ME-EM 2016-17 Annual Report

Department of Mechanical Engineering-Engineering Mechanics, Michigan Technological University

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In the ME-EM Department, we challenge our students with experiences designed to foster the leadership and aptitude they need to be fully contributing engineers from day one on the job. What’s it like to walk in their shoes? In this year’s annual report, you’ll have a chance to find out.

In these pages you’ll hear from undergraduate students involved in ME-EM Capstone Senior Design. They join small teams and connect with industry through open-ended, year-long projects that encompass the design process from ideation to realization.

You’ll hear from students who run an Enterprise team. They develop products, processes, and services for multiple years in the business-like environment of a much larger team. Michigan Tech’s Enterprise program, with 26 teams across campus, is nationally recognized as a best practice.

Next, our graduate students share their stories. From autonomous systems to space systems, ranging from the nano-to-macro scale, they tell what it’s like to conduct research alongside their advisors—and create new possibilities in the world around us.

My hope is that through these stories from our students, you will see we have great students. Perhaps one of them will bring back memories of your own experience at Michigan Tech.

This past year ME-EM faculty and staff successfully secured several large grants—funding that advances our longstanding goal of developing nationally-recognized research centers. I’m pleased to bring you their exciting news, too.

Last but not least, my own thoughts. In a few simple words, thank you. Preparing students to become immediately contributing engineers requires widespread support. On behalf of our students, faculty, and staff, I would like to personally thank all who impact and support our next generation of engineers.

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

In alignment with our strategic plan, we continue to work toward achieving international leadership positions in each of our four research thrust areas by first securing national research centers.

With funding from NASA, Dr. Gregory Odegard is establishing the Institute for Ultra-Strong Composites by Computational Design (US-COMP) a new space technology research center on the Michigan Tech campus. Collaborators include 11 universities, 23 faculty members, two partner companies, and the US Air Force Research Lab. Their goal is to create lighter and stronger carbon nanotube-based materials for the next generation of space exploration. US-COMP will bring in $15 Million over the course of five years. See page 78.

US-COMP takes its position alongside two existing campus research centers, including the Center for Agile and Interconnected Microgrids (AIM) and the Advanced Power Systems Labs (APS LABS). Led by Drs. Gordon Parker and Rush Robinett, AIM was recently selected for a US Department of Defense contract exploring ship power capabilities through exergy control.

Along with contributions from Dr. Ossama Abdelkhalik, Dr. Wayne Weaver in the Department of Electrical and Computer Engineering, and Dr. Laura Brown in the Department of Computer Science, the AIM team advances the development of agile microgrid systems across many applications.

Dr. Jeff Naber, with researchers, graduate students, and in partnership with GM, will develop the next generation of control systems for light-duty hybrid electric vehicles through a $3.5 Million award from the US Department of Energy’s Advanced Research Projects Agency-Energy (ARPA-E). Housed at the APS LABS, the project will bring together research from Drs. Darrell Robinette and Mahdi Shahbakhti in the ME-EM Department, Dr. Bo Chen with dual appointment in the ME-EM Department and the Department of Electrical and Computer Engineering Department, and Dr. Kuilin Zhang in the Department of Civil and Environmental Engineering to enhance controls, aiming for a 20 percent reduction in energy consumption.

With the continuous advancement of our centers, we have been able to attract and retain highly qualified graduate students, and faculty who are experts in their fields. We look forward to maintaining these trends and further developing our relationships with government and industry partners.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION
• 9th in BSME enrollment, 13th in BSME degrees awarded
• 5th in MSME enrollment, 17th in MSME degrees awarded
• 26th in PhD enrollment, 48th in PhD degrees awarded

NATIONAL SCIENCE FOUNDATION
23rd in research expenditures ($12.96 million) among all mechanical research in the US

US NEWS & WORLD REPORT AMERICA’S BEST GRADUATE SCHOOLS
65th among the top 177 (top 38%) doctoral-granting ME departments

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

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“Our undergraduates are well rounded. In addition to the fundamentals of engineering science, our curriculum teaches them communication, computational, and hands-on skills. The finishing touch to their education is the capstone project, which they can either take through the prestigious Enterprise Program or through our rigorous Senior Design Program.”

*DR. GREGORY ODEGARD*
ME-EM undergraduates are a rare commodity. Challenges? They thrive on those. Adversity? Bring it on.

Hands-on, head-on. Senior Design and Enterprise projects hone their skills and prepare them for future success.

READ THEIR STORIES ➔
At Michigan Tech, I learned how to learn.”

