10-2021

ME-EM 2020-21 Annual Report

Department of Mechanical Engineering-Engineering Mechanics, Michigan Technological University

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ME-EM

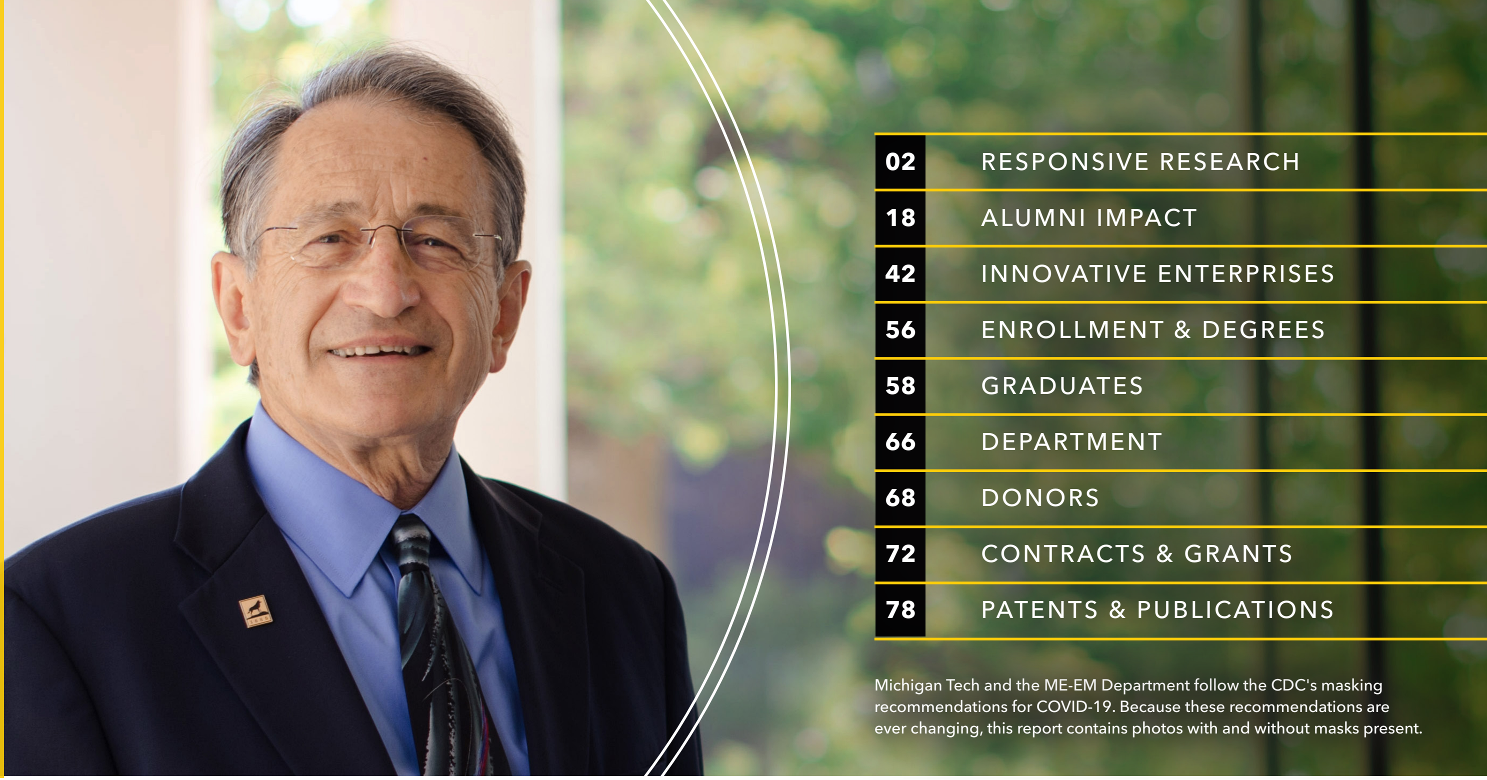
MECHANICAL ENGINEERING — ENGINEERING MECHANICS

LEGACIES OF EXCELLENCE

PAGES 2-55 →

Michigan Technological University
1885

[2020-21] ANNUAL REPORT



Michigan Tech and the ME-EM Department follow the CDC's masking recommendations for COVID-19. Because these recommendations are ever changing, this report contains photos with and without masks present.

DEAR ALUMNI & FRIENDS

As engineers, we constantly seek opportunities to improve the lives of others through the products we create and the research we pursue. In this annual report, we highlight the efforts of our faculty, staff, students, and alumni to increase product efficiency, reduce weight and energy consumption, and improve safety.

Both here on campus and beyond, as engineers and alumni, our students leave a legacy of excellence. I am proud to witness their commitment to serve and make a positive impact in the world.

Our faculty are likewise living out their commitment to student success by consistently updating the curriculum—weaving in big data, artificial intelligence, and industry 4.0 principles.

This year we report on the success of our Department's innovative research, and highlight the ability of our faculty to collaborate across departments and universities—continuing our collective goal of establishing national centers.

In 2021, we inducted the largest-ever class into our ME-EM Academy. These outstanding graduates are role models for our students by sharing their experiences in product design, their commitment to leadership development, and passion for civic responsibility. Here we feature several alumni, including our class of three Presidential Council of Alumnae (PCA) inductees.

Building on our previous successful curriculum revision, our faculty describe modules and course options, newly designed to prepare our graduates for the industrial revolution.

You'll also learn about Michigan Tech's new Metrology Center, which will bring in the latest measurement tools to increase student knowledge and hands-on measurement skills.

Last but not least, I am delighted to share with you our brand new, state-of-the-art 3D metal printer—made possible by generous donations from our supportive ME-EM alumni.

Our Department's success is made possible through the widespread engagement of our community, students, and our dedicated faculty and staff. And vital support comes both from the University and your own important contributions—our alumni, friends, and corporate sponsors.

I am forever grateful for the trust you have offered me, and for the contribution each of you has made toward our collective legacy of excellence.

William W. Predebon

William W. Predebon, PhD
J.S. Endowed Department Chair & ME-EM Professor
wwpredeb@mtu.edu

A LEGACY OF RESEARCH

The Department has continued to strengthen educational programs by attracting diverse faculty and staff with a broad spectrum of research capabilities. These faculty have pursued high-value contracts and grants pertaining to our research thrust areas and efforts to secure national research centers and institutes.

Dr. Sajjad Bigham is addressing the water security challenge through a portable desalination device with funding from the Department of Energy (DOE). Currently working on the prototype system in the lab with a solar collector, Bigham will compete among eight teams in 2022 (pg. 8).

With $2 million from the DOE, Dr. Darrell Robinette is optimizing vehicle cohort behavior and targeting a 10 percent energy savings through connectivity data and vehicle drive automation (pg. 14).

Having achieved a 20 percent energy savings in NEXTCAR I, researchers including Drs. Jeff Naber, Darrell Robinette, Bo Chen, and Jeremy Bos have been selected for NEXTCAR II.

Aligned with the Autonomous and Intelligent Systems initiative in Tech Forward, the group is enhancing several vehicles to achieve autonomy levels 4 and 5 (pg. 6).

Through funding from NASA, Dr. Paul van Susante has begun exploring environmental propellant captured on the moon and Mars to eliminate the need for payloads of liquid oxygen and hydrogen (pg. 10).

US-COMP analyzes surface behaviors of carbon nanotube-based composites for next-generation space travel. Members of the Institute are now in their final year of NASA funding (pg.12).

The processing of mixed plastic waste in recycling offers new promise as Dr. Ezra Bar-Ziv forges ahead through the WASTE Center with funding from the DOE (pg. 4).

The full scope of our research extends far beyond these initiatives, and our volume of research continues to advance thanks to our highly qualified graduate students, faculty, and staff.

NATIONAL SCIENCE FOUNDATION

16

16 in research expenditures among all mechanical engineering research in the US

US NEWS & WORLD REPORT: AMERICA'S BEST

34

Undergraduate Schools: 34 (top 10%) among all US doctoral-granting universities

US NEWS & WORLD REPORT: AMERICA'S BEST

63

Graduate Schools: 65 (top 35%) among all US doctoral-granting ME departments

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

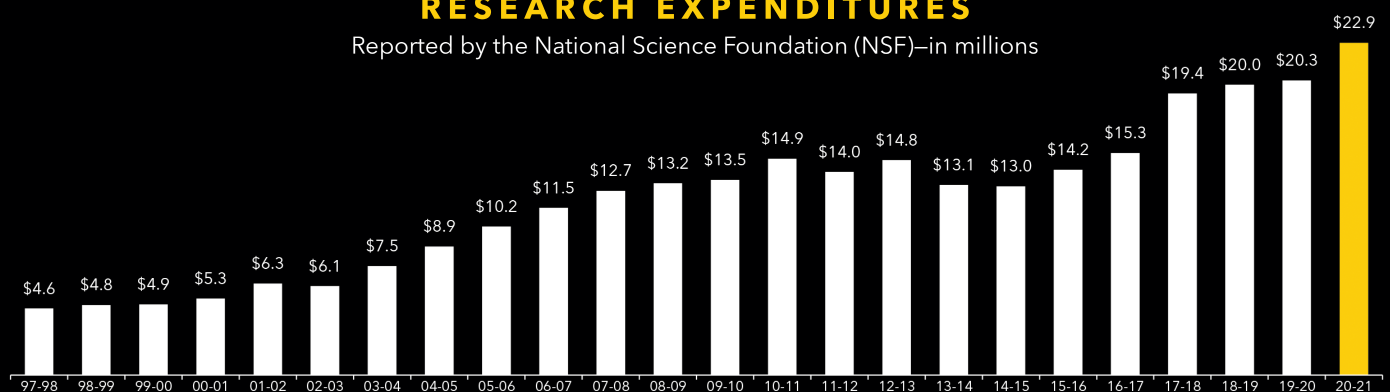
BSME: 8 in enrollment, 19 in degrees awarded

MSME: 5 in enrollment, 16 in degrees awarded

PhD: 26 in enrollment, 21 in degrees awarded

1997-2021 RESEARCH EXPENDITURES

Reported by the National Science Foundation (NSF)—in millions



Research expenditures are an estimate at publication time and are corrected in the next annual report.

RESPONSIVE RESEARCH

Faculty in the ME-EM Department remain dedicated to their craft. Consistently pushing the state-of-the-art, they ensure our students are prepared to innovate in any industry they pursue–from automotive to aerospace, waste and recycling to water systems.

16

THE ME-EM DEPARTMENT IS RANKED 16TH IN RESEARCH EXPENDITURES AMONG ALL MECHANICAL ENGINEERING RESEARCH IN THE US BY THE NATIONAL SCIENCE FOUNDATION (NSF)

RECYCLED OPPORTUNITIES

Three years ago, China put a ban on the import of wastes including paper and cardboard, pushing Congress, the National Science Foundation, and the Department of Energy to find a solution with a wide approach—beyond the technical—bringing in education, training, and resources. The disruption to industry created shockwaves for many. For Dr. Ezra Bar-Ziv and his students, it created another window of opportunity.

"We have been working with materials from municipal solid wastes, household trash, and industrial residues and exploring what we can do with it. How can we use it as a resource instead of as a menace to get something useful from the materials," says Bar-Ziv.

One of Bar-Ziv's major research objectives has been to separate the organic from the non-organic forms of waste. "We then use that organic waste to produce a solid fuel that is clean and economically competitive with any fuel on the market," he says. "Municipalities commonly pay a fee to do something with their waste, but with this solution, their wastes are removed, they get paid for it, and the resulting fuel is homogenous and 80 percent renewable."

Through their research, they have moved into the design stage, producing sufficient quantities to enable a customer to test it in a pilot facility. "We have modified our thermal processes and mechanical systems over the past two years, transitioning a horizontal extrusion into a more vertical 'L' shape for decreased footprint, providing flexibility and productivity," he explains.

Additional research is being conducted on the topic of recycling through a team involved in the catalysis process.

> *"We have two solutions we are exploring. With the first, instead of taking mixed plastic wastes and purifying them back to their original properties (which can be prohibitively expensive), we use the plastic waste in a different application. We take the mix of polymers and interlink them to make a new polymer to be used for something else."*
> *—Dr. Ezra Bar-Ziv*

The team, involving researchers from various institutes, including Dr. Armando McDonald from University of Idaho, Dr. Jordan Klinger from Idaho National Lab, Drs. George Huber and Victor Zavala from University of Wisconsin, and Dr. Karl Englund from Washington State University, have been able to form the resulting plastic material into a building stud for construction.

"For example, when you replace a wood stud with something less expensive, you have a good solution. It's a win-win," he says. "We have also started an industrial partnership to explore structural properties for components of interior household products that would utilize the recycled plastics, such as furniture."

Bar-Ziv's group is further hoping to turn to landscaping and external applications for expanded usability applications. He explains, "While we are in the early stages, we have secured a source for the mixed plastic waste and partners interested in using the output in their product. We are confident we will have something in less than a year."

In every application, Bar-Ziv keeps economic value at the core to ensure the result has a direct application in the market.

> *"We keep it connected to the economic drivers, starting with an economic assessment. If it makes 'cents + sense' and meets a market need, we go all the way—forming alliances with industry partners and other universities to help achieve our vision and realize the best results," says Bar-Ziv.*

After studying with Bar-Ziv, students can never see waste the same way again and many have found success in the industry. Dr. Stas Zinchik, a former PhD student of Bar-Ziv, founded a start-up company to commercialize the Michigan Tech waste technology. Dr. Zhuo Xu, another former PhD student, is continuing research on wastes in an academic environment, while Shreyas Kolapokar, a current PhD student, is continuing in industrial development.

His excitement on what can be made, how carbon can be kept out of the atmosphere, and where these materials can be marketed brings light to the dark world of waste.

To Bar-Ziv, there is no garbage—just raw material whose value is waiting to be unlocked through engineering. Paired with the keys of understanding, he transfers this enthusiasm to the next generation of engineers.

PARTNERS

- Idaho National Lab
- University of Idaho
- University of Wisconsin
- Washington State University

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DRIVING CHANGE

After accomplishing the mission of NEXTCAR I, Dr. Jeff Naber and his team are looking to continue shaping the future of connected and autonomous vehicles through participation in NEXTCAR II.

With funding from the Department of Energy's Advanced Research Projects-Energy (ARPA-E), the team will shift their focus from a 20 percent reduction in energy consumption in light-duty hybrid electric vehicles to a broader application of vehicles with level 4 and 5 of autonomy.

Before being awarded inclusion to NEXTCAR II, the team developed and demonstrated their energy reduction technologies on a fleet of eight Gen II Chevy Volts on a 24-mile test loop, showcasing their energy optimization, forecasting, and controls including vehicle-to-vehicle communications, location mapping, and thorough data management.

"We met our goals for energy reduction on the Chevy Volt, which set us up for NEXTCAR II now in partnership with GM on the Bolt electric vehicle (EV) and with Stellantis for an evaluation on the RAM 1500 and the Chrysler plug-in hybrid electric vehicle (PHEV) Pacifica," says Jeff Naber.

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- American Center for Mobility
- GM
- Stellantis

Naber and the team will seek to reduce energy consumption by 30 percent in the hybrid Chrysler Pacifica and further apply the savings to the RAM 1500 and the Chevy Bolt, while also considering level 4 and 5 autonomy to gain efficiencies.

"The impact of this program through our $4.5 million grant is greater because of the diversity in vehicle and propulsion systems technology that can be influenced by our developments," explains Naber.

The first challenge the group faces is developing three autonomous vehicles integrated with in-vehicle energy controls to meet their goals. "We have Drs. Jeremy Bos and Darrell Robinette on the team to leverage the work they have done in the SAE AutoDrive Challenge and are bringing in external suppliers to achieve level 4 autonomy functions," he adds. "With NEXTCAR I, we didn't have autonomy functions in the picture, so now we have the added instrumentation, intelligence, and all of the vehicle integration that comes along with autonomy."

A key component of NEXTCAR II is the conversion and deployment of the NEXTCAR I technologies in these three new vehicles, with further expansions enabled by the higher levels of vehicle automation and autonomy.

> *"At the end of the project, we will have all three vehicle systems operating as fully autonomous—with LIDAR, sensors, integrated controls, and actuation of steering, braking, and acceleration."*
> *—Dr. Jeff Naber*

The group will maintain vehicles in multiple locations, both on the Michigan Tech campus and for road testing at the American Center for Mobility (ACM). ACM is a partner in the project, along with Stellantis and GM. The team is lead by Naber, with Co-PIs Drs. Jeremy Bos, Darrell Robinette, Bo Chen, Grant Ovist, and Basha Dudekula along with several graduate students.

> *"We are excited about the opportunities NEXTCAR II brings us with the tighter vehicle integrations and front-end level 4 and 5 autonomy. We are getting to work on, implement, and test things that are beyond the current state-of-the-art," says Naber.*

"We will be conducting the baseline testing here and controls development in the labs at the APSRC and then we'll conduct closed track testing at ACM to implement our defined controls and autonomy specifications," replies Naber. "There are many teams working on autonomous vehicles, but with NEXTCAR we get the opportunity to combine that with energy reduction objectives."

The NEXTCAR team is delivering engineering solutions as they move from abstracted technology to direct implementation within the realities of on-road conditions.

> *"We are combining theory, simulation, and real-world implementation on three different vehicle platforms that will have a true impact on our roadways. We know the energy to run the computers and the sensors in today and tomorrow's vehicles will be a significant penalty especially for EVs. Everyone has different solutions, but we get to zero in on it further," Naber explains.*

The NEXTCAR II project is enhanced by the University's Tech Forward initiative in Autonomous and Intelligent Systems, led by Naber. Efforts over the last two years include developing the RAM and simultaneously a Great Lakes Research Center watercraft for the purposes of extending research and education in these areas across campus.

BRINE-ING AN IMPACT

"The final goal of our research is to positively impact peoples' lives. It's why we work on commercially-viable technologies and it's how our research could deliver a positive impact."

With such clarity of purpose, Dr. Sajjad Bigham expresses his mission—one that shapes his research around energy-related Grand Challenges and forms a foundation for learning how to lead beyond the classroom.

"No matter what research we are doing, I hope it positively impacts my students' emotional intelligence and personal growth. Students in my lab work incredibly hard under various expectations to overcome technical challenges, meet project timelines, and communicate effectively with our research partners," Bigham shares.

"They know they need to deliver challenging milestones, and in the process they learn very well how to manage stress when their progress is not smooth."

Bigham is focused on developing research that matters to society. He explores ways to build more efficient solutions surrounding clean energy technologies and greenhouse gas pollution reduction, while training next generation engineers to tackle hard problems.

In his most recent funded research venture, Bigham works on improving the solar desalination process through a project sponsored by the Solar Energy Technologies Office (SETO) of the US Department of Energy (DOE). The project is a part of "The American-Made Challenges: Solar Desalination Prize"—a four-stage competition designed to accelerate the development of low-cost desalination systems that use solar-thermal power to produce clean water from salt water.

His concept on a portable desalination device advanced from the first stage of competition with 160 teams into the Innovation Stage of 19 teams—winning $50,000. They have been further winnowed in the next phase down to eight teams, securing additional funding of $350,000 from the DOE.

"Water security is a challenge globally. If teams in the competition are successful, we could not only address some emerging water challenges here in the US, but also contribute to the global fresh water shortage in other countries," says Bigham. "Our concept for the portable device is particularly tuned to treat brines with high concentration levels. Currently, if brine concentrate exceeds a certain level in traditional membrane desalination processes, the membrane fails to operate."

"Right now we're working on a small prototype system in a lab environment," he adds. "We'll conduct testing with a solar collector and obtain field test data as we work toward the next phase of the competition."

Building energy efficiency is another focus of Bigham's research, where his team is entering the final year of a three-year, $920,000 grant from the DOE's Building Technology Office with Samsung Electronics America on next-generation gas-driven technologies.

Clothes dryers used in hospitals, hotels, and laundry rooms often run on natural gas and operate nearly 24 hours per day, meaning clothes dryers contribute to a large portion of their energy consumption. After presenting this problem to a DOE program manager, Bigham was tasked with finding a solution.

The funding is under the ARPA-E HITEMMP (High-Intensity Thermal Exchange through Materials and Manufacturing Processes) program seeking to develop new approaches and technologies for the design and manufacture of high temperature, high pressure, and highly compact heat exchangers and components. Bigham, in collaboration with his industrial partners and Oak Ridge National Laboratory, are using advanced ceramic-based 3D printing technology to develop next-generation light, low-cost, ultra-compact, high-temperature high-pressure (HTHP) heat exchangers. The exchangers will operate at temperatures above 1100°C (2012°F) and at pressures above 80 bar (1160 psi).

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Oak Ridge National Laboratory

SAMSUNG

"When using a gas clothes dryer, we burn natural gas to dry the clothes. Instead of simply burning the fuel to uplift the energy usage, we proposed drying with a thermodynamic cycle. The current rate for combined energy factor (CEF) of a gas clothes dryer is 3.3 pounds of dry clothes per kilowatt hour. We submitted an application with a rough calculation using the laws of thermodynamics, proposing to achieve a CEF of 5.7 pounds of dry clothes per kilowatt hour," he says.

> *"We partnered with Samsung and received DOE funding under the Buildings Energy Efficiency Frontiers & Innovation Technologies (BENEFIT) program. After two years of work, we were able to test with real clothes and exceeded a CEF of 6 pounds of dry clothes per kilowatt hour, demonstrating a substantial improvement in energy efficiency of existing gas clothes dryers on the market with the first-generation prototype."*
> *—Dr. Sajjad Bigham*

At the energy production level, Bigham continues to introduce novel energy technologies through a $2.4 million grant from the DOE's Advanced Research Project Agency-Energy (ARPA-E) for supercritical carbon dioxide power plants.

"We have two years remaining on this project exploring the use of ceramic additive manufacturing to 3D print monolithic sintered silicon carbide (SSiC) heat exchangers, which are required for managing target HTHP working environments," notes Bigham. "Our team is working through technical challenges—making various versions of heat exchangers, running tests, and continually improving our methods."

While Bigham's impact on the life of his students is immeasurable, his work in energy efficiency is moving technologies steadily toward the broad horizon of the market, where he expects them to pass the rigorous tests of feasibility and deliver the promise of a better tomorrow.

ROCKY ROAD TO SPACE FUEL

Helping NASA achieve their mission of returning humans to the moon not only inspires Dr. Paul van Susante, it has become the central focus of his research.

"We first explore the problems NASA is facing and then develop a customer-centric approach, understanding the gaps, and ultimately solving the problem. While you need ideas to begin, successful research is about understanding what the customer wants and the best way to find a resolution," explains van Susante.

Over the course of the last four years, his research team has received several funded research projects. Some focused on exploring and developing mining. Others on producing alternative fuels and oxidizers for manned missions to the moon or Mars using natively found resources to produce propellants for the return trip to Earth. While exploring options to eliminate weight on space missions (for increased carrying capacity of useful payload) van Susante's team are creating feasible methods for extracting water from rock and ice deposits.

WATER FROM ROCK

Van Susante's team has big plans for the gypsum found on Mars: it contains up to 20 percent water, and they intend to extract it. With an end date of January 2022, the group is in the final stages of testing their waterjet-based process to fracture the gypsum into a slurry, which they can ingest and process. Testing in their vacuum chamber, van Susante's team has created a slurry suction component to lift the water and gypsum from a simulated moon/mars surface.

With a technology readiness level 4 (on a scale of 1-9), the system will collect and process the rock particles with a dome over the waterjet to contain the spray and capture spray particles.

"We are still working on a full system design, but we have done a sealing test in the vacuum chamber and it has worked well using splash shields inside the dome, which prevent evaporation and create a successful water capture sequence with triple the volume, compared to not having a splash shield present," says van Susante.

As they work through the system design, they are carefully considering dome size. "With a bigger dome, the pressure integrates over the dome surface area requiring greater push down force with the waterjet, but with smaller domes you need to move more," he notes. "This is something we are focused on in the final six months of the project, especially when considering the depth to excavate, which we've limited to one meter maximum."

WATER FROM ICE

Another challenge his team is tasked with is extracting water from buried glaciers on Mars through a partnership with Honeybee Robotics. "We've been using our vacuum chamber to test the process of melting through the ice, melting the cavern, and pumping to where it is needed," explains van Susante.

Analyzing optimal probe materials and geometries, the group is in the data collection and experimentation phase to determine the best methodology. Van Susante notes, "There are a lot of factors that come into play when comparing: where can we land safely with astronauts and where can we land for scientific benefits? Where is there a buried glacier nearby, what form is the ice in, and how deep is it buried?"

Van Susante and his team are tackling another challenge to find and analyze lunar ice on the surface of the moon. "We are developing a percussive cone penetrometer—a rod you hammer into the ground that determines the geotechnical properties and compactness," he says.

> *"With the cone penetrometer, we have been funded with $2 million. The project involves stopping every 10 cm to heat the cone to detect and quantify volatiles—water in the form of ice, also methane, mercury, and others—creating a thermal profile of the lunar subsurface."*
> *—Dr. Paul van Susante*

Because volatiles all change phase at different temperatures, van Susante and his research team can identify the specific compounds and the length of time each sample remained at temperature, which ultimately determines the quantity of volatiles present. The cone geometry provides the geotechnical properties from a mining perspective. The heated cone penetrometer will be combined with ground-penetrating radar to detect what happens between the cone penetrometer holes—creating a map of what is present on the lunar surface to a depth of one meter.

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HONEYBEE ROBOTICS

HuskyWorks—van Susante's Planetary Surface Technology Development Lab—paired with his client-centric approach, allows his team to quickly ideate, test, and prototype technologies: yielding increased opportunities for space exploration.

> *"Our iterative approach enables us to build something and quickly see what fails, how to improve it, optimize it, and perfect it," shares van Susante.*

CHALLENGING STRUCTURE

Leading the charge in developing a new lighter, stronger, tougher polymer composite for human deep-space exploration, the Ultra-Strong Composites by Computational Design (US-COMP) Institute under the direction of Dr. Greg Odegard has pivoted with agility during their final year of a five-year project.

"When we began developing these ultra-strong composites, we weren't sure of the best starting fibers and polymers, but over time we started to realize certain nanotubes and resins consistently outperformed others. Through this period of development, we realized what our critical path to maximize performance would be, and decided to focus only on that, rather than explore the full range of possibilities," explains Odegard.

For the past 21 years, scientists around the world have invested time, money, and effort to understand carbon nanotubes. But the islands of knowledge remain isolated in a vast sea of unknown behavior.

"When we started the project, we were confident we were going put effort into getting the polymers to work well. The last thing we expected was the need to focus so much on the carbon nanotubes; but we'll also put effort in how to make the nanotube material stronger using modeling and experimental methods," Odegard notes.

The NASA-funded research project brings together academia and industry partners with a range of expertise in molecular modeling, manufacturing, material synthesis, and testing.

"Our partners at Florida State are manufacturing the panels that we make from the carbon nanotube materials and the polymers and then they are shipped to the University of Utah for testing. During the testing, the panels are cut up and analyzed, then the results are shared back with the full institute."

The challenge when working with carbon nanotubes is their structure. "Under the most powerful optical microscope you see a certain structure, but when you look under an SEM microscope you see a completely different structure. In order to understand how to build the best composite panel, we have to understand everything at each length scale," Odegard explains.

The US-COMP Institute has created dedicated experiments and computational models for the chosen carbon nanotube material structure at each length scale.

"We can all see the different parts in our sub-groups and then we communicate that to the rest of the team, building a more complete picture from the little pictures at the individual scales," he says.

LEARN MORE: US-COMP.COM

> *"We found the hierarchical modeling approach is hard to make work. What works best is a concurrent approach. We each answer questions at our own length scales, feed our findings to manufacturing, and then see how they in turn tweak the processing parameters. We've achieved a remarkable workflow and a new model for collaboration."*
> *—Dr. Greg Odegard*

Achieving their year four goal to understand the internal structure of the carbon nanotube materials, the institute has shifted focus to surface behaviors. As part of the project, they are tasked with bringing the carbon nanotube material together with the final selected polymer.

"We are looking at the surface treatment of the carbon nanotubes and how to get it to best work with the polymer of choice," remarks Odegard. "We are excited to expand our scope of machine learning methods to better understand the material, accelerating our understanding of how processing parameters impact the structure and how that ultimately impacts the bulk material properties."

While machine learning has been part of the project scope from the beginning, the computational team is using their collected data to build a series of training sets. "The training sets will allow us to perfect our algorithms, learn from them, and hopefully influence product performance—potentially illuminating patterns we didn't even see," he explains.

As the project draws to a close this year, the team continues to analyze their objectives set by NASA, which focus on producing a material that offers triple the strength and stiffness of the current state-of-the-art.

As Odegard puts it, "The objectives set on this project are difficult to achieve. We knew that when we started. Regardless of whether we meet the numbers, as a group we have been able to push the envelope way beyond where we started in 2017—expanding the performance in a very short time period. This was made possible through remarkable collaboration across the institute."

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NASA

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- University of Utah
- Virginia Commonwealth University
- Nanocomp Technologies
- Solvay
- US Air Force Research Lab

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OPTIMIZED INTERACTIONS

Building on the success of previous research and with $2 million in funding from the Department of Energy, Dr. Darrell Robinette is seeking to achieve an additional 10 percent energy savings by optimizing vehicle cohort behavior.

This work comes as a result of the Michigan Tech NEXTCAR team's development and successful achievement of a 20 percent energy savings on a passenger vehicle that was already superbly engineered by the OEM.

Through the project, the group is exploring the synergy between vehicle connectivity data and vehicle drive automation to achieve this new stretch goal.

"In the project, there is a simulation component, where we will develop algorithms for a benchtop simulation. We are working with AVL Powertrain to create a centralized optimization approach where all the data from the vehicle goes to a cloud computer, acting as a broker, to analyze the situation and determine what the best course of actions are for total group energy consumption," says Robinette.

As part of the effort, AVL Powertrain will create a "system of systems" simulation and ultimately a hardware-in-the-loop set-up that will allow the vehicles to send their data, including GPS, as well as vehicle speed, torque, and spacing to the brokering agent.

The computing takes place real-time in the model environment and communicates to each vehicle what it should do for the next few seconds—giving the whole cohort a coordinated behavior.

In optimizing the energy consumption of multiple vehicles, a detailed list of characteristics is required, which is where BorgWarner comes in with their powertrain configuration models for battery electric vehicles, plug-in hybrid electric vehicles, and internal combustion engines, while Navistar is providing models for heavy-duty trucks and a vehicle to conduct the testing.

"We realize we have to expand the data sharing capabilities to make better, more contextually-relevant decisions. Vehicle models will be key to demonstrating a more comprehensive ecosystem."
—Dr. Darrell Robinette

"The system of systems will tell us how to best operate the vehicle cohort to minimize energy consumption and achieve the maximum benefit, while building on our understanding of how an individual vehicle will consume energy at different loads, including starting and stopping," notes Robinette.

Optimization has been achieved at the powertrain level for an individual vehicle, but now Robinette and his team will expand that for real-time optimization of a group on a 10 to 15 second drive horizon. "We will be factoring in vehicle-to-infrastructure and vehicle-to-vehicle information in our virtual benchtop to understand how the vehicles can support one another," he states.

The communication will take place through a cellular vehicle-to-everything (CV2x) network built by Michigan Tech with help from Traffic Technology Services (TTS). The firm is providing cellular connection to traffic lights around southeast Michigan to optimize traffic throughput in infrastructure.

"We have an aggressive timeline to finish by December 2022, but we know there are inefficiencies, especially when it comes to stopping, reaccelerating, and platoon formulation. If we can prevent a vehicle from going all the way to zero as we approach the lights, smoothing out transients, and rapid accelerations, there are many opportunities to reduce consumption," notes Robinette.

The group is targeting 10 to 50 percent energy savings across a group of vehicles, depending on length of infrastructure considered.

To align with the future of the automotive industry, the group is focused on improving integration of connectivity with autonomous driving. Testing will be run at the American Center for Mobility (ACM) utilizing autonomous driving when possible and feasible, and human-in-the-loop driving with an indicator to conduct the maneuvers.

PARTNERS

- American Center for Mobility (ACM)
- AVL Powertrain
- BorgWarner
- Navistar
- Traffic Technology Services (TTS)

Tests will be run using several light-duty vehicles, small cars, a minivan, a full-size truck, and a Class 8 heavy-duty truck. "We know human drivers don't typically like to follow heavy-duty trucks, but the optimizer would tell us that having a big vehicle in front and the smaller vehicles in the back greatly reduces cohort energy consumption," explains Robinette.

Having already completed an initial simulation with the system of systems environment, the group is collecting preliminary results for correlation and developing a design of experiments to identify edge cases for energy savings opportunities. Many of the vehicles being utilized for testing are either on the Michigan Tech campus or at ACM for other research projects and have successfully demonstrated a stable cellular connection.

The graduate students and industry partners supporting this research are creating the fourth industrial revolution.

"We are creating analytical tools that pair detailed vehicle powertrain models with AI optimization under various traffic scenarios. It is amazing to be a part of the synergy of connectivity and automated driving," Robinette shares.

PRINTING INTO THE FUTURE

"Productive on day one," is how industry describes our graduates. This characteristic is derived from years of hands-on experience designing with advanced software and prototyping with contemporary hardware.

In keeping with this core brand, a high resolution, state-of-the-art, 3D metal printer is now online through the ME-EM Department, thanks to donations from several distinguished ME-EM alumni and support from Scarlett, Inc.

These alumni have committed nearly $1 million to support this initiative and the Department's efforts to continually adapt. The first funding source came in the form of a significant discount on the 3D Systems printer from Scarlett, Inc. through alumnus Jim Scarlett. An anonymous ME-EM alumnus donated a large portion of the funding for the base cost of the printer while Department Chair Bill Predebon coordinated donations from the ME-EM alumni network.

"No other university in the country has a 3D metal printer with the resolution that ours offers or that prints with as many metals as the one on our campus does. We are trailblazers and will be ahead of the curve for a while thanks to these donations."
—Dr. Bill Predebon, ME-EM Dept. Chair

The 3D metal printer boasts 5 micron accuracy layer by layer, with an 11-inch wide, 11-inch deep, and 16-inch tall working volume. "It's one of the most accurate 3D metal printers on the market. With a billet of nearly 1 cubic foot, you can make a full size or scaled down version of just about anything," notes Predebon.

The printer is being housed in a shared facility within the Department of Materials Science and Engineering (MSE) and will be available for faculty and graduate students for research projects, as well as for undergraduate Senior Design Capstone and Enterprise projects.

Using a process called direct metal printing, the printer lays down fine metal powders and then fuses them with a laser to print each layer of the metal part. "It is additive manufacturing, where you are adding materials—bit by bit," explains Predebon. "It's comparable to what students will see in industry, so they will have a chance to not only see it but utilize it—producing parts similar to what industry is doing."

Organic and internally-complex shapes are possible with additive manufacturing, and the future of 3D printing lies in powdered bed fusion.

"With this technology, you can make very complicated, small parts with thin walls that tolerate high stress. From biomedical to aerospace applications, the sky is the limit."
—Russ Stein, MSE Research Engineer

These fish were printed during the training process to demonstrate the level of accuracy and intricacies made possible by the 3D metal printer.

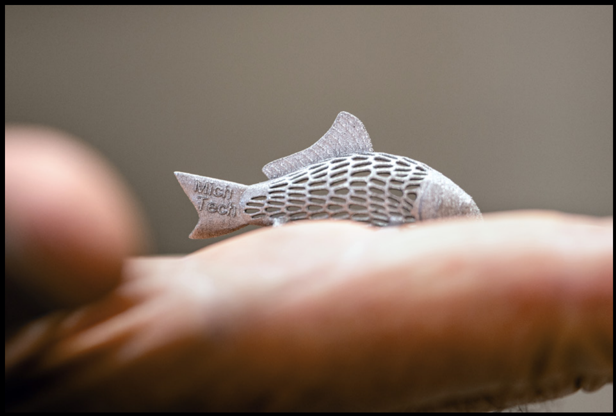
Sriram Malladi, Assistant Professor in the ME-EM Department, is looking forward to using the printer to test structures with advanced dynamics properties. "If you are in an automobile or plane, the engine creates excessive noise and vibration, which we don't want to reach the passengers."

He has conducted research to help isolate the vibrations using a rubber damping material that can be sprayed on a vehicle to isolate the vibration, but this adds significant mass. With the new 3D metal printing technology, Malladi hopes to design the structure itself to isolate the energy.

"We will design it to isolate the engine's cruising frequencies, and then print an array of connected elements with the 3D metal printer so the resulting structure is flexible like the acoustic foam, but has a sturdy structure," he shares.

> *"This new equipment gives us opportunities to optimize a complex element design. We can develop and test iteratively without requiring full-on machining and assembly."*
> *—Dr. Sriram Malladi*

One challenge of the printer is maintaining and stocking the metal powders required for printing. "We will start with stainless steel, titanium, aluminum, maraging steel, and Inconel alloys, and hope to add more. Just the initial powder purchase will be close to $100,000. We hope to find a sponsor to ensure we have the powders on hand for our researchers and students to effectively utilize the system," remarks Stein.

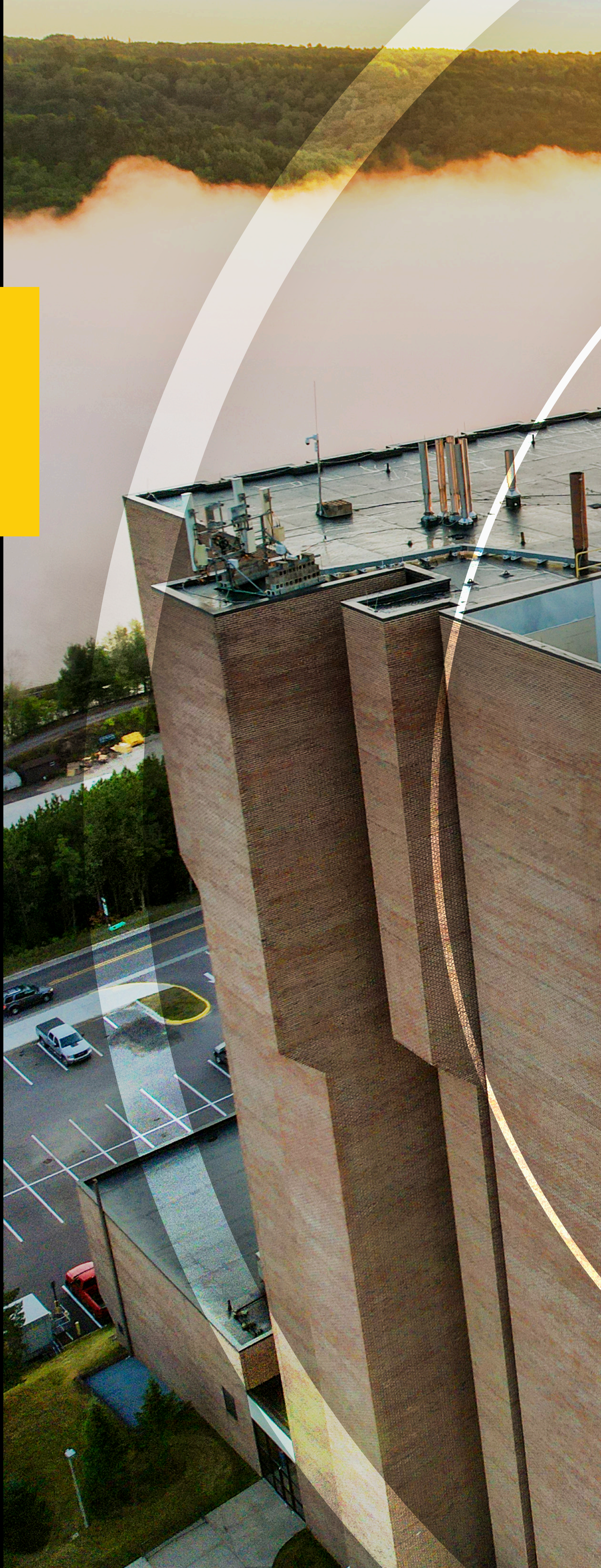


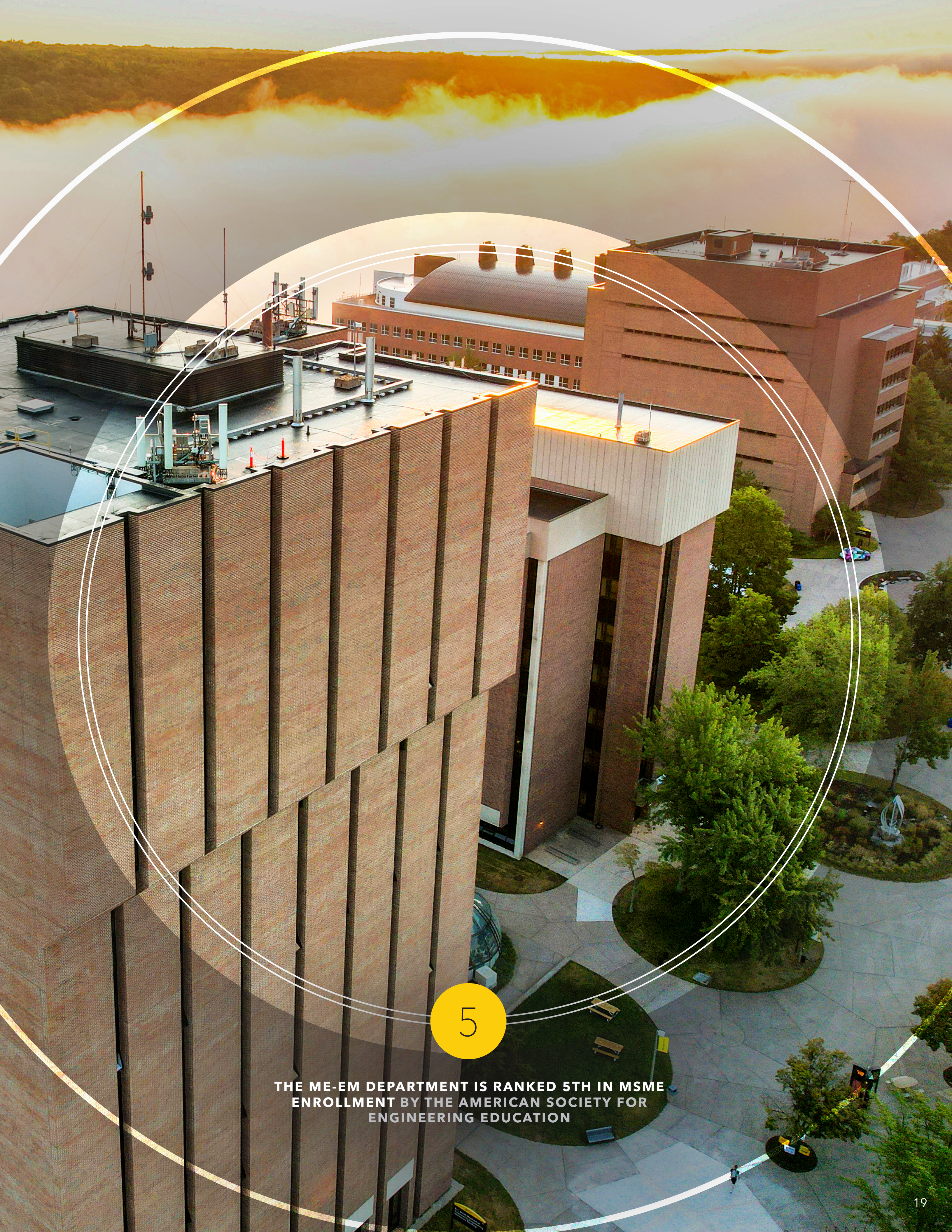
Researchers focused on material development can also take advantage of the printer. "We are able to produce our own metal powders for the system. This means we can use the printer to deposit experimental metal compositions and test unique metal alloys customized to the 3D printing process," notes Predebon.

Thanks to the generous alumni network within the Department, our students and faculty can remain at the forefront, working with industry-leading technology to develop complex metal parts—ensuring our graduates will be ready to prototype on day one.

ALUMNI IMPACT

Our alumni are committed to improving the lives of those they lead, the safety of those they serve, the efficiency of the market, and the growth opportunities of the next generation. This year's Academy and PCA inductees are modeling the future.




5
THE ME-EM DEPARTMENT IS RANKED 5TH IN MSME ENROLLMENT BY THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

2020 - 2021

ME-EM ACADEMY

The purpose of the Academy is to honor outstanding graduates of the Michigan Technological University Department of Mechanical Engineering - Engineering Mechanics. Selection into the Academy recognizes excellence and leadership in engineering and civic affairs.

This induction honors some of the most successful of the more than 13,000 alumni of Michigan Tech's ME-EM Department.

Portraits and a brief biography of Academy members are prominently displayed in the ME-EM lobby to serve as inspirational role models for future mechanical engineering and engineering mechanics students.

ME-EM ACADEMY INDUCTEE

BRETT CHOUINARD

"I discovered my love for simulation at Michigan Tech. It began in the computer lab we called the 'Fishbowl' with a finite element course that was cutting edge—an emerging concept in industry at the time," says Brett Chouinard. This course would influence not only Chouinard's career, but the entire simulation industry.

While he started at General Electric Aircraft Engines, he quickly realized he wanted to advance simulation technologies, using a solutions-focused approach to resolve engineering problems. The "how" for Chouinard was equally as interesting as the "why," coupled with a singular focus on reaching the solution.

He transitioned into a role at Altair on-site at Ford simulating automotive suspensions. This practical application let him view the tools from a user perspective, and this would prove a critical lesson before moving another step toward the heart of simulation, working inside Altair.

"I was able to bring a new perspective to my role at Altair because I focus on the destination, rather than the road. Our work doesn't need to be the perfect answer, it needs to achieve the goal," shares Chouinard.

Always aware that some people in business are unable to see beyond the problem horizon to an obscure solution, he has found Altair's toolbox often has what is needed to find an answer, and then to communicate the results. "Sometimes you get there elegantly, other times you have to dig. Even with a messy solution, you can take what you learned and create an elegant solution later."

> *"When working in business development, I help customers solve the problems they are experiencing in industry—principles I learned at Michigan Tech."*
> *—Brett Chouinard*

This philosophy is being taught through the Mechanical Engineering Practice courses that Chouinard helped guide through his role in the External Advisory Board.

"Michigan Tech is continuing to expand on the hands-on practical approach to engineering by incorporating simulation and prototyping into the curriculum," says Chouinard. "It all comes back to giving students the practical experience of solving the problems and not just having them experiment with the software." He sees that coming into full development with the addition of courses in machine learning and artificial intelligence. "You can learn a lot through prototyping, but with simulation you can build faster and fail faster," he explains.

Humbled to receive the award, he values the teamwork elements promoted in the Department. "I haven't been promoted because I have the answers, quite the contrary, in fact. It's about being willing to listen and integrate others' ideas into a practical solution," notes Chouinard.

ALTAIR

Currently serving as President and Chief Operating Officer, Chouinard has been with Altair since 1994.

2 + 2

BRETT CHOUINARD CAME TO MICHIGAN TECH AS A TRANSFER STUDENT FROM NORTHWESTERN COMMUNITY COLLEGE, LEADING TO A PARTNERSHIP BETWEEN THE INSTITUTIONS

ME-EM ACADEMY INDUCTEE

MARGARET COBB

"Engineering is about never giving up," says Margaret Cobb. "There are many pathways to a solution and being willing to explore an alternate path is the beauty of the creative journey."

Cobb's affinity for math, encouraged by her second grade math teacher, ultimately led her to pursue a degree at Michigan Tech.

Graduating and entering the workforce as a female engineer in the 1980s was a challenge, but Cobb's tenacity helped her tolerate the tension and bias, while building consensus around solutions.

She made many advances working in computer systems, energy management, and utilities before transitioning to Microsoft—leading teams on Windows and Xbox launches.

"Every time you get into a tough situation, you're building on previous experiences and learning new skills. In challenging times, we need to remember the adversities we've already persevered through and how we can apply that to new situations," says Cobb.

After 17 years in various training, sales, and marketing positions at Microsoft, she stepped up for a new challenge back in product engineering as the General Manager of Technical Sales for Lenovo.

"It was a testament to Tech to see how easily my engineering background came back and served me in the role. Honing those skills throughout my career made the transition back to engineering painless," she notes.

She advanced quickly due to her ability to break a problem down. This approach has helped in all aspects of her career and in her work in public service. Hoping to encourage and train others in the field of science, technology, engineering, art, and mathematics, Cobb and her husband started a private, self-funded foundation encouraging low-income students to explore extracurricular activities not funded by public schools.

"We want to create excitement for girls around the sciences through opportunities in coding, mechanics, and robotics classes, along with athletics and cultural courses," shares Cobb. "There aren't enough people telling girls that they can do this work. We can make math more approachable if we talk about solving puzzles instead of math equations. Puzzles can be defined in many relatable ways—solving mysteries or doing jigsaw or word puzzles. Math, mechanics, and all things engineering become more palatable once girls have the confidence to problem-solve."

> *"If you enjoy solving puzzles, you can be a good engineer because it is about putting pieces together to create a solution. When I say this to girls, I can see faces light up."*
> *—Margaret Cobb*

Microsoft

Margaret Cobb worked for Microsoft in various capacities from 1991 to 2020 and recently started the Cobb Foundation, Northwest to provide extracurricular opportunities to low-income students.

380 INCHES OF SNOW HER FIRST YEAR AT MICHIGAN TECH IN 1978

- One of 14 children in her family, Cobb received a Michigan Tech Board of Control Scholarship that funded her education
- She started studying chemical engineering, but switched to mechanical engineering for greater flexibility—opportunities in thermodynamics, robotics, materials, structures, bioengineering

ME-EM ACADEMY INDUCTEE

JUAN DALLA RIZZA

Engineering was the natural career choice for Juan Dalla Rizza who as a youth enjoyed working with his hands and possessed an inquisitive mind that enjoyed challenging traditional concepts.

"The decisive moment came to me in high school. I worked on a project for an engineering company to retrofit C-47 aircraft with supports for machine guns during the Vietnam War. It was fascinating to listen to an older engineer talk about forces on the supports we were designing and how to test them to ensure it would stand up to the pressure. From the moment we finished that conversation, I knew I would pursue engineering," says Dalla Rizza.

After initially focusing on design engineering, Dalla Rizza looked to the construction industry, where he found passion by combining his mechanical know-how with electrical systems. He started his own business, Dalla Rizza & Associates Consulting Engineers, Inc. "We design mechanical and electrical systems for commercial buildings, including offices, industrial warehouses, and restaurants, which are structured to their specific application," he explains.

Specializing in one-of-a-kind building designs, his team of engineers work on close to 150 projects a year, including interior fit-ups, fire protection, plumbing, power, and lighting. "We design one-of-a-kind buildings and are the caretakers for many other hundred-year-old structures," notes Dalla Rizza.

Although his work primarily focuses on the mechanical and electrical systems, Dalla Rizza applies the concepts learned at Michigan Tech on a regular basis.

> *"We were taught to formulate a design and carry it through. You need discipline to focus and complete the task, while being a strategic thinker to ensure your design accounts for the various principles at play."*
> *—Juan Dalla Rizza*

His success is built on a foundation of education and adapted through experience. "We use technology available in the marketplace to fit into the design we use. We innovate through design and integrate those elements to build a new composition," says Dalla Rizza.

Dalla Rizza has taken his experience and ability to 'listen to the buildings' to create a thriving business. "Buildings have a tendency to talk. If you are willing to listen, they will tell you what is and isn't working."

"A design works, or it doesn't. Once you have the technical knowledge, you can ascertain what needs to be modified, updated, or improved. The key to success is listening," Dalla Rizza remarks.

DALLA-RIZZA & ASSOCIATES
consulting engineers, inc.

Juan Dalla Rizza started his business in 1982, focusing on mechanical and electrical systems for the construction of commercial and tenant building improvements for large office complexes in Florida.

1.5M+

DALLA RIZZA'S COMPANY WORKS ON ~1.5-2 MILLION SQUARE FEET PER YEAR OF OFFICE SPACE RENOVATIONS OR NEW CONSTRUCTION

ME-EM ACADEMY INDUCTEE

KIMBERLY FOSTER

Kimberly Foster has her eyes set on the chance to change engineering at an institutional level. "Engineering is about so much more than numbers. It's about creativity, problem-solving, and the ability to make the world a better place," she says. "We need to do a better job with public relations for the engineering career path to show its truth breadth."

One change she would like to bring about as Dean of the School of Science & Engineering at Tulane is to build a set of exploratory courses that any student can take to introduce concepts of engineering.

> *"Some students don't see how engineering relates to their sought-after career and others get lost in the basic courses in the first few years and don't reach the engaging engineering courses. We can do better to show the next generation there is room in engineering for all types of people."*
> *—Kimberly Foster*

Through an engineering education, students acquire a varied skill set that can be applied to numerous areas. "We have found the finance industry hires engineers because of their technical background and ability to problem-solve. The technical education is useful and offers many ways to contribute in biotechnology, product design, automotive, and thermodynamics," explains Foster.

The problem-solving abilities of engineers can be utilized in innovative spaces as well for a varied career path. "Starting a company or inventing a product are viable paths for engineers," remarks Foster. "The intersection of engineering and innovation is an area where we can certainly encourage students. As faculty educating young engineers, we need to think about how to train them to make the best contributions."

Seeking to identify best practices to develop engineers, Foster is leveraging her role to redefine educational excellence. "We need to find ways to describe what it means to be good, competent, or excellent and create an assessment tool that will value getting the work done, rather than just rewarding those who test well. We know people learn and work in different ways and that's one way we can expand diversity, equity, and inclusion."

> *"Engineering is for everyone. Giving diverse thinkers the opportunity to create their own solutions means life tomorrow will be better than it is today."*

Tulane University

Kimberly Foster has been the Dean of the Science & Engineering Department at Tulane University in New Orleans since 2018.

12 KIMBERLY FOSTER HOLDS 12 US PATENTS IN AREAS OF MICROSYSTEMS

- Kimberly Foster was surrounded by engineering education having grown up as the daughter of Chris Passerello, a retired ME-EM faculty member
- She was inducted into the Michigan Tech Presidential Council of Alumnae in 2006

ME-EM ACADEMY INDUCTEE

PAMELA KLYN

"There is an emotional tie to engineering when the work you are doing makes someone's life better or their workload easier," says Pamela Klyn.

While at Michigan Tech, Klyn realized that the successful creation of products to improve lives goes beyond meeting the engineering requirements, it means a deeper understanding of the user.

> *"Understanding customer requirements is at the core of everything we do at Whirlpool. If we understand why a customer needs something and what the end outcomes need to be, we can create a better product."*
> *—Pamela Klyn*

But these requirements from consumers are often intangible or difficult for them to explain; a consumer does many routine tasks almost without thinking, which is where the world of data analytics and machine learning comes in. She supports adding it to the mechanical engineering curriculum: "The adaptation of the curriculum for data analytics is incredibly important given the power of data and how it is used in industry to build an understanding of the consumer, beyond what they can convey themselves," explains Klyn.

Through the connectivity offered in new models of appliances for the home, Whirlpool removes noise from customer surveys and obtains data beyond what a consumer can describe, collecting data sets to see how a given appliance is being used.

"With connectivity elements, we know that our consumers are looking for reminders to alert them when the laundry is done and ready to be changed. We see usage patterns and can bring better features and options to the next generation that no one could articulate in the past," she says.

Trained to listen and ask questions throughout her engineering education and career, Klyn has found this skill set helpful in her marketing and engineering roles.

> *"In engineering at Michigan Tech, you learn to solve problems in a way that others don't. Those problem-solving skills are critical when it comes to redesigning products in a way that is better for the consumer."*

"Whether we are looking at connectivity, marketing, or financing data, I was trained to look at the problem, understand what we are trying to solve, listen to the options for solving it, and then strive for the best outcome. That's how engineers improve tomorrow."

Whirlpool®

Pamela Klyn has dedicated her career to Whirlpool Corporation, her employer since graduating from Michigan Tech in 1993.

MS + MBA

DURING HER TIME AT WHIRLPOOL, KLYN HAS OBTAINED BOTH AN MS IN MECHANICAL ENGINEERING AND AN MBA

ME-EM ACADEMY INDUCTEE

KARL LAPEER

Karl LaPeer sees engineering as the key to both the business investments he makes at Peninsula Capital Partners and the humanitarian service work he does around the world. "I'm in the best place for a curious engineer. As an investment manager, I get to finance new ideas, evaluate strategic plans, and help companies succeed," he explains.

After several successful years working in robotics domestically and internationally, LaPeer decided to pursue an MBA.

> *"I left engineering, but never stopped being an engineer. I meet some of the best learners and thinkers in my role and get to leverage the skills I developed as an engineer. Every day I get to synthesize an incredible amount of information, analyze it, and then put in place strategies that benefit the businesses we invest in."*
> *—Karl LaPeer*

At Peninsula Capital Partners, he invests in middle market companies going through a change in ownership, capital investment program, or a business innovation.

"My mindset for each business we invest in is how can we create the best pathway for everyone in the organization to win. We help give them the training and tools needed to succeed," says LaPeer.

The team-oriented, collaborative environment he experienced at Michigan Tech helped him launch a lifetime of service.

> *"Everything I've earned has been for a reason—to help others. It's crazy, but if a high school teacher hadn't told me engineering was an option, if I hadn't been encouraged by someone to pursue an MBA, I wouldn't be able to give back to others in a substantial way."*

LaPeer and his wife, Christine, a fellow Michigan Tech alumna, and their family have been on about 40 humanitarian aid trips, built orphanages in India, funded water chlorination systems, established food aid programs, and served in shelters for women rescued from human trafficking in Nepal. The LaPeer family also gives back to Michigan Tech through full tuition scholarships to selected incoming students.

He shares, "We give back because we wouldn't have made it through college without the support we received. Each day we try to do something special to create a better world for others."

PENINSULA CAPITAL PARTNERS L.L.C.

Serving as a partner at Peninsula Capital Partners, a private equity firm-based in Detroit, Karl LaPeer advances engineering innovation through the companies he invests in.

4 NUMBER OF ORPHANAGES THE LAPEER FAMILY HAS FUNDED

ME-EM ACADEMY INDUCTEE

ROBERT MESSINA

"One of an engineer's important value-adds is being an idea generator and innovator. From there, it's about the network and the tools—connecting an innovative solution to an end user market. The skills learned at Michigan Tech are vital to that successful outcome," notes Robert Messina, Senior Vice President of Global Product Development & Product Management at JLG. He thrives on ideation and conceptualization, leading to machines that allow operators to work safely and productively.

During his education at Michigan Tech, Messina was required to solve open-ended problems. This practice helped him build meaningful symbolic representation and become fluent with industry tools.

> *"There are countless tools available today for engineers entering the workforce. As engineers, we need to consider the entire eco-system, decide what requires simulation, and what requires only calculation. Each idea or problem requires an appropriate level of analysis."*
> *—Robert Messina*

In his role, Messina focuses on providing space for engineers to be creative and find their place. "Leaders can foster experiences for early career engineers, providing guidance for long-term career choices, whether they seek to become a subject matter expert, grow expertise across a wide range of disciplines, or work for a start-up," he says.

Engineers entering the workforce today are immersed in a rapidly changing technological landscape with a pace of innovation that is accelerating. "How do we make it easier for students to be better innovators? How do we help eliminate the noise? And how do we help them find the path that's best for them?" asks Messina. "Engineers graduating from Michigan Tech are top-rated assets because they immediately add value to an organization—evaluating career options by taking internships across different industries can mean a career and personal mission that is more than just a job."

Messina has had the opportunity to work in a range of topic areas over the course of his career, first at Chrysler and later at Oshkosh/JLG, but by far the most rewarding area has been in his current leadership role. "Sometimes in engineering roles it is hard to be yourself, but here I can do that while creating an environment that helps the next generation," explains Messina. "Engineers are the creatives in the business ecosystem. It's very gratifying to support their creative efforts and foster the self-confidence they need to deliver their next breakthrough product. There's nothing else like it."

JLG®

With global research and development centers, Rob Messina leads product development teams developing premium products in North America, electrified products in Europe, and value products in Asia.

MESSINA HELPED DEVELOP THE WORLD'S TALLEST SELF-PROPELLED AERIAL WORK PLATFORM AT JLG

- Worked on automatic transmissions at Chrysler for 15 years prior to moving to Oshkosh/JLG
- Developed the industry's first completely electric scissor lift at JLG
- Awarded contracts for multiple vehicles by the US Government, including the M-ATV, the JLTV, and the next-gen USPS vehicle

ME-EM ACADEMY INDUCTEE

DOUG PARKS

The world of engineering is constantly changing and adapting to improve efficiencies, reduce costs, and create better, safer systems. Fostering change has been the overarching theme of Doug Parks' career in engineering.

> *"I was a hands-on physical, motors, mechanisms, problem-solving-focused student. I'm an engineer through and through. I enjoy making things better for people—building a better, more efficient car and solving problems no one else has even thought of yet."*
> *—Doug Parks*

Tackling new challenges head-on has been rewarding for Parks, who has been a leader on many of General Motor's electric vehicle projects. Using science, technology, and creativity to improve life is what fuels his passion for electric and self-driving vehicles. That extends to the planet, too: Parks is hoping to change the atmospheric carbon trajectory.

"We are building a better experience for our customers, where they don't need to go to a gas station to fuel up. We don't have the complete electric vehicle infrastructure or technology yet, but we are working to solve the charging and cost problems, which will be a global game-changer," he says.

The way Parks explores problems of infrastructure, charging, and cost centers around a method he learned at Michigan Tech: create a deep understanding of the pathways, break down the root causes, and build a better solution. "In the real world, not just in engineering, if you break down the concepts into smaller pieces, everything is solvable. If you understand the logic, you can build everything back together," he explains.

On that vein, Parks is proud the Department has continued to align with industry trends when adapting their curriculum. "I don't think we yet realize the full impact software has on our systems—so understanding computation and software development, and incorporating machine learning and artificial intelligence into what we do as engineers—is critical."

> *"These technologies will influence how fast things change, but at the core, we engineers are always following basic problem-solving principles."*

Doug Parks has served in various roles in engineering (and finance) since he began his career at General Motors in 1984, including leading efforts in their electric vehicle line-up.

259 PARKS LEAD THE TEAM RESPONSIBLE FOR INCREASING THE 2020 CHEVROLET BOLT'S ELECTRIC VEHICLE RANGE TO 259 MILES

3 SELF DRIVING TEST VEHICLE GENERATIONS CREATED IN 16 MONTHS WHILE LEADING THE AUTONOMOUS VEHICLE ENGINEERING PROGRAM

ME-EM ACADEMY INDUCTEE

GORDON RENN

Taking time to understand the problem, collaborate across teams, and build a better solution is the critical thinking process Gordon Renn learned during his education at Michigan Tech.

"A complicated problem is a series of simple problems. I learned how to break down a complicated problem to establish a simple solution and that's something I've done both on my own and in teams," Renn explains.

Having established several successful businesses, Renn encourages engineers to think critically and learn to be a leader. Collaboration and communication are essential for the success of teams—a combination of elements Rend is proud to see as the cornerstone for senior design projects in Michigan Tech's mechanical engineering curriculum.

> *"Teams are essential to business. If you can work with and influence your team, you will have the drive to advance your team to the next level. Surround yourself with great and well-meaning people and learn how to work with them and ultimately be the person they want to work with."*
> *—Gordon Renn*

In addition, Renn acquired a deep understanding of the engineering concepts in his courses at Michigan Tech. He still uses them to examine the mechanics and conditions of various machines operating in his businesses.

> *"I've run into situations where people have said something can't be done, but that has driven me further to prove it can be—and that has led to the success of my machinery in the market."*

When exploring a problem, Renn applies knowledge surrounding fluid mechanics, chemistry, mechanics, and physics to see why each part is reacting in the way it is, how the machine can be corrected, and ultimately how the process can be improved for others.

> *"With all of the technology surrounding us, engineers have the fundamental background that even if they don't have the direct answer, they know how to use their broad knowledge base to get there. Success comes from remaining humble and retaining the ability to listen while leading teams."*

FOX CONVERTING®

Gordon Renn has been with Fox Converting since 1984 and is currently serving as President, CEO, and Chairman.

5 RENN REMEMBERS FIVE KEY CONCEPTS FROM EACH CLASS HE TOOK AND HAS APPLIED MOST AT SOME POINT IN HIS CAREER

HE IS A LEGACY ALUMNUS FOLLOWING IN THE FOOTSTEPS OF HIS FATHER, WHO GRADUATED WITH A BSME DEGREE IN 1953

ME-EM ACADEMY INDUCTEE

SHERYL SORBY

Engineering education can be like a mountain path—steep and dangerous, or stable and developed. How students are introduced to the mountain shapes their choices. "If we put a 'math gate' up before students can see how amazing it is to engineer a product, we've curtailed their sense of possibility," says Sheryl Sorby, Immediate Past President of American Society of Engineering Education (ASEE). "We should be building bridges and opening new paths up the mountain for those that enjoy creative problem-solving."

Sorby is hoping she can broaden and diversify engineering opportunities for all students. "We need to bring in new people whose opinions we rarely seek to solve problems. We can't continue to have the same people sitting around a table creating solutions who do not reflect the people living in our world," she says.

> *"We need people with different life experiences, coming from different places, and with different viewpoints to solve the problems."*
> *—Sheryl Sorby*

A critical step of problem-solving is first capturing what the problem is at a deep level, even before putting in any effort into solving that problem.

"If we don't talk to the people experiencing the issue first-hand to understand what they need, we will likely create a less than optimal solution or solve the wrong problem entirely," she says.

Scoping out problems in engineering ultimately begins with communication and taking time to listen. "If we want to build inclusive, diverse teams, then listening is the most important skill. Most engineers can speak and write well, but we can all improve our listening," Sorby says. "Curriculums tend to focus on technology, but listening and learning when and what questions to ask is how we advance engineering on a deeper level."

These shifts in engineering curriculum are something Sorby is focused on through her role at ASEE. "We have an effort focused on changing the mindset of the students and faculty to get them to look at engineering differently. We initially hoped it would be a two- to three-year effort, but it is looking more like a 10-year project. We need to look at what our students need today to creatively solve problems facing the world, redefine who can become an engineer, and who believes it is possible for them."

The need for more diversity, inclusion, and equality in engineering means that the community of engineers as a group will require a broader context of solution development. She adds, "We need to look at the base of the mountain, to build more pathways, and support people coming to engineering from all points on the compass."

ASEE

Seeking to highlight all the possible pathways into engineering, Sheryl Sorby is increasing opportunities for underrepresented populations in her role as Immediate Past President of ASEE.

ME-EM ACADEMY INDUCTEE

CHRIS YAKES

Versatile, adaptable, and ready for a challenge is how Chris Yakes describes students in the ME-EM Department—characteristics Yakes lives out daily in his role at Oshkosh Corporation.

"Coming out of mechanical engineering, you're wired to solve problems: for research, business, or finance. You have a mindset to fix any problem, even in challenging environments," he explains.

While at Michigan Tech, students not only confront difficult courses but also deal with a hostile winter environment, where getting to campus can be tough, especially during a Houghton January. They collaborate on real-world projects and learn to cope with communication issues, too.

> *"In senior design you get to work with a team and learn the nuances of cooperating with people, and that's real life. You learn to work through that while walking your project from design into production. And you do this while managing colder temperatures outside, and higher snowfall volumes. It makes Michigan Tech grads a bit tougher."*
> *—Chris Yakes*

Creating solutions for real problems is what drew Yakes into engineering. "I always knew I wanted to do something in math and science, but in high school I discovered a drive for fixing problems and making life better," he says.

Yakes found the ideal fit at Oshkosh, where the innovative work he does with its products improves and protects the lives of people who rely on them every day.

"Working on vehicles in the industries we serve, we know we are saving lives—whether it is building a military truck to withstand a blast event or creating a support system for firefighters going into the flames," he says. "It has a real impact when you deploy a new design that can withstand a certain load because if it moves forward, it will likely save someone's life."

> *"If you want to make an impact, put yourself in a position where the work you are doing is having a significant value on the customer or on society."*

The world is changing with automation and creating opportunities for engineers with the ability to find solutions which go beyond engineering. "I tell young people to serve wherever their hearts lead them."

OSHKOSH™

Beginning as a senior project engineer, Chris Yakes has been with Oshkosh Corporation since 1997 and has since taken on various leadership positions in a range of subject areas.

29 YAKES HAS 29 PATENTS IN HYBRID SYSTEMS AND AUTONOMOUS VEHICLES

OSHKOSH IS WORKING TO ESTABLISH A BUSINESS INCUBATION PROGRAM WITH MICHIGAN TECH TO ENCOURAGE NEW AND UNIQUE IDEAS AMONG YOUNG ENGINEERS

ACADEMY MEMBERS

Frank Agosti
BSME '58

Tony Altobelli
BSME '86

Carl Avers
BSME '62

Richard Bayer
BSME '44

John Beattie
BSME '63

Wilfred Bobier
BSME '43

Thomas Bronz
BSME '89

John Calder
BSME '67, MBA '76

Xintan Chang
MSMG '83, PhD EM '88

Brett Chouinard
BSME '88

Margaret Cobb
BSME '83

Timothy Coffield
BSME '84

John Cook
BSME '42

Charles Cretors
BSME '63

Charles Cronenworth
BSME '44

Robert D'Amour
BSME '48

Juan Dalla Rizza
BSME '71

Dean Diver
BSME '65

John Drake
BSME '64, MSBA '69

John Eastman Sr.
BSME '58

Theodore Edwards
BSME '50

Paul Fernstrum
BSME '65

Kimberly Foster
BSME '94

Edward Gaffney
BSME '51

Joseph Gemignani
BSME '53

James Gerdeen
BSME '59

John Hallquist
MSEM '72, PhD ME-EM '74

Douglas Hamar
BSME '84

William Hartwick
BSME '48

Gerald Haycock
BSME '68

Ralph Hayden
BSME '33

Richard Henes
BSME '48

Ray Herner
BSME '54

David Hill
BSME '65

Colleen Jones-Cervantes
BSME '83

Daniel Kapp
BSME '76

Raymond Kauppila
MSME '60

Pamela Rogers Klyn
BSME '93

Pete Knudson
BSME '64

Brian Krinock
BSME/BSMG '85

Martin Lagina
BSME '77

Charles Lamoreaux
BSME '56

Karl LaPeer
BSME '85

Charles Laurila
BSME '59

Gary Lawrey
BSME '79

Craig Lazzari
BSME '42

Albert Maki
BSME '48

Paul Masini
BSME/BBA '69

Tom McKie
BSME '47

Robert Messina
BSME '93

Fred Mitchell
BSME '61

Bob Monica
BSME '50

Tom Moore
BSME '66

Lawrence Mulholland
BSME '55

Eric Nielsen
BSME '80

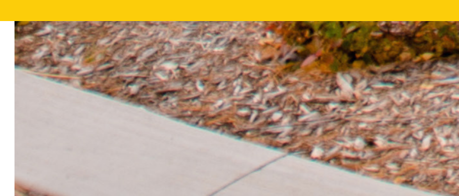
Douglas Parks
BSME '84

Merle Potter
BSME '58, MSEM '61

Norman Pratt
BSME '42

Anthony Raimondo
BSME '62

Kamlakar Rajurkar
MSME '78, PhD ME-EM '81



*ONLY MICHIGAN TECH DEGREES LISTED

Jack Real
BSME '37

Gordon Renn
BSME '82

James Reum
BSME '53

Daniel Rivard
BSME '59

Richard Robbins
BSME '56

Dale Roberto
BSME '69

Christine Roberts
BSME '91

Paul Rogers
BSME '88, PhD ME-EM '04

Vijay Sazawal
BSME '75

Harold Schock
BSME '74, PhD EM '79

Frederic Sherriff
BSME '63

Sheryl Sorby
MSEM '86, PhD ME-EM '91

James Sorenson
BSME '60, MSME '61

Fred Spagnoletti
BSME '65

James Stone
BSME '40

Martha Sullivan
BSME '80

Paul Swift
BSME '33

Maurice Taylor
BSME '68

Camiel Thorrez
BSME '70

Robert Thresher
BSME '62, MSME '67

Raymond Trewhella
BSME '56

William Turunen
BSME '39

James Vorhes
BSME '47

Thomas Walker
BSME '68

Donald Wheatley
BSME '62, MSME '63

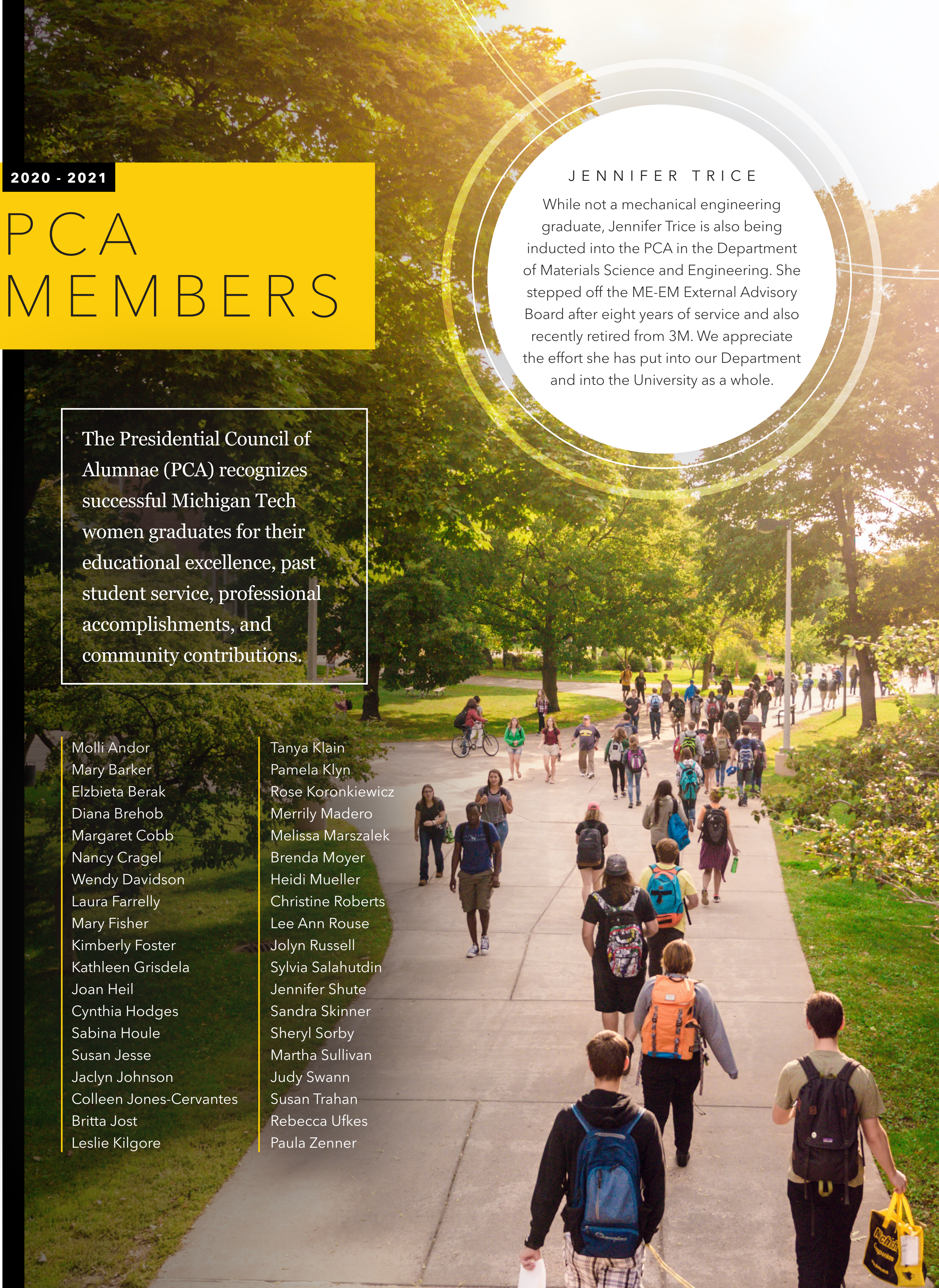
Harold Wiens
BSME '68

Stephen Williams
BSME '86

Terry Woychowski
BSME '78

Christopher Yakes
BSME '95

Hussein Zbib
BSME '81, MSME '83, PhD ME-EM '87



2020 - 2021

PCA MEMBERS

The Presidential Council of Alumnae (PCA) recognizes successful Michigan Tech women graduates for their educational excellence, past student service, professional accomplishments, and community contributions.

JENNIFER TRICE

While not a mechanical engineering graduate, Jennifer Trice is also being inducted into the PCA in the Department of Materials Science and Engineering. She stepped off the ME-EM External Advisory Board after eight years of service and also recently retired from 3M. We appreciate the effort she has put into our Department and into the University as a whole.

- Molli Andor
- Mary Barker
- Elzbieta Berak
- Diana Brehob
- Margaret Cobb
- Nancy Cragel
- Wendy Davidson
- Laura Farrelly
- Mary Fisher
- Kimberly Foster
- Kathleen Grisdela
- Joan Heil
- Cynthia Hodges
- Sabina Houle
- Susan Jesse
- Jaclyn Johnson
- Colleen Jones-Cervantes
- Britta Jost
- Leslie Kilgore
- Tanya Klain
- Pamela Klyn
- Rose Koronkiewicz
- Merrily Madero
- Melissa Marszalek
- Brenda Moyer
- Heidi Mueller
- Christine Roberts
- Lee Ann Rouse
- Jolyn Russell
- Sylvia Salahutdin
- Jennifer Shute
- Sandra Skinner
- Sheryl Sorby
- Martha Sullivan
- Judy Swann
- Susan Trahan
- Rebecca Ufkes
- Paula Zenner

PCA INDUCTEE

MOLLI ANDOR

Boldly go. Don't be afraid to try something new.

"When I first started, I had no experience with engines or powertrain and never would have guessed I would land on, and really enjoy, working on engines," says Molli Andor, who now works at Ford as a powertrain manufacturing engineer. Of her experiences at Michigan Tech, Andor says the ones that impacted her the most were the hands-on learning opportunities.

> *"Senior design will always stand out to me because it was the most like working in a real-world scenario—experiencing program management and product design with a customer, navigating issues with a team, and using industry-standard software. It really prepared me for the workplace."*
> *—Molli Andor*

While at Michigan Tech, Andor also found passion in her Introduction to Design and Manufacturing course and the lab component. "I enjoyed working with the CNC mill and lathe programming so much that I was asked to be a lab assistant. I remained in that role through graduation, where I was able to support other students, connect with faculty, and engage with coursework," she shares.

The lab gave her an opportunity to lead small groups, which has contributed to the soft skills she utilizes daily at Ford. "When you are working with and teaching others, you discover what questions fresh eyes raise. It gives you a chance to perceive failure modes you would normally miss," explains Andor.

The solid base that mechanical engineering provided her, along with the continually adapting curriculum, have helped ensure Andor and others are prepared for future challenges.

> *"Michigan Tech is incorporating industry elements into the curriculum that surround the internet of things, artificial intelligence, machine learning, and industry 4.0 to help students understand how to connect data systems and use data analytics."*

The updated curriculum in mechanical engineering gives students quick problem-solving skills, and a solid understanding of which principles to apply in order to find good, strong solutions.

> *"My education prepared me for the reality of a changing workforce—how future technology transformations could impact not only me, but the next generation of engineers, too."*

Molli Andor works as an engine assembly process engineer at Ford, working with the nano-engine family and coordinating with suppliers, tooling, and other OEMs.

PCA INDUCTEE

JACLYN JOHNSON

Engineering impacts aren't always realized immediately. It can take years before industry adopts technology based on research, but for Jaclyn Johnson, seeing that impact is worth the wait. It has been a steady source of motivation during her graduate studies and her time as a lecturer in the ME-EM Department.

After completing her undergraduate degree in physics and math, Johnson arrived at Michigan Tech seeking a practical approach to engineering. "I was welcomed into Dr. Jeff Naber's research group and started working on the fixed-volume combustion vessel," she shares.

> *"It was surreal as a graduate student to be doing something state-of-the-art; being able to build it and then—with my own eyes and a high-speed camera—visualize dynamics in combustion. The data we created was quickly adopted by our industry partners."*
> *—Jaclyn Johnson*

Through these partner companies, including Ford, John Deere, and Stellantis (formerly Fiat Chrysler Automobiles), Johnson knew her results were going to be leveraged.

"It was rewarding to see the application of what we were doing—watching the injectors and characterizing the spray behavior—and knowing it wasn't just for an abstract project. These companies recognized the value of the results right away," she says.

The satisfaction of having an impact guided Johnson toward an open position in the Department as a lecturer, and also inspired her to advise the Engineering Ambassadors program on campus. "The program brings Michigan Tech students to schools for local outreach across a range of engineering majors and disciplines. Students give a short presentation on a topic and then conduct a related engineering-based activity. We try to get the presentation to relate to what the students are learning in class to promote engineering as a career option," explains Johnson.

Giving back to students and guiding the next generation of engineers is a responsibility Johnson values, whether she is teaching a course in energy thermalfluids, or advising a senior design team.

"I enjoy teaching and interacting with mechanical engineering students, especially seeing the 'yes' moments where the concept clicks with them," notes Johnson. "Working with students early in the curriculum, it's rewarding to see them again after a few years as they bring all the concepts together during senior design and prepare to move into their new careers. Our Department's 'product' is making great engineers. Their lifetime of achievements is our ultimate impact."

Michigan Technological University 1885

During the summer, Jaclyn Johnson combines teaching and research—teaching for the first part, then transitioning to her image processing work in the combustion lab.

400

NUMBER OF LOCAL STUDENTS REACHED EVERY YEAR IN THE ELEMENTARY AND MIDDLE SCHOOL GRADE LEVELS AS A RESULT OF THE ENGINEERING AMBASSADOR PROGRAM

PCA INDUCTEE

LESLIE KILGORE

We often recognize strength in loud ways, such as a sports rally. Other times strength is quiet, yet unyielding.

Leslie Kilgore personifies the latter. As a young female African-American engineer, she faced daunting challenges in her education and career that have instilled resilience, perseverance, and conviction.

> *"There is very little 'give up' in me and that's rooted in the experiences I have worked through—as a woman, a young engineer, and with cultural differences."*
> *—Leslie Kilgore*

At Michigan Tech in the 1990s, Kilgore experienced more than the usual challenges of rigorous academics: microaggressions, ignorance, and sometimes traumatic racism, but she made a conscious decision each day to move forward. "We faced things like people not wanting to work with us in labs and groups. It was a continuum of things, but that didn't stop me from my work. It built a level of perseverance that has served me in navigating challenges," she shares.

Kilgore helps others through her diversity by encouraging them to turn unfamiliar scenarios and risks into beneficial experiences.

"You can choose to do something different with diversity. I was on a team at General Motors with four older Caucasian engineers and that experience changed my perspective because they were old enough not to be threatened by me. I was able to have a safety net to display and develop my skills as an engineer," explains Kilgore, who now leads a diverse team at Weber-Stephen Products on new product development.

> *"In two years on the team, we won several industry awards and did great work because we got past the minutiae of culture, age, and gender and focused on delivering outstanding design."*

Students frequently have their first interactions with industry through internships or co-ops, but Kilgore encourages industry projects in class and on campus earlier in the educational experience.

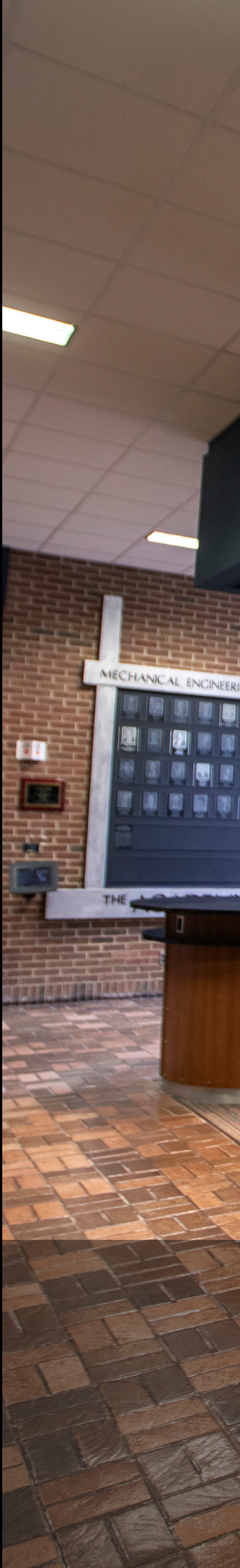
"I suggest involving students with product design and industry-linked projects and project management from the very beginning. It would also be beneficial to put females in leadership roles for the teams because it is going to happen in the workplace. There is value in the faculty initiating that and not always having the ethnic and gender minorities push for it," she says.

Kilgore is encouraged by the shift across the country of people willing to stand up for their work and own their intelligence.

> *"The outcomes and results should be improved because I was there—the product, the environment, the team. I hope my involvement with the ME-EM Department can likewise serve the Michigan Tech campus well. That's always my objective. We do better when we know better, and we learn better from a calm voice."*

Leslie Kilgore spent 21 years working in the automotive industry at General Motors and has recently transitioned to Weber-Stephen Products as Vice President of New Product Development.


Xintan Chang
Ph.D. 1998
Professor & Emeritus President
Xi'an University of Science & Technology
Brett R. Chouinard
BSME 1988
President & Chief Operating Officer
Altair Engineering, Inc.
M. Margaret Cobb
BSME 1983
President
The Cobb Foundation, NW
David C. Hill
BSME 1965
Vehicle Line Executive, Performance Cars
Chief Engineer, Corvette Division
General Motors Corporation
Colleen L. Jones-Cervantes
BSME 1983
Vice President for Product Supply & Trading
Chevron Corp.
Daniel R. Kapp
BSME 1976
Director, Powertrain Research
& Advanced Engineering
Ford Motor Co.
Norman R. Pratt
BSME 1942
Manager of Nuclear Projects
Dow Chemical Company
Anthony F. Raimondo
BSME 1962
Chairman & CEO
Behlen Manufacturing Co.
Dr. Kamlakar P. Rajurkar
MSME 1978, PhD MEEM 1982
Professor of Mechanical Engineering
Director, Nontraditional Manufacturing Center
University of Nebraska-Lincoln
Raymond M. Trewhella
BSME 1956
President and CEO, Retired
Glassmaster Company
William A. Turunen
BSME 1939
Fluid Dynamics Researcher
General Motors Corporation
James G. Vorhes
BSME 1947
Vice President,
Consumer Relations & Service Staff
General Motors Corporation



19

THE ME-EM DEPARTMENT IS RANKED 19TH IN BSME DEGREES AWARDED BY THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

The lobby of the Mechanical Engineering-Engineering Mechanics building provides recognition for our academy inductees and honors our donors—who all play a significant role in the lives of our engineering students.

Our students benefit from the involvement, advice, scholarships, laboratories, and equipment that our generous alumni and donors support and fund. We appreciate the value they share in helping to build educational opportunities for our students.

FEATURED ALUMNI

HAJJ FLEMINGS

When Hajj Flemings looks at a city, he sees more than the streets and buildings. Blessed with an uncanny gift for looking deeper into places, people, and cultures, Flemings invites those around him to bring their light and search with him for the essential.

When he graduated from Michigan Tech, he was prepared to adapt to his new work environment on the factory floor at Ford while refining the key concepts for his future Rebrand Cities.

> *"I knew on day one that I didn't want to be an engineer my whole life, but I also knew the degree taught discipline and trained you on how to solve problems. The educational experience gave me an appreciation for adapting and prepared me for the future."*
> *—Hajj Flemings*

At Ford he was a quality engineer responsible for 20 percent of their aftermarket parts, including remanufactured engines and catalytic converters.

"I was giving instructions to people who worked on the line longer than I had been alive, but it was through that role I gained an appreciation for making complex concepts simple, while learning to communicate with people who knew more about the core job than I did," he shares. "It helped me prepare to pivot on my career when the time was right."

Being a creative at heart, Flemings was writing a branding book and establishing his business while preparing for an exit plan from Ford. "Quality engineering continues to influence what I do today to think beyond aesthetics. It means creating something that works, makes business sense, and is accessible and sustainable," he explains. "In everything I do, I am thinking about the entire design process and how the product meets reality."

There is a seasonality of products and people. Products have a lifecycle just like people who leave their positions. "When creating, we need to ensure we have everything on the ground needed to create it, know how to put it in the hands of the consumer, and make sure there is a documentation trail, so we can hand it off to the next person," notes Flemings.

The grit and determination he gained working through challenging coursework at Michigan Tech has enabled him to lead rebranding efforts for cities across the country and in Haiti. Looking back on his career successes, Flemings is inspired:

> *"The greatest opportunity I have in my role is to learn from others' stories, develop relationships, and to be able to write the stories of businesses and cities to impact their culture."*

EXTERNAL ADVISORY BOARD

The External Advisory Board (EAB) is a select group of corporate, university, and government leaders, many of whom are ME-EM alumni. EAB members share their expertise and provide assistance with curriculum direction, research topics, resource development, and education-industry partnership.

They offer professional insight and provide valuable input, shaping the state-of-the-art engineering education that takes place in the ME-EM Department. Members can serve a maximum of two four-year terms.

Brett Chouinard, Altair Engineering, Inc.

Marie Cleveland, FedEx (retired)

Justin Dahlager, John Deere

Michael Davenport, American Iron and Steel Institute (AISI)

Brian Demos, American Axle & Mfg. (AAM)

Christopher Duke, Stellantis

Alexa Ellswood, General Motors Company

William Flood, Moog, Inc.

Kimberly Foster, Tulane University

Alan Frank, Whirlpool Corp.

Jim Hayes, Dow Coatings Materials (DOW)

James Heldt, Mercury Marine

Shashi P. Karna, CCDC Army Research Lab

Leah Lemanski, Nexteer Automotive Corp.

David Lomasney, Maclean-Fogg Component Solutions

Kevin Manor, Toyota Motor North America, R&D

Darwin Moon, The Boeing Company

Brenda Moyer, Dana Inc.

Heidi Mueller, Ford Motor Company

Steve Reasoner, Stryker Instruments

Christine Roberts, Poly

Peter Sandretto, Stellantis (retired)

William Schell, Caterpillar, Inc.

Robert Sharpe, Cummins, Inc.

Darrin Traczyk, 3M Company

Jason Verboomen, Kimberly Clark Corp.

Brian Witt, Kohler Company

Chris Yakes, Oshkosh Corp.

26

THE ME-EM DEPARTMENT IS RANKED 26TH IN PHD ENROLLMENT BY THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

INNOVATIVE ENTERPRISES

While preparing for industry 4.0 in our evolving curriculum, we ensure our students are prepared for the real world through hands-on, project-based opportunities. Collaborating and innovating in laboratories, coursework, Enterprises, and Senior Design Capstones, our students develop skill sets for their future.


OXTS
BOLT EV
Michigan Tech
GENERAL MOTORS

AN ENTERPRISING ENDEAVOR

Expanding opportunities for students to work on projects related to deep space missions, the Multiplanetary Innovation Enterprise and the Planetary Surface Technology Development Laboratory (PSTDL), both under the direction of Dr. Paul van Susante, offer students a hands-on learning experience through NASA-funded competitions and research projects.

While in-person competitions were scuttled due to the COVID-19 pandemic, the Lunabotics team under the Enterprise was one of 50 teams selected to develop a robot to perform excavations on the moon.

The competition imposes a 60 kg mass requirement and has a robot simulate mining behavior on the moon to collect mineral "stones" buried under the surface aggregate.

"In the competition, robots must autonomously drive across the obstacle zone to the excavation zone and excavate the rocks with the added uncertainty of randomized orientation at the start. Points are only awarded for the rocks collected, not the dust and debris," says van Susante.

The current robot design is nearing completion, but they are facing supply issues with electronics—a challenge across the industry. While developing a robot for a lunar scenario, the Enterprise team saw an opportunity to expand their skillset by developing a marine robot.

"We've done initial testing in the wave tank with the robot floating and diving, and have made adjustments to improve the design to achieve balance." He notes, "We would eventually like to expand the underwater robot's capabilities to collect rock samples from the Portage waterway and potentially map out flooded mines, like Quincy."

Last year, the PSTDL team participated in NASA's Big Idea Competition. They were challenged to enhance opportunities for lunar missions by enabling operations in the permanently-shaded areas of the moon. The group proposed T-REX, a robot complete with a tether to convey energy and data via a superconducting cable.

> *"Our group was one of eight semifinalists, and ultimately received the Artemis Award with $162,000 to build and test our vehicle."*
> *— Dr. Paul van Susante*

This development of the T-REX robot to deploy the superconducting cable in the shaded regions of the moon further led to the team's application and the $100,000 grand prize award for the Watts on the Moon Challenge to build the next generation of energy infrastructure for the moon.

> *"NASA came up with a competition with three scenarios. We applied for scenario two—delivering power from a power plant to a water extraction plant inside the crater. We have been able to use the technology from our T-REX rover, which was designed to connect power from one place to another using a superconducting cable," notes van Susante.*

Developed with student support through PSTDL, the group has partnered with a cable production company for developing a small, multi-path cable.

"With a multi-path cable, we are able to send power, as well as communication, providing a local network connection for other vehicles below line-of-sight in the moon's craters," he explains.

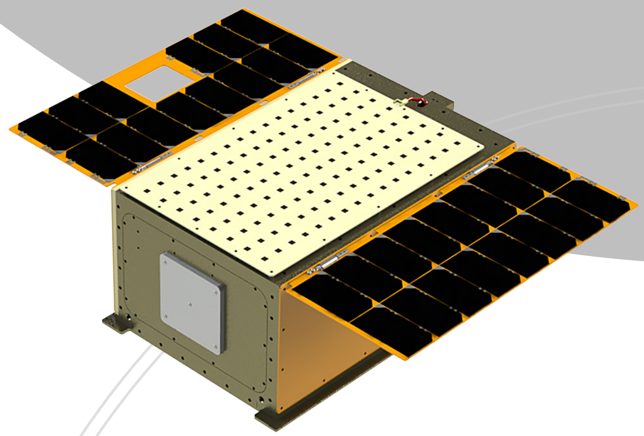
The team received the phase I prize and is hoping to participate in the phase II competition following the build-out of their prototype.

> *"I feel we have a high chance of success. We've already developed our vehicle to deploy a power cable. Now we can test it in our dusty thermal vacuum chamber right here on campus, to simulate lunar conditions."*

Van Susante continues, "Our rover travels down a 45 degree crater wall while deploying the system. Through the first competition, we had isolated many critical system attributes, dealing with power, unrolling the cable, and monitoring tensile load as we moved."

Students in the Multiplanetary Innovation Enterprise and PSTDL are building the "stuff of dreams," contributing to NASA's return to the moon, and fulfilling a lifelong dream of van Susante: to build the vehicles that will make the moon part of the Earth's economic sphere.

SPONSOR



THEN THERE WERE THREE

The Aerospace Enterprise, under the direction of Dr. Brad King, is launching satellites as well as student careers. At the University Nanosatellite Program, sponsored by the Air Force Research Lab (AFRL) in August, ten students from the Enterprise team presented their latest satellite application, Auris, to judges from several space-related agencies.

The challenge for the competition was to develop a satellite mission that is relevant to both industry and the military. Students conceived of the idea for Auris, a "listening satellite," through discussions with Enterprise alumni working in industry and their interest in monitoring communication from other satellites to estimate bandwidth utilization.

"Ten university teams were in attendance and owe were among the three selected to proceed. We now move on to 'Phase B' of the program and have a guaranteed launch opportunity with substantial funding to complete the design and integration of our spacecraft," says Matthew Sietsema, Chief Engineer for the Aerospace Enterprise.

As a result of this award, the Aerospace Enterprise will soon have three satellites in space. Stratus, a climate monitoring satellite that determines cloud height and cloud top winds, was set for a March 2021 launch date. However, it was delayed due to the pandemic and is planned for launch in 2022. Oculus, an imaging target for ground-based cameras for the Department of Defense, was launched in June 2019.

"The Enterprise has remained on the same trajectory and has been very successful by all measures," remarks King. "Students do a great job managing themselves and the leadership to replace themselves as they graduate and new members move up. It's a challenge to juggle more than one satellite, but our students have remained focused and hard working while managing several projects and it's a testament to their tenacity."

Creating real-world, hands-on learning opportunities for around 100 students per semester, the Enterprise serves as a stepping stone for many as they launch their careers.

> *"Our students, even if they aren't in leadership roles, do well securing positions in the aerospace industry. We tend to perform well compared to other universities because we offer a three-year, long-term program, which allows our students to maintain the situational knowledge required to solve complex problems."*
> *—Dr. Brad King*

Unlike many others applying for launches, the Enterprise team offers stability with a mix of backgrounds and a lot of hands to complete the tasks. "Many universities compete through undergraduate senior design style programs, so every year they have a new group of students, while others compete as a team of three to five graduate students, but those are challenged by a limited bandwidth. Five students struggle to do full vehicle design, but our team offers volume, duration, and consistency which is an uncommon structure," he says.

Enterprise provides students with an opportunity to apply concepts from coursework and perceive its impact first-hand. "It motivates them to focus on the fundamentals, while also seeing that engineering is about more than that. They must master skills that aren't taught, but are still needed to be a good engineer," shares King.

"They utilize the fundamentals in the early stages of product development, but once that is set, they focus on structure planning, scheduling, product deliverables, and reporting. These are not intrinsic to engineering, but they are crucial to engineering success."

While the Enterprise doesn't specifically teach team building, there are structures built-in that reflect industry—creating small, effective teams and defining communication strategies. "Through the years, we have also identified the types of projects that are the best fit for us. The most successful programs we have are when we can integrate existing technologies to accomplish a valuable function.

SPONSORS

We are doing great education and leadership preparation, building in lessons, and preparing students for the tech space," explains King.

The Enterprise has experienced success, but students have also been through challenging times. King notes:

> *"It's a valuable part of their educational experience to hit a roadblock, struggle, develop a plan to overcome the challenge, and hit a deadline they didn't think they would make. I've seen our groups plan for a deadline six months out and worry they won't hit it. But then they dig into the work, release their doubts, focus, and ultimately accomplish their goal."*

Part of the Enterprise team's success has come from the refinement of industry standard tools, software, and processes for complex systems engineering.

"We developed an internal system to achieve the output products for the programs, tracking how to meet the AFRL requirements with standard business tools. When we first developed it here, it was a competitive advantage over other universities, however, AFRL requires our method be utilized by all university programs, so now others follow the same practices," says King. "As a result, it's shifting how aerospace companies operate."

Despite their success, the Enterprise commonly works on unknown timelines, seeking funding for various projects, and not knowing what might be funded next. As a result, the Enterprise would welcome a long-term financial sponsor to support mission and vehicle development, ensuring that career pathways and program success for so many outstanding students is not left up to chance.

OUTFITTING THE FUTURE

The future lies with autonomy—a vision GM and SAE have supported through the SAE AutoDrive Challenge, which kicked off in 2017.

Michigan Tech's involvement is organized through the Robotic Systems Enterprise, a collaborative effort between the Departments of Electrical and Computer Engineering and Mechanical Engineering-Engineering Mechanics, and led by **Drs. Jeremy Bos** and **Darrell Robinette**. AutoDrive Challenge I was the first phase of competition, where the teams outfitted a Chevy Bolt with sensors, controls, and computer processors to operate at SAE level 4 at competition close.

With a delay in competition close-out due to COVID-19, the Robotic Systems Enterprise team went into their final year of competition prepared to navigate an urban driving course in automatic mode, where students were tasked with successful requirements management, systems engineering, product development, and controls for fully autonomous systems.

"Our team did very well on vehicle programming, control, and navigation using LIDAR technologies with smooth vehicle operation and lane centering through the M-City test course. We had a technical issue that resulted in a rules violation, so we did not receive points for the dynamic portion, which was heartbreaking but encouraging looking forward," shares Darrell Robinette.

Despite the violation, the team placed third overall and received the second most awards in three consecutive years. The competition also serves as a way to encourage engineers to think beyond the car—to consider the societal implications of the new technology.

"As engineers, it is our job to think about autonomy in a broad sense: how to make it reliable, something we can put our family in from point A to point B, and have a level of comfort and confidence in the engineering behind that," explains Bos.

In rural areas, the aging population would benefit from autonomous systems for independence from calling friends, family, and rideshare programs to reach the doctor, the grocery store, or to visit family.

> *"Our team developed an accessibility standard for those hard of hearing or with sight impairments—and received first place with our final report."*
> *—Dr. Jeremy Bos*

While the AutoDrive Challenge I is complete, the Robotic Systems Enterprise team is just beginning to explore their next challenge after being chosen as one of 10 universities competing in the AutoDrive Challenge II.

"In the first year of the new competition, all teams will be working with a surrogate platform: a wheeled tool chest that will serve as the 'vehicle' with sensors. We will move it around and demonstrate our ability to detect objects and make routing decisions. Year one is all about showing the judges your software and architecture before adding in the complications of a full-up vehicle," says Robinette.

This is a switch from AutoDrive I, where teams were provided a car from the beginning. "It is a challenge to take something and make it autonomous at the full vehicle level with all the safety checks and software limitations, so they are simplifying the problem for the first year to help all teams build confidence," he explains.

Students in the Enterprise who worked on the AutoDrive Challenge I will be able to continue into AutoDrive Challenge II, while the group looks to recruit new undergraduate and graduate students.

"We will be able to carry over anything we designed and developed from the first challenge; however, we will also be making changes to our software architecture and systems to improve efficiency and modularity," notes Robinette. "GM is allowing us to keep the Chevy Bolt, so we have something that works to continually test on."

While the details of the competition are not yet fully public, the Robotic Systems Enterprise team knows they will need to transform a regular production vehicle into a level 4 autonomous vehicle, while competing against nationally recognized universities that boast large budgets and impressive student involvement.

"While we are smaller on a university scale, with a smaller budget, our students have proven we innovate to succeed while employing fiscal efficiency efforts. This competition gives us a chance to showcase our discipline and engineering acumen," he remarks.

Focused on training the next generation of engineers, the AutoDrive Challenges present students with a unique opportunity to integrate principles of robotics, controls, and systems engineering.

> *"Through AutoDrive, our students go beyond automotive concerns to explore concepts in autonomy, mobility, and robotics. If we approach everything like an engineering problem, test for every condition, and think about the ways it could fail, our students will be ready for any challenge."*
> *—Dr. Darrell Robinette*

To further expand involvement with autonomy across campus, the College of Engineering is looking to build a shared mobility testing workspace to advance the concepts and foster discussions around the emerging societal transformations.

SPONSORS

MEASURED SUCCESS

Continuing to meet their mission of preparing engineering students for successful careers, the Department is creating a Metrology Lab, sponsored by Nucor, to provide students with the resources to take highly accurate measurements for their project components.

"We are grateful to Nucor for their generous donation of $100,000 to develop the center, which will have a significant impact on our students' educational experiences and research while ensuring that our graduates are prepared in the field," remarks Dr. Bill Predebon, Department Chair.

"We want to see our students use their hands for physical engineering and that happens in measurement. The center is about developing that intuition," explains Rachel Store, research engineer and head of the Metrology Lab. "The students will take data to document their product performance—all while better understanding their product quality through metrics."

The lab will expand on traditional measurement tools, bring in new, industry-standard equipment, and tie in data-driven manufacturing.

"The Metrology Lab will introduce our students to the ambiguity of engineering, where they can take a measurement, understand a piece of reality, and get the best approximation for the ideal case. They'll also understand how that changes, based on the tool used for the measurement," shares Store.

The lab will feature traditional and new, state-of-the-art equipment that students will encounter in industry, including calipers, micrometers, a flexible arm coordinate-measurement machine (CMM), optical microscope, microhardness testers, tachometers, strobometers, and infrared and thermal scanners.

Through the coursework, students will get to work hands-on with the equipment and build their understanding of proper measurement methods.

"We will give them the resources to collect the physical measurements, which is about more than taking your ruler and putting it against something. It's about understanding the tolerances, exploring profilometry using contact and non-contact surface finishers, and challenging them on how their constituent parts fit together," Store says.

Through the Metrology Lab, faculty and staff hope to get students' gears turning on how measurement fits into the design process and the importance of part validation. "We find students have challenges with understanding clearances and what is an appropriate deviation for measurement," she shares.

By the time a student is in their final semester, the goal is for them to have been in the Metrology Lab three times: once for Mechanical Engineering Practice I, then for MEEM 3600, and finally in their Senior Design Capstone or Enterprise project.

"These introductions to the lab will hopefully help them feel confident in their ability to take measurements, and understand what the right measurement tool is for their specific use case." Store continues:

> *"We want to teach students the foundational principles for measurement so they know how to apply them and go beyond the technicalities of theoretical engineering."*

Along with the new equipment, the modules included within the Introduction to Manufacturing course will be adapted to incorporate concepts in data-driven manufacturing.

"We are giving students exposure to the equipment they will see in industry when they graduate. Striving to achieve good familiarity with part validation tasks, and knowing the equipment well, is critical to being effective on day one," says Store.

> *"We are giving students the tools needed for quality control and helping them see the changes being made in the manufacturing world. We know familiarity and fluency strengthen their hands-on, intensive experience. Confidence is built on reality."*

SPONSOR
NUCOR

4IR CURRICULUM INITIATIVE

The rapid pace of technological change favors agile and adaptive organizations. Although the ME-EM Department is among the largest in the nation, it continues to efficiently evolve its curriculum to ensure graduates are thoroughly prepared.

Through reviews of industry trends and adaptations, the faculty began a shift to swiftly incorporate fourth industrial revolution, big data, machine learning, and artificial intelligence (AI) into the curriculum in 2018. The results of those efforts will be implemented through undergraduate and graduate courses in the fall and spring semesters.

"The fourth industrial revolution will have a significant impact on the careers of our graduates, so we have adapted our educational programs to align with the digital mechanical engineering space. This bolsters our commitment to students and the industries that hire our graduates," explains **Dr. Bill Predebon**, Department Chair.

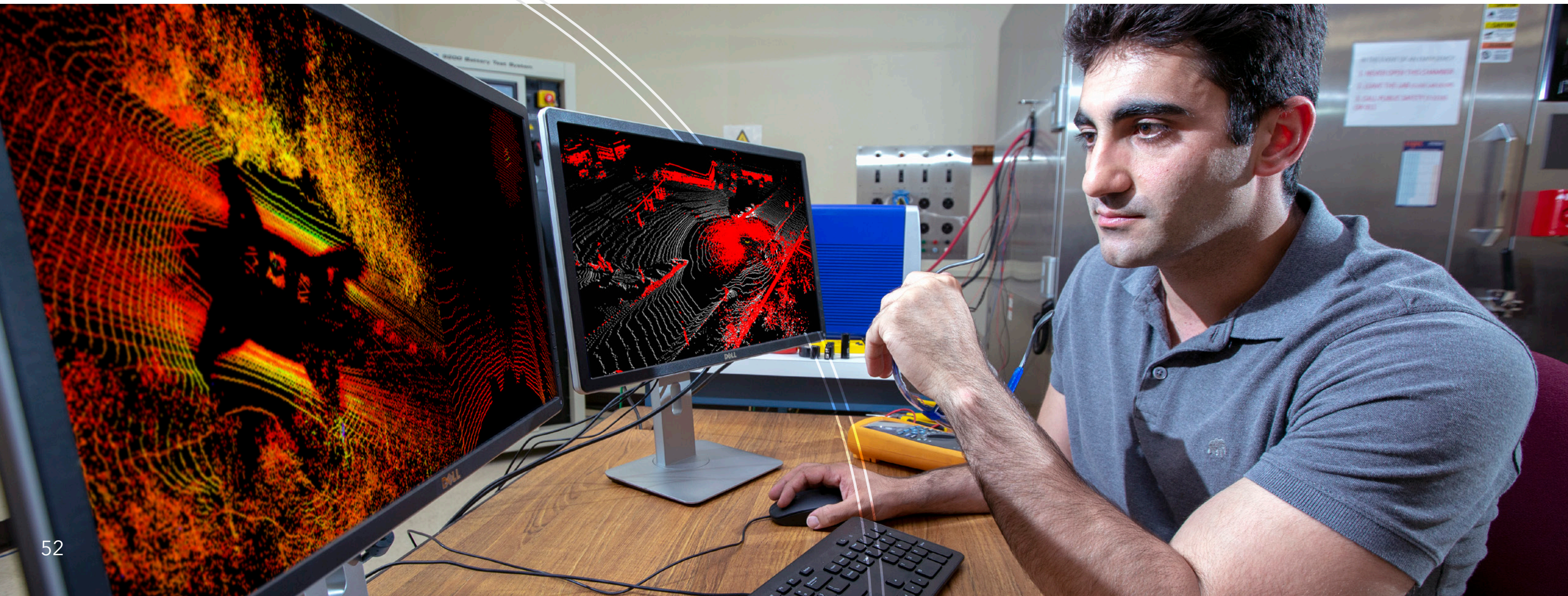
Modules being developed for courses and labs address big data and machine learning environments.

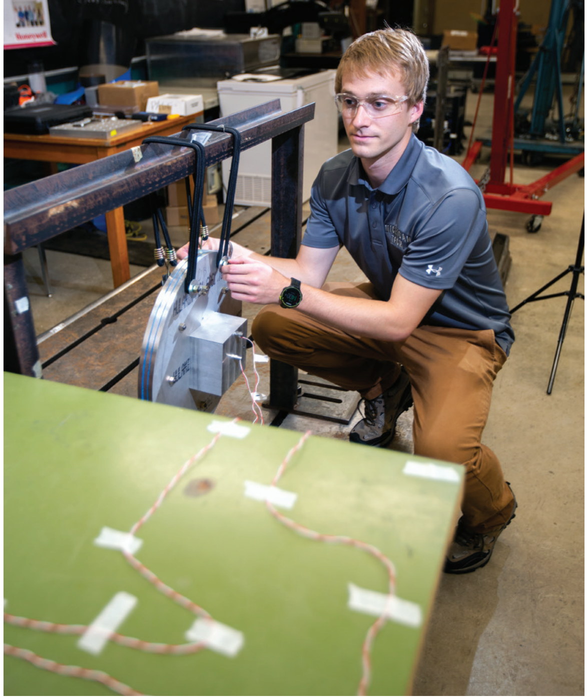
Revisions to the curriculum impact:

- MEEM 2150: Mechanics of Materials
- MEEM 2201: Thermodynamics
- MEEM 3600: Introduction to Manufacturing
- MEEM 4901 & 4911: Senior Capstone Design Sequence
- MEEM 4702: Integration of AI-Enabled Agents for Structural Health Monitoring
- MEEM 5230: Advanced Heat Transfer
- MEEM 5999: Data Driven Vibroacoustics
- Engineering Learning Center: Peer-Instruction through Teaming

Leading the efforts of the revision in Mechanics of Materials course is **Dr. Aneet Narendranat**. Through the coursework, students learn and apply theories of calculating the strength of a structure. While the concept hasn't changed since the 1950s, how the machines and humans interact for real-time decision making and support has advanced.

> *"As a mechanical engineer, data science principles are becoming a tool to employ, so what we are integrating into the course is a blend of computer programming, real-time data collection, and monitoring."*
> *—Dr. Aneet Narendranat*





Students create a general-purpose function that solves equations. This modeling tool can be taken with them after graduation as a web-based decision making tool that can be adapted to many problems, based on their situation.

"The tool generates synthetic data which it then analyzes; it uses real engineering methods and provides flexibility to change what the 'measured' data looks like without needing new hardware and it can be integrated with other neural networks," he shares. "With the artificial intelligence elements, our students are given an immense opportunity to create something of value that can move on with them–through their education and even into their careers."

The curriculum revisions are being carefully planned and rolled out to ensure students learn the critical concepts for each course with the data elements added in layers. "We are taking our first step to add in a module for the Thermodynamics course that will address data analytics and big data, but our primary focus is to not add any new content to overwhelm the students," remarks **Dr. Ana Dyreson**.

In Dyreson's Thermodynamics course, students will utilize MATLAB, a tool they have already used, with equations of state.

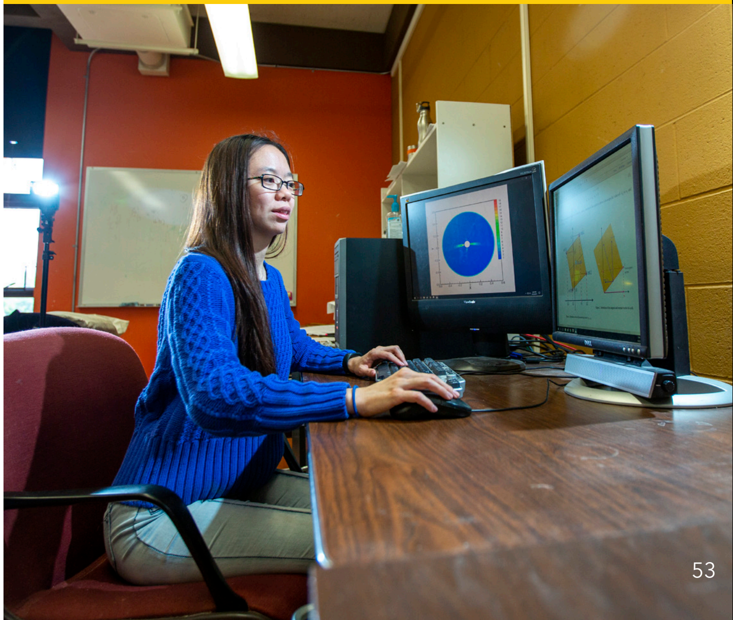
> *"The big data piece will come in on these state equations, which will transition from written problems to data analytics–bringing in another skill, but also serving as a practice opportunity."*
> *—Dr. Ana Dyreson*

Focused on enriching the course with big data, Dyreson hopes to allow students to understand the principles, recognize the principles in data, and transition the big data concepts from a black box to a framework they at least partially understand.

Dyreson is encouraged by the opportunities big data presents: "Thermodynamics is often invisible, but can be perceived through mapping patterns. Some we know from life experiences, but when we don't have intuition to rely on, the data gives us something to wrap our heads around."

Refining the current structure of the Introduction to Manufacturing course, **Dr. Fei Long** is reworking the coursework and lecture elements to include a module on data analysis, probability, and statistics. "In the discussion, we will show students how data analysis techniques are used in manufacturing, especially for product quality assurance," explains Long. The data analytics information will then be applied in a lab setting for hands-on experience in data collection and monitoring.

> *"The lab portion will show students how to tell if the data collection is working or if there are measurement problems. They'll learn how to abstract the information and apply probability and statistics to parameterize the features of the data set."*
> *—Dr. Fei Long*



Of the course adaptations, Long is focused on two areas. The first will be adding a manufacturing simulation that will guide students on defining the processes for making an aluminum bottle and planning a production line.

"In the production planning phase, students will explore what it looks like to bring a design into production–looking at the efficiency, energy, and the cost of the materials. After everything has been verified and the models are created, then they will use the software tools to perform an evaluation," explains Long.

Data can be collected along the manufacturing line and has improved the industry. "Computers are good at pattern recognition and can often detect a problem before humans can. It is a benefit of integrating AI into the workforce; we just need to train our students to think in that way while still remaining true to engineering fundamentals," Long says.

To bridge the gap with AI algorithms and visual systems, Dr. Yongchao Yang is leading the charge in creating a dynamic course for structural health monitoring.

"We commonly use sensors to measure the vibration and response of a dynamic system to indicate a building's structural health. With the new AI-empowered technique, we can integrate computational sensing capabilities and train deep learning models to understand diffraction limits more accurately," Yang notes.

Students will put structural health monitoring concepts into practice to enhance their deep learning and physics-based simulation understandings. Yang is excited for the hands-on experiences students will receive in the lab:

> *"Our students will use a camera to capture vibration and use deep learning to process the data, comparing this method with traditional sensor measurements. It will encourage them to explore all concepts and pathways."*
> *—Dr. Yongchao Yang*

Neural networks serve as the building blocks for a majority of the machine learning and AI algorithms that surround heat transfer problems. Dr. Hassan Masoud will guide graduate students through industry 4.0 and problem-solving.

"Neural networks are global approximators of functions. They aren't always the most efficient way to solve a problem and we need to train our students on when and how to use them," says Masoud, who focuses on the simplification of neural networks.

While machine learning offers students an exciting and challenging way to solve a problem, Masoud focuses his efforts on the big picture. He seeks to ensure the problem is solved in an efficient and effective manner.

"Machine learning isn't a magic tool box that will solve all of your problems. There are pros and cons to every method, and a lot of things we can do to simplify the problem before giving it to the computer. I encourage 'physics-informed' deep learning."
—Dr. Hassan Masoud

Machine learning will be a part of a graduate's role in industry as data becomes increasingly available with internet-connected devices, but Masoud remains dedicated to providing students with a principled framework for understanding data.

"We need to teach our students a reliable approach. Machine learning isn't just a way to produce numbers on a graph that look reasonable. If students keep themselves rooted in first principles behavior, we can teach them machine learning is an option in the tool box. It can be one you reach for once you have simplified the problem and verified it is the best and final option—not just the 'easy' one," explains Masoud.

A special course is also being created in Data Driven Vibration Acoustics by **Dr. Sriram Malladi** to further enhance undergraduates' abilities. Students will gather and process data through feature extraction related to vibration and acoustics.

"To provide hands-on learning opportunities, students will create a baseline dataset using tools like a camera, accelerometer, or a microphone. They will move from the baseline to create a training set and conduct principal components analysis. As data-driven engineers, students will focus on how to select the right tool for their specific application—realizing there are hundreds of tools available."
—Dr. Sriram Malladi

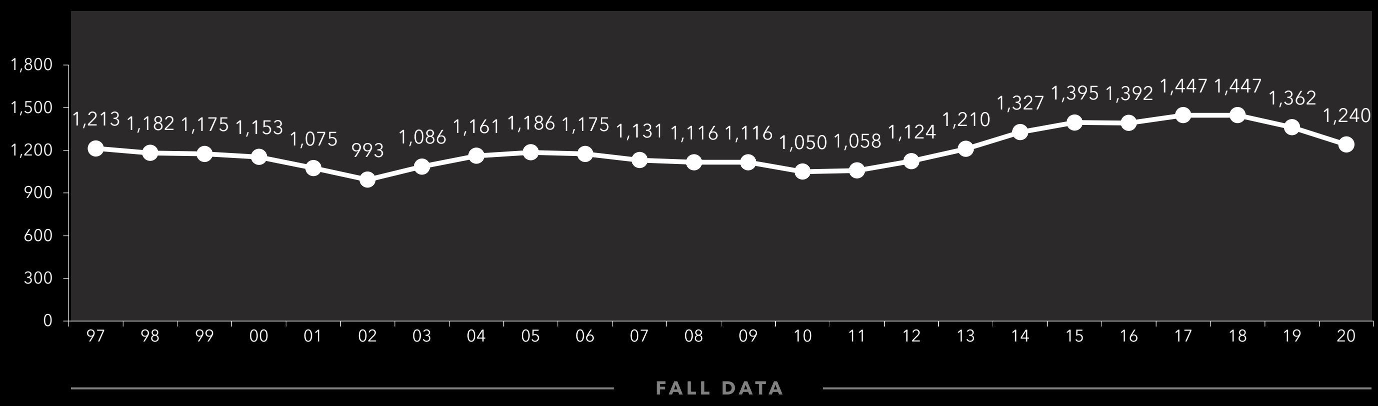
Over summer, Malladi has been working to collect acoustic data of people walking, biking, and running. Through the course, students will use the vibration measurements to characterize the sensor response and ultimately create a classification model.

"This will be a hands-on class with two lecture days and two days of practical. There is a right time to do data analytics and machine learning, so my effort will be on repackaging everything so these young engineers can understand it from a first principles standpoint and from an application perspective," he says.

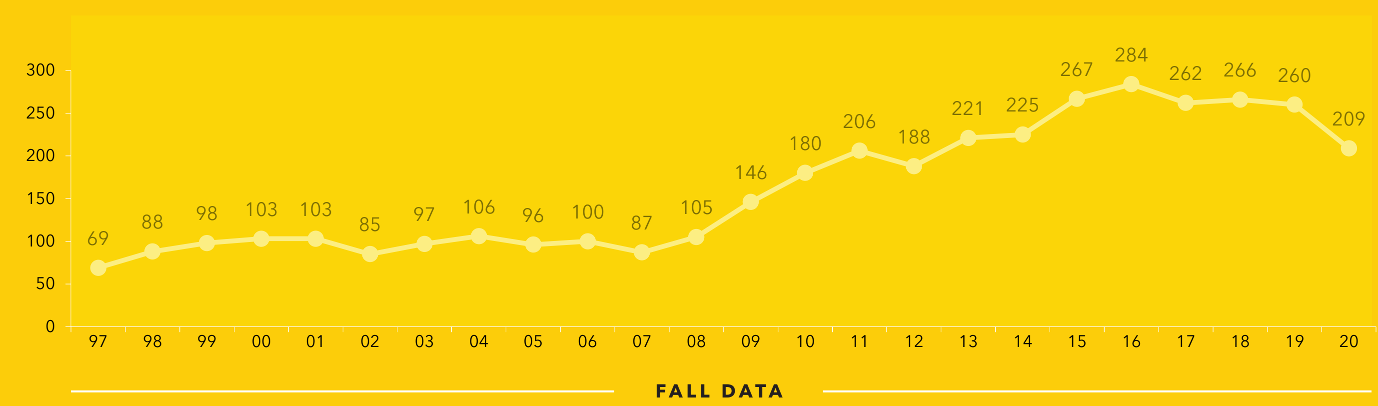
In the spring semester, these courses will be rolled out as a pilot, while the faculty refine the courses for the best possible student outcomes. At the core, the faculty remain committed to ensuring our graduates are prepared for emerging challenges.

"We are developing a student's ability to visualize measurement distributions, understand why they take that shape, and what the underlying process may be. Fundamental understanding is not replaced by machine learning, rather it is enhanced to round out their educational experience," explains Masoud.

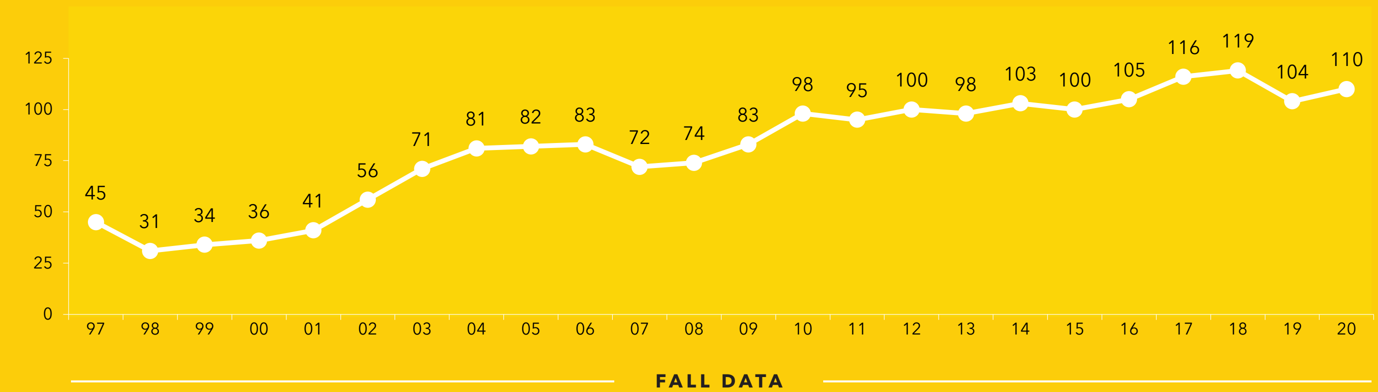
BS ENROLLMENT



MS ENROLLMENT

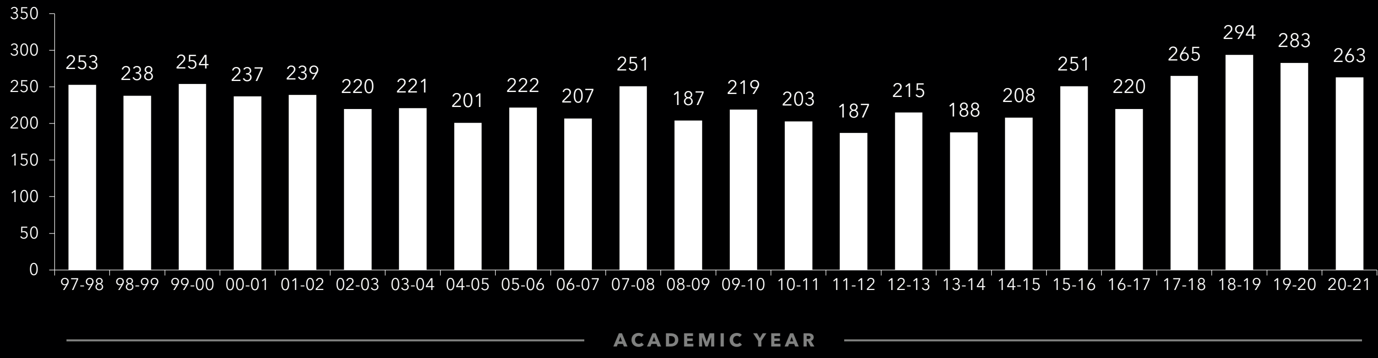


PHD ENROLLMENT

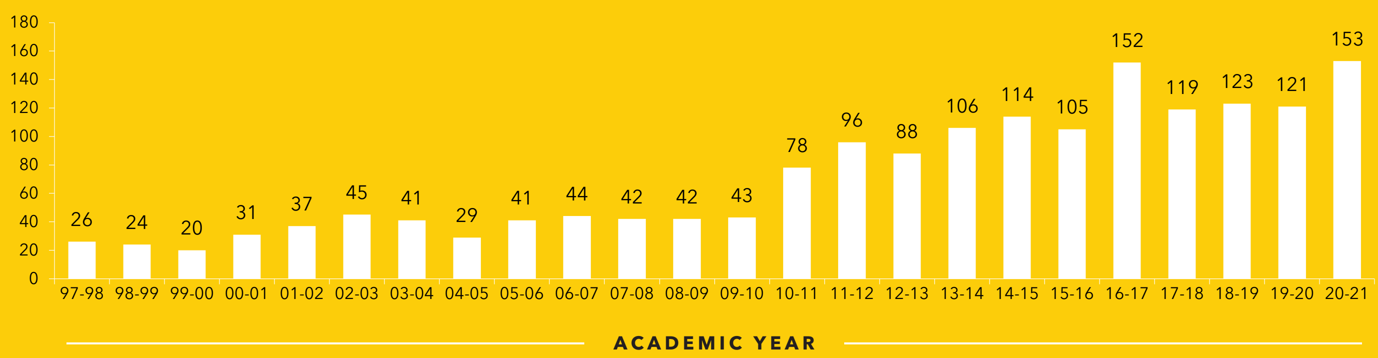


In a few cases, the BS enrollment and degree data may differ from past publications because the official, final enrollment data is only available after this publication goes to press.

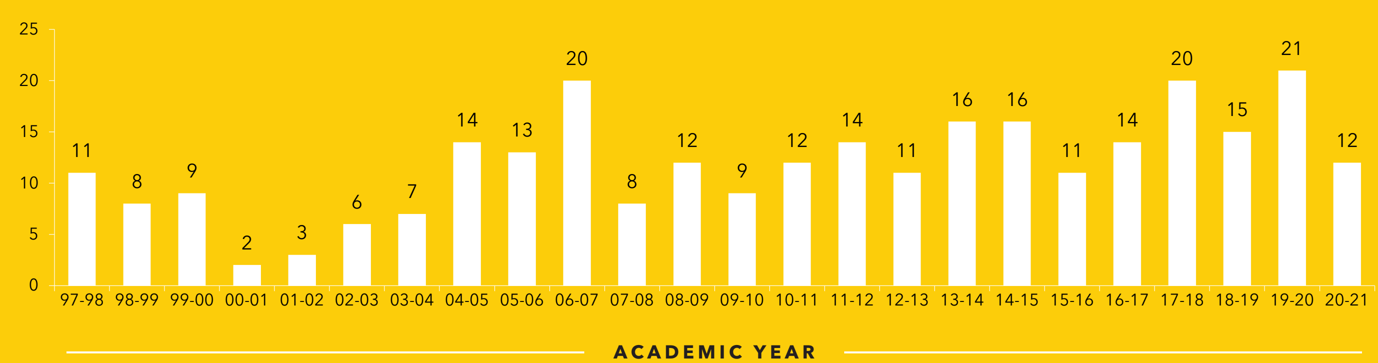
BS DEGREES



MS DEGREES



PHD DEGREES



BS GRADUATES (263)

SUMMER 2020 (17)

Josh M. Carpenter
Clay H. Cross
Gita A. Deonarain - Magna Cum Laude
AJ N. Ebling
Mitchell J. Fitzpatrick
Tristin R. Franckowiak
Claire E. Hill - Magna Cum Laude
Tyler J. Kulich
Jordan D. Null - Magna Cum Laude
Zach S. Rutherford
Sidney A. Schroeder
Zach M. Schwab
Tyler G. Seaman
Greg S. Seppanen
Aaron J. Streng
Nicole C. Wright
Sam M. Wurst - Cum Laude

FALL 2020 (101)

Leah O. Arnt
Alex J. Ashley
Alex J. Basaj
Nathan J. Beining
Jesse J. Boehm
Brandon P. Bomireto
Sawyer Braun - Magna Cum Laude
Riley L. Bretting Cum Laude
Matthew P. Brownson - Cum Laude
Sam C. Bulthuis - Cum Laude
Griffin J. Carpenter
Jian Chen
Christian T. Choate
Jared R. Clabots
Cole F. Dalquist
Joseph M. DeMaria
Benjamin C. Eddy
Jacob R. Ehle
Samantha E. Evans
Cade A. Ferguson
Josie A. Fiore - Magna Cum Laude
Marcy E. Fries
Sam D. Gaffney
Kagan W. Govek
Chris W. Grande
Chase T. Gregory
Kyle J. Hannah
Matthew S. Hasbrouck - Summa Cum Laude
Blake E. Hereau
Jackson L. Hover
Jenna M. Hoyer
Michael J. Hubbard
Nathan D. Isley
Dylan M. Jensen - Cum Laude
Sam A. Johnson
Corbin J. Johnson
Josh M. Kalkman
Adam J. Kallioinen
Mitchell G. Kemppainen
Todd A. Kiilunen
Abby F. Kirk
Jacob H. Knott
Trevor A. Krygier
Adam C. Kurdelski - Magna Cum Laude
Duncan M. Lackner - Magna Cum Laude
Larry R. Lamb
Jared M. Langdon
Braeden W. Lawrence - Cum Laude
Andrew P. Lewinski
Jason J. Looker
Jake C. Luikart
Peter E. Lund
Ben D. Lutz - Summa Cum Laude
Aidan J. Lynch
Jake R. Macey - Cum Laude
Zachary D. Mans
Shane T. Marquardt
Donny L. Marwin
Ryan A. Mattson
Camden A. Maxey
Job P. Mayer - Cum Laude
Harrison D. Mills - Cum Laude
Walter J. Mistak
Chelsea L. Morin
Avery R. Mosley
Amanda Moya
William H. Ohm
Joe R. Outinen
Carter A. Paprocki
Jake C. Paulsen
Josh A. Penrose
Lucas M. Piekarski - Cum Laude
Ross T. Rantanen
Spencer W. Reed
Hunter V. Richards
Michael W. Rosenquist - Cum Laude
Connor G. Rowley
Chase A. Scheel
Austin A. Scheerer
Kyrstin M. Schmidt - Cum Laude
Travis J. Seagmen
Brandon N. Simone
Brandon A. Spawn - Cum Laude
Ben D. Spiller
Bryce A. Stallworth
Tyler E. Strauss - Cum Laude
Matt J. Tracey - Cum Laude
Alexander R. Tuomi
Mustafa H. Turi
Samuel D. Vanderlin
Xochitl A. Villezcas
Rachael L. Violassi
Theo C. Wachowski - Magna Cum Laude
Andrew C. Wells
Tyler J. White - Summa Cum Laude
Annalisa F. Wiesner - Magna Cum Laude
Harrison E. Woelfel
Jordan L. Woldt
Daniel Wu
Yixiong Xiao
Loryn R. Zeno - Magna Cum Laude

SPRING 2021 (145)

Blake E. Aakhus
Noah H. Agata
Josh W. Albrecht - Summa Cum Laude
Braeden B. Anex
Thomas C. Arbanas - Magna Cum Laude
Lane E. Beaumier - Magna Cum Laude
Hannah E. Bekkala

8

THE ME-EM DEPARTMENT IS RANKED 8TH IN BSME ENROLLMENT BY THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

David C. Bell
Jacob T. Bely
Alec C. Berger
Abby A. Bevilacqua - Magna Cum Laude
Sean J. Bex
Grace E. Biehl
Cody D. Blast
Brian D. Blust - Magna Cum Laude
Benjamin M. Bolzman - Magna Cum Laude
Brooke C. Breen - Cum Laude
Andrew G. Bretz - Summa Cum Laude
Brent M. Bulgarelli
Brian C. Byler
Matthew A. Casey
Michael J. Chynoweth
Tyler L. Cobb
Jacob S. Coscarelly - Cum Laude
Liam J. Curtin - Magna Cum Laude
Alex B. Czarnecki - Summa Cum Laude
Luke A. Daavettila
Evan W. Dalgord
Eli J. Datema - Cum Laude
Hayden A. DeLong
Alexandra N. DeYoung
Nathan B. Duisterhof-DeBoer - Cum Laude
Kurt J. Egelhaaf
Eriq R. Eichinger
Noah C. Ekdom - Magna Cum Laude
Ethan J. Fisher
Collin M. Francis
Evan W. Fuerst
Sam N. Gibbs - Magna Cum Laude
Jon G. Gietek - Magna Cum Laude
Austin M. Gifford - Summa Cum Laude
Mike D. Groeneveld
Dan J. Hallam - Summa Cum Laude
Dairion N. Hartshorn
Sam R. Hawkins - Summa Cum Laude
Rocket J. Hefferan
Justin J. Henderson
Jacob M. Herbert - Magna Cum Laude
Kip C. Herich
Sarah M. Hirsch - Magna Cum Laude
Matt E. Hoefle - Cum Laude
Sam L. Horne
Brandon W. Howard - Cum Laude
Clayton D. Hubred
Bryce M. Hudson - Cum Laude
Nate J. Huebner - Cum Laude
Tristan A. Hunt
Austin C. Ihrig
LeeAnne Jauquet - Magna Cum Laude
Hunter M. Jeffreys
Ben R. Johnson - Magna Cum Laude
George B. Johnson - Magna Cum Laude
Tristan J. Johnson
Brady G. Jonas - Cum Laude
Matt P. Juzwiak
Robert J. Kassel
Tristan J. Keckonen
Will R. Kendall
Lukas J. Kenimer
Collin M. Kerkstra - Summa Cum Laude
Josh J. Klobuchar
Austin E. Kosinski
Liam V. Kosloski
Owen P. Krautkramer
Alec T. Kusaka
Ethan E. Lindborg
Brandon P. Linna
Andrew J. Lippens
Ty C. Longstreet - Cum Laude
Liam J. MacGillivray
Matthew K. Makarewicz
Harsh M. Malu
Isaiah L. Mattson
Sam T. Medley
Courtney A. Melville - Cum Laude
Noah D. Miller
Alec J. Milliron - Magna Cum Laude
Martin N. Mueller
Ben J. Mulder - Cum Laude
Justin D. Novotny
Ethan G. Odriscoll - Cum Laude
Nick B. Olsen
Jake R. Oomkes - Magna Cum Laude
Jared F. Ottman
Mark M. Ousdigian - Summa Cum Laude
Ethan N. Parker - Cum Laude
Kory A. Patrick
Anthony P. Patteri - Cum Laude
Tyler J. Petermann - Magna Cum Laude
Luke E. Pietila - Cum Laude
Lucas S. Prince
Garrett J. Radosa - Summa Cum Laude
Anthony M. Rebera - Magna Cum Laude
Ken G. Redner
Mary C. Repp - Magna Cum Laude
Peadar R. Richards
Alex J. Roelant - Cum Laude
Corey J. Rothering
David J. Rozinka
John C. Ruf - Magna Cum Laude
Philip J. Schaub - Cum Laude
Sean S. Scsavnicki - Summa Cum Laude
Austin G. Selle
Chase A. Shorey - Magna Cum Laude
Reid D. Slagboom
Derek J. Slominski
Carter H. Slunick
Brenden S. Sluyter
Trevor J. Smith
David C. Soderman - Summa Cum Laude
Sarah E. Stadler - Cum Laude
Jake G. Starry
Lexi L. Steve
Mike A. Stinchcomb - Magna Cum Laude
Allison M. Storm
Noah G. Taylor
Logan R. Thomas - Cum Laude
Ty N. Timmermann
Brandon R. Tolsma
Bridget A. Troost
Andrea E. Udovich
Jordan S. Van Calster
Joseph H. Van Linn - Summa Cum Laude
Landon R. VanAcker
Case J. Vander Ploeg - Magna Cum Laude
Olivia M. Vargo
Tabitha L. Walsh
Christian K. Walters - Summa Cum Laude
Joseph M. Weber - Magna Cum Laude
Lucas A. Wenderski - Magna Cum Laude
Nick S. Weykamp
Jared A. Wohlford
Todd J. Woloszyk
Avery M. Woodbury
Emily R. Zeitunian - Magna Cum Laude

MS GRADUATES (152)

SUMMER 2020 (27)

Abhi, Himansshu
Advisor: Craig R. Friedrich
Course work only

Arora, Manas
Advisor: Craig R. Friedrich
Course work only

Awasthi, Rishabh
Advisor: Trisha Sain
Sensitivity and Uncertainty Quantification of Continuum and Stochastic Bond Dissociation Kinetics Based Cohesive Laws

Hoehnen, Mattias M.
Advisor: Craig R. Friedrich
Course work only

Khairnar, Pushkar Prashant
Advisor: Susanta Ghosh
A Bayesian Convolutional Neural Network Based Classifier to Detect Breast Cancer from Histopathological Images and Uncertainty Quantification

Komma, Akhil
Advisor: Craig R. Friedrich
Course work only

Kommineni, Raghu Ram
Advisor: Jeffrey D. Naber
Course work only

Liimatta, Jacob R.
Advisor: Craig R. Friedrich
Course work only

Markl, Jonathan B.
Advisors: Jason R. Blough and Andrew R. Barnard
Analysis of a Circular Resonant Plate for Shock Testing

McCann, Connor J.
Advisor: Craig R. Friedrich
Course work only

Mishra, Sumit
Advisor: Craig R. Friedrich
Course work only

Nadeem, Syed Ahmad
Advisors: Mahdi Shahbakhti and Darrell L. Robinette
Development of an Anti-Jerk Controller for Both Locked and Slipping Torque Converter Conditions in a Vehicle

Nelson, Walker H.
Advisor: Andrew R. Barnard
Active Noise Control Using Carbon Nanotube Thermophones: Case Study for an Automotive HVAC Application

Parikh, Pruthak Milankumar
Advisor: Craig R. Friedrich
Course work only

Patwardhan, Narendra Prakash
Advisor: Zequn Wang
Proximal Reliability Optimization for Reinforcement Learning

Price, Thomas K.
Advisor: Gordon G. Parker
A Neural Network Approach to Estimate Buoy Mooring Line Sensor Deflection

Rahane, Atharva Manoj
Advisor: Amitabh Narain
Efficient Enhancement of Micro-Nucleation Rates in Flow-Boiling - by Concurrent Micro-Structuring of the Boiling-Surface and its Judicious Energization by Piezoelectric-Transducer Induced Acoustic Vibrations

Sathe, Chinmay Prasad
Advisor: Craig R. Friedrich
Course work only

Sethia, Shreyans Subhash
Advisor: Jeffrey D. Naber
Radio Frequency Studies of Soot Loading and Ammonia Storage on a Diesel Particulate Filter with a SCR Catalyst Coating

Shanbhag, Vishal Umesh
Advisor: Craig R. Friedrich
Course work only

Shegokar, Saurabh Shankar
Advisor: Gregory M. Odegard
Buckling Load Study on Pop Nut (Rivet) Using Finite Element Analysis

Shetty, Subin Sayinatha
Advisor: Craig R. Friedrich
Course work only

Sitaraman, Radhika
Advisors: Mahdi Shahbakhti and Jeffrey D. Naber
Identification of Heat Release Shapes and Combustion Phasing Control of an L TC Engine

Tak, Sudarshan
Advisor: Craig R. Friedrich
Course work only

Vatsa, Shubham
Advisor: Jeffrey D. Naber
Vehicle Dynamics Modeling for Autonomous Drifting and Clothoid Based Waypoint Interpolation

Wagh, Aditya Vasant
Advisor: Yongchao Yang
Deep Learning of Nonlinear Dynamical System

FALL 2020 (39)

Bhalla, Prateek Sameer
Advisor: Craig R. Friedrich
Course work only

Close, Brett M.
Advisor: Craig R. Friedrich
Course work only

Cohen, Zachary J.
Advisors: Andrew R. Barnard and Vijaya Venkata Narasimha Sriram Malladi
Experimental Characterization of Spool Valve Flow Noise

Dalvi, Manoj Dilip
Advisor: Craig R. Friedrich
Course work only

16

THE ME-EM DEPARTMENT IS RANKED 16TH IN MSME DEGREES AWARDED BY THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Ellingson, Max A.
Advisor: Craig R. Friedrich
Course work only

Essenmacher, Kevin L.
Advisor: Craig R. Friedrich
Course work only

Gaikwad, Gaurav Santosh
Advisor: Craig R. Friedrich
Course work only

Heyne Minehart, Cooper J.
Advisors: Jason R. Blough and Jeffrey D. Naber
Data Driven Sensor Fusion for Cycle-Cycle IMEP Estimation

Jain, Shubham Rajesh
Advisor: Craig R. Friedrich
Course work only

Karkare, Ketan
Advisor: Craig R. Friedrich
Course work only

Kotha, Venkata Ramana
Advisor: Craig R. Friedrich
Course work only

Krishna Kumar, Abhijit
Advisor: Craig R. Friedrich
Course work only

Kulkarni, Rushikesh Dilip
Advisor: Craig R. Friedrich
Course work only

Kumar, Sai Prashanth
Advisor: Youngchul Ra
Generation of Premix Laminar Flame Speed Library

Kushwaha, Shivom
Advisor: Craig R. Friedrich
Course work only

Lindfors, Jonathon W.
Advisor: Jeremy J. Worm
Impact of Water Ingestion on Combustion Performance in a Spark Ignited Internal Combustion Engine

MacLean, John G.
Advisor: Gordon G. Parker
Course work only

Malik, Nitish
Advisor: Craig R. Friedrich
Course work only

Masna, Sudhachandra
Advisor: Craig R. Friedrich
Course work only

Mcjunkin, Adam C.
Advisor: Craig R. Friedrich
Course work only

Miller, Tyler J.
Advisors: Jeffrey D. Naber and Jeremy J. Worm
Design, Build, and Analysis of a Compressed Natural Gas Direct Injection Compression Ignition Single Cylinder Research Engine

Nain, Raman
Advisor: Craig R. Friedrich
Course work only

Narodzonek, Brandon T.
Advisor: Jeffrey D. Naber
Development of an Eco Approach and Departure Application to Improve Energy Consumption of a Plug-In Hybrid Vehicle in Charge Depleting Mode

Nikam, Parag Balasaheb
Advisor: Susanta Ghosh
Phase Field Fracture Modeling of Chemically Strengthened Glass

O'Mara, Reese W.
Advisor: Craig R. Friedrich
Course work only

Patil, Amit Vilas
Advisor: Craig R. Friedrich
Course work only

Pawar, Gaurav Sudhakar
Advisor: Craig R. Friedrich
Course work only

Pothugunti, Venkata Siva Sai Manoj
Advisor: Craig R. Friedrich
Course work only

Purushothaman, Ashwin Karthik
Advisor: Youngchul Ra
Numerical Investigation of Spray Characterization of Heater-GDI System

Puttur, Umamaheswar
Advisor: Sajjad Bigham
Development and Experimental Investigation of a Lung-Inspired 3D-Printed Desiccant-Coated Heat Exchanger

Rajput, Vibhor Kumar
Advisor: Craig R. Friedrich
Course work only

Ramsey, Andrew N.
Advisor: Craig R. Friedrich
Course work only

Shah, Parin Kaushik
Advisor: Craig R. Friedrich
Course work only

Shively, Alexander J.
Advisor: Craig R. Friedrich
Course work only

Sule, Salil Sanjay
Advisor: Craig R. Friedrich
Course work only

Taware, Vikas Dilip
Advisor: Craig R. Friedrich
Course work only

Taylor, Cora J.
Advisors: James P. DeClerck and Jason R. Blough
Using Transfer Path Analysis and Frequency Based Substructuring to Develop a Robust Vibration Laboratory Dynamic Test Fixture Design Process

Van Linn, James H.
Advisor: Craig R. Friedrich
Course work only

Voruganti, Someswar
Advisor: Craig R. Friedrich
Course work only

MS GRADUATES (152)

SPRING 2021 (86)

Abhyankar, Shreyas Sriniwas
Advisor: Craig R. Friedrich
Course work only

Akash Raj, FNU
Advisor: Craig R. Friedrich
Course work only

Anumula, Anvesh
Advisor: Craig R. Friedrich
Course work only

Baas, Bradley D.
Advisors: Paulus J. van Susante and Guy A. Meadows
Investigation of a Machine-Plant Interface for Extracting Rooted Invasive Aquatic Plants

Baghel, Sachin
Advisor: Craig R. Friedrich
Course work only

Barrett, Trevor M.
Advisor: Craig R. Friedrich
Course work only

Bende, Manas Prabhakar
Advisor: Craig R. Friedrich
Course work only

Bhatia, Yakshu
Advisor: Craig R. Friedrich
Course work only

Biederwolf, Matthew A.
Advisor: Craig R. Friedrich
Course work only

Bindal, Himanshu
Advisor: Craig R. Friedrich
Course work only

Chandra, Aparna
Advisor: Craig R. Friedrich
Course work only

Chinchane, Shubham Shashikant
Advisor: Craig R. Friedrich
Course work only

Chitlu, Venkata Sai Sekhar
Advisor: Craig R. Friedrich
Course work only

Dalvi, Pratik Devendra
Advisor: Craig R. Friedrich
Course work only

Damarla, Bala Vadan
Advisor: Craig R. Friedrich
Course work only

Deokule, Atharva Jitendra
Advisor: Craig R. Friedrich
Course work only

Deshpande, Tanmay
Advisor: Craig R. Friedrich
Course work only

Frybarger, Lucas R.
Advisor: Craig R. Friedrich
Course work only

Ganesan, Vimalraj
Advisor: Craig R. Friedrich
Course work only

Ghorpade, Vishvajeet Mahadeo Rao
Advisor: Craig R. Friedrich
Course work only

Gosar, Poonam Vijay
Advisor: Craig R. Friedrich
Course work only

Govardhan, Rohan Ravindra
Advisor: Craig R. Friedrich
Course work only

Gudadhe, Devendra Vinay
Advisor: Craig R. Friedrich
Course work only

Gupta, Kartikey
Advisor: Craig R. Friedrich
Course work only

Gupta, Shivam
Advisor: Sajjad Bigham
Membrane-Based Heat Sink for Enhanced Flow Boiling Performance and Reliability

Hardikar, Manas
Advisor: Craig R. Friedrich
Course work only

Hempy, Abigail A.
Advisors: Jason R. Blough and Darrell L. Robinette
Transient Maneuvers and Pressure Analysis on an Automotive Torque Converter

Hendrickson, Nicholas V.
Advisor: Craig R. Friedrich
Course work only

Hubbard, Benjamin R.
Advisors: Joshua M. Pearce and Gordon G. Parker
Design and Testing of an Open Source Vacuum Oven for Research, Community Recycling, and Additive Manufacturing

Jabez James, FNU
Advisor: Craig R. Friedrich
Course work only

Jensen, Nicholas J.
Advisors: Gordon G. Parker and Jason R. Blough
Base Vibration Effects on Additive Manufactured Part Quality: A Study of 3D Printing Onboard U.S. Navy Ships

Jisoria, Hitesh Kumar
Advisor: Craig R. Friedrich
Course work only

Kadam, Hrishikesh
Advisor: Craig R. Friedrich
Course work only

Kadu, Rahi Vinod
Advisor: Craig R. Friedrich
Course work only

Kanvinde, Swapnil Anil
Advisor: Craig R. Friedrich
Course work only

Karanke, Saurabh Ashok
Advisor: Craig R. Friedrich
Course work only

Kautzer, Amanda R.
Advisor: Craig R. Friedrich
Course work only

Kelley, Jonathan D.
Advisor: Craig R. Friedrich
Course work only

Kodavali, Rohit Sai Ganesh
Advisor: Craig R. Friedrich
Course work only

Koranne, Aditya Milind
Advisor: Craig R. Friedrich
Course work only

Korgaonkar, Pratik Jayavant
Advisor: Craig R. Friedrich
Course work only

Kumar, Aman
Advisor: Craig R. Friedrich
Course work only

Male, Sai Mohit Raj
Advisor: Craig R. Friedrich
Course work only

Malekar, Isha Sanjiv
Advisor: Gordon G. Parker
Nonlinear Model Predictive Control of Wave Energy Converter

Mhatre, Shreyas Nitin
Advisor: Craig R. Friedrich
Course work only

Mohanan, Vishal
Advisor: Craig R. Friedrich
Course work only

More, Raunak Praveen
Advisor: Craig R. Friedrich
Course work only

Mowade, Ketan Sanjay
Advisor: Craig R. Friedrich
Course work only

Navindgikar, Rishal Harish
Advisor: Craig R. Friedrich
Course work only

Nerella, Gnana Venkata Naga Sai Kumar
Advisor: Craig R. Friedrich
Course work only

Nikumbh, Ashwini Arvind
Advisor: Susanta Ghosh
Atomistic Continuum Simulations for Nano-Indentation and Compression of Multi-Layer Graphene

Panchal, Yash Dilip
Advisor: Craig R. Friedrich
Course work only

Pandey, Vinay Kumar
Advisor: Craig R. Friedrich
Course work only

Pandya, Divya Kamlesh
Advisor: Craig R. Friedrich
Course work only

Patel, Poojan Sanjay
Advisor: Craig R. Friedrich
Course work only

Patel, Trushant D.
Advisor: Craig R. Friedrich
Course work only

Pathak, Vijay Kumar
Advisor: Susanta Ghosh
Studying the Effects of Initial Crack Angle on the Crack Propagation in Graphene Nano-Ribbon through Molecular Dynamics Simulations

Pathrudkar, Shashank
Advisor: Susanta Ghosh
Deformation Manifold Learning Model for Multi Walled Carbon Nanotubes

Patil, Shubham Vishwanath
Advisor: Craig R. Friedrich
Course work only

Pennala, Marcus
Advisor: Craig R. Friedrich
Course work only

Pradhan, Shyam Sundar
Advisor: Craig R. Friedrich
Course work only

Prado, Carlos E.
Advisor: Craig R. Friedrich
Course work only

Qureshi, Hamdaan
Advisor: Craig R. Friedrich
Course work only

Radhakrishna, Suman
Advisor: Craig R. Friedrich
Course work only

Rajavelu, Gowtham
Advisor: Craig R. Friedrich
Course work only

Ravikumar, Sudharshan
Advisor: Craig R. Friedrich
Course work only

Rawoot, Altaf Adam
Advisor: Craig R. Friedrich
Course work only

Rudraraju, Manish
Advisor: Craig R. Friedrich
Course work only

Saini, Abhijeet
Advisor: Craig R. Friedrich
Course work only

Satish Kumar, Yogesh Kumar
Advisor: Chang Kyoung Choi
Economic Sustainability Analysis of Natural Leather Industry, and Its Alternative Advancements

Schumaker, Noah N.
Advisor: Craig R. Friedrich
Course work only

Serra, Sophia G.
Advisor: Craig R. Friedrich
Course work only

Sharma, Rohit
Advisor: Craig R. Friedrich
Course work only

Shivarkar, Rutuja Sunil
Advisor: Craig R. Friedrich
Course work only

Singh, Aayush
Advisor: Craig R. Friedrich
Course work only

Sinha, Shubham
Advisor: Susanta Ghosh
Phase-Field Fracture Modeling for Interlocking Micro-Architectured Materials

Sivakumar Dhaya, Aakash
Advisor: Craig R. Friedrich
Course work only

Szostak, Chase A.
Advisor: Craig R. Friedrich
Course work only

Tetzloff, Thomas N.
Advisor: Craig R. Friedrich
Course work only

Tiwari, Shivam
Advisor: Craig R. Friedrich
Course work only

Tsao, Robert
Advisor: Craig R. Friedrich
Course work only

Turowski, Nicholas A.
Advisor: Craig R. Friedrich
Course work only

Vaglica, Stephania M.
Advisor: Andrew R. Barnard
Application of Carbon Nanotube Thermophones as Duct Noise Cancelling Speakers: Using New Technology with Old Theories

Wavrunek, Travis A.
Advisor: Paulus J. van Susante
Active Gravity Offloading System with Infrared Tracking for Rover Testing

Wendawek, Leykun Bezabeh
Advisor: Craig R. Friedrich
Course work only

Zhang, Duo
Advisor: Bo Chen
Comparison of Path Planning Approaches of Autonomous Vehicles for Obstacle Avoidance Application

MENG GRADUATE (1)

Kung, Hsiang En
Advisor: Leonard J. Bohmann
Practicum Waived

PHD GRADUATES (12)

SUMMER 2020 (4)

Jalal, Sarah
Advisor: Fernando L. Ponta
Reduced-Order Characterization of the Aeroelastic Response of Stall-Controlled Wind Turbines Under Atmospheric Turbulence

Mancuso, Thomas
Advisors: Abhijit Mukherjee and Craig R. Friedrich
Assessment and Improvement of Computational Fluid Dynamics Methods for Separated Turbulent Flows at Low Reynolds Numbers

Miranda, Alexander W.
Advisor: Steven Y. Goldsmith
Cyber Risk Management and Modeling for Photovoltaic (PV) Plants

Pourhasanzadehsharifi, Maryam
Advisors: Jeffrey D. Naber and Seong-Young Lee
Study of Spark Discharge and Cycle-to-cycle Combustion Variations using Optical Diagnostics

FALL 2020 (4)

Furlich, Jon E.
Advisor: Darrell L. Robinette
Experimental Evaluation of an RWD Vehicle with Parameter Extraction for Analytical Modeling and Evaluation

Li, Mingyang
Advisor: Zequn Wang
Heterogeneous Uncertainty Quantification for Reliability-Based Design Optimization

Oncken, Joseph E.
Advisor: Bo Chen
Real-Time Predictive Control of Connected Vehicle Powertrains for Improved Energy Efficiency

Wang, Xin
Advisors: Bo Chen and Jeffrey D. Naber
A Study of Model-based Control Strategy for a Gasoline Turbocharged Direct Injected Spark Ignited Engine

SPRING 2021 (4)

Bouman, Troy M.
Advisor: Andrew R. Barnard
Development of the Carbon Nanotube Thermoacoustic Loudspeaker

Jamali, Arash
Advisor: Yongchul Ra
A Combustion Model for Multi-Component Fuels Based on Relative Reactivity and Molecular Structure

Raber, Mary B.
Advisor: Sheryl A. Sorby
An Exploration of the Practice of Engineering as Experienced Through the Capstone Course

Xu, Zhuo
Advisor: Ezra Bar-Ziv
Torrefaction of Mixed Solid Waste

ORDER OF THE ENGINEER

FALL 2020
Virtual event

SPRING 2021
Virtual event

Both sessions of the 2020-21 academic year Order of the Engineer were held virtually via Zoom.

We were able to recognize, honor, and welcome over 100 engineers into the profession.

GRADUATE STUDENT FELLOWSHIPS

SUMMER 2020 - SPRING 2021

Doctoral Finishing Fellowship
Zhuo Xu
Zhihao Zhao
Esmaeil Dehdashti
Shahab Bayani Ahangar

Outstanding Graduate Student Teaching Award
Akshay Shankarrao Dongre
Joshua Kemppainen
Yugandhara Yuvraj Patil

Topping Fellowship
Salman Hussein
Pradeep Bhat
Jiachen Zhei

Alumni Fellowship
Apurva Baruah

Dean's Award for Outstanding Scholarship
Prateek Sameer Bhalla
Troy Bouman
Jon Furlich
Saeed Jafari Kang
Zhuo Xu
Jiongxun Zhang
Zhihao Zhao

GRADUATE SCHOOL FELLOWSHIPS

Gadi Fellowship
Nathan Ford

GEM Fellowship
Swapnil Kanvinde

GRADUATE SEMINAR SERIES

EXTERNAL SPEAKERS

Dr. Sa'ed Alajlouni
Hashemite University
Passive and Device-Free Human Activity Monitoring from Floor Vibrations: Focusing on the Problem of Occupant Localization and Path Tracking using Hidden Floor Accelerometers

Dr. Ravi Kishore
National Renewable Energy Lab
Low-grade Thermal Energy Conversion and Storage

Dr. Robert Brown
Iowa State University
Heterodoxy in Fast Pyrolysis of Biomass

Dr. Anita Sengupta
University of Southern California
The Human Exploration of Mars

Dr. Anubhab Roy
Indian Institute of Technology Madras of Chennai, India
Inertial Slender Body Theory

Dr. Eric Morgan
MIT Lincoln Laboratory
From Microgrids to Aluminum Fuel: Energy Research for National Security at MIT Lincoln Laboratory

Dr. George Huber
University of Wisconsin-Madison
The Design of Catalytic Processes for the Conversion of Biomass and Plastics into Fuels and Chemicals

Dr. Michael Craig
University of Michigan
Electric Power Systems in a Changing Climate: Reliability, Costs, and Equity

Dr. Boris Chudnovsky
Israel Electric Corporation
Burning of Renewable Fuels Produced from Carbon Dioxide Aimed for Greenhouse Emission Reduction

Dr. Patrick Musgrave
US Naval Research Laboratory
Bio-inspired Propulsion Using Traveling Waves: The Development and Implementation of Structure-Borne Traveling Waves

Harunori Nagata
Hokkaido University, Japan
Hybrid Rocket Propulsion for Space Exploration Missions

Dr. Naga Srujana Goteti
Electric Power Research Institute
Adding Renewables to the Grid: Effects of Storage

Dr. Ramin Bostanabad
Northwestern University
Latent Spaces in Design, Mechanics, and Beyond

MICHIGAN TECH SPEAKERS

Dr. Sriram Malladi
Department of Mechanical Engineering-Engineering Mechanics
Innovations in Studying Wave-propagation via Data-Centric Engineering

Dr. Mary Zadeh
Department of Mechanical Engineering-Engineering Mechanics
Optical Diagnostics of Ignition and Combustion in High-speed Flows

Dr. Yongchao Yang
Department of Mechanical Engineering-Engineering Mechanics
Physics-guided Machine Learning Methodology for Full-field Imaging and Characterization of Structural Dynamics

Dr. Jung Yun Bae
Department of Mechanical Engineering-Engineering Mechanics
Intelligent Autonomous Navigation for Multiple Heterogeneous Autonomous Vehicles

Dr. Ana Dyreson
Department of Mechanical Engineering-Engineering Mechanics
Climate and Water Stress in a Changing Power System and Implications for the Great Lakes Region

Dr. Sarah Sun
Department of Mechanical Engineering-Engineering Mechanics
E-Logo: Embroidered Wearable Electronics

Dr. Chang Kyoung (CK) Choi
Department of Mechanical Engineering-Engineering Mechanics
Cultured Meat: A Safe and Sustainable Protein Alternative at the Human-Animal Interface

Dr. Ricardo Eiris
Department of Civil, Environmental, and Geospatial Engineering
Learning and Training for Tomorrow's Industry 4.0 Construction Workforce

Dr. Jim Baker
Associate Vice President for Research Administration
The Intersection of Innovation, Intellectual Property Rights, and Commercialization as a Tool for Maximizing Public Benefit from Research

Dr. Lan (Emily) Zhang
Department of Electrical and Computer Engineering
Augmenting Radio Environments for Better Wireless Ecosystems

Dr. Nancy Barr
Department of Mechanical Engineering-Engineering Mechanics
What does it mean to have 'Strong Communication Skills'?

Dr. Weihua Zhou
Department of Applied Computing
Artificial Intelligence for Medical Image Analysis: Our Approaches

Dr. Smitha Rao
Department of Biomedical Engineering
MEMS Devices and the Future

FACULTY AWARDS & HONORS 2020-2021

Dr. Jeff Allen was elected a Fellow of the American Society of Mechanical Engineers (ASME) in recognition for his research contributions in optical diagnostic development for investigating fluid and heat transfer phenomena, his engineering design contributions in microgravity while at NASA, and his leadership in engineering education.

Dr. Nancy Barr was appointed associate editor for STEM for Prompt: A Journal of Academic Writing Assignments.

Dr. Sajjad Bigham leads a team composed of academia, industry, and a DOE national lab to develop next-generation 3D printed, low-cost, ultra-compact, high-temperature and high-pressure heat exchangers. The team received $2.4 million for the work, including a $1.8 million HITEMMP award through the Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E).

Dr. Sajjad Bigham, and researchers from Oak Ridge National Lab, were among eight teams (out of 162) selected as semi-finalists to advance to the 2nd phase of the DOE Solar Desalination Prize competition. The team "Solar Desalt: Sorption-Based ZLD Technology" will receive $350K in funding to advance their research using solar-thermal energy to purify water with very high salt content.

Drs. Sajjad Bigham, **Ana Dyreson**, and **Hassan Masoud** were selected by Michigan Tech's VP for Research Office as recipients of Fall 2020 Research Excellence Fund Awards.

Dr. Jason Blough was selected to receive the Society for Experimental Mechanics, Inc. (SEM) 2021 DeMichele Award.

Dr. Jason Blough was elected to the Society of Automotive Engineers (SAE) Fellow Grade.

Dr. Jason Blough was named a 2021 Michigan Tech Distinguished Professor.

Dr. Chang Kyoung Choi was among those honored at an award ceremony held in December during the 2020 Korean Society of Mechanical Engineers Annual Conference as a corresponding author of a paper published in the Journal of Mechanical Science and Technology that was selected for the 2019 JMST Best Paper Award.

Dr. Craig R. Friedrich retired after 13.5 years as ME-EM Associate Chair and Director of Graduate Studies and 27 years with the ME-EM department. He was granted professor emeritus status. He will continue working with his students in an advisory role and will stay active in his current research.

Dr. Jaclyn Johnson was recognized by her students and colleagues during an IDEA Hub/Center for Teaching and Learning Q&A Session and Workshop in June for an excellent job of managing the sudden transition to online teaching in the wake of COVID-19.

Dr. L. Brad King is the Aerospace Enterprise faculty advisor of Michigan Tech's next student-built satellite set to Launch in 2021. Aerospace Enterprise's second cube satellite "Stratus" will use infrared imagery to gather cloud data to validate and improve numerical weather models.

Dr. Fei Long was the winner of the 2021 Mechanical Engineering Teacher of the Year Award.

Dr. Jeffrey Naber and co-PIs **Drs. Darrell Robinette**, **Bo Chen**, and Jeremy Bos (ECE/APSRC) received $4,498,650 in funding for the second phase of the NEXTCAR program from the U.S. DOE's ARPA-E.

Dr. Greg Odegard was selected as the John O. Hallquist Endowed Chair in Computational Mechanics in the Dept of Mechanical Engineering-Engineering Mechanics.

Dr. Greg Odegard was awarded the 2021 Michigan Tech Research Award as announced by the VP for Research Office. Odegard has made a significant impact in the field of composite materials research through his pioneering work with computational modeling techniques to predict the influence of molecular structure on bulk-level properties of composite materials. As an internationally recognized leader, he is making great strides in his field of research with a demonstrated strength in balancing research, teaching and administrative duties throughout his career.

Dr. Gordon Parker was recognized by members of the Michigan Tech Greek community as an exceptional faculty member at the 15th Annual Fraternity and Sorority Life Awards Ceremony.

Dr. Darrell Robinette was promoted from assistant professor without tenure to associate professor with tenure.

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UNDERGRADUATE SCHOOL RANKED 34TH (TOP 10%) AMONG ALL US DOCTORAL-GRANTING ME DEPARTMENTS
BY US NEWS & WORLD REPORT

Dr. Darrell Robinette and co-PI **Drs. Jeff Naber**, **Bo Chen**, and **Jung Yun Bae,** and Christopher Morgan (Pavlis Honors College) received $1,999,951 in funding for a DoE project titled "Energy Optimization of Light and Heavy-Duty Vehicle Cohorts of Mixed Connectivity, Automation and Propulsion System Capabilities Via Meshed V2V-V2I and Expanded Data Sharing."

Dr. Trisha Sain received a Spring 2021 Portage Health Foundation Research Excellence Fund (PHF-REF-RS) Research Seed Grant.

Dr. Ye "Sarah" Sun was selected as the Lou and Herbert Wacker Professorship in Mechanical Engineering. Dr. Sun is being recognized as an outstanding researcher and rising star in the area of wearable sensors, systems, and robotics and a respected member of the smart health community.

Dr. Paul van Susante (PI) and co-investigators Tim Eisele (ChemEng), **Dr. Jeff Allen** (ME-EM), Tim Scarlett (SS) and Kris Zacny of Honeybee Robotics, were selected for a $1.99M NASA LuSTR grant as part of NASA's Space Technology Mission Directorate for the project: "Percussive Hot Cone Penetrometer (PHCP) and Ground Penetrating Radar (GPR) for Geotechnical and Volatiles Mapping."

Dr. Paul van Susante was the advisor of Michigan Tech's BIG Idea Challenge student team that won the NASA Breakthrough, Innovative and Game-changing (BIG) Idea Challenge, winning the First Place Artemis Award for their Tethered-permanently shadowed Region Explorer (T-REX) concept.

Dr. Paul van Susante's Planetary Surface Technology Development Lab was awarded $100k for winning the Grand Prize for scenario 2 in the NASA Watts on the Moon Challenge.

Dr. Wayne Weaver has been promoted from associate professor with tenure to professor with tenure.

Dr. Yongchao Yang was among the authors whose paper won an International Conference on Modal Analysis (IMAC) of the Society for Experimental Mechanics (SEM) best paper award.

Dr. Yongchao Yang was a recipient of a Spring 2021 Research Excellence Fund (REF) award as announced by the Associate VP for Research Development Office.

MISSION

PREPARE ENGINEERING STUDENTS FOR SUCCESSFUL CAREERS.

VISION

BE A NATIONALLY RECOGNIZED MECHANICAL ENGINEERING DEPARTMENT THAT ATTRACTS, REWARDS, AND RETAINS OUTSTANDING STUDENTS, FACULTY, AND STAFF—BE A DEPARTMENT OF CHOICE NATIONALLY.

EXECUTIVE COMMITTEE

DR. WILLIAM J. ENDRES
Manufacturing & Industrial Area Director

DR. IBRAHIM MISKIOGLU
Solid Mechanics Area Director

DR. FERNANDO PONTA
Design & Dynamic Systems Area Director

DR. YE "SARAH" SUN
Energy Thermofluids Area Director

DR. JEFFREY S. ALLEN
Associate Chair & Director of Undergraduate Studies

DR. CRAIG R. FRIEDRICH (F'20) /
DR. JASON R. BLOUGH (S'21)
Associate Chair & Director of Graduate Studies

DR. GREGORY M. ODEGARD
Director of Research

PAULA F. ZENNER, MS
Director of Operations & Finance

DR. WILLIAM W. PREDEBON
J.S. Endowed Department Chair & Professor

2020-2021

ME-EM DONORS

Donations by Michigan Tech alumni and friends who contributed directly to the ME-EM Department, as well as to scholarships that benefit students and to the emergency assistance funds that were set up for Michigan Tech students during the COVID-19 pandemic, have been vital to the success of the Department. Contributions from August 2, 2020 to July 31, 2021 are listed below.
Note: Employee matching gifts are listed among individuals.

The Department would like to sincerely thank you for your support. Every dollar donated matters. Each of you are making a difference in the lives of our students, faculty, and staff.

INDIVIDUALS

$100,000 - $200,000

Rudolph '62 & Judith Shunta
Jack W. Sullivan '68

$50,000 - $99,999

John '64 & Cathi Drake
Mark '85 & Michelle Gauthier
Rex '69 & Linda Stone

$10,000 - $49,999

Frank '58 & Mary Agosti
Paul V. De Baeke '55
Thomas '84 & Suzanne Fedorka
Joan M. Heil '83
Richard W. Job '63
Brian '85 & Julie Krinock
Kurt S. Lehmann '85
Wilbur T. Livingston '68
Amitabh & Rooma Narain
Catherine & Richard Podkul
Elizabeth '88 & Michael Pulick '86
Marcia '82 & John '82 Ross
Peter '64 & Anita Sandretto
Ronald E. Starr P.E. '67
Victor '50 & Elaine Swanson

$5,000 - $9,999

John '67 & Joan Calder
John L. Feldman '61
Paul '65 & Sandra Fernstrum
Glenn Wheelock '85 & Carol Tillis
Donald D. Horton III, P.E. '70
Pamela '93 & Steven Klyn
Roger W. Lange '57
Robert E. Monica '50
Eric '93 & Christine Roberts '91
Jeffrey '05 & Angela Schut
Marian I. Scott '48
Eric Suydam '91 & Kathleen Cafferty
Timothy '81 & Lori Thomas
Dr. John P. Zarling '64

$1,000 - $4,999

Dr. Tony N. Altobelli '86
Christine '72 & Carl Anderson '72
John '71 & Barbara Baker
Lynda K. Barley
Kent '83 & Karen Barnhart '83
William '86 & Wendy Basta
Robert '67 & Kathleen Bauer
William B. Bennett '92
Dr. Diana D. Brehob '78
John '77 & Julie Cabaniss
Colleen '83 & Winston Cervantes
Brett Chouinard '88 & Brenda Kasper
Robert '70 & Gaylann Cleereman
Marie '82 & Michael Cleveland '82
Charles '63 & Linda Cretors
Juan '71 & Dorothy Dalla Rizza
Michael '93 & Sharon Davenport
Laurence '85 & Barbara Dobrot
Danny '78 & Carol Dodge
Richard F. Dufresne '69
Lawrence '73 & Sharon Duhaime
Christian '97 & Julie Elenbaum '97
Donald R. Elzinga, Jr. '84
Gaylord T. Faull '74
Todd '92 & Dana Fernstrum
Bernard '55 & Marilyn Finn
Daniel '62 & Evelyn Folk
Thomas '81 & Barbara Fowler
Norman '58 & Norma Glomski
Kenneth L. Graesser '60
Benjamin '02 & Rebecca Grisso
William '84 & Claudia Hamilton
Gerald '68 & Ann Haycock '68
David '69 & Janice Hegg
Ronald W. Henning '72
Anna M. Hradel '60
Thomas '80 & Susan Jamar
Sarah '14 & David Joda '16
Daniel Kapp '76 & Linda Lavastida-Kapp
John '64 & Kathleen Keagle '64
Bryce J. Kinder '16
Charles '55 & Marilyn Knauer
Frederick '81 & Lou Anne Koerschner '81
Randall '79 & Sue Kortering
Douglas '84 & Susanne Kuchta
Michael '77 & Cheryl LaCourt
Jason D. LaLonde '03

$1,000 - $4,999 (cont.)

Leah '95 & Brian Lemanski '92
John C. Linton P.E. '51
Thomas R. Lowe '62
James '82 & Carolyn Luyckx
Terrence '65 & Rosalie Maki
Dianne A. Malesko
Raymond '52 & Juliana Marttila
Felix '54 & Lois Mickus
Sanjeev Musalimadugu '97
Eric A. Nielsen '80
Kenneth '83 & Catherine Panasiewicz
Charles '73 & Judy Paterka
Jon H. Peppel P.E. '64
Lynn E. Peterson '63
Christopher '83 & Melissa Plude
William & Mary Ann Predebon
Peter T. Prouty '85
Wallace '53 & Helga Renn
Daniel '59 & Eleanor Rivard
Timothy '68 & Beverly Rosemeyer
A. Michael Santoski '73 & Melissa Anderson
Robert '77 & Elly Sattler
Trista K. Schieffer '97
Helena '94 & David Seiver
Earl '61 & Sylvia Seppala
David '81 & Julee Sipes
David '69 & Linda Stone
Robert '62 & Mary Thresher
Laura M. Townsend '84
Darrin '11 & Dagmara Traczyk
Larry '69 & Deborah Vojtech
Dean D. Waldie '79
Kathleen '82 & Erick Webb '82
Robert & Sandra Westphal
Gary L. Wick '87
Kenneth '91 & Jennifer Williams
William '61 & Marlene Winter
Thomas Young '80 & Simone Decaro-Young
Jeffery '83 & Melissa Zawisza
Mark A. Zimmerman '79

$500 - $999

Jon '95 & Rebecca Ahola
John G. Allen '75
Darrell A. Bacon '67
Andrew '02 & Rebecca Barnard
Donald '71 & Joyce Bouws
James '87 & Andrea '88 Butler
William '75 & Marilyn Callow
John '68 & Sharon Campbell
Robert '96 & Joanne Chalgren
Siddhant Yog Dange '18
Brian J. Demos '99
William '66 & Constance Eddy
Jacob '58 & Nancy Erkkila
R. James '53 & C. Anita Fagan
Steven J. Fornetti '84
Alan '89 & Judy Frank
Roy '68 & Linda Granstrom
Jesse '00 & Karen Gwidt '00
James '89 & Ingrid Hayes '89
Teresa '82 & Joseph Healy
Bruce '84 & Wendy Hegberg
Robert Knapp '71 & Mary Janet Kachmarsky Knapp '72
Edward F. Kodunce'58
Charles '59 & Phyllis Laurila
Jason M. Markesino'03
Brian '88 & Emily Mason '88
James A. Mattson '70
Darwin '79 & Margarita Moon
Brenda M. Moyer '84
Thomas C. Newhouse '69
Jerry & Carole Null
Heath '08 & Amy Nunnemacher
Jan '83 & Ellen Rankinen '83
Charles '72 & Terry Roossien
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Inaugural members began their four-year terms on July 1, 2020. This group of appointees will actively assist the Department Chair in fundraising.

Interested in joining CPAB? Nominations and self-nominations are welcomed and accepted.

> "Our CPAB has been working diligently to connect with alumni in our Department to facilitate a re-engagement in the form of time, talent, and treasure. We appreciate their efforts to build a strong support system for our Department and future Department Chairs."
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DESIGN & WRITING
Monte Consulting

PHOTOGRAPHY
Monte Consulting, Michigan Tech, Contributors

CONTRACTS & GRANTS

ADVANCED POWER SYSTEMS $18,391,297

TITLE	NAME	SPONSOR	TOTAL	PERIOD	FY 21
APRA-E NEXTCAR Phase II: L4/L5 CAV Enabled Energy Reduction	PI: Jeffrey Naber Co-PI: Bo Chen, Darrell Robinette	US Dept of Energy	$5,831,167	2017-2024	$5,831,167
Limited Sharing	PI: Jeffrey Naber Co-PI: Tucker Alsup, Paul Dice, Christopher Morgan, Darrell Robinette, Wayne Weaver, Jeremy Worm	Limited Sharing	$3,326,127	2019-2021	$150,974
Energy Optimization of Light & Heavy-Duty Vehicle Cohorts of Mixed Connectivity Automation & Propulsion System Capabilities via Meshed V2V-V2I & Expanded Data Sharing	PI: Darrell Robinette Co-PI: Jung Yun Bae, Bo Chen, Christopher Morgan, Jeffrey Naber	US Dept of Energy	$2,587,739	2020-2021	$1,730,943
Limited Sharing	PI: Jeffrey Naber Co-PI: Paul Dice, Joel Duncan, Youngchul Ra, Henry Schmidt, Mahdi Shahbakhti, Jeremy Worm	Limited Sharing	$1,786,494	2019-2020	$259,530
Feasibility Study on Production of Composite Material from Plastic-Fiber Wastes	PI: Ezra Bar-Ziv	National Science Foundation	$1,004,895	2018-2022	$149,999
Reduced Cost & Complexity for Off-Highway Aftertreatment	PI: Jeffrey Naber Co-PI: John Johnson, Gordon Parker	Pacific Northwest National Laboratory	$870,320	2021	$249,844
Torrefaction of Sorted MSW Pellets to Produce a Uniform Feedstock for Biopower	PI: Ezra Bar-Ziv	Battelle Energy Alliance LLC/Idaho National Laboratory	$658,218	2018-2021	$90,005
Development of Reduced Order Models (ROMs) for Wind Turbine Plant Aerodynamic Structural Control & Electrical Grid Interaction	PI: Fernando Ponta	Sandia National Laboratories	$318,000	2019-2022	$233,000
FY 2020 Interoperability & Grid Integration Support	PI: Bo Chen	UChicago Argonne LLC	$248,627	2019-2021	$126,923
Alternative Fuels Research with Argonne National Laboratory	PI: Scott Miers	Argonne National Laboratory	$225,835	2019-2021	$83,616
Time-Domain & Multi-Axis Resonant Plate Shock Test	PI: Jason Blough Co-PI: James DeClerck, Charles Van Karsen	Honeywell Federal Manufacturing & Technologies LLC	$148,000	2020-2021	$148,000
Multi-Axis Resonant Fixture Shock	PI: Jason Blough Co-PI: James DeClerck, Charles Van Karsen	Honeywell Federal Manufacturing & Technologies LLC	$130,500	2020	$25,000

ADVANCED POWER SYSTEMS (CONT.) $18,391,297

TITLE	NAME	SPONSOR	TOTAL	PERIOD	FY 21
Rear Drive Automatic Transmission System Sensitivity Modeling & Synthesis-Extension	PI: Darrell Robinette	General Motors LLC	$125,070	2018-2022	$31,998
Frequency Response Inspection of AM Parts	PI: Jason Blough Co-PI: Andrew Barnard, Sriram Malladi	Honeywell Federal Manufacturing & Technologies LLC	$116,000	2021	$116,000
Various Sponsors: A Consortium to Advance the State-of-the-Art in Light Duty Engine Efficiency and Emissions	PI: Jeremy Worm Co-PI: Tucker Alsup, Joel Duncan, Jeffrey Naber, Henry Schmidt	Ford Motor Co	$107,020	2019-2022	$107,020
GAF RTC Study APS Labs	PI: Paul Dice	GAF Energy LLC	$95,972	2021-2023	$95,972
Full Field Dynamic Response	PI: Jason Blough Co-PI: James DeClerck, Charles Van Karsen	Honeywell Federal Manufacturing & Technologies LLC	$95,000	2020	$25,000
Frequency Response Inspection of AM Parts	PI: Jason Blough Co-PI: Andrew Barnard, Sriram Malladi	Honeywell Federal Manufacturing & Technologies LLC	$86,819	2020	$25,000
Investigation of Water Injection for High Compression Ratio High Efficiency Engine	PI: Jeffrey Naber Co-PI: Niranjan Miganakallu Narasimhamurthy, Jeremy Worm	Nostrum Energy LLC	$86,784	2020-2021	$86,784
Full Field Response for Simulation & Prediction	PI: Jason Blough Co-PI: James DeClerck, Charles Van Karsen	Honeywell Federal Manufacturing & Technologies LLC	$70,000	2020-2021	$70,000
Customer Discovery for Waste Torrefaction Technology	PI: Ezra Bar-Ziv	National Science Foundation	$69,570	2021-2022	$69,570
Powertrain Sensor Fusion for Combustion Control & Diagnostics	PI: Jeffrey Naber Co-PI: Jason Blough	Ford Motor Co	$60,000	2021	$60,000
Various Sponsor: A Consortium to Advanced the State-of-the-Art in Light Duty Engine Efficiency and Emissions (FCA)	PI: Jeremy Worm Co-PI: Tucker Alsup, Joel Duncan, Jeffrey Naber, Henry Schmidt	FCA US LLC (Fiat Chrysler Automobiles)	$53,510	2019-2022	$53,510
Various Sponsor: A Consortium to Advanced the State-of-the-Art in Light Duty Engine Efficiency and Emissions	PI: Jeremy Worm Co-PI: Tucker Alsup, Joel Duncan, Jeffrey Naber, Henry Schmidt	General Motors LLC	$53,510	2019-2022	$53,510
Various Sponsor: A Consortium to Advanced the State-of-the-Art in Light Duty Engine Efficiency and Emissions	PI: Jeremy Worm Co-PI: Tucker Alsup, Joel Duncan, Jeffrey Naber, Henry Schmidt	Nostrum Energy LLC	$53,510	2019-2022	$53,510

CONTRACTS & GRANTS

ADVANCED POWER SYSTEMS (CONT.) $18,391,297

TITLE	NAME	SPONSOR	TOTAL	PERIOD	FY 21
Integration & Test of Condenbine System with ISB Engine CPhase II	PI: Jeffrey Naber Co-PI: Brian Eggart, William Hansley	Nostrum Energy LLC	$51,917	2021	$51,917
Direct Injection of Water as an Enabler for High Brake Mean Effective Pressure	PI: Jeremy Worm Co-PI: Tucker Alsup, Joel Duncan, William Hansley, Jeffrey Naber	Nostrum Energy LLC	$45,423	2020-2021	$45,423
GRADUATE STUDENT PROJECT: Analysis & Simulation	PI: Jeffrey Naber	Aramco Services Co	$21,950	2020	$21,950
Integration & Test of Condenbine System with ISB Engine	PI: Jeffrey Naber Co-PI: Brian Eggart	Nostrum Energy LLC	$19,815	2020-2021	$19,815
Evaluation of the Environmental Enclosure & Thermal Management System on a Natural Gas Fueled Genset	PI: Jeremy Worm	Enchanted Rock LLC	$16,500	2021	$16,650
Stationary Power Targeting Ultra-low Emissions via Dual Fuel Diesel Natural Gas using Nostrum's Kinetic Diesel Injector Technology	PI: Jeffrey Naber	Nostrum Energy LLC	$13,345	2020	$13,345
Investigation of S55 GDI Spray	PI: William Atkinson Co-PI: Jeffrey Naber	Nostrum Energy LLC	$5,300	2020-2021	$5,300
Investigation of VR30 GDI Spray	PI: William Atkinson Co-PI: Paul Dice, Jeffrey Naber	Nostrum Energy LLC	$4,500	2020-2021	$4,500
Visualization of Diesel Kinetic Breakup Injector	PI: William Atkinson Co-PI: Jeffrey Naber, Henry Schmidt	Nostrum Energy LLC	$3,860	2021	$3,860

AGILE INTERCONNECTED MICROGRIDS $368,098

TITLE	NAME	SPONSOR	TOTAL	PERIOD	FY 21
Meta-stability of Pulsed Load Microgrids	PI: Wayne Weaver	Sandia National Laboratories	$242,000	2020-2021	$215,000
Ship Vibration Mitigation for Additive Manufacturing Equipment	PI: Gordon Parker Co-PI: Jason Blough	Advanced Technology and Research Corp	$98,099	2020-2021	$98,099
Limited Sharing	PI: Gordon Parker	Limited Sharing	$49,999	2020-2021	$49,999
Thruster Concept Testing	PI: Wayne Weaver	Great Lakes Sound and Vibration	$5,000	2021-2022	$5,000

ENGINEERING EDUCATION INNOVATION $241,609

TITLE	NAME	SPONSOR	TOTAL	PERIOD	FY 21
STUDENT DESIGN: Situational Sensor Automated Insertion Suite	PI: William Endres	Dzyne Technologies Inc	$37,456	2021-2022	$37,456
STUDENT DESIGN: Dense Loading Machine Improvement	PI: William Endres	Honeywell UOP	$22,473	2021-2022	$22,473
SENIOR DESIGN: Advanced PPE Filtration System	PI: William Endres	Stryker Instruments	$22,473	2021-2022	$22,473
STUDENT DESIGN: Auto Reciprocating Blade - Test Rig Improvement	PI: William Endres	Milwaukee Elec Tool Co	$20,676	2020-2021	$20,676
SENIOR DESIGN: Auto Reciprocating Blade - Test Rig Improvement	PI: William Endres	Milwaukee Elec Tool Co	$20,424	2021	$20,424
STUDENT DESIGN: Portable Locomotive Wheel Lathe Improvement	PI: William Endres	Independent Machine Company	$17,230	2021	$17,230
STUDENT DESIGN: Aerospace Propulsion Outreach Program: Design of Low Loss Ducted Inlet	PI: Kazuya Tajiri Co-PI: William Endres	ARCTOS Technology Solutions LLC	$13,095	2020-2021	$13,095
STUDENT DESIGN: Passenger Car Seat Back Panel Design	PI: William Endres	Adient US LLC	$11,987	2020	$11,987
STUDENT DESIGN: EV Battery Thermo-Structural Design	PI: William Endres	Covestro LLC	$11,985	2020-2021	$11,985
STUDENT DESIGN: LED Light Module Radiative Heating Test Apparatus	PI: William Endres	Covestro LLC	$11,985	2020-2021	$11,985
STUDENT DESIGN: Novel BLDC Motor Winding Alternatives	PI: William Endres	GHSP	$8,989	2020-2021	$8,989
STUDENT DESIGN: Portable Oxygen Concentrator	PI: William Endres	Obenchain Valerie	$8,989	2021	$8,989
STUDENT DESIGN: Fixed Select Lever Design with Feedback	PI: William Endres	GHSP	$8,989	2021	$8,989
SENIOR DESIGN: Direct Casting with Additive Manufactured Patterns	PI: William Endres	Mercury Marine	$7,492	2021-2022	$7,492
STUDENT DESIGN: Trailer Articulation Sensing System	PI: William Endres	Horizon Global Americas	$5,993	2021	$5,993
STUDENT DESIGN: Lightweight Trailer Hitch Design	PI: William Endres	Horizon Global Americas	$5,993	2021	$5,993
STUDENT DESIGN: Landing System for Uncertain Terrain	PI: William Endres	Arizona State University	$1,345	2021	$1,345
STUDENT DESIGN: Returning Samples of Hypothesized Surfaces	PI: William Endres	Arizona State University	$1,345	2020-2021	$1,345
STUDENT DESIGN: Robotic Explorer for Hypothesized Surfaces	PI: William Endres	Arizona State University	$1,345	2020	$1,345
STUDENT DESIGN: Sampling System for Hypothesized Surfaces	PI: William Endres	Arizona State University	$1,345	2020-2021	$1,345

CONTRACTS & GRANTS

MULTISCALE TECHNOLOGIES INSTITUTE $344,266

TITLE	NAME	SPONSOR	TOTAL	PERIOD	FY 21
A Multiscale Multiphysics Computational Modeling and Experimental Study for Thermo-oxidation in Polymers	PI: Trisha Sain	US Dept of Defense	$401,530	2020-2022	$125,201
Caterpillar Hydraulic Fluid Borne Sound	PI: Andrew Barnard Co-PI: Sriram Malladi	Caterpillar Inc	$190,000	2018-2021	$60,000
Applying High-speed Visualization and Machine Learning for Car Crash Test Analysis	PI: Chang Kyoung Choi Co-PI: Yongchao Yang	Hyundai Motor Co	$149,500	2021	$149,500
REF-PHF-RS: A Computational Model for the Degradation of Magnesium-Based Implants in Stress Coupled Chemically Corrosive Environment	PI: Trisha Sain	Michigan Technological University	$9,565	2020-2021	$9,565

SPACE SYSTEMS $1,542,090

TITLE	NAME	SPONSOR	TOTAL	PERIOD	FY 21
Percussive Hot Cone Penetrometer (PHCP) and Ground Penetrating Radar (GPR) for Geotechnical and Volatiles Mapping	PI: Paulus van Susante Co-PI: Jeffrey Allen	National Aeronautics & Space Administration	$1,990,068	2021-2023	$998,997
Performance Characterization of a Low-power Hall Effect Thruster	PI: William Predebon Co-PI: Lyon King	Orbion Space Technology Inc	$438,193	2019-2021	$232,047
T-Rex (Tethered - permanently shadowed Region EXplorer)	PI: Paulus van Susante	National Institute of Aerospace	$244,584	2020-2021	$134,713
Center for Lunar and Asteroid Surface Science (NASA SSERVI CAN)	PI: Paulus van Susante	University of Central Florida	$150,000	2019-2024	$30,000
RedWater: Extraction of Water from Mars' Ice Deposits	PI: Paulus van Susante	Honeybee Robotics Ltd	$122,500	2019-2021	$23,333
NIAC Phase 2: Lunar Polar Mining Outpost	PI: Paulus van Susante	Trans Astronautica Corp	$98,000	2020-2022	$98,000
Lunar Water Extraction Techniques and Systems (WETS)	PI: Paulus van Susante	Trans Astronautica Corp	$25,000	2021	$25,000

ENERGY $98,194

TITLE	NAME	SPONSOR	TOTAL	PERIOD	FY 21
Collaborative Research: Individual and Collective Dynamics of Marangoni Surface Tension Effects Between Particles	PI: Hassan Masoud	National Science Foundation	$287,376	2017-2021	$15,143
REF-RS: A Dataset for Energy-Water-Climate Research across Disciplines	PI: Ana Dyreson	Michigan Technological University	$58,151	2019-2021	$58,151
REF-RS: Absorption-based Zero Liquid Discharge Distillation Concept: Physics of Crystallization and Performance Evaluation	PI: Sajjad Bigham	Michigan Technological University	$24,900	2021-2022	$24,900
REF-PHF-RS: A Computational Model for the Degradation of Magnesium-Based Implants in Stress Coupled Chemically Corrosive Environment	PI: Trisha Sain	Michigan Technological University	$9,565	2020-2021	$9,565

DYNAMIC SYSTEMS $231,585

TITLE	NAME	SPONSOR	TOTAL	PERIOD	FY 21
Development of a methodology for low-frequency sound measurement for field tests	PI: Andrew Barnard	Paul S Veneklasen Research Foundation	$89,726	2020-2021	$71,410
Dual Use CNT application	PI: Andrew Barnard	Great Lakes Sound and Vibration	$45,000	2018-2023	$45,000
CAREER: System-on-Cloth: A Cloud Manufacturing Framework for Embroidered Wearable Electronics	PI: Ye Sun	National Science Foundation	$631,914	2020-2021	$50,000
REF-RS: Multi-task Adaptive AI-enabled Deep Q-controller	PI: Yongchao Yang	Michigan Technological University	$32,400	2020-2021	$32,400
REF-RS: Physics-informed Deep Learning for 4D Visualization	PI: Hassan Masoud	Michigan Technological University	$25,283	2020-2021	$25,283
ENTERPRISE: SERC Dry Combat Submersible Salinity Specific Configurations	PI: Andrew Barnard Co-PI: Christopher Morgan	Stevens Institute of Technology	$7,492	2021-2022	$7,492

PATENTS & PUBLICATIONS

PATENTS, COPYRIGHTS, LICENSES

Barnard, Andrew R., "Solid-State Transducer, System, and Method," Mar 2021, Patent No. US 10,943,577.

Abdelkhalik, Ossama O., **Robinett, Rush D.**, Korde, Umesh A., "Nonlinear controller for nonlinear wave energy converters," Nov 2020, Patent No. 10,823,134.

Abdelkhalik, Ossama O., **Robinett, Rush D.**, Korde, Umesh A., "Nonlinear power flow control for networked AC/DC microgrids," May 2020, Patent No. 10,666,054.

BOOKS, CHAPTERS IN

Anakok, Isil, **Malladi, Vijaya Venkata Narasimha Sriram**, Tarazaga, Pablo A., (2020) "A Theoretical Study on the Generation and Propagation of Traveling Waves in Strings," in Topics in Modal Analysis & Testing, Volume 8, Ed: Springer, Cham, pp. 311–316.

Devine, Timothy A., **Malladi, Vijaya Venkata Narasimha Sriram**, Tarazaga, Pablo A., (2020) "Electromechanical Impedance Method for Applications in Boundary Condition Replication," in Sensors and Instrumentation, Aircraft/Aerospace, Energy Harvesting & Dynamic Environments Testing, Volume 7, Ed: Springer, Cham, pp. 93–96.

Feichtl, Blake, Thompson, Caleb, Liboro, Tyler, Siddiqui, Saad, **Malladi, Vijaya Venkata Narasimha Sriram**, Devine, Tim, Tarazaga, Pablo A., (2020) "Event Detection and Localization Using Machine Learning on a Staircase," in Dynamics of Civil Structures, Volume 2, Ed: Springer, Cham, pp. 219–223.

Motaharibidgoli, Seyedmostafa, **Malladi, Vijaya Venkata Narasimha Sriram**, Tarazaga, Pablo A. (2020) "Generating Anechoic Traveling Wave in Beams with Various Boundary Conditions," in Sensors and Instrumentation, Aircraft/Aerospace, Energy Harvesting & Dynamic Environments Testing, Volume 7, Ed: Springer, Cham, pp. 387–393.

Maza, Mauro S., Albakri, Mohammad I., **Malladi, Vijaya Venkata Narasimha Sriram**, Tarazaga, Pablo A., (2020) "On Wave Propagation in Smart Buildings," in Dynamics of Civil Structures, Volume 2, Ed: Springer, Cham, pp. 237–242.

Devine, Timothy A., **Malladi, Vijaya Venkata Narasimha Sriram**, Tarazaga, Pablo A., (2020) "Replicating Responses: A Virtual Environmental Test of Unknown Boundary Conditions," in Sensors and Instrumentation, Aircraft/Aerospace, Energy Harvesting & Dynamic Environments Testing, Volume 7, Ed: Springer, Cham, pp. 335–340.

Neighborgall, Campbell R., Kothari, Karan, **Malladi, Vijaya Venkata Narasimha Sriram**, Tarazaga, Pablo, Paruchuri, Sai T., Kurdila, Andrew, (2020) "Shaping the Frequency Response Function (FRF) of a Multi-Degree-of-Freedom (MDOF) Structure Using Arrays of Tuned Vibration Absorbers (TVA)," in Topics in Modal Analysis & Testing, Volume 8, Ed: Springer, Cham, pp. 317–326.

Davaria, Sheyda, **Malladi, Vijaya Venkata Narasimha Sriram**, Avilovas, Lukas, Dobson, Phillip, Cammarano, Andrea, Tarazaga, Pablo A., (2020) "Study on Developing Micro-Scale Artificial Hair Cells," in Special Topics in Structural Dynamics & Experimental Techniques, Volume 5, Ed: Springer, Cham, pp. 95–99.

Olaya, Michael N., **Odegard, Gregory M.**, Maiaru, Marianna, (2021) "A Novel Approach to Characterization of Composite Polymer Matrix Materials for Integrated Computational Materials Engineering Approaches," in AIAA Scitech 2021 Forum, published online, https://doi.org/10.2514/6.2021-1889

Scott, Wesley, Adams, Matthew, **Yang, Yongchao**, Mascareñas, David, (2020) "Full-Field Mode Shape Analysis, Alignment and Averaging Across Measurements," in Special Topics in Structural Dynamics & Experimental Techniques, Volume 5, Ed: Springer, Cham, pp. 71–75.

Brand, Howard, Kauppila, Tia, Wielgus, Kayla, Martinez, Bridget, Miller, Nathan, Tippetts, Trevor, **Yang, Yongchao**, Mascareñas, David, (2020) "Imager-Based Characterization of Viscoelastic Material Properties," in Topics in Modal Analysis & Testing, Volume 8, Ed: Springer, Cham, pp. 215–224.

Hayes, Cedric, Schelle, Caleb, Taylor, Greg, Martinez, Bridget, Kenyon, Garrett, Lienert, Thomas, **Yang, Yongchao**, Mascareñas, David, (2020) "Imager-Based Techniques for Analyzing Metallic Melt Pools for Additive Manufacturing," in Special Topics in Structural Dynamics & Experimental Techniques, Volume 5, Ed: Springer, Cham, pp. 63–69.

JOURNAL ARTICLES

Ahangar, Shahab, **Allen, Jeffrey**, Lee, Seong-Hyuk, **Choi, Chang Kyoung**, "Surface Plasmon Resonance Imaging: A Technique to Reveal the Dropwise Condensation Mechanism," J. Heat Transfer. Mar 2020, 142(3): 030903. DOI: https://doi.org/10.1115/1.4046136

Ahangar, Shahab, Konduru, Vinay, **Allen, Jeffrey**, Miljikovic, Nenad, Lee, Seong-Hyuk, **Choi, Chang Kyoung**, "Development of automated angle-scanning, high-speed surface plasmon resonance imaging and SPRi visualization for the study of dropwise condensation," Experiments in Fluids, volume 61, Article number: 12 (2020). DOI: https://doi.org/10.1007/s00348-019-2844-9

Note: **bold text** indicates ME-EM faculty members and *italicized text* indicates current and past ME-EM students.

Bae, Jung Yun, **Park, Myoungkuk**, "A Heuristic for Efficient Coordination of Multiple Heterogeneous Mobile Robots Considering Workload Balance," in IEEE Robotics and Automation Letters, vol. 6, no. 2, pp. 4064-4070, April 2021, DOI: https://doi.org/10.1109/LRA.2021.3067286

Xu, Zhuo, Albrecht, Joshua W., Kolapkar, Shreyas K., Zinchik, Stas, **Bar Ziv, Ezra,** "Chlorine Removal from US Solid Waste Blends through Torrefaction," Appl. Sci. 2020, 10(9), 3337. DOI: https://doi.org/10.3390/app10093337

Xu, Zhuo, Kolapkar, Shreyas S., Zinchik, Stas, **Bar Ziv, Ezra**, McDonald, Armando, "Comprehensive kinetic study of thermal degradation of polyvinylchloride (PVC)," Polymer Degradation and Stability, Volume 176, June 2020, 109148. DOI: https://doi.org/10.1016/j.polymdegradstab.2020.109148

Zinchik, Stas, *Xu, Zhou, Kolapkar, Shreyas S*., **Bar Ziv, Ezra**, McDonald, Armando, "Properties of pellets of torrefied U.S. waste blends," Waste Management, Volume 104, 1 March 2020, Pages 130-138. DOI: https://doi.org/10.1016/j.wasman.2020.01.009

Prabhu, Suraj, **Barnard, Andrew R**., "Design and characterization of an enclosed coaxial carbon nanotube speaker," The Journal of the Acoustical Society of America 147, EL333 (2020). DOI: https://doi.org/10.1121/10.0001029

Barr, Nancy B., **Johnson, Jaclyn E**., "Trajectories in Turmoil: A Case Study of Engineering Students' Reactions to Disruptions in their Community of Practice," in IEEE Transactions on Professional Communication, vol. 64, no. 1, pp. 38-51, March 2021. DOI: https://doi.org/10.1109/TPC.2021.3057149

Cai, Shiying, **Cai, Chunpei** and Li, Jun, "Highly Dilute Gas Flows Through A Non-Isothermal Planar Micro-Channel," Physics of Fluids 32, 072006 (2020). DOI: https://doi.org/10.1063/5.0013451

Zhang, Kai, *Cai, Shiying*, **Cai, Chunpei**, Cooke, David L., "A parallel particle-in-cell code for spacecraft charging problems," Journal of Plasma Physics, Volume 86, Issue 3, June 2020, 905860308. DOI: https://doi.org/10.1017/S0022377820000410

Oncken, Joseph, **Chen, Bo**, ""Real-Time Model Predictive Powertrain Control for a Connected Plug-In Hybrid Electric Vehicle," in IEEE Transactions on Vehicular Technology, vol. 69, no. 8, pp. 8420-8432, Aug. 2020, DOI: https://doi.org/10.1109/TVT.2020.3000471

Oncken, Joseph, Sachdeva, Kovid, Wang, Huanqing, **Chen, Bo**, "Integrated Predictive Powertrain Control for a Multimode Plug-in Hybrid Electric Vehicle," in IEEE/ASME Transactions on Mechatronics, vol. 26, no. 3, pp. 1248-1259, June 2021. DOI: https://doi.org/10.1109/TMECH.2021.3061287

Jeong, Chanho, Lee, Hyungju, Kim, Dae Yun, Lee, Seong Hyuk, *Bayani Ahangar, Shahab*, **Choi, Chang Kyoung**, "Quantitative analysis of contact line behaviors of evaporating binary mixture droplets using surface plasmon resonance imaging," International Journal of Heat and Mass Transfer, Volume 165, Part A, February 2021, 120690. DOI: https://doi.org/10.1016/j.ijheatmasstransfer.2020.120690

Kim, Daeyoon, Jeong, Chan-ho, Lee, Hyungjoo, **Choi, Chang Kyoung**, Lee, Seong-Hyuk, "Modeling of the finite boundary limit of evaporation flux in the contact line region using the surface plasmon resonance imaging," International Communications in Heat and Mass Transfer, Volume 116, July 2020, 104598. DOI: https://doi.org/10.1016/j.icheatmasstransfer.2020.104598

Moon, Joo Hyun, Lee, Sangmin, **Choi, Chang Kyoung**, Lee, Seong Hyuk, "Dynamic characteristics of droplet impingement on microscale hole-patterned surfaces with anodization," International Communications in Heat and Mass Transfer, Volume 124, May 2021, 105260. DOI: https://doi.org/10.1016/j.icheatmasstransfer.2021.105260

Bellur, Kishan, *Médici, Ezequiel F*.**, Choi, Chang Kyoung**, Hermanson, James C. and **Allen, Jeffrey S.**, "Multi-scale approach to model steady meniscus evaporation in a wetting fluid," Phys. Rev. Fluids 5, 024001 – Published 10 February 2020. DOI: https://doi.org/10.1103/PhysRevFluids.5.024001

Voisin, N., **A Dyreson, A.**, Fu, T, O'Connell, M., Turner, S.W.D., "Impact of climate change on water availability and its propagation through the Western U.S. power grid," Applied Energy, 2020 Volume 276, 15 October 2020, 115467 – Elsevier. DOI: https://doi.org/10.1016/j.apenergy.2020.115467

Baker, Erin A., Vara, Alexander D., Salisbury, Meagan R., Fleischer, Mackenzie M., Baker, Kevin C., Fortin, Paul T., Roberts, Richard V., **Friedrich, Craig R**., "Titania nanotube morphologies for osseointegration via models of in vitro osseointegrative potential and in vivo intramedullary fixation," J. Biomedical Materials Research, Part B, Applied Biomaterials, Volume 108, Issue 4, May 2020, pp. 1483,1493. DOI: https://doi.org/10.1002/jbm.b.34496

PATENTS & PUBLICATIONS (CONT.)

Yadav, Upendra, Pathrudkar, Shashank, **Ghosh, Susanta**, "Interpretable machine learning model for the deformation of multiwalled carbon nanotubes," Phys. Rev. 2021, APS, B 103, 035407. Published 11 January 2021. DOI: https://doi.org/10.1103/PhysRevB.103.035407

Jane, Robert S., **Goldsmith, Steven Y., Parker, Gordon G., Weaver, Wayne W**., Rizzo, Denise M., "Adaptive leader election for control of tactical microgrids," Journal of Defense Modeling and Simulation: Applications, Methodology, Technology, pp. 1-20, March, 2020. DOI: https://doi.org/10.1177/1548512920904785

Iyer, Kartik, Scheel, Janet D., Schumacher, Jörg, and Sreenivasan, Katepalli R., "Classical 1/3 scaling of convection holds up to Ra = 10^{15}," PNAS April 7, 2020 117 (14) 7594-7598; first published March 25, 2020. DOI: https://doi.org/10.1073/pnas.1922794117

Iyer, Kartik, Scheel, Janet D., Schumacher, Jörg, and Sreenivasan, Katepalli R., "Reply to He et al.: The dependence of heat transport law on aspect ratio is still unclear," PNAS December 1, 2020 117 (48) 30024; first published November 24, 2020; DOI: https://doi.org/10.1073/pnas.2007913117

Iyer, Kartik, Sreenivasan, Katepalli R., Yeung, P. K., "Scaling exponents saturate in three-dimensional isotropic turbulence," Physical Review Fluids - APS, Issue. Vol. 5, Iss. 5 — May 2020. DOI: https://doi.org/10.1103/PhysRevFluids.5.054605

Johnson, Jaclyn E., Barr, Nancy B., "Moving Hands-On Mechanical Engineering Experiences Online: Course Redesigns and Student Perspectives," *Online Learning*, v25 n1 p209-219 Mar 2021. ISSN: ISSN-2472-5749. DOI: http://dx.doi.org/10.24059/olj.v25i1.2465

Torelli, Roberto, Scarcelli, Riccardo, Som, Sibendu, Zhu, *Xiucheng*, **Lee, Seong-Young, Naber, Jeffrey**, Markt, David, Raessi, Mehdi, "Toward predictive and computationally affordable Lagrangian–Eulerian modeling of spray–wall interaction," International Journal of Engine Research, Volume: 21 issue: 2, page(s): 263-280. Feb 2020. DOI: https://doi.org/10.1177%2F1468087419870619

Zhai, Jiachen**, Lee, Seong-Young**, Ahujal, Nitisha, Zhao, Le, Zhu, Xiucheng, "An energy model of droplet impingement on an inclined wall under isothermal and non-isothermal environments," International Journal of Heat and Mass Transfer, Volume 156, August 2020, 119892. DOI: https://doi.org/10.1016/j.ijheatmasstransfer.2020.119892

Mi, Xue, Bromley, Emily K., Joshi, Pratik U., **Long, Fei**, Heldt, Caryn L., "Virus Isoelectric Point Determination Using Single-Particle Chemical Force Microscopy," Langmuir 2020, 36, 1, 370–378. Published in issue 14, January 2020. DOI: https://doi.org/10.1021/acs.langmuir.9b03070

Ahangar, Shahab B., Jeong, Chan H., **Long, Fei**, **Allen, Jeffrey**, Lee, Seong H., **Choi, Chang Kyoung**, "The Effect of Adsorbed Volatile Organic Compounds on an Ultrathin Water Film Measurement," Appl. Sci. 2020, 10(17), 5981; DOI: https://doi.org/10.3390/app10175981

Albakri, Mohammad I., **Malladi, Vijaya Venkata Narasimha Sriram,** Gugercin, Serkan, Tarazaga, Pablo A., "Estimating dispersion curves from Frequency Response Functions via Vector-Fitting," Mechanical Systems and Signal Processing, Volume 140, June 2020, 106597. DOI: https://doi.org/10.1016/j.ymssp.2019.106597

Esmaeil Dehdashti, Gregory W. Reich and **Hassan Masoud**, "Collective Sensitivity of Artificial Hair Sensors to Flow Direction," AIAA Journal, 2021, arc.aiaa.org. Published Online: 9 Feb 2021. DOI: https://doi.org/10.2514/1.J060290

Dehdashti, Esmaeil, Razizadeh, Meghdad, **Masoud, Hassan**, "Heat transfer from a particle in laminar flows of a variable thermal conductivity fluid," International Journal of Heat and Mass Transfer, Volume 171, June 2021, 121067. DOI: https://doi.org/10.1016/j.ijheatmasstransfer.2021.121067

Sur, Samrat, **Masoud, Hassan,** Rothstein, Jonathan, "The Effect of Shape on the Motion and Stability of Marangoni Surfers," J. Fluids Eng. Jan 2021, 143(1): 011301 (15 pages). DOI: https://doi.org/10.1115/1.4048139

Dehdashti, Esmaeil, **Masoud, Hassan,** "Forced convection heat transfer from a particle at small and large Peclet numbers," J. Heat Transfer. Jun 2020, 142(6): 061803 (9 pages). DOI: https://doi.org/10.1115/1.4046590

Jafari Kang, Saeed, Sur, Samrat, Rothstein, Jonathan, **Masoud, Hassan,** "Forward, reverse, and no motion of Marangoni surfers under confinement," Phys. Rev. Fluids 5, 084004 – Published 12 August 2020. DOI: https://doi.org/10.1103/PhysRevFluids.5.084004

Meadows, Guy A., Shuchman, Robert A., Burns, Joseph W., *Trinklein, Eddy H*., **Parker, Gordon G**., Nwogu, Okey, "Seaworthiness Through Intelligent Trajectory Control," Marine Technology Society Journal, Volume 54, Number 3, May/June 2020, pp. 18-22(5). DOI: https://doi.org/10.4031/MTSJ.54.3.3

Enginsoy, H. M., Bayraktar, E., Katundi, D., Gatamorta, F., **Miskioglu, Ibrahim**, "Comprehensive analysis and manufacture of recycled aluminum-based hybrid metal matrix composites through the combined method; sintering and sintering + forging," Composites Part B: Engineering, Volume 194, 1 August 2020, 108040. DOI: https://doi.org/10.1016/j.compositesb.2020.108040

Soules, James G., **Morse, Stephen M**., Norville, H. S., "Application of the Glass Failure Prediction Model to Flat Odd-Shaped Glass Using Finite-Element Modeling," Journal of Architectural Engineering, Vol. 26, Issue 4 (December 2020). DOI: https://doi.org/10.1061/(ASCE)AE.1943-5568.0000437

Soules, James G., **Morse, Stephen M.,** Norville, H. S., "Application of the Glass Failure Prediction Model to Flat Glass Using Finite-Element Modeling," Journal of Architectural Engineering. Vol. 26, Issue 2 (June 2020). DOI: https://doi.org/10.1061/(ASCE)AE.1943-5568.0000395

Blanchet, Samir, **Morse, Stephen M.,** Norville, H. S., "Effects of Silicone Coatings on Heat Strengthened and Fully Tempered Glass," Journal of Architectural Engineering, Vol. 26, Issue 2 (June 2020). DOI: https://doi.org/10.1061/(ASCE)AE.1943-5568.0000403

Zhao, Zhihao, *Zhu, Xiucheng*, **Naber, Jeffrey, Lee, Seong-Young,** "Assessment of impinged flame structure in high-pressure direct diesel injection," International Journal of Engine Research, Volume: 21 issue: 2, page(s): 391-405 (February 2020). DOI: https://doi.org/10.1177%2F1468087419859788

Pisani, William A., Radue, Matthew S., Patil, Sagar U., **Odegard, Gregory M**., "Interfacial modeling of flattened CNT composites with cyanate ester and PEEK polymers," Composites Part B: Engineering, Volume 211, 15 April 2021, 108672. DOI: https://doi.org/10.1016/j.compositesb.2021.108672

Aluko, Olanrewaju, Shankara, Gowtham, **Odegard, Gregory M.,** "The assessment of carbon nanotube (CNT) geometry on the mechanical properties of epoxy nanocomposites," Journal of Micromechanics and Molecular Physics Vol. 05, No. 03, 2050005 (2020). DOI: https://doi.org/10.1142/S2424913020500058

Rahman, Aowabin, *Deshpande, Prathamesh, Radue, Matthew S*., **Odegard, Gregory M., Shankara, Gowtham, Ghosh, Susanta,** Spear, Ashley D., "A machine learning framework for predicting the shear strength of carbon nanotube-polymer interfaces based on molecular dynamics simulation data," Composites Science and Technology, Volume 207, 3 May 2021, 108627. DOI: https://doi.org/10.1016/j.compscitech.2020.108627

Kirmani, Mohammad H., *Sachdeva, Geeta, Pandey, Ravindra,* **Odegard, Gregory M**., Liang, Richard, Kumar, Satish, "Cure Behavior Changes and Compression of Carbon Nanotubes in Aerospace Grade Bismaleimide-Carbon Nanotube Sheet Nanocomposites," ACS Applied Nano Materials, 2021, 4,3. pp. 2476-2485. DOI: https://doi.org/10.1021/acsanm.0c03013

Onuoha, Chinomso, Drozdov, Grigorii, Liang, Zhiyong, **Odegard, Gregory M.**, Siochi, Emilie J., and *Dumitrică, Traian*, "Computational Investigation of Large-Diameter Carbon Nanotubes in Bundles for High-Strength Materials," ACS Appl. Nano Mater. 2020, 3, 6, 5014–5018. DOI: https://doi.org/10.1021/acsanm.0c01462

Sachdeva, Geeta, Lobato, Álvaro, *Pandey, Ravindra*, and **Odegard, Gregory M.**, "Mechanical Response of Polymer Epoxy/BMI Composites with Graphene and a Boron Nitride Monolayer from First Principles," ACS Appl. Polym. Mater. 2021, 3, 2, pp. 1052–1059. DOI: https://doi.org/10.1021/acsapm.0c01306

Patil, Sagar U., Radue, Matthew S., Pisani, William A., Deshpande, Prathamesh, Xu, Hao, *Al Mahmud, Hashim*, Dumitrica, Traian, **Odegard, Gregory M**., "Interfacial characteristics between flattened CNT stacks and polyimides: A molecular dynamics study," Computational Materials Science, Volume 185, December 2020, 109970. DOI: https://doi.org/10.1016/j.commatsci.2020.109970

Al Mahmud, Hashim, Radue, Matthew S., Chinkanjanarot, Sorayot, **Odegard, Gregory M.,** "Multiscale Modeling of Epoxy-Based Nanocomposites Reinforced with Functionalized and Non-Functionalized Graphene Nanoplatelets," Polymers 2021, 13(12), 1958. DOI: https://doi.org/10.3390/polym13121958

Bamane, Swapnil S., Gaikwad, Prashik S., Radue, Matthew S., Shankara, Gowtham, **Odegard, Gregory M.,** "Wetting Simulations of High-Performance Polymer Resins on Carbon Surfaces as a Function of Temperature Using Molecular Dynamics," Polymers 2021, 13(13), 2162. DOI: https://doi.org/10.3390/polym13132162

Damirchi, Behzad, *Radue, Matthew S*., Kanhaiya, Krishan, Heinz, Hendrik, **Odegard, Gregory M.,** van Duin, Adri C. T., "ReaxFF Reactive Force Field Study of Polymerization of a Polymer Matrix in a Carbon Nanotube-Composite System," J. Phys. Chem. C 2020, 124, 37, 20488–20497. DOI: https://doi.org/10.1021/acs.jpcc.0c03509

PATENTS & PUBLICATIONS (CONT.)

Trinklein, Eddy H., *Cook, Michael D*., **Parker, Gordon G., Weaver, Wayne W**., "Exergy optimal multi-physics aircraft microgrid control architecture," International Journal of Electrical Power & Energy Systems, Volume 114, January 2020, 105403. DOI: https://doi.org/10.1016/j.ijepes.2019.105403

Cook, Michael D., Trinklein, Eddy H., **Parker, Gordon G**., *Heath, Matthew J*., **Weaver, Wayne W**., **Robinett, III, Rush D**., Wilson, David G., ""Reduced order model verification of a DC microgrid for controller design and determination of storage requirements," International Journal of Electrical Power & Energy Systems, Volume 114, January 2020, 105404. DOI: https://doi.org/10.1016/j.ijepes.2019.105404

Zheng, Ting, Wang, Xiaodong, Liu, Yingyi, *Bayaniahangar, Rasoul*, Li, Hongbin, Lu, Chunrui, Xu, Nuo, Yao, Zhaoding, Qiao, Yingjie, Zhang, Dongxing, **Pour Shahid Saeed Abadi, Parisa**, "Polyaniline-decorated hyaluronic acid-carbon nanotube hybrid microfiber as a flexible supercapacitor electrode material," Carbon, Volume 159, 15 April 2020, Pages 65-73. DOI: https://doi.org/10.1016/j.carbon.2019.11.074

De Jesus Rivera, Edward, **Robinette, Darrell, Blough, Jason R., Anderson, Carl L.,** "Mathematics of Turbomachinery," PNAS December 1, 2020 117 (48) 30024; first published November 24, 2020. DOI: https://doi.org/10.1073/pnas.2007913117

Jurmu, Luke, **Robinette, Darrell, Blough, Jason R.,** Gehringer, Mark, "Design and Test of a Torsional Vibration Absorber in Series with a Planetary Gear Set," Journal of Vibration and Control, July 1, 2021; 27(13-14):1498-1510. DOI: https://doi.org/10.1177%2F1077546320943801

Konica, Shabnam, **Sain, Trisha,** "A thermodynamically consistent chemo-mechanically coupled large deformation model for polymer oxidation," Journal of the Mechanics and Physics of Solids. Volume 137, April 2020, 103858. DOI: https://doi.org/10.1016/j.jmps.2019.103858

Bijaieh, Mehrzad M., **Weaver, Wayne W., Robinett, Rush D.,** "Energy Storage Power and Energy Sizing and Specification Using HSSPFC," Electronics 2020, 9(4), 638; DOI: https://doi.org/10.3390/electronics9040638

Zhou, Xiang, Abdelkhalik, Ossama O., **Weaver, Wayne W.,** "Power Take-Off and Energy Storage System Static Modeling and Sizing for Direct Drive Wave Energy Converter to Support Ocean Sensing Applications," J. Mar. Sci. Eng. 2020, 8(7), 513. DOI: https://doi.org/10.3390/jmse8070513

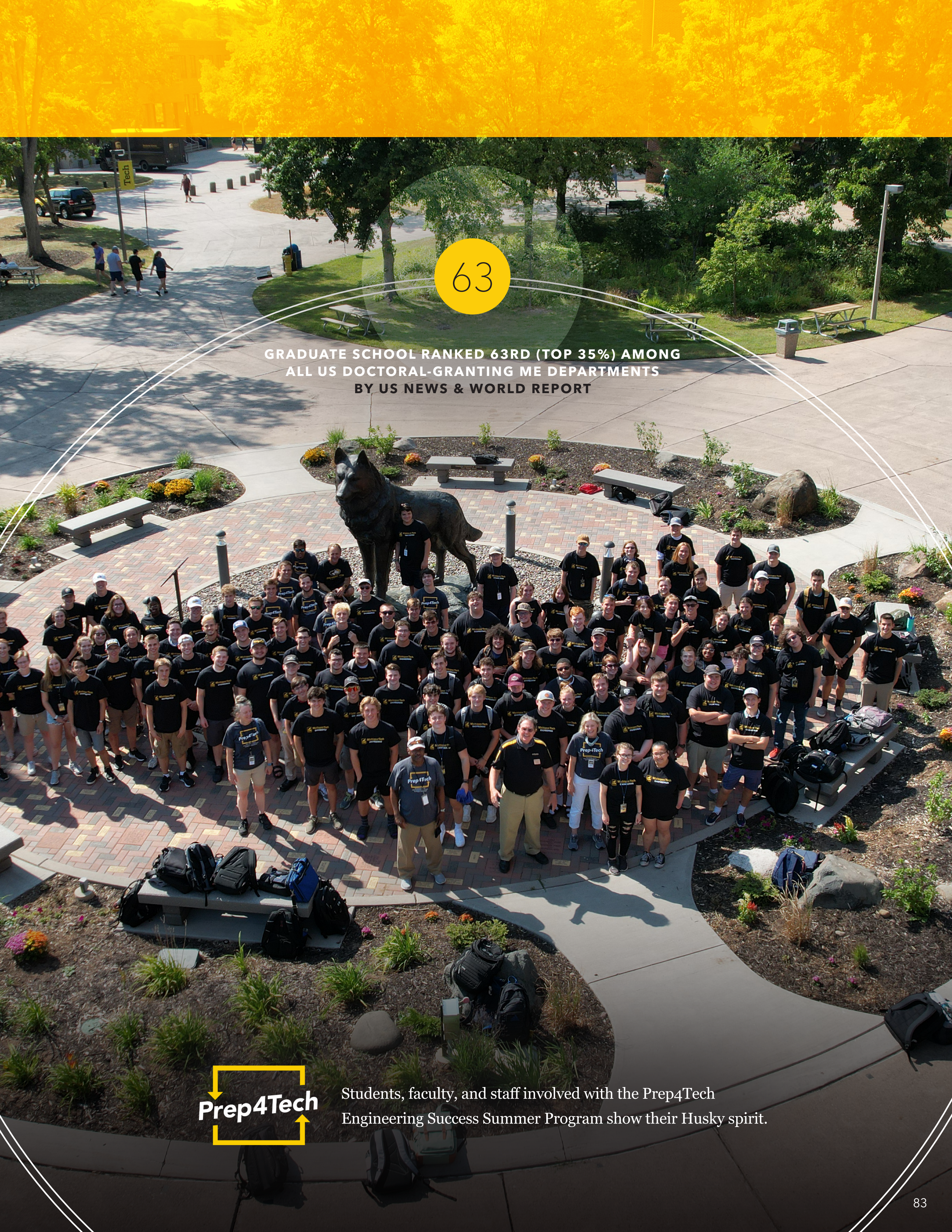
Chen, Siyu, You, Zhanping, **Yang, Song-Lin,** Gracida Alvarez, Ulises R., Luke, Rose E., "Influence of Air Void Structures on the Coefficient of Permeability of Asphalt Mixtures," Powder Technology, Volume 377, 2 January 2021, Pages 1-9. DOI: https://doi.org/10.1016/j.powtec.2020.08.082

Yang, Yongchao, Dorn, Charles, Farrar, Charles, Mascareñas, David, "Blind, simultaneous identification of full-field vibration modes and large rigid-body motion of output-only structures from digital video measurements," Engineering Structures, Volume 207, 15 March 2020, 110183. DOI: https://doi.org/10.1016/j.engstruct.2020.110183

Yang, Yongchao, Dorn, Charles, "Affinity propagation clustering of full-field, high-spatial-dimensional measurements for robust output-only modal identification: A proof-of-concept study," Journal of Sound and Vibration, Volume 483, 29 September 2020, 115473 DOI: https://doi.org/10.1016/j.jsv.2020.115473

Yang, Ruoyu, Singh, Shubhendu Kumar, Tavakkoli, Mostafa, Amiri, Nikta, **Yang, Yongchao,** Karami, M. Amin, Rai, Rahul, "CNN-LSTM deep learning architecture for computer vision-based modal frequency detection," Mechanical Systems and Signal Processing, Volume 144, 2020, 106885, ISSN 0888-3270, DOI: https://doi.org/10.1016/j.ymssp.2020.106885

Martinez, Bridget, Green, Andre, Silva, Moises F., **Yang, Yongchao,** Mascareñas, David, "Sparse and Random Sampling Techniques for High-Resolution, Full-Field, BSS-Based Structural Dynamics Identification from Video," Sensors 2020, 20(12), 3526. DOI: https://doi.org/10.3390/s20123526



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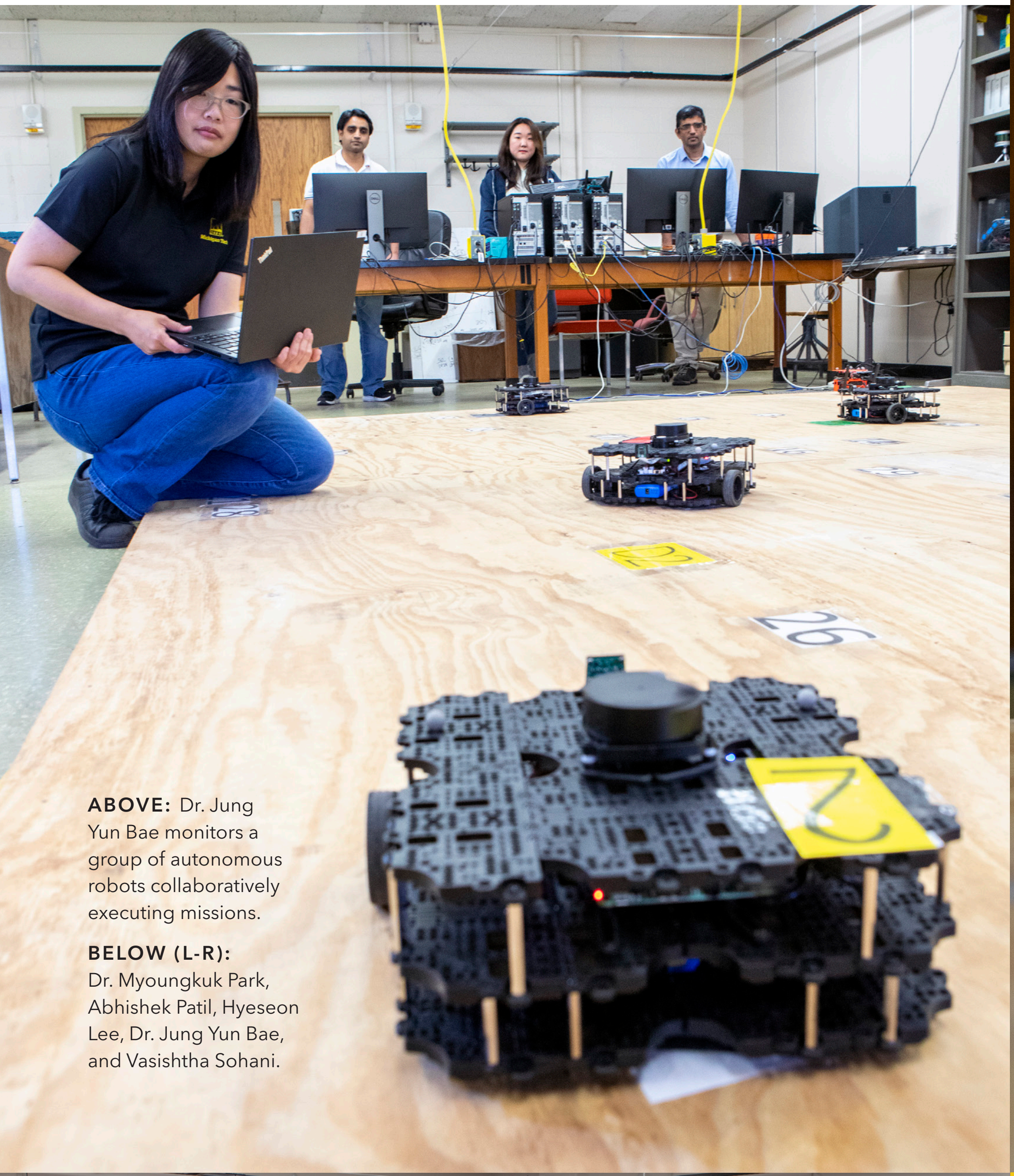
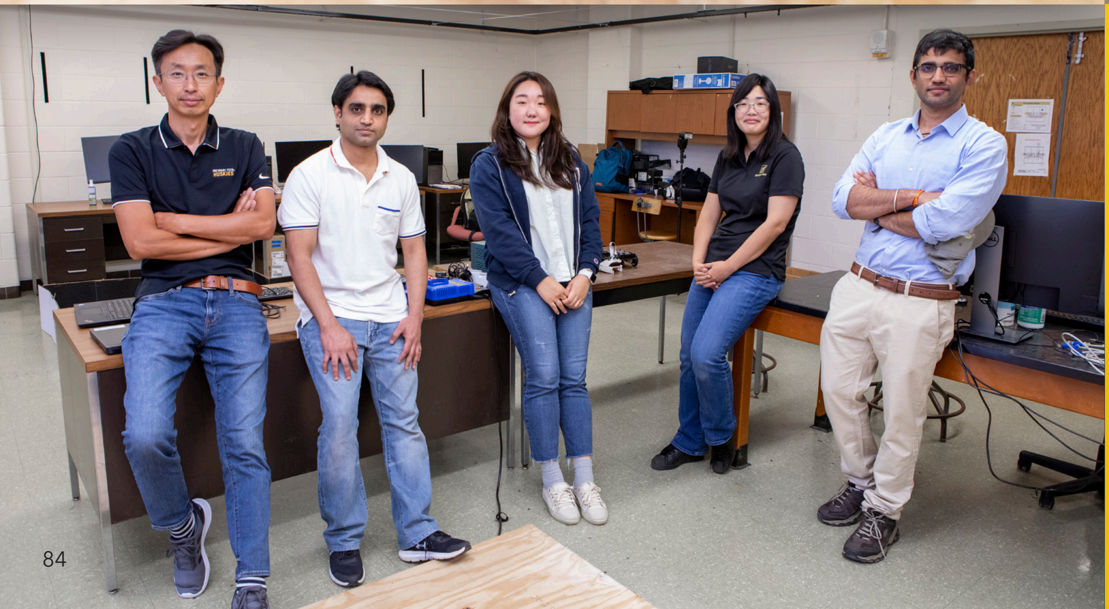


ABOVE: Dr. Jung Yun Bae monitors a group of autonomous robots collaboratively executing missions.

BELOW (L-R): Dr. Myoungkuk Park, Abhishek Patil, Hyeseon Lee, Dr. Jung Yun Bae, and Vasishtha Sohani.



1

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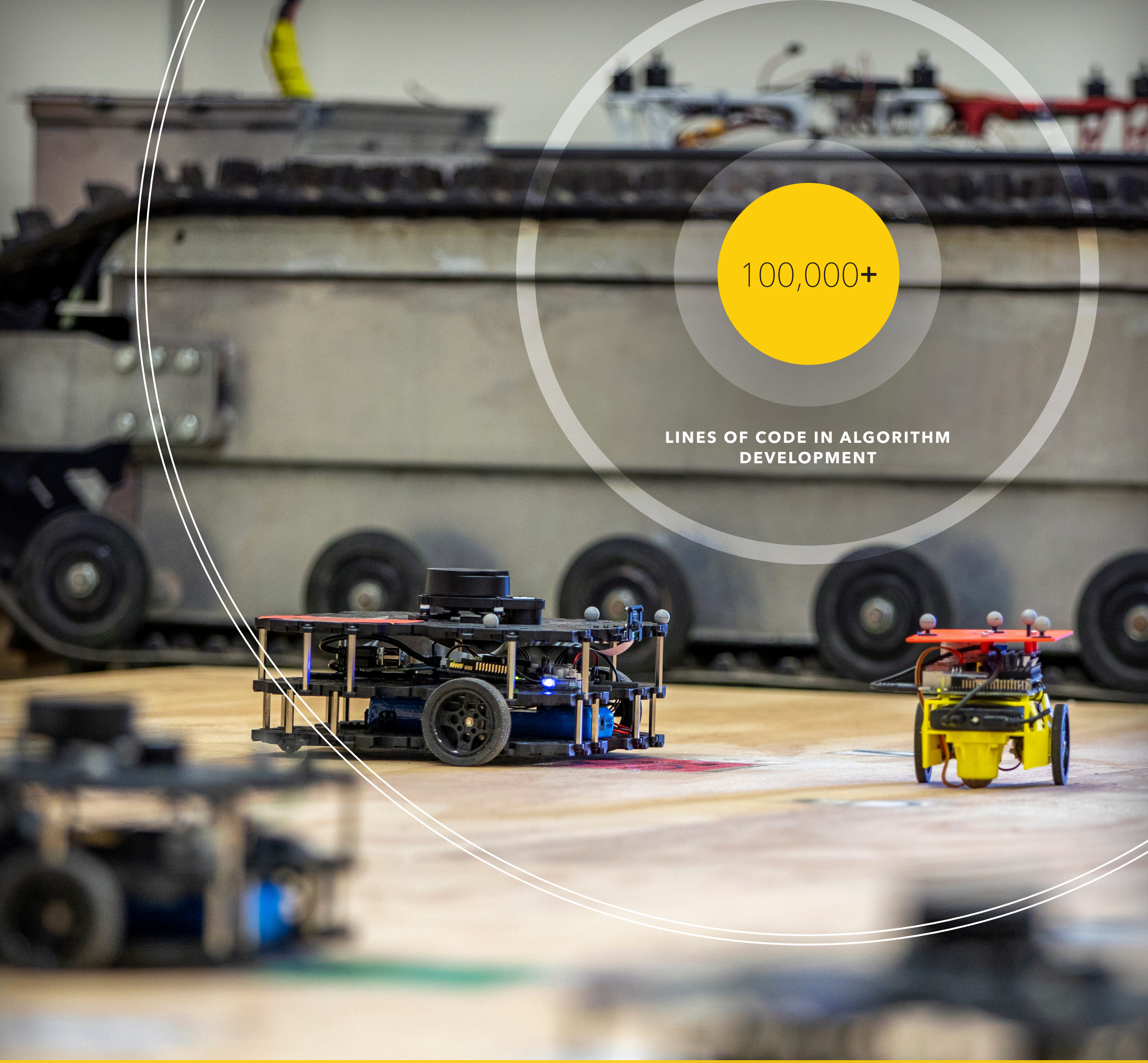

Dr. Jung Yun Bae came to Michigan Tech in 2019 and has a joint appointment as an Assistant Professor in the ME-EM and Applied Computing Departments.

Bae and her team develop system intelligence for efficient operations of heterogeneous multi-robot teams. Her primary goal is to develop an operational strategy for multi-agent autonomous vehicle systems.

In her laboratory, Bae and her students utilize motion capture technologies on the robots to track where the autonomous, self-guided robots are at all times and test routing, control, optimization, and navigation as the robots maneuver through mazes. Her team seeks to reduce uncertainty and enhance path planning with autonomous vehicles that maintain differing structures and functions.

ME-EM DEPARTMENT
Michigan Technological University
1400 Townsend Drive
Houghton, MI 49931-1295

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The T-REX robot was designed, built, and tested in the Planetary Surface Technology Development Laboratory at Michigan Tech. It was created around the concept of delivering power to dark craters on the moon. Under the direction of Dr. Paul van Susante, students developed a rover concept to advance energy infrastructure for the moon—introducing opportunities for communication between devices.