Buffett cover band that evolved over the years to also produce and perform original music. "Around 2004, music from our first record was being played on SiriusXM Radio Margaritaville, and that led to our being invited to play shows in conjunction with Buffett's touring schedule and then for the various Margaritaville-related operations—resorts, casinos, theme nights, etc." said Lister, who has enjoyed playing shows all over the United States. "Many members of The Coral Reefer Band have made appearances with us over the years as well."

The Boat Drunks have toured the country playing Margaritaville-related events.

Lister has been playing the drums for more than 50 years, starting with his middle school's band. His father was also a musician, playing trumpet in big band groups during and after WWII.

As an engineer, Lister focuses on testing and verifying HVAC and building control systems for critical containment laboratories, cleanroom labs, and health-care operations. Despite working full-time, he has still managed to perform an average of 50 shows per year at home and on the road.

"I love playing behind vocalists and harmony singers," Lister reflected. "It's a challenge to be 'felt but not heard'—in other words, to stay out of the way, but provide a groove that can move with the vocalist's interpretation."

Bahnfleth and his wife, Mary Louise, met as students in the music program at Illinois.

BILL BAHNFLETH, ALUMNUS

Fellow MechSE alum Bill Bahnfleth (BSME 1979, MSME 1980, PhD ME 1989) has also been playing music for most of his life. "My first lessons were on a spinet organ with a teacher who worked out of a music store in Downers Grove, Illinois," he said, unlike most organists who start music lessons on piano.

"I had always wanted to study organ at the university, but convinced myself that without a piano background, I'd have no chance of being accepted by Jerald Hamilton, the organ professor at Illinois in those days," said Bahnfleth, who now also plays piano and harpsichord. However, a serendipitous encounter led to an audition for Hamilton, who took him on as a non-major and later suggested that he major in organ performance. Bahnfleth took that advice, earning a bachelor's degree in music in 1988.

"It was a life-changing experience," he said, remembering his time on campus as being busy and productive. "I was spending the morning on campus taking music lessons, afternoons working half-time at the U.S. Army Construction Engineering Research Laboratory, working on my doctoral dissertation, and returning to campus to practice in the evening."

> "To my amazement, my earlier acquired piano technique turned out to be lying in wait, only to burst out into a blues rock genre."
>
> *- Joseph Bentsman*

Bahnfleth has worked for nearly 30 years at Penn State University, where he is a professor of architectural engineering. With a particular interest in controlling bioaerosols, he chaired the ASHRAE Epidemic Task Force from 2020 to 2022, which developed guidance for reducing indoor transmission of respiratory diseases to increase building safety, and now chairs a project committee focused on developing a standard for controlling infectious aerosols.

He credits the late Dr. Wilbert Stoecker (MSME 1951), professor emeritus of mechanical engineering, as being a role model in both engineering and music. (Lister also credits Stoecker as being one of his favorite music instructors.)

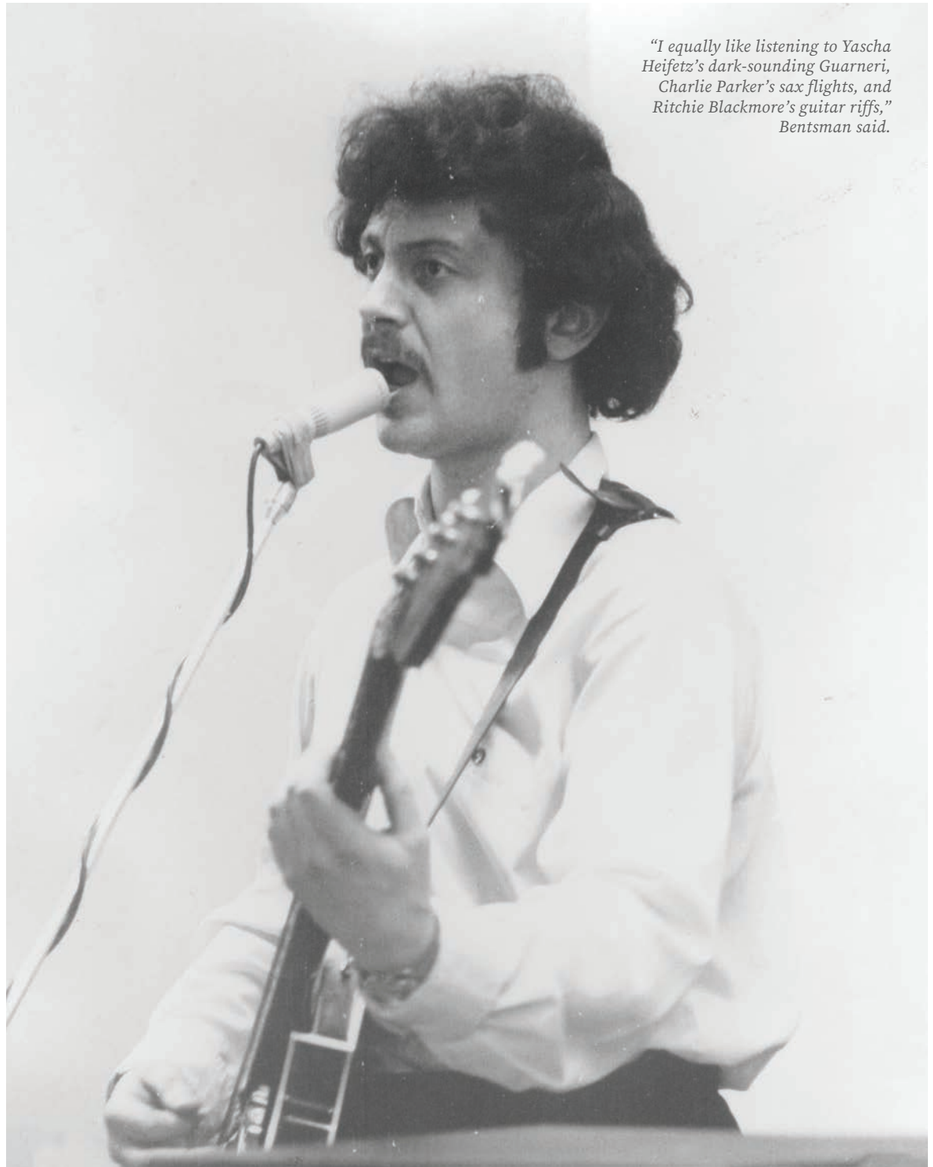
JOSEPH BENTSMAN, FACULTY

MechSE Professor Joseph Bentsman began studying classical music as a child in Soviet Belorussia. "Children in intelligentsia families were expected to study piano," he reflected. He later moved on to guitar and drums, playing in his high school rock band, but ultimately returned to his roots after seeing a friend play piano rock.

"To my amazement, my earlier acquired piano technique turned out to be lying in wait, only to burst out into a blues rock genre," he said.

After high school, Bentsman was invited by the Minsk-based rock band Golden Apples to form a duet with their singer, Leonid Bortkevich. They each had big plans for the future—in Bentsman's case, to defend his PhD and become a professor; for Bortkevich, to join the Minsk Philharmonic performance program and eventually become the People's Artist, the highest musical honor in the Soviet Union.

"Little did we know that both our plans would come true well beyond our expectations—for Leonid, becoming a lead singer in Pesnyary, the top 1970s Soviet rock band, with millions of records sold."



"I equally like listening to Yascha Heifetz's dark-sounding Guarneri, Charlie Parker's sax flights, and Ritchie Blackmore's guitar riffs," Bentsman said.

Bentsman's adventures with music continued during his time in service. "In 1973, when I was drafted into the Soviet army to serve in a Siberia military base, I was invited to sing folk songs in a base choir over the weekends and I also organized my own rock band there," he said.

His research focuses on the modeling and control of systems best described by partial differential equations. He earned his PhD in electrical engineering (control theory) from the Illinois Institute of Technology and was a postdoctoral fellow at the University of Michigan. He enjoys playing piano and guitar whenever he finds an opportunity and likes to play a version of Jailhouse Rock – which he refers to as "Joe's House Rock" – for his PhD students upon completion of their defense.

BLAKE JOHNSON, FACULTY

Teaching Assistant Professor Blake Johnson has found a way to incorporate his own passion for music in TAM 252 (Solid Mechanics Design). As a PhD student at UIUC, Johnson was co-advised by Aerospace Engineering Professor Greg Elliott. During his postdoc at Iowa State University, he had the opportunity to learn woodworking while contributing to research projects that employed wooden structures. In his spare time, he used that knowledge to begin building custom guitars.

When he joined the MechSE faculty in 2013, he reconnected with Elliott.

"Greg and I started building lap steel guitars to give to friends," said Johnson, who first started playing guitar in eighth grade. "He would rough cut my guitar designs on a CNC mill in his garage and I did the electronics and finishing work."

The new hobby inspired Johnson to introduce a similar project to TAM 252. "A guitar string is little more than a piece of prismatic steel that experiences uniaxial tension, which is among the most basic concepts taught in TAM 251 and 252," he explained. He tasked students with creating a single-string proof of concept prototype that allows a lap steel guitar musician to repeatably actuate a hands-free linkage system to increase the string's tension to a precise new tension then revert to its original one.

In addition to guitar, Johnson also plays bass and harmonica.

> "One thing I've come to believe is that engineering is very much a creative endeavor, and I don't want to constrain that too much."
>
> *- Blake Johnson*

> I was always fascinated that the same physics that govern such beautiful music can also be used to solve really complex technological problems.
>
> *- Katie Matlack*

"The basic idea is to create an entry-level instrument that could be purchased on the order of a few hundred dollars with capabilities similar to those of a pedal steel guitar, which are much more complex and can cost thousands of dollars," he said.

Since the first iteration of the guitar project several years ago, Johnson has witnessed many creative solutions including pneumatic actuation using a pressure tube controlled by the musician's mouth as well as Arduino-controlled servos and mechanically actuated bicycle brake cables connected to a bass drum pedal. "One thing I've come to believe is that engineering is very much a creative endeavor, and I don't want to constrain that too much," he said.

KATIE MATLACK, FACULTY

Associate Professor Katie Matlack began studying piano when she was five years old. She picked up the violin a few years later and continued with both instruments through high school.

"I was always trying to find a way to overlap my hobby-type interests with my academic interests, and that brought me to the field of acoustics," she said of her undergraduate studies. While in college, she took a summer job at an architectural acoustics consulting firm that provided an opportunity to work on optimizing sound propagation through space for various scenarios.

Continuing to explore the field, Matlack began researching damage interrogation via ultrasound while in graduate school and then investigated material design for sound propagation control during her postdoctoral fellowship at ETH Zurich.

"Anything acoustic always excites me, which stems from my passion for music," Matlack said. "I was always fascinated that the same physics that govern such beautiful music can also be used to solve really complex technological problems."

Her research group, the Wave Propagation and Metamaterials Laboratory, is investigating several research projects in various areas of acoustics, such as using ultrasound to interrogate material properties in different types of structural materials for non-destructive damage evaluation. The team is also exploring nonlinear phononic materials whose microstructure can be designed for a particular wave propagation response.

"I'm interested in developing programs for K–12 outreach that capitalize on music interest so those students can find interesting pathways in science and engineering," Matlack said of the inspiration for an Engineering Open House exhibit, which demonstrated phononic properties by passing audible frequencies through a homemade crystal structure.

Katie Matlack

Betsy Smith (left) and undergraduate researchers Nate Scriba and Eunice Yoon played their own instruments as part of their EOH demonstration. Although her main instrument is the cello, Smith can play several instruments including trumpet and sousaphone.

BETSY SMITH, GRADUATE STUDENT

Mechanical engineering PhD student Betsy Smith credits her own music background with bolstering her inherent understanding of characteristics of nonlinearity, such as harmonics, in materials.

"Music is one of the reasons I joined Katie's lab," Smith said, noting that a MechSE story about Matlack's musical training and transition into acoustics had piqued her interest. "Even if the research isn't specifically music related, the math-music connection is still there. I think she and I followed a similar path."

Smith, who led the EOH demonstration, noted that although some audience members may not have fully grasped the complex concept of phononics, they could still experience the audible differences as a frequency was played through and then near the crystal. Smith and other students in the group displayed their own instruments to emphasize the musical theme for kids.

EDITOR'S NOTE:

Alumna and MechSE writer Taylor Tucker (BSEM 2017) has played piano for most of her life. She received Division I recognition from the Northwestern University Festival of Music while in high school and studied classical performance in UIUC's music program for non-majors as an undergrad.

"Music has always been in my life—thanks to my mom and dad, I was listening to anything from Liszt to the Rolling Stones before I could walk," she said, reflecting on early memories that have become inherently tied to music.

Tucker currently holds an engineering education fellowship at the Siebel Center for Design, where she leads a team working to create evidence-based methods for supporting course development focused on human-centered engineering design.

"What really stood out to me from writing this article are the quiet ways in which music intricately weaves itself into different aspects of our lives. As engineers, we may not be able to measure the impact a musical background may have on our work or decisions, but it seems that somehow, as with anything that matters, it's there."

Taylor Tucker

Alumni News

In Memoriam

Edward Caulfield (BSME 1972, MS TAM 1974, PhD TAM 1979) of Naperville, IL, and Waterford, WI, passed away November 6, 2022. He was 73. Illinois was a big part of his life, and in 2009 he received the Grainger College of Engineering Alumni Award for Distinguished Service. He worked as a mechanical engineer, eventually starting his own company, Caulfield Engineering. In 2015, in honor of his longtime mentor, Professor Robert E. Miller, he established the Robert Miller Scholarship.

Robert Kern (BSME 1947) passed away at his home in Wisconsin on November 8, 2022, at the age of 96. He was the co-founder, with his wife Patricia, of Generac Corporation and The Kern Family Foundation. Kern designed a lightweight portable generator, manufacturing it in a garage before building Generac's headquarters in 1965. By the time he retired in 2006, Generac was the world's largest producer of portable and stand-by generators. In 2015, he was inducted into the Grainger College of Engineering Hall of Fame.

A professor, engineer, writer, NAE member, and one of MechSE's most prominent alumni, **Henry Petroski** (MS TAM 1964, PhD TAM 1968) passed away from cancer on June 14, 2023. He was 81. Petroski worked at Argonne National Lab and taught at Illinois, UT Austin, and Duke University, from which he retired after a 40-year faculty career. Petroski wrote numerous books, articles and essays for publications including *The New York Times, The Washington Post* and the *Wall Street Journal*. His worldwide acclaim also came for his thoughtful books exploring the engineering of everyday items such as pencils and toothpicks.

William Vavrik (BSME 1957) passed away on June 12, 2022 at the age of 91. Vavrik was a design engineer for Northern Illinois Gas Company and an instructor at the Institute of Gas Technology, a division of the Illinois Institute of Technology. In 2018, Vavrik and his wife established the William and Marie Vavrik MechSE Engineering Visionary Scholarship Fund.

The Washington Post has called **Jigar Shah** (BSME 1996) one of the most important men in America when it comes to boosting the nation's deployment of clean energy and meeting President Biden's ambitious climate goals. Shah is the director of the DoE's Loan Programs Office – responsible for the approximately $40 billion in government-backed loans to companies that are working on green energy infrastructure.

Hesai Group, a supplier of sensors for self-driving vehicles, made its debut on the Nasdaq, raising $190 million in its IPO. Hesai Technology's co-founder and CEO is **Yifan David Li** (MSME 2009, PhD ME 2013), who studied under Professor Elizabeth Hsiao-Wecksler.

A suite of software, called NASGRO, co-developed by **Craig McClung** (MS TAM 1984, PhD ME 1988) has been inducted into the Space Technology Hall of Fame. NASGRO, originally developed by NASA, analyzes fatigue crack growth and fracture in structures and mechanical components.

Last fall, **Amy Shen** (PhD TAM 2000) assumed the role of Provost at Okinawa Institute of Science and Technology in Japan, where she has been a faculty member since 2014.

Climate leader **Jon Creyts** (BSME 1992) has been named the new CEO of the Rocky Mountain Institute (RMI), an independent nonprofit that transforms global energy systems in an effort to attain a zero-carbon future.

Melonee Wise (BSME 2004, MSME 2006) was a recipient of the 2022 Engelberger Robotics Award, the world's most prestigious robotics honor. Previously the founder and CEO of Fetch Robotics – best known for its autonomous mobile robots for warehouses – Wise is now Chief Technology Officer for Agility Robotics.

Illinois Governor JB Pritzker appointed alumnus **Abel Kho** (BSEM 1994) to the State Board of Health. Kho is a tenured professor of Medicine and Preventive Medicine at Northwestern University.

Two alumni have been elected to the National Academy of Engineering. A technical Fellow at Boeing, **Chao-Hsin Lin** (PhD ME 1989) is licensed as an environmental engineer in his native Taiwan as well as a mechanical engineer in Washington and Michigan. **John Sutherland** (BSME 1980, MSME 1982), professor and the Fehsenfeld Family Head of Environmental and Ecological Engineering at Purdue University, is one of the world's leading authorities on the application of sustainability principles to design, manufacturing, and other industrial issues.

Alumni Give Back

Introducing the Jackson Innovation Studio

In summer 2022, the MechSE Department welcomed the Jackson family to campus to celebrate the naming and official opening of the Jackson Innovation Studio.

The educational lab in the Sidney Lu Mechanical Engineering Building is the largest space in MechSE MakerWorks, the suite of labs that expand throughout the Lu MEB's entire lower level. The Jackson Innovation Studio provides students with incredible hands-on learning with a vast set of CNC machine tools, 3D printers, laser cutters, waterjets, and more.

The family, including Discovery Partners Institute Director and MechSE alumnus **Bill Jackson** (BSME 1982, MSME 1983), donated to the Lu MEB construction and renovation project and expressed a wish to honor two family patriarchs.

"Just a little background on why we're celebrating Charles Woodrow and William Charles Jackson," Bill Jackson said. "My uncle was pretty special. He was a professor at Georgia Tech, but he got his undergraduate degree here. And my dad was kind of like MacGyver. This gift is from our whole family because the university has meant a lot to us and this is just a small way to say thanks."

It was during this celebration that Jackson consulted with student employees about additional equipment needs – resulting in a personal equipment donation that was customized to fit their requests. Updates included Ultimaker S5 3D printers and Cricut Maker 3+ kits as well as a variety of hand tools and CNC router accessories.

"We want the studio to be a learning environment that is not held back by equipment or software," Jackson said. "The Jackson Innovation Studio is about the learning of innovation concepts—fast to fail, diverging concept development—and innovative characteristics like curiosity, teamwork, and others."

Inventables founder adds CNC machine to MechSE MakerWorks

MechSE MakerWorks has welcomed a CNC machine through a generous donation from alumnus **Zach Kaplan** (BSME 2001). The Inventables founder gifted a 4' x 4' X-Carve Pro CNC machine accompanied by the Easel Pro software.

"I've been passionate about expanding project-based learning and giving undergraduate mechanical engineers access to the machine shop since I was a student at U of I," Kaplan said. "During my own academic career, the open-ended engineering projects I worked on were the most rewarding and engaging. They helped me integrate the concepts we learned in class better than problem sets."

His passion for accessible fabrication also inspired Inventables. Founded in 2002, the Chicago-based company brings manufacturing technology to millions of people.

With the new machine and software, students will be able to carve wood, plastic, and soft metals in the Wood Maker Studio, as well as enjoy a free five-year subscription to Easel Pro. The CNC adds to a plethora of maker machinery in the MakerWorks labs, including drill presses, belt sanders, and a variety of benchtop saws.◆

2023 Alumni Awards

MECHSE DISTINGUISHED ALUMNI AWARD

Since 1968, MechSE has given this award to alumni who have established careers and have served in a professional and technical capacity to honor the department and the university.

John Shimkus (BSME 1982), retired Vice President of the IBM Corporation

Steve Vavrik (BSME 1990, MSME 1991), advisor to Broad Reach Power, an independent power producer

MECHSE OUTSTANDING YOUNG ALUMNI AWARD

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

Samantha Knoll (BSEM 2011, MS TAM 2013, PhD TAM 2016), Customer Experience Director for New Business Models within the Crop Science Division at Bayer

Chris Nobre (BSME 2015), Senior Operations Engineer at Amazon

Bryan Petrus (BSME 2005, MSME 2013, PhD ME 2014), Process Automation Engineer at Nucor Steel Decatur

GRAINGER ALUMNI AWARD FOR DISTINGUISHED SERVICE

The Grainger College of Engineering announced seven alumni as recipients of the 2023 Alumni Award for Distinguished Service. Winners are selected annually and recognized for professional distinction through outstanding leadership, contributions to the field of engineering, creativity and entrepreneurship; as well as service to society, the professional community, and to the department, college or university.

MechSE alumnus **Eric Brown** (BSME 1998, MSTAM 2001, PhD TAM 2003) was one of this year's winners. Brown is a Senior Scientist in the Office of Experiment Science at Los Alamos National Laboratory (LANL).

Poised for Growth

In FY 2023, The Grainger College of Engineering was awarded major funding from the campus' Investment for Growth Program. One of their two funded college-wide projects – "Online Programs and Hy-Flex Classrooms" – will help MechSE, along with other Grainger departments, to accelerate growth in both our undergraduate and online professional master's degree programs.