ThOMAS TETZLOFF

The team chose to move away from gas power in favor of electric for a lightweight, foldable design, achieving greater torque and better run-times. Going electric allowed them to use hub motors, hiding the power source inside the wheel for greater flexibility in the folding structure. “Instead of a drivetrain between with a chain and shaft, hindering the ability for it to fold, we went with the hub motors, which don’t require rigid power delivery,” says Tetzloff.

The iterative design process to create the greatest impact helped shape the mindset of the team. Initially thinking of the system as a Senior Design Project, they soon realized this was a human-centered design task.

“At a pivotal moment when we realized we were designing it for a soldier in the field. There is a person out there fighting, and we’re designing it for them, for their mission,” he says.
The team was comprised of ME-EM Department students Tetzloff, Dean Johnson, and Kyle Raboin (pictured above), as well as Matt Miller from the Department of Electrical and Computer Engineering. “I feel immensely lucky to have been on this project with team members of various backgrounds,” Tetzloff says.

Tetzloff is building on his accomplishments as a design engineer at the product development firm GS Engineering. While his goal of becoming an engineer has been fulfilled, he has chosen to continue his education at Michigan Tech with a master’s degree in mechanical engineering.

“The competition”

“Our transport system was carrying 600 pounds during testing, but at competition it failed when a bolt holding the toggle snapped,” says Tetzloff. “We thought we were out, but the Air Force representatives encouraged us to fix the system, giving us 15 minutes to find a solution. We worked together to splint the toggle and were able to complete the endurance run.”
HANDS-ON EXPERIENCES

On the factory floor at Nexteer Automotive, working on a co-op while attending Delta Community College, Tabitha Gillman found her passion: she thrived when facing the urgent challenges presented by modern manufacturing.

Gillman faced her own personal challenge as well—whether or not to follow that passion into engineering. “I knew if I wanted the best degree in mechanical engineering, it had to be Michigan Tech.”

Entering Michigan Tech in her fourth year of college was a steep challenge. It meant tackling Mechanical Engineering Practice (MEP) courses along with technical electives in Human Factors, Material Handling, and Quality Engineering.

“I enjoyed being hands-on and working on the factory floor, so I enrolled in courses focused on optimizing floor layout and operator experience. In the Human Factors course, we looked beyond the ergonomics of seat design. We analyzed machinery with operators to ensure all buttons and switches were easily accessible, without overextending. In the Material Handling course, we covered more than just the layout of the factory floor. We looked at cranes and forklifts and also learned how to assemble a conveyor belt to optimize the product path. I followed those two with the course on Quality Engineering to learn how to ensure products come out with the same specifications each time and how to maintain the process continually, from start to finish,” she says.

Gillman’s experiences and coursework made her an ideal team member for the Coupling Drill Attachment Senior Design project, sponsored by Stryker Corporation.

“Our project has an end result—someone is actually going to use what we designed, and it is making a difference.” Tabitha Gillman
SENIOR DESIGN EXPERIENCE
Soon after graduation from Michigan Tech, Gillman secured a position with AstenJohnson as a production expeditor and seaming process engineer. “It’s a role in production control and manufacturing engineering, ensuring all the machines are running smoothly, much like the Quality Engineering course I took as an undergraduate,” she says. Stepping into this exciting new role, Gillman has no regrets about following her passion to Michigan Tech.

THE PROBLEM
Stryker came to the ME-EM Department looking for a Senior Design team to redesign a drill attachment coupling mechanism. The existing drill attachment, used during medical surgeries on the head and spine, was not intuitive. Medical staff struggled to attach and detach the various instruments required for surgery. The existing design put a great deal of strain on the user when removing any attachment using a direct pull.

Stryker’s specifications included:
• An axial holding force of at least five pounds
• Deflection equal to or less than the current mode (0.005 inches)
• An attach or detach time of three seconds
• Corrosion-resistant material that can be sterilized in an autoclave
• Manufacturing cost less than the current model

Gillman and her team, consisting of Steven Hans Creutz, Meridith Murley, Harry Hutton, and Cole Aukee, added their own ergonomics requirement to the project: the new attachment mechanism must use less than 7.5 foot-pounds of torque so a fifth percentile American female could operate the mechanism in the allotted three-second time.

THE RESULTS
The team met and exceeded all of the criteria for the project. The final attachment mechanism design had:
• An axial holding force of 11 pounds
• Deflection of 0.002 inches
• An attach or detach time of 0.5 seconds
• Made of stainless steel, which is corrosion resistant and autoclavable
• Achieved a 10 percent reduction in manufacturing cