What do you get when you give some of the brightest and most motivated student minds access to a world-class faculty and facilities and present them with extremely difficult problems to solve?

Mechanical engineers who have a positive impact on the world around them.

As chair of the University of Michigan Department of Mechanical Engineering (U-M ME), I have the privilege of seeing this on a daily basis. Our work — our teaching, our research, our service to the profession — has a real, tangible, positive influence. Each day I work, our students, staff, and faculty work together to develop solutions that improve our world and the quality of life of its inhabitants.

Engagement, innovation, impact. These threads are woven throughout the efforts and accomplishments we’re proud to share in the following pages.

From AI, automotive engineering, and biosystems to robotics, sustainable energy, materials, and transportation of the future, our faculty conduct high-impact research that crosses traditional disciplinary boundaries. Collaborations span the College, the University, and the world, spurring innovation. That spirit of innovation began “at home,” with several departmental initiatives designed to fuel our faculty and students’ creativity. Engaging faculty and students in our teaching, research, and service enterprise. Our research portfolio is broadened and takes center stage in the new $75 million Ford Equinox Building.

The ME Board of Regents approved the schematic design for the $75 million Ford Equinox Building. The new (and very cool) facility will include labs customized for many types of robotics, technologies and applications. Several ME faculty conduct robotics research and will have space in the new building for their work.

In addition to receiving a number of prestigious awards, our faculty are having a broader impact through service, playing leading roles in many areas of the University and beyond. (Read more in ME Leads on page 6.) Further extending our impact, we welcome five new faculty members this year: assistant professors Solomon Adena, Ashley Bucsko, Jim Estrada, and Nima Fazeli, and lecturer Heather Cooper.

We also welcome our new Diversity, Equity & Inclusion (DEI) Coordinator Dawn Wheeler, who will support DEI activities for faculty, staff, and students so that these concepts become even more ingrained in who we are and what we do. (Read more about Dawn and his role in the Q&A on page 35.) We’re excited, too, about our new WoMEntoring student group, launched to support community-building among female students and open to all students. You can learn more about the impetus for WoMEntoring in the Q&A with co-founder Laurie Katherine Chan on page 33.

You’ll find many other examples throughout this report of how our work is making a difference and preparing our students for careers defined by contribution and service. I hope they inspire you the way they do me — everyday.

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MECHANICAL ENGINEERING

2018-19 ANNUAL REPORT

IN THE NEWS

TRENDS & STATISTICS

Degrees Conferred 2017-18

- MSE: 142
- BSE: 309
- PhD: 55

Annual Research Expenditures 2018-19

- NIH: $1,739,852
- NSF: $4,459,535
- DoE: $5,602,624
- DoD: $7,817,683
- ALL OTHER: $35,229,849

Faculty Profile

- JOURNAL CHIEF EDITORS & JOURNAL EDITORIAL BOARD OR ASSOC. EDITOR APPTS.: 77
- NSF CAREER OR PVI AWARDS: 45
- NAE MEMBERS: 10
- NSF PECASE OR PFF AWARDS: 5
- SOCIETY FELLOWS: 82

Faculty Trends

- Tenured and Tenure-Track

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JOURNAL CHIEF EDITORS

- 4

JOURNAL EDITORIAL BOARD OR ASSOC. EDITOR APPTS.

- 77

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ALL OTHER

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ME LEADS

Featuring nine ME faculty who are motivating others through their leadership — on campus, nationally, globally. We’re proud of the prominent roles they play at the University of Michigan and beyond, and we asked them to briefly describe their work, their favorite parts about it, and its impact. Here’s what they had to say:

KON-WELL WANG

Stephen F.残本金Endowed Professor of Mechanical Engineering

Dean, College of Engineering

The National Science Foundation (NSF) Division of Engineering Education and Centers that I lead invests in the creation of 21st-century engineers and the discovery of transformative technologies via convergent research to achieve societal impact. Its focus includes enabling centers and networks, such as the large-scale Engineering Research Centers (ERCs), that address grand challenges via basic research and launch new industries, broadening participation in engineering, improving education, and developing the engineering workforce of tomorrow.

I’m thrilled to have the opportunity to provide strategic leadership and serve the scientific enterprise at the national level in this role. My ME background, as a researcher, an educator, and an administrator (former department chair), helped prepare me for this role. My ME background, as a researcher, an educator, and an administrator (former department chair), helped prepare me for this role. My ME background, as a researcher, an educator, and an administrator (former department chair), helped prepare me for this role. My ME background, as a researcher, an educator, and an administrator (former department chair), helped prepare me for this role.

BOGDAN EPUREANU

Arthur F. Thurnau Collegiate Professor of Mechanical Engineering

Director, National Science Foundation (NSF) Engineering Education and Centers

The ARC is a hub where new ideas are generated and translated into key technologies in several areas of autonomy of ground systems. These include vehicle dynamics, control, and autonomous behavior; human-autonomy learning; high-performance architectures and materials; intelligent power systems; and fleet operations and vehicle system of systems integration. For example, ARC leads the way in the creation of the next-generation combat vehicles.

I am passionate about building ecosystems of research and innovation based on sustainable brand-define for talented people to succeed. That involves securing resources, defining values, creating strategies, and implementing processes. I find most rewarding the success that ARC students, faculty, government sponsors, and industry partners achieve in the ARC’s diverse projects.

My background is nonlinear dynamics, an area of research that helps us understand, model, and predict unique phenomena in complex systems, both engineered and natural. The ARC deals with complex systems that involve autonomous assets and their interaction with humans. Such convergence of disciplines and integrative thinking are prevalent in nonlinear dynamics and key strengths that ensure ARC’s longevity.

KRISHNA GARIKIPATI

Professor, Mechanical Engineering

Director, Michigan Institute for Computational Science and Engineering (MICISE)

MICISE has now a broad and deeply engaged community of computational scientists and engineers across the University. This has led to significantly greater and higher quality activity in research, education, and outreach for computational science and engineering.

Additionally, we are recognized beyond the University as a leading institute of computational science and engineering. This breadth of connections in engineering and science that Mechanical Engineering fosters has allowed me to engage with faculty members of all possible intellectual backgrounds at the University in my role as MICISE director. Among my favorite aspects of this role is the charting of future directions of research in computational science and engineering.

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DIANN BREI

Professor, Mechanical Engineering

Chair and Professor, Division of Integrative Systems + Design (ISD)

As Associate Dean for Research (ADR), I support the research activities across the College of Engineering. There are over 1,000 sponsored research projects going on at any given time in the CoE, from very small to very large, totaling about $270 million in annual expenditures. In this role, I enjoy having a bird’s-eye view of the many research topics our faculty and students are exploring — they teach me something new every day. Our team in the ADR’s office is committed to helping our faculty engage in impactful research efforts. Much of what we do is embodied in the College’s strategic plan, MCH2020, where I manage the research pillar, including our Blue Sky Initiative. Our office also interfaces with units across the University and with external partners in government and industry. Whether it is working with the federal government on sponsored programs, developing resources from industry and private benefactors, or maintaining a culture of research compliance, our goal is always to provide research opportunities to and support for our faculty and students.

STEVE CECCIO

Professor, Mechanical Engineering

Dean, and Distinguished Professor of Engineering

Engineering Analytics and Data Science Research Group

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Professor, Mechanical Engineering

Chair and Professor, Division of Integrative Systems + Design (ISD)

As chair of ISD, I oversee the full division, including faculty, our six graduate programs, staff, and students. I really treasure our uniqueness — bringing together and effectively integrating across disciplines to holistically create real systems that add value to industry and are more broadly to society. Energy systems, automotive systems, manufacturing systems, and other systems — from you design and build such complex systems in this rapidly changing world encompass so many aspects beyond the technical, including social, global, political, business, and environmental contexts.

We’re educating tomorrow’s leaders to think transformatively since many industries are drastically changing. Our students aren’t just contributing; they’re leading. One of the best parts of my role is hearing industry leaders who work with our students say, “We don’t know exactly what you’re doing, but we want more of it.” We instill an integrative mindset in our students that is available to the work force of tomorrow. The world needs people who can think who can lead — in an integrative way.
Mechanical Engineering is unstoppable, diverse, and inspiring.

ANGELA VIOLI
Professor, Mechanical Engineering
Principal Investigator, Accelerating the transition to a healthier, Michigan-based economy for all (AME)
Blue Sky Institute

Antibiotic resistance has risen by as much as two-thirds in the last two decades and is now responsible for an estimated 700,000 deaths annually worldwide. By 2050, it is estimated that it will cause 10 million deaths per year — unless we ramp up efforts to tackle it.

It’s been incredible to create a diverse team of outstanding researchers from across the University to work on a common vision: to use machine learning, molecular simulations, and biological experiments to develop next-generation antimicrobial nanomaterials that lower the odds of bacterial resistance.

In addition to scientific publications, we’re reaching out to companies, government agencies, and NGOs to make sure our efforts get our team and Michigan on the map and these organizations are aware of our novelty, breadth, and uniqueness. We’ve also developed new instructional modules for high school science students and taught a course for eighth-grade students.

We plan to expand this work to include elementary, secondary, and college students. There’s so much momentum, and we’re excited about the many opportunities ahead.

DAWN TILBURY
Professor, Mechanical Engineering
Assistant Director, Engineering Education, National Science Foundation (NSF)

The mission of the National Science Foundation (NSF) is to promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense.

Most of the funds we are allocated by congress are sent out the door, to fund basic research — from astronomy to zoology, and everything in between. We also strongly support basic research, both creating opportunities for women and underrepresented minorities to participate in education and research activities and expanding our resources to underserved states and communities.

Fundamental, basic research originally funded by NSF has led to 3D printing, touchscreens, and search engines. I look forward to seeing the advances that will arise out of the research we’re funding today.

In my role as Assistant Director for Engineering, I get to work with incredible people. I had met many people in the Engineering directorate before — writing proposals, serving on panels, attending workshops, etc.

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At U-M ME, I learned to appreciate this type of multidisciplinary approach to research. I also found a very collaborative environment there, with faculty interested in working together, and helping each other, identifying challenges problems to work on that have a significant impact on the field, in industry, and on society.

Cooper is the newest LEO Lecturer for ME and is coordinating the ME 650 capstone design course. She comes to U-M ME with over 15 years’ combined practice in industry and education, most recently as an education programs manager with the SME Education Foundation. She previously worked as a trainer and simulation performance engineer for General Motors, an assistant professor of mechanical engineering technology at Purdue University, and a secondary math teacher in New York City.

“I am excited to be teaching the ME 650 capstone design course at U-M because it is a perfect blend of teaching, mentoring, and real engineering problems. My industry practice experience allows me to enhance the curriculum with many relevant examples of design processes, collaboration, ethics, and career development. My goal is to help inspire the next generation of U-M mechanical engineers to use their unique talents to change the world.”

What drew you to U-M ME and how do you hope to help make it even better?

HEATHER COOPER
Title: LEO Lecturer
Education: Graduate of Purdue University with a BS in Mechanical Engineering and a Master’s in Engineering, Masters in mathematics education from New York University

SOLOMON ADERA
Title: Assistant Professor
Education: PhD in Mechanical Engineering from MIT, Post doc from Harvard University

Research: Fundamental studies of heat and mass transfer, fluid-structure interactions, and water-energy nexus.

“In addition to academic excellence and longstanding reputation, the University of Michigan is diverse and inclusive. I was impressed by the collegiality of faculty and staff that I had the pleasure of meeting during my visit. I am delighted to join ME at U-M.”
Christina Rice

U-M ME is a good place to pursue this NSF-funded research because of the interdisciplinary nature of the program. For example, I frequently work with chemical engineers and the U-M hospital during my research. U-M ME also provides a good balance between fundamental work and emerging fast-to-market technologies. Finally, the faculty and staff blow me away with their support of my work and well-being.

I am working on simulating polymer behavior, specifically polymers that are heavy and take a long time to move. This means researching new algorithms that are computationally efficient and studying the physics of the polymers as they interact with surfaces and neighboring molecules. This research allows us to rapidly screen innovative new polymers for application and to gain fundamental insight into small-scale polymer behavior that is difficult to capture experimentally. This research has applications in several fields, from health to energy, but one application area we are particularly interested in pursuing is the role of polymers in blood clotting.

Revanth Damerla

I chose to come to U-M ME because it gives me the opportunity to work on cutting-edge research at an institution with world-class facilities and resources. U-M ME is unique in that it also provides multiple pathways to translate my research into real-world solutions and have societal impact.

I am currently working on the design of an upper limb prostheses concept for transtibial amputees. This prostheses will hopefully provide improved functionality over existing solutions and more closely mimic the capabilities of a real arm. This would increase convenience for amputees as well as allow them to have improved independence.

Nosakhare (Nosa) Edoiyoia

U-M ME is a great place to utilize my NSF Award because I am working with an advisor who has a wealth of knowledge in this field and I have access to the resources I need to learn about, design for, and implement my ideas for research.

I am working to increase the productivity of additive manufacturing machines (3D printers) through the development of advanced control algorithms and improved mechanical design. My research will address one of the key drawbacks of this field and I have access to the resources I need to learn about, design for, and implement my ideas for research.
The University of Michigan Mechanical Engineering Department celebrated a major milestone in 2018, its 150th anniversary! ME helped pioneer the field 150 years ago, and continues to be a worldwide leader in research and education, both basic and translational, from transportation engineering to energy, from bio/health to manufacturing and beyond. Throughout 2018 the Department celebrated its sesquicentennial with a variety of events, including a distinguished speaker lecture series, culminating on September 21, 2018 with a full day of on-campus activities including panel discussions focusing on the Department’s rich history and exciting future. The celebration also included a dinner at the historic Henry Ford Museum in Dearborn.
Opening in early 2020, the Ford Robotics building will become the home of Michigan Robotics. The 140,000-square-foot, four-story complex will house classrooms, offices, a startup-style open collaboration area, and tailored lab space for a variety of robotic technologies. The building will include a three-story fly zone for autonomous aerial vehicles, an outdoor obstacle course for walking robots, high-bay garage space for self-driving cars, and dedicated space for rehabilitation and mobility robots such as prosthetics and exoskeletons.

And in a unique agreement, Ford will lease the fourth floor to perform robotics research and engineering in collaboration with U-M and other industry leaders.

This new building is designed to promote collaborative work across disciplines, involving students and faculty at all levels, from a variety of fields. U-M ME is the most represented department in Robotics with six core and eight affiliate faculty. U-M ME Joint Professor Jessy Grizzle is the Director of the Robotics Institute.
MECHANICAL ENGINEERING

When we’re successful, we’ll have a CO₂ negative material. Not only does using plant fibers prevent CO₂ emissions during fiber production, our methods also reclaim CO₂ as the plants grow.”

Taub, in collaboration with Ford Motor Company and ME Research Associate Professor Mihaela Banu, are looking beyond carbon neutrality and toward nature for a greener alternative: natural fibers from plants, since they absorb — rather than release — CO₂ as they grow.

Ford Motor Company has been developing natural fiber composites for over 10 years and has implemented many “green” materials in semi-structural Ford parts, including a wheel stray-filled storage bin, nos-hull-filled wiring harness, and a cellulose-based armrest substrate. However, due to strength and stiffness limitations, natural fibers have yet to fully replace glass fiber reinforcement in structural automotive applications. In 2016, Ford’s team initiated a project to improve the properties of natural fibers using nanomaterials, and the project evolved into a doctoral thesis investigated by Amy Langhorst, a research scientist at Ford and PhD student in Taub’s group.

“Lightening the weight of the machines that move people by land, sea, and air is beneficial for many reasons, including improved fuel efficiency and the ability to carry higher payloads or added safety systems. A 10% reduction in the weight of a passenger car, for instance, leads to about a 6% improvement in fuel economy. One key strategy to reduce weight is to design structures using lighter materials with improved properties, such as those with greater specific strength and stiffness. Given their light weight, most polymers are attractive materials for weight reduction, but they’re neither strong enough nor stiff enough for structural applications. As a result, manufacturers across industries add reinforcing fibers such as glass and more recently, carbon fiber, to add strength and stiffness to the material.”

“Triple challenge”

Taub’s group is working with bamboo, hemp, and flax, adding an environmentally friendly nanomaterial to particular cells in the plants during growth or after harvesting to improve strength and stiffness. The cells form fibers, and these would then be extracted and used to reinforce the polymer composites.

Part of the challenge, noted Taub, is that plant transport mechanisms are extremely complex, which makes getting even nanoscale material to the targeted cells difficult. And therein lies another challenge: the need to work simultaneously at multiple scales. Extracting the strengthened fibers presents yet another hurdle since current methods can cause the fibers to undergo damage. The team is developing new ways to extract them from the plant to avoid this.

Abundant applications

With three decades of auto industry experience, Taub is first looking at automotive applications for the natural-fiber reinforce- ments under development. “But we’re certainly not restricted to one application — everything from appliances and sporting goods to commercial aircraft and ocean-going vessels could make use of natural-fiber-reinforced composites if we’re successful,” he said.

And although the process for producing the strong natural fibers will be different than for glass or carbon fibers, the processing and equipment used for forming the resulting polymer composite into structures remains for the most part the same from an industrial perspective.

“Not only does using plant fibers prevent CO₂ emissions during fiber production, our methods also reclaim CO₂ as the plants grow. We should be able to achieve lighter-weight structures, enabling better fuel economy using materials that are CO₂ negative. Our challenge is to improve the mechanical properties of the fibers while maintaining low cost.”

What we’re looking at is a material substitution that fits into existing processing capabilities,” Taub said. This means the natural fibers have potential for large-scale implantation, which is key to positively impacting the environment.

“To have a real impact,” he said, “we have to replace tons of material. Fortunately, enough of this plant material is already being grown, so what we’re focused on now is improving the properties, improving the existing methods, and making these advances with minimal cost increases.”

The project draws upon expertise across the University and includes collaborator Regina Bausum, associate professor of Ecology and Evolutionary Biology. Students from the Fall 2019 semester of MSE’s Blue Sky Initiative, the Materials Science and Engineering senior capstone design course, will conduct an environmental lifecycle and cost analyses.

The project grew out of work by graduate student Amy Langhorst, who earned her bachelor’s degree in U-M’s Materials Science and Engineering in 2013 and took the senior design course with Taub. She now works at Ford Motor Company and is pursuing a doctoral degree with Taub as her advisor.

The project is part of U-M’s Global CO₂ initiative, which supports development of sustainable and commercially viable carbon-negative technologies. Funding for early-stage, exploratory work is provided through the U-M College of Engineering Blue Sky Initiative, designed to help faculty develop high-risk, high-reward concepts. Additional funding is being provided by Ford Motor Company.

The project has high reward potential. “When we’re successful, we’ll have a CO₂ negative material,” Taub said. “Not only does using plant fibers prevent CO₂ emissions during fiber production, our methods also reclaim CO₂ as the plants grow. We should be able to achieve lighter-weight structures, enabling better fuel economy using materials that are CO₂ negative. Our challenge is to improve the mechanical properties of the fibers while maintaining low cost.”
OPEN-SOURCE BIONIC LEG

A new open-source, artificially intelligent prosthetic leg designed by University of Michigan and Shirley Ryan AbilityLab researchers is now available to the scientific community. The leg’s free-to-core design and programming are intended to improve the quality of life of patients and accelerate scientific advances by offering a unified platform to fragmented research efforts across the field of bionics.

“Our Open Source Bionic Leg will enable investigators to efficiently solve challenges associated with controlling bionic legs across a range of activities in the lab and out in the community,” said lead designer Elliott Rouse, core faculty at U-M’s Robotics Institute and assistant professor of mechanical engineering. “In addition, we hope our bionic leg will unite researchers with a common hardware platform, and enable new investigators from related fields to develop innovative control strategies.”

In Chicago, unveiled the leg and its platform at the Amazon re:MARS conference in Las Vegas. Details on where to order the parts, how to program the leg are now available open-source.org/leg. Researchers who work directly with patients with disabilities often have to build their own robotic leg system, said Rouse. Instead of starting from scratch, researchers can take this common platform and, after some assembly, begin working on better solutions to help people with mobility impairments. The common platform enables researchers to efficiently solve challenges associated with controlling bionic legs across a range of activities in the lab and out in the community.

Elliott Rouse, ME Assistant Professor and collaborator Levi Hargrove, director of the Center for Bionic Medicine at the Shirley Ryan AbilityLab, a research hospital in Chicago, unveiled the leg and its platform at the Amazon re:MARS conference in Las Vegas. Details on where to order the parts, how to program the leg are now available open-source.org/leg. Researchers who work directly with patients with disabilities often have to build their own robotic leg system, said Rouse. Instead of starting from scratch, researchers can take this common platform and, after some assembly, begin working on better solutions to help people with mobility impairments. The common platform enables researchers to efficiently solve challenges associated with controlling bionic legs across a range of activities in the lab and out in the community.

In addition, the team adapted a drone controller to provide much higher torque. These lower-geared motors allow for more efficient, linear control and more human-like movements. Researchers who work directly with people with disabilities often have to build their own robotic leg system, said Rouse. Instead of starting from scratch, researchers can take this common platform and, after some assembly, begin working on better solutions to help people with mobility impairments. The common platform enables researchers to efficiently solve challenges associated with controlling bionic legs across a range of activities in the lab and out in the community.

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Efficient, first-of-a-kind design

While designing the leg, Rouse focused on keeping it simple, low cost, and portable, yet highly performant. The result incorporates relatively inexpensive parts from just a few suppliers: a bionic leg, which researchers can then iterate and build upon. While there exist many open-source projects that develop prosthetics for the upper body, such as hands, this is the first such platform for the lower extremities. Research in lower limb bionics has traditionally lagged that of the upper limb prosthetics, primarily due to the high risk to maintain balance and support a patient’s entire body. The full bionic leg as specified costs $28,500, which includes parts machined by Star Rapid, actuators from Daply, Inc., and a Raspberry Pi mini-computer that powers the artificial intelligence.

The team previously presented progress on the leg at the 2018 IEEE International Conference on Biomimetic Robotics and Biomechatronics. This paper included first-author Alejandrina Avina, a PhD student in mechanical engineering at U-M, and Luke Mooney, co-founder of Daply, Inc. They are now partnering with researchers at CTI, Carnegie Mellon University; the University of Texas at Dallas, Georgia Tech, VA Puget Sound and University of Washington; and the University of Sydney. The project is supported by the National Science Foundation’s National Robotics Initiative and the NSF Renewed Hope Foundation.

This represents the future of research—rapid prototyping of open-source robotic hardware and embedded systems with shared code.

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SOLAR-POWERED WASTEWATER TREATMENT COUPLED WITH ENERGY AND NUTRIENT RECOVERY

Bala Chandran, who directs the U-M Transport and Reaction Engineering for sustainable Energy (TRE3) Laboratory, also notes a bit of irony. “Some of the nutrients and chemical species present in wastewater could actually provide energy, yet we’re spending money and energy to get rid of them. Wastewater is a misplaced resource in that respect.”

State-of-the-art techniques to remediate nitrogen-based contaminants from wastewater are biological (microbial) and electrochemical ion-exchange processes. Both processes are typically energy-intensive. Biological approaches may not be applicable for all wastewater streams, especially in areas with low or no solar resource, or unsuitable for microbial growth, and electrochemical ion-exchange approaches will be constrained by the availability of drinking water applications often result in the generation of secondary waste streams.

Bala Chandran’s research group, including ME doctoral student Luisa Barrera and ME senior Erika Brower, is developing solar-powered wastewater nitrate treatment pathways that facilitate the recovery of energy by producing value-added chemicals from these nutrients. “Our goal is to identify solar-powered wastewater nitrate treatment pathways that facilitate the recovery of energy by producing value-added chemicals from these nutrients,” said Bala Chandran. The work is funded by her startup funds and Mcubed, a University initiative to encourage innovative, interdisciplinary research.

An experimental component entails reactor prototyping, design, and demonstration of a solar-powered photocatalytic reactor to recover the energy and nutrients from the wastewater nitrates. “Since we don’t yet fully understand which nitrate reduction pathway is the most effective in maximizing energy recovery from the treatment process and which materials and device-scale designs help attain the most optimal process which materials and device-scale designs are the most effective in maximizing energy recovery from the treatment process and which materials and device-scale designs help attain the most optimal process,” Chandran said.

The results also indicate there is scope for improved efficiencies added by new materials discovery and design, which might be the case. “We need to find new processes and scalable ways to approach waste- water treatment. This is critical to help balance the global nitrogen cycle, a problem the National Academy of Engineering has designated a grand challenge for engineering in the 21st century.

Next steps include developing an experimentally validated modeling framework for understanding the combined influences of various physical phenomena and prototyping and evaluating reactor components against those of state-of-the-art reactors to measure performance and predict efficiencies. “From there, we’ll work on the design and fabrication of the reactor itself,” said Bala Chandran. “We focus on first prototyping the improvements we think will make a real difference.”

Making a difference is crucial, she added. “We need to find new processes that don’t just destroy but also recover energy.”
TOWARD SMART DENTAL IMPLANTS

The system Banu and colleagues are developing overcomes several challenges of current artificial implants and is likely to enhance patient outcomes, overall health and quality of life.

“Intelligent dental implants have the real potential to improve patients’ lives,” said Laurie McCauley, dean of the U-M School of Dentistry and a collaborator with Banu’s team, along with Gustavo Mendosa, DDS, MS, PhD, clinical associate professor, and Sun-Kung Bak, DDS, clinical assistant professor.

“Many people, particularly those with health problems that affect their bones or who have had cancer treatment — and healthy people, too — are suffering with issues related to tooth loss,” Banu added, “and we probably can help them.”

Worldwide, nearly 150 million people suffer from edentulism, or toothlessness. In the United States, about 15 million people have natural tooth. Instead, the dental implant fuses with surrounding bone, and it is missing the PDL region. The PDL region is important for blood supply, infection resistance and tooth tactile sensation. M-Cubed approaches: a new concept of dental implant surface, taking into account the periodontal ligament regeneration combined with a porous structure of the titanium implant to fit bone cell adhesion and growth around the wall of the implant, a process known as osteointegration. Using a new approach, Banu and her doctoral student, Jieke Wang, have introduced porosity inside the implant and demonstrated that doing so gives bone cells greater, and deeper, surface area for adhesion.

“The specific porosity we introduced has two important effects,” Banu said. “It offers greater stability and it decreases the stiffness of the implant. In this way, we can match the stiffness of the implant to the bone more closely and mitigate much of the nonuniform stresses.”

Many patients seek treatment before symptoms develop. To date, Banu’s team has manufactured a prototype system and, in vitro, demonstrated an improved osteointegration rate compared to a solid titanium structure. Postdoctoral fellow Jessica Alves Ferreira, DDS, was integral to obtaining these results.

Intelligent dental implants have the real potential to improve patients’ Lives.”

Improving compatibility through porosity

For success over the long term, implants must be stiff enough to withstand the stresses caused by chewing, which leads to perpendicular loading as well as lateral and rotational displacements. Together, these create nonuniform stresses on the bone that, over time, can lead to trouble.

In finite element simulations, Banu’s group has shown that even very small displacements or rotations of the implant will generate nonuniform stress points, which lead to inflammation. And this process, when it occurs repeatedly, often results in infection. A mismatch between the stiffness of the implant and stiffness of the bone also contributes to nonuniform stresses.

Today’s implants, primarily made from titanium and its alloys, are solid, with the surface treated through chemical etching or laser ablation to create pores. The roughened surfaces facilitate bone cell adhesion and growth around the wall of the implant, a process known as osteointegration. Using a new approach, Banu and her doctoral student, Jieke Wang, have introduced porosity inside the implant and demonstrated that doing so gives bone cells greater, and deeper, surface area for adhesion.

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Novel manufacturing approaches

While conventional implants are produced by cutting and milling a metal rod, Banu’s group has demonstrated another concept. She and her team are using selective laser sintering of titanium (and the alloy Ti6Al4V) powder and resin to create a porous titanium form. Future work will also see another additive 3D manufacturing process, direct metal printing.

During the manufacturing process, a sensor will be embedded in the implant to monitor displacement and stresses. This solution was developed together with Bogdan I. Popa, assistant professor in ME. The intriguing design and its manufacturability attracted Robert Buechler, a senior ME student, to be deeply involved in realizing the system’s first virtual version. The sensor will be interrogated wirelessly and passively and therefore won’t require a power source. Signals from the sensor will be recorded by software — an app installed on the user’s smartphone, watch, tablet, or other mobile device. The data can then be used to predict the evolution of implant mobility and to detect possible failures early. This will enable physicians to seek treatment before symptoms develop.

The team has been working together since 2015. “It’s been a close and productive collaboration,” Banu said. “Few other places in the world have this caliber, depth, and breadth of engineering and biomechanical expertise.”

B - bone; PDL - periodontal ligament; C – cementum; D – dentin

Smart dental implant systems

U-M ME student Robert Buechler and U-M ME Professor Bogdan I. Popa discuss designing the embedded sensor in the implant.

The system Banu and colleagues are developing overcomes several challenges of current artificial implants and is likely to enhance patient outcomes, overall health and quality of life.

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Until now, the part of the ear that processes speech was poorly reflected in computer models, but University of Michigan researchers have figured out the math that describes how it works. It could help improve hearing tests and devices that restore some hearing to the deaf.

Inside the ear, a snail-shaped organ called the cochlea takes in pressure information from the eardrum and turns it into nerve impulses that are sent to the brain. A full understanding of how this tube-like structure does its work, from end to end, has been elusive.

“No one has been able to piece together a complete model that describes the entire cochlea, especially at the apex, or the end furthest from the eardrum,” said Karl Grosh, a professor of mechanical engineering. “Existing models were unable to match the low frequencies processed at the apex. And that’s been a problem since it’s where speech is processed.”

That apex has been problematic for researchers because it is tapered and features a different cell structure from the base. Due to its location further inside the ear, it has been harder to access for testing without doing damage.

Recent advances in optical coherence tomography (OCT), the use of light waves to create 3D images and measure how sound moves through different parts of the ear, have allowed for a closer look at the cochlea’s apex region.

Using OCT data from other researchers, Grosh worked with Aritra Sasmal, a PhD student in mechanical engineering, to break down the cochlea’s mechanics, fluid-structure interaction, and cell makeup.

Their work sheds new light on the role of a particular part of the cochlea, the basilar membrane. It runs the length of the cochlea, separating two liquid-filled tubes, the scala media and scala tympani. Previous research has suggested that the membrane is the critical element to the ear’s ability to amplify and transmit sound waves. But Grosh and Sasmal’s work shows the basilar membrane is only part of the equation. They showed that subtle changes in the cell structure along the cochlear spiral and the shapes of the liquid-filled tubes are key elements at speech frequencies. Their work is published online in the Proceedings of the National Academy of Sciences.

“Most numerical models work well at the base but fail miserably at the apex,” Sasmal said. “Our modeling work is the first to show why the apex behaves differently, and it paves the way for modeling the transduction of speech and music at the level of the cochlea.”

The researchers believe their model is promising for improving the way newborns are tested for hearing impairment. One non-invasive procedure, typically done in the first days of life, sends two tones into the ear and records a third tone that is produced in response. A better understanding of the cochlea’s function, particularly at the apex/low frequency region, can help better analyze the third tone, improving our understanding of the baby’s hearing.

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ICE PROOFING

BIG STRUCTURES WITH A “BEAUTIFUL DEMONSTRATION OF MECHANICS”

A new class of coatings that sheds ice effortlessly from even large surfaces has moved researchers closer to their decades-long goal of ice-proofing cargo ships, airplanes, power lines, and other large structures.

The spray-on coatings, developed at the University of Michigan, cause ice to fall away from structures — regardless of their size — with just the force of a light breeze, or often the weight of the ice itself. A paper on the research is published in Science.

The researchers overcame a major limitation of previous ice-repellent coatings — while they worked well on small areas, they were ineffective once the surface area got large enough.

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The researchers overcame a major limitation of previous ice-repellent coatings — while they worked well on small areas, they were ineffective once the surface area got large enough.

“The problem with this strategy is that the larger the sheet of ice, the more force is required. We found that we were bumping up against the limits of low adhesion strength, and our coatings became ineffective once the surface area got large enough,” said Tuteja.

The new coatings solve the problem by introducing a second strategy: low interfacial toughness, or LIT. Surfaces with low interfacial toughness encourage cracks to form between ice and the surface. And unlike breaking an ice sheet using adhesive, which requires tearing the entire sheet free, a crack only breaks the surface free along its leading edge. Once that crack starts, it can quickly spread across the entire ice/surface interface, regardless of its applications size.

“I imagine pulling a rug across a floor,” said Michael Thouless, the Janine Johnson Warren Professor of Engineering and mechanical engineering. “If you tug on the rug, the harder it is to move. You are resisted by the force of the entire interface between the rug and floor. The frictional force is analogous to the interfacial strength. But now imagine there’s a wrinkle in that rug. It’s easy to keep pushing that wrinkle across the rug, regardless of how big the rug is. The resistance to propagating the wrinkle is analogous to the interfacial toughness that resists the propagation of a crack.”

Thouless explains that the concept of interfacial toughness is well known in the field of fracture mechanics, where it underpins the mechanics of products like laminated surfaces and adhesively-based aircraft parts. But until now, it hadn’t been applied in ice mitigation. The advance came when Thouless learned of Tuteja’s previous coatings work and saw an opportunity.

Traditionally, fracture mechanics researchers only care about interfacial toughness, and ice mitigation researchers often only care about interfacial strength,” Thouless said. “But both parameters are important for understanding adhesion.

“I pointed out to Anish that if he were to test increasing lengths of ice, he would feel the failure load would grow while interfacial strength was important, but then plateaus once toughness becomes important,” Thouless continued. “Anish and his students repeated these experiments and ended up with a really beautiful demonstration of the mechanics, and a new concept for ice adhesion.”

For decades, coating research has focused on lowering adhesion strength—the force per unit area required to tear a sheet of ice from a surface,” said Tuteja. “But both parameters are important for understanding adhesion.

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Michael Thouless
ME Professor

To test the idea, Tuteja’s team used a technique he honed during previous coating research, which breaks with the traditional materials science “mis-and-see” approach. By mapping out the fundamental properties of a wide library of substances and adding interfacial toughness as well as adhesion strength to the equation, they were able to mathematically predict the properties of a coating without the need to physically test each one. This enabled them to concoct a wide variety of combinations, each with a specifically tailored balance between interfacial toughness and adhesion strength.

They tested a variety of coatings on large surfaces—a rigid aluminum sheet approximately 3 feet square, and a flexible aluminum piece approximately 1 inch wide and 3 feet long, to mimic a power line. On every surface, ice fell off immediately due to its own weight. It stuck fast, however, to the control surfaces, which were identical in size—one was uncoated and another was coated with a traditional icephobic coating.

The team’s next step is to improve its durability of the LIT coatings. Tuteja explains that LIT coatings tend to be thin and hard, unlike the thick, rubbery coatings that are designed for low adhesion strength. Making the thin coatings durable can be a challenge, but Tuteja is confident that the team will be able to dial in the right mix of interfacial toughness, adhesion strength, and modulus for a variety of applications.

The paper is titled “Low Interfacial Toughness Materials for Effective Large-Scale De-Icing.” In addition to Tuteja and Thouless, the team included mechanical engineering graduate researcher Abhishek Dhayana and former U-M materials science and engineering graduate student Kevin Golovin. The research was funded by the Office of Naval Research, the Air Force Office of Scientific Research, the National Science Foundation, the Nanomanufacturing program (grant #1351412), and the U-M College of Engineering MTRAC Transportation program.

Michael Thouless
ME Professor

The advantage of designing coatings based on their fundamental mechanical properties is that you don’t end up with just one coating,” he said. “You get more of a recipe, and you can then adjust that recipe to create a variety of slightly different coatings for different applications.”

The team followed a “beautiful demonstration of mechanics,” Anish Tuteja, an associate professor in the U-M Department of Materials Science and Engineering, described how he and his colleagues turned to a property that isn’t well known in the field of fracture mechanics. “The larger the sheet of ice, the more force is required. We found that we were bumping up against the limits of low adhesion strength, and our coatings became ineffective once the surface area got large enough.”

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MECHANICAL ENGINEERING

TOWARD MOLECULAR COMPUTERS: FIRST MEASUREMENT OF SINGLE-MOLECULE HEAT TRANSFER

If Moore’s law’s endpoint is really computer components made from single molecules, we’re going to need to know how to cool them.

Heat transfer through a single molecule has been measured for the first time by an international team of researchers led by the University of Michigan. This could be a step toward molecular computing—building circuits up from molecules rather than carving them out of silicon as a way to max out Moore’s law and make the most powerful conventional computers possible.

Moore’s law began as an observation that the number of transistors in an integrated circuit doubles every two years, doubling the density of processing power. Molecular computing is widely believed to be Moore’s law’s end game, but many obstacles stand in the way, one of which is heat transfer.

“Heat is a problem in molecular computing because the electronic components are essentially strings of atoms bridging two electrodes. As the molecule gets hot, the atoms vibrate very rapidly, and the string can break,” said Edgar Meyhofer, a professor of mechanical engineering at the University of Michigan.

Until now, the transfer of heat along these molecules couldn’t be measured, let alone controlled. But Meyhofer and Pramod Reddy, also a professor of mechanical engineering at U-M, have led the first experiment observing the rate at which heat flows through a molecular chain. Their team included researchers from Japan, Germany, and South Korea.

“While electronic aspects of molecular computing have been studied for the past 15 or 20 years, heat flows have been impossible to study experimentally,” said Reddy. “The faster heat can dissipate from molecular junctions, the more reliable future molecular computing devices could be.”

Meyhofer and Reddy have been building the capability to do this experiment for nearly a decade. They developed a heat-measuring device, or calorimeter, that is almost totally isolated from the rest of the room, enabling it to have excellent thermal sensitivity. They heated the calorimeter to about 20 to 40 Celsius degrees above the room temperature.

The calorimeter was equipped with a gold electrode with a nanometer-sized tip, roughly a thousandth the thickness of a human hair. The U-M group and a team from Kyoto University, visiting Ann Arbor from Seoul, South Korea, prepared a room-temperature gold electrode, and the scientists between the calorimeter and the electrode held at room temperature.

They brought the two electrodes together until they just touched, which enabled some chains of carbon atoms to attach to the calorimeter’s electrode. With the electrodes in contact, heat flowed freely from the calorimeter, as did an electrical current. The researchers then slowly drew the electrodes apart, so that only the chains of carbon atoms connected them.

Over the course of the separation, these chains continued to rip or drop away, one after the other. The team used the amount of electrical current flowing across the electrodes to deduce how many molecules remained. Collaborators at the University of Konstanz in Germany and the Okinawa Institute of Science and Technology Graduate University in Japan had calculated the current expected when just one molecule remained—as well as the expected heat transfer across that molecule.

When a single molecule remained between the electrodes, the team held the electrodes at that separation until it broke away on its own. This caused a sudden, minuscule rise in the temperature of the calorimeter, and from that temperature increase, the team figured out how much heat had been flowing through the single-molecule carbon chain.

They conducted heat flow experiments with carbon chains between two and 10 atoms long, but the length of the chain did not seem to affect the rate at which heat moved through it. The heat transfer rate was about 20 picowatts (20 trillionths of a watt) per degree Celsius of difference through it. The expected heat transfer across that molecule was about two to ten times the length of the 10-atom chain tested in this study.

The team is now exploring how to investigate whether that is true.

Heat transfer through a single molecule has been measured for the first time by an international team of researchers led by the University of Michigan. This could be a step toward molecular computers.

This work is described in a paper in the journal Nature, titled, “Thermal conductance of single-molecule junctions.” This study was funded by the U.S. Office of Naval Research, Department of Energy, and National Science Foundation; the Korean National Research Foundation; and the German Research Foundation. The devices were made in the Luria Nanofabrication Facility at U-M.

“However, things are very different at the nanoscale,” Cui added. “One extreme case is molecular junctions, in which quantum effects dominate their transport properties. We found that the electrical conductance falls exponentially as the length increases, whereas the thermal conductance is more or less the same.”

Theoretical predictions suggest that heat’s ease of movement at the nanoscale holds up even as the molecular chains get much longer; 100 nanometers in length or more—roughly 100 times the length of the 10-atom chain tested in this study. The team is now exploring how to investigate whether that is true.

This work is described in a paper in the journal Nature, titled, “Thermal conductance of single-molecule junctions.”

MOLECULE HEAT TRANSFER

A device that enables measuring the heat flow through a single-molecule junction. The device consists of two electrodes, with a coating of molecules (chains of carbon atoms) bridging the room-temperature electrode and the heated, nanometer-scale tip of the heated electrode. CREDIT: Longji Cui, Nanomechanics and Nanoscale Transport Labs, Michigan Engineering

Meyhofer is also a professor of biomedical engineering. Reddy is also a professor of materials science and engineering. Cui will be an assistant professor of mechanical engineering and materials science and engineering at the University of Colorado, Boulder, starting in January 2020.

The illustration on the left shows the heat flow through a single-molecule junction. CREDIT: Longji Cui, Nanomechanics and Nanoscale Transport Labs, Michigan Engineering
MECHANICAL ENGINEERING

MECHANICAL ENGINEERING

ME POSITIONED TO LEAD SUSTAINABILITY EFFORTS

Mechanical engineers are perfectly positioned to lead efforts toward more sustainable energy, but they can’t do it alone. Margaret Wooldridge, Arthur F. Thurnau Professor of Mechanical Engineering, imparts this message to students in many ways, including through the Advanced Energy Solutions (ME 433) course she developed more than 12 years ago and in her leadership of the Dow Sustainability Fellows Program, which she has directed for the past two years.

“On the first day of class every semester, I tell students the foundation of the ME discipline is in moving energy around. When we look at sustainable energy solutions, this is us,” Wooldridge said. “It isn’t exactly a hard sell. A course on sustainable energy topics could only be successful because students are craving the information. They want to be part of a bigger solution and conversation about how we can move toward more sustainable energy generation and use,” said Wooldridge, who has been working on and teaching the physics of climate change in thermodynamics courses long before it moved into mainstream focus.

When Wooldridge first offered the Advanced Energy Solutions course in Fall 2007, about 25 students enrolled. Now two sections of Advanced Energy Solutions are offered every semester to full-classrooms. Six instructors teach over 200 students annually and although the course is an elective, nearly every graduating ME student has taken it.

Grassroots behavior change

Working in teams, students complete two main projects: a video about a high-impact but low- or no-cost behavior change to reduce energy demand and a more technical written report. Common videos projects over the years have included moving from disposable plastic water bottles to reusable containers and carpooling or biking to work. Other student teams have chosen the impact of reducing beef consumption, turning off the water when brushing teeth, and replacing incandescent and compact fluorescent bulbs with LEDs.

“Many of the videos are extraordinarily clever in how the teams present the problem and the behavior change, and many also make policy suggestions,” Wooldridge said.

The projects teach an important lesson — that while policy and technological solutions require interdisciplinarity and transformative technologies. All of these aspects are crucial to projects like these.”

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To ensure interdisciplinarity, project teams must include representatives from at least three U-M schools or colleges. Wooldridge’s team includes students and faculty from the College of Engineering, Michigan Ross and the School for Environment and Sustainability. College alumni, entrepreneurs, and faculty at the University of Science and Technology (KNUST) in Kumasi, Ghana, also participated.

There are so many decisions involved in selecting and optimizing sustainable technologies,” said Saitou. “As students learn math and engineering, they develop a systems view to know how to pose each decision-making problem. You also need to think big in order to affect the economic and environmental aspects. The changes need to make truckers respect the environment and train tomorrow’s technologies. All of these aspects are crucial to projects like these.”

In both her courses and the Dow Sustainability Fellows Program, Wooldridge is most pleased and impressed by the solutions teams develop and by "how they internalize opportunities and challenges. They come out with a real sense of personal ownership and leadership.” Many take jobs in the energy sector and other sustainability-related areas. In a recent impact assessment, fellows reported the program was their only opportunity to have this type of interdisciplinarity experience. Such experiences are “very influential,” Wooldridge said. About 85% of past fellows reported rise working in a sustainability-related career. “And that’s my goal,” she said, “to help them internalize the expectation to be an engineering professional as well as a global citizen.”

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MECH 423

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Laine Katherine Chan
Graduate of the Mechanical Engineering SUGS program, MSE ’19 BSE ’18

EXCELLENCE IN EDUCATION

Why do you think it is important to have a group like WoMEntoring for the women in ME?
Belonging to a community is so important for education. Having a group of people who automatically share and understand your experiences validates the feelings of female engineers. My first semester of college, I joined an a cappella group. I wasn’t exactly like the other women in the group and it led to feelings of isolation. My second semester, I joined Society of Women Engineers and became very active attending events most nights of the week. I became close to the newly elected executive board, 4 out of 5 of whom were rising seniors in mechanical engineering. This changed my entire college experience. I finally belonged and had women to look up to. I was fortunate to quickly find a group of mentors in my major, but not everyone is so lucky and the feelings of loneliness and isolation can continue.

What goals does WoMEntoring have for the ME community?
WoMEntoring hopes to foster an environment of inclusion and openness, while providing a space where women can acknowledge the hardships experienced daily. Being able to recognize and vocalize injustices is the first step toward change. My experience in DEI is very social justice-oriented and as a result I am quick to point out the flaws present throughout the entire engineering community that have developed from systemic oppression. Through the creation of WoMEntoring, the Mechanical Engineering department has signaled that they support women in STEM and will work to retain them in the field of mechanical engineering.

How did you become involved in WoMEntoring?
I first became involved with WoMEntoring by participating in a Women in Mechanical Engineering Focus Group in October 2018. For Winter 2019, I knew I would be taking one less class than my usual load and decided I wanted to do more to contribute to the efforts related to the focus group. In December, I approached Rachel [Casanova, Manager of Academic Programs] about creating a job so that I could help with WoMEntoring by planning events and being the department’s point person to the students on the committee. This became the Diversity, Equity and Inclusion (DEI) Intern position that I now hold.

Before working as the DEI Intern, I worked as the first solely dedicated Diversity Peer Educator (DPE) in the Martha Cook Building for University Housing for two years. In this position, I educated my residents on diversity, equity, inclusion, and social justice and advised the building’s multicultural council, which I advocated in my first year as the DPE to create. I became the Diversity, Equity and Inclusion (DEI) Intern position that I now hold.

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MECHANICAL ENGINEERING

King, Jr. Spirit Awards in 2018. Later in 2018, I was also one of the recipients of the Mechanical Engineering Department’s Charles Vest Award. Charles Vest was a well-known and an ME profes- sor at Michigan. Later in his career he became the president of MIT, where he worked to make the institution more accommodating for female employees.

In many ways, I feel very connected to Charles Vest. In the final sem- ester of my baccalaureate, I was one of the student facilitators for an introduction to social justice class that incoming residents advisors are required to take in order to work for University Housing. This opportunity gave me my first taste of life as an educator. That same semester, I offered a position to be a Graduate Student Instruc- tor for ENGR 101, the intro to computer science class. My biggest goal as a GSIT was to create a community for my students and teach them that classes are for more than learning: they are also a vehicle to create friendships that will carry you through college and beyond. While I was able to infuse social justice into my classroom, this was not the GEI work I was accustomed to. When I went to Rachel want- ing to do more for the Department, it was partially because my life doesn’t feel complete when I’m not involved in some type of social justice work. I’m so grateful and thankful the ME Department gave me the opportunity to explore that work.

What are your goals as a female studying mechanical engineering?

My overall goal as a female mechanical engineer is to pro- mote and support other women in mechanical engineering. I plan to mentor younger women at my company to champion their success while striving to make things better for women in STEM overall. I aim to have experienced a decent amount of marginalization in industry. At my second internship, I returned to the same group at the same company with the same manager. This manager made me get his laptop charger for him because he didn’t want to walk up the stairs despite having a brand-new male intern in the group and it being my second summer at another internship. I had my testing stopped and my manager needed to come and stand in the lab with me while I worked because other employees felt I looked young. But he had walked by without saying anything earlier when a male intern, who happened to be younger than myself, was in the lab with me. Currently, my career goal is to be the first Chief Diversity Divi- sion at the company I am going to work for full time. Many people believe that I can’t be able to achieve this, but I know that any work worth doing isn’t easy and I’m ready for the challenges! Having dedicated DEI positions shows an organization’s willingness to adapt with the times and allows them to strive to be a leader in their field in terms of change.

Does being a woman in engineering give you advantages to problem-solving?

I think being a woman in engi-

neering, and especially being a woman of color in engineering, makes me more empathetic. I know the stories when I see a machine shop or pick up a tool. I understand how someone could feel marginalized. This allows me to connect to people more easily, which gives me an advantage in industry. People are more willing to help me and take the time to get to know me. This means that any problem I can’t solve on my own, I have dozens of friends at a company who can help. But strictly speaking whether or not being a woman gives me advantages to problem-solving on my own, I think it does. I used to be afraid of a world that wasn’t created for me. When people think of someone with a master’s in mechanical engineering, they most likely don’t imagine me. So I’m accustomed to modifying my intended approach to achieve the desired result.

What is next for you and how did ME get you there?

My most recent adventure is working full time for Schlumberger, the oilfield service company. In late August, I will be leaving my job in Abu Dhabi, UAE. Then I will move to Ecuador for 16 months, where I will be the lead engi- neer on oil rigs in the Amazon rainforest. Following my 18 months abroad, I will move to Houston, Texas to work in the office where I hope to become a recruit- ment specialist. In addition, I hope to spearhead the sustainability and diversity initiatives at the company.

For my master’s and late in my career, I decided to try out an additional ME-specific orientation, beginning in Summer 2018. I have been involved with a variety of DEI projects including the planning and evaluating of programs for U-M LASA, the creation of a storytelling series, “Value the Voice,” for the University’s Department of Afroamerican and African Studies, and a role on the Michigan Men’s Steering Committee, to help build sustainable and diverse initiatives at the company.

Transfer Student Program

Transfer students are a growing percentage of our mechanical engineering student body, with a particular emphasis placed on coursework that aids students in transferring to the School of Engineering. We have seen students involved in the orientation forming something of a group in other languages, and will need to use MATLAB in their early ME courses.

These activities are intended to help incoming students form a cohort of people they know, and act as a lead-in to discussion of key topics from their earlier math and physics courses that they may want to review.
"The challenge to all of us should be how we clear those hurdles to make an impact on engineering, science, and society, not to worry if we belong."

The U-M ME Academic Services Office (ASO) has been selected as a team recipient of the 2018 Annual Distinguished Diversity Leaders Award (DDLA)!

In close partnership with the U-M Vice Provost for Equity & Inclusion and Chief Diversity Office and Associate Vice President for Human Resources, the Distinguished Diversity Leaders Award was established to spotlight and honor the staff members who work tirelessly toward achieving a welcoming and supportive campus environment with their dedication and contributions to diversity, equity, and inclusion. They will be honored at the COLA Ceremony on December 11th at the Michigan League.

Congratulations Rachel Casanova, Rachael Clarke, Adam Mael, Tim Moore, Kristel Oelke, Kathryn Orwig, Julie Tashjian, and Davon Wheeler.
In June of 2019, U-M ME participated in WISE (Women in Science and Engineering) GISE (Girls in Science and Engineering), a summer day camp for current 7th- and 8th-graders where real scientists engage students in dynamic, hands-on experiments to foster curiosity and build confidence in STEM (Science, Technology, Engineering, and Math). GISE is sponsored by the University of Michigan Women in Science and Engineering (WISE) Program in cooperation with the College of Literature, Science, and the Arts, The College of Engineering, and the U-M Medical School.

During the program campers learned from world-renowned women scientists and engineers and role model students who share their interest in science, math, and engineering. Focus projects are planned and taught by University of Michigan faculty, staff, and students. The camp’s counselors are undergraduate student leaders in science and engineering robustly trained in safety and facilitation. ME faculty Ellen Arruda and Serife Tol participated.

Tol launched the Inspire-ME as part of the camp because she is passionate about developing a mechanical engineering module for the WISE GISE camp. Joined by her undergraduate student Michael Rose, she hosted approximately 40 7th- and 8th-grade female students on the U-M campus, teaching them vibration, acoustic, and wave propagation concepts through demonstrations and hands-on activities.

Arruda’s group worked with campers to perform experiments on various materials to estimate their stiffness. The girls measured how the distance between two lines drawn on the material changed as weights were added to the bottom clamp to stretch it. The girls learned about force, strain, and stiffness. They also worked on teaching the girls about friction by performing experiments to estimate the coefficient of friction between two polymer sheets by securing the bottom material to a ramp and measuring the minimum angle required to induce sliding of the top material.

To find out more about WISE GISE, please visit https://lsa.umich.edu/wise/k-12-students-families/summer-camps/girls-in-science-and-engineering.html.

U-M ME HELPS SPUR INTEREST IN STEM THROUGH WISE GISE CAMP

U-M ME’s ME450 capstone design project course is meant to challenge our future mechanical engineers. Required by all ME undergraduate students, the semester-long projects allow them the opportunity to apply almost everything they have learned from the first several years of school on an open-ended design problem. And these “real world” projects almost always include projects that aim to make a difference in the lives of others.

The photos featured here showcase a recent ME450 project worked on by U-M ME students.

The team, which was comprised of U-M ME students Fossa Amponsah, Alex Anderson, Sarah Fuhrman, Megan Lucas, Joseph Martinez, and Margaret Poppe, focused on making mobility device improvements to Braden Gandee’s power wheelchair. The improvements were aimed to allow Gandee, who was born with Cerebral Palsy to join in playing soccer with his friends. Two of the issues he was wrangling with were that his chair would run over the ball when he was playing, and that he couldn’t kick the ball while sitting.

The team was able to build out some solutions, try them out, and then make any necessary adjustments to Gandee’s chair while he tested it finished with a soccer ball at the University of Michigan’s Oosterbaan Field House.

ME450 projects are proposed from the different areas of study within mechanical engineering and reflect the expertise of instructing faculty. Each semester, several of the projects come from industry partners, as students really enjoy working on these “real-world” projects and sponsors like having access to bright, talented, enthusiastic students. Faculty-sponsored, Global Health, and student-initiated projects are also offered each semester.

Interested in sponsoring an ME450 project? Visit http://me450.engin.umich.edu/project-sponsorship-information.html for more information.
#GoingBeyondME

STUDENT BLOGS

U-M ME students do some pretty amazing things. Here are a few examples of the work they do both within ME and beyond, #GoingBeyondME.

Matt Pirone, ME Master’s Student

I am starting my second year as a dual master’s student in mechanical engineering and design science, intending to graduate in the Winter 2020 semester. I earned my bachelor’s degree in Biomedical Engineering at the University of Michigan in 2018 with a biochemical concentration, but in my final two years of undergrad I became particularly interested in the application of design in an engineering context through two important academic internship experiences. I was a participant for the Global Health Design Initiative (GHDI) and traveled to Ghana for two months to conduct clinical observations to inform my team’s design of a device for post-partum hemorrhage. I was also hired as a program assistant at the U-M Center for Socially Engaged Design (C-SED), where I helped develop training protocols and consulted on student-led design projects. For me, working with C-SED united academia, which focuses on theory, and the real world, which focuses on application. By the time I finished my undergraduate studies, I became interested in applying my growing knowledge of socially engaged design principles specific to the field of sustainable development.

To read Matt’s full blog piece, visit https://me.engin.umich.edu/news-events/news/going-beyond-stories-me-students-matt-pirone

Abby Chapin, ME Senior

¡Hola mis amigos! My name is Abby Chapin and I am going to be a fifth-year senior in ME here at U-M. This summer, four other U-M engineering honors students and I participated in a two-week volunteer abroad trip to Guatemala. All of us (Emrich Shan, CS; Utsav Lathia, CS; Marissa Martinelli, BME; Marina Engstrom, ME) were working together on coffee plantations learning about the process and taking a look into the daily lives of the farmers. We were partnered with De La Gente, (DLG), an organization that assists 5 co-ops of farmers from all over Guatemala to give them the support and sustainability education they need to keep their businesses running and lucrative. We worked with the farmers of the San Miguel Escobar co-op. DLG wants to show that the farmers’ work is just as valuable as anyone else’s, and wants the farmers to be able to do more than just survive. DLG knows they can’t change the system that has been in Guatemala for 500 years, but at least the farmers they support know that there are people willing to do something about it. Being a farmer is not synonymous with being poor. No one in the world would be able to live without farmers! Since there is still a large dependency on coffee, people still want to be coffee farmers, but with more fair opportunities. No one wants to necessarily move away from coffee farming, but they just want their hard work to be valued for what it is which would allow them to provide for their families. . .

To read Abby’s full blog piece, visit https://me.engin.umich.edu/news-events/news/going-beyond-me-abby-chapin
Mario Medina, ME PhD Student

My name is Mario Medina and I am a PhD candidate in the Mechanical Engineering Department. I currently work on understanding the physical mechanisms that govern spray behavior of fuel injectors as it pertains to atomization, under non-reactive and reactive conditions. I also look at a phenomenon known as injector tip wetting, which is responsible for high particulate emissions during certain engine operating conditions. I am in my 5th year of graduate school and I’m planning to present my dissertation by early-mid March 2020. During my time at the University of Michigan (U-M) I have been involved in many programs, organizations, workshops, and research projects. I want to share my experiences that have left a lasting impression during my time at U-M as a graduate mechanical engineering student. First, I will focus on my research experiences at three separate institutions: U-M, Robert Bosch LLC (Bosch), and the Universitat Politècnica de València (UPV). Second, I will go over my involvement with the Society of Hispanic Professional Engineers – Graduate Committee (SHPE-GC). . .

To read Mario’s full blog piece, visit:
https://me.engin.umich.edu/news-events/news/going-beyond-me-mario-medina
Distinguished Alumni Award Recipient

Marshall Jones (BSE ME ’65)

Mechanical Engineering alumnus Marshall Jones has been selected to receive the 2019 U-M ME Alumni Merit Award. Jones, a mechanical engineer at General Electric (GE), pioneered the use of lasers for industrial materials processing. He invented novel methods to weld dissimilar metals, and developed fiber optic systems making lasers more convenient for industrial applications. He is a member of the National Academy of Engineering and was inducted into the National Inventors Hall of Fame in 2017. He holds over 50 U.S. patents and 57 foreign patents.

IN HIS OWN WORDS

“Within ME, I truly loved design, as well as the mechanics and materials of all lab work. U-M ME’s design training laid the way for my first job in high energy physics at Brookhaven National Labs and that same training provided a great foundation for my grad studies at U-Mass, opening the door to my current career at GE Global Research in laser technology. It was this foundation that led to my election to the National Academy of Engineering and the National Inventors Hall of Fame. I do feel so very honored to have been selected to receive the 2019 ME Department Alumni Merit Award. I truly love the ME Department at the University of Michigan; Go Blue!”

DTE Endowed Professorship

In May of 2019 U-M ME Professor Volker Sick was installed as the DTE Energy Professor of Advanced Energy Research. The DTE Energy Professorship of Advanced Energy Research was established in September 2007 with a $2 million endowment commitment, funded with a $1.5 million grant from the DTE Energy Foundation and a $500K matching grant from then-U-M president Mary Sue Coleman.

Sick is the third faculty member to hold this title.

At U-M since finishing his PhD at Heidelberg University in Germany, Sick was promoted to full professor in 2005 and served as the Associaate Vice President for Research from 2012-2018. He currently leads the Global CO2 Initiative, a research effort focusing on “carbon-negative, dollar-positive” commercially sustainable approaches that have the potential to reduce global CO2 emissions.

Alex Gallimore, Dean of the College of Engineering, commented on the importance of the DTE relationship: “We value DTE’s longstanding support of the University. They have provided nearly $8 million in funding to the success of U-M students through competitions and support in the College of Engineering, Michigan Ross, University Musical Society, and Michigan Medicine to name a few. DTE’s comprehensive engineering recruiting reinforces the excellent relationship between our two organizations. Thank you, DTE, for your ongoing commitment to the University of Michigan.”

Heather Rivard, DTE Senior Vice President of Distribution Operations, said, “The DTE Energy Foundation is one of the largest foundations in the state of Michigan and proud to be working in collaboration with President Schlissel on carbon neutrality goals at the University.”

The essential funding provided by endowed professorships serves to attract, reward, and retain outstanding faculty, bringing prestige and recognition to the recipient and acknowledging their contributions to the University and their field.

The DTE Energy Professor of Advanced Energy Research is one of five corporate endowed chairs at U-M.
FACULTY & STUDENT AWARDS

EXTERNAL FACULTY AWARDS

Ellen Aruffo Society of Engineering, BSEE James R. Rice Medal, 2019
AMME Best Paper Award, 2018
Jesse Austin-Breenman ASME Ben C. Sparks Medal Award, 2019
SM Best Student Award, 2018
Andre Bothman AACC Control Engineering Practice Award, 2019
American Chemical Society Fellowship, 2019
Disa Broi SAE Fellowship, 2018
SOM Limits Achievement Award, 2018
Prasad Sengupta IEEE Fellow, 2018
Karl Grosh U.S. Association for Computational Mechanics Fellow, 2018
Fellow of The Combustion Institute, 2019
Yoram Koren Foreign Member of the Chinese Academy of Engineering, 2018
ASME Pi Tau Sigma Gold Medal Award, 2019
ASME Per Bruel Gold Medal for Noise Control and Acoustics, 2019
Karl Grosh U.S. Association for Computational Mechanics Fellow, 2019
ASME NADAI Medal, 2019
Society of Engineering (SES) James R. Rice Medal, 2018
Ellen Arruffo Society of Engineering, BSEE James R. Rice Medal, 2019
AMME Best Paper Award, 2018
Jesse Austin-Breenman ASME Ben C. Sparks Medal Award, 2019
SM Best Student Award, 2018
Andre Bothman AACC Control Engineering Practice Award, 2019
American Chemical Society Fellowship, 2019
Disa Broi SAE Fellowship, 2018
SOM Limits Achievement Award, 2018
Prasad Sengupta IEEE Fellow, 2018
Karl Grosh U.S. Association for Computational Mechanics Fellow, 2018
Fellow of The Combustion Institute, 2019
Yoram Koren Foreign Member of the Chinese Academy of Engineering, 2018
ASME Pi Tau Sigma Gold Medal Award, 2019
ASME Per Bruel Gold Medal for Noise Control and Acoustics, 2019
Karl Grosh U.S. Association for Computational Mechanics Fellow, 2019
ASME NADAI Medal, 2019
Society of Engineering (SES) James R. Rice Medal, 2018
Ellen Arruffo Society of Engineering, BSEE James R. Rice Medal, 2019
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ASME NADAI Medal, 2019
Society of Engineering (SES) James R. Rice Medal, 2018

INTERNAL FACULTY AWARDS

Miki Banu University of Michigan Office of Research Faculty Award, 2019
University of Michigan Research Faculty Award, 2019
ISTE Award, 2019
Kazuo Saito IEEE Fellow, 2018
Peter Sengupta IEEE Fellow, 2018
Miki Banu NSF CAREER Award, 2019
Nitin George NSF CAREER Award, 2018
Shanna Daly NSF CAREER Award, 2018
DARPA Young Faculty Award, 2018
Fellow of The Combustion Institute, 2019
Fellow of The Combustion Institute, 2019
NSF CAREER Award, 2018
NSF CAREER Award, 2019
NSF CAREER Award, 2019
NSF CAREER Award, 2019
Shanna Daly NSF CAREER Award, 2019
DARPA Young Faculty Award, 2018
NSF CAREER Award, 2018
Fellow of The Combustion Institute, 2019
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