Grainger plans to upgrade the technology in instructional labs; create sustainable TA training programs to support online instruction and provide necessary faculty support for courses with online students; translate curricular content to online delivery with a focus on utilizing augmented reality and virtual reality (AR/VR) in labs; and more successfully identify and recruit potential learners.

In MechSE, this will mean hiring more teaching professors to specialize in and support online instruction, as well as more TA support for online office hours, assessment, and course management; and added lecture-capture capabilities throughout the Sidney Lu MEB.

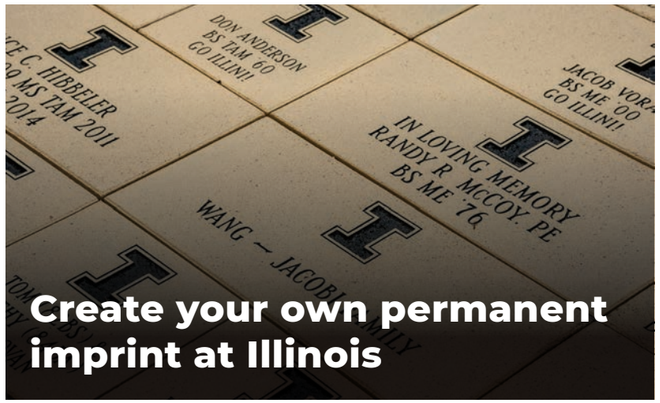
"MechSE degrees are in extremely high demand, and our ME and TAM courses support programs throughout the college," said Department Head Tony Jacobi. "But we need to evolve from the 'traditional' course delivery to more broadly serve MechSE and society. We need to boldly build on what we learned during the early stages of the pandemic—that many courses can be more impactful when delivered in an asynchronous online or hybrid modality. This funding should help enable us to do that."

MechSE faculty: Heavyweights in awards and honors

Recognition of exceptional achievements of faculty with external awards and honors is an important component of institutional rankings and reputation. Grainger Engineering faculty are routinely awarded for research and teaching achievements that have played a significant role in its top ten ranking (U.S. News and World Report).

The MechSE Department is no different. Nearly every year since 2014, MechSE's faculty have been nominated for an average of 40 to 50 national, international, campus, and college awards and recognition—with an impressive eight-year average of nearly 40% of those nominations resulting in a win. Additionally, a record number of our faculty also hold a named appointment, such as a professorship or chair, with several holding more than one of these titles.

"The recognition our faculty receive through prestigious awards and named appointments is a reflection of their excellent scholarship and impactful leadership, and of course that recognition shines back on the department as a whole. 'Excellence begets excellence,' and our internationally renowned faculty attract the very best students and new faculty who want to join them as colleagues. The awards alone don't fuel it, but they certainly help amplify our critical mass," said Jacobi.



Create your own permanent imprint at Illinois

A prominent feature of the Sidney Lu Mechanical Engineering Building is the new paved brick plaza, a beautiful gathering spot at the center entrance facing Green Street. Individuals, companies, and organizations can become a permanent part of the building, the MechSE Department, and the University of Illinois by sponsoring one of these pavers with a personalized engraved message.

Your inscription could honor a friend or family member, memorialize a cherished professor, or show the world you're a supporter of MechSE. An engraved paver can also be a unique, meaningful, and lasting gift. Most importantly, your contribution is an investment that will help empower the department to continue to be among the best in the world.

Purchase your paver today!

go.mechse.illinois.edu/pavers

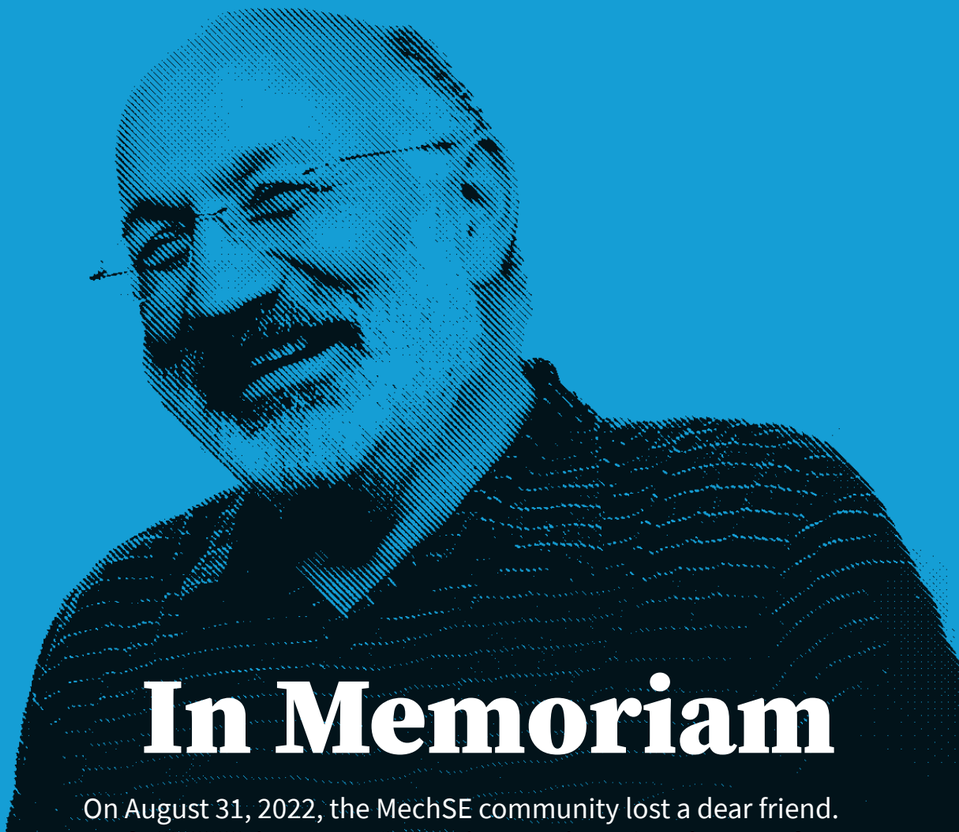
> ***A paver is a great way to contribute to an environment that will benefit generations of MechSE students to come. I wanted to help create an environment that makes it clear to our students what a great extended family they are part of.***
>
> *- Professor Elif Ertekin*

Support our inclusive community

MechSE benefits when individuals from different personal, cultural, and disciplinary perspectives work together. Increasing the diversity of our faculty and students is fundamental to our mission. Purposeful scholarships, fellowships, and other recruiting tools can enable us to accelerate the diversity of our academics, research, and future workforce. Learn how a gift to our DEI fund can help us recruit and foster a truly inclusive MechSE community.

Learn more about our diversity, equity, and inclusion initiatives:

go.mechse.illinois.edu/DEI



In Memoriam

On August 31, 2022, the MechSE community lost a dear friend. Professor Predrag "Pega" Hrnjak passed away at the age of 70.

Pega Hrnjak earned his D.Sc. in 1992 from the University of Belgrade, in Yugoslavia, where he was also on faculty, rising to the rank of Associate Professor. He joined the MechSE Department in 1993 (then Mechanical and Industrial Engineering), earning recognition as Stoecker Faculty Fellow and Distinguished Research Professor, and serving for many years as Director of the Air Conditioning and Refrigeration Center (ACRC), an Industry/University Cooperative Research Center founded by the National Science Foundation that still thrives today.

Hrnjak was internationally recognized for his technical leadership. His research ranged from fundamentals of refrigerant-lubricant mixtures and the dynamics of developing two-phase flow, to optimizing design of components and systems around the properties of various refrigerants and their compatible lubricants.

In 2003, he founded Creative Thermal Solutions, and what began as a "garage business" grew under his tireless leadership to the state-of-the-art, 100,000 sq. ft. research facility it is today. Between the ACRC and CTS, Hrnjak managed to incubate a critical mass of enthusiastic researchers, engineers, and support staff of nearly 100 people working simultaneously on the sustainable HVAC&R technologies for which he was so passionate. He was engaged in deeply impactful research on a wide range of natural refrigerant projects, from low-charge ammonia to ejectors for transcritical CO_2 to some of the early CO_2 mobile air conditioning systems.

Hrnjak's direct impact on the next generation of scholars was also extraordinary. He mentored nearly 120 students to graduate degrees and welcomed close to 100 visiting scholars to his research team. His boundless energy was directed toward helping others reach their full potential, professionally and personally, and his impact was profound. He is deeply missed. ◆

Grainger College of Engineering
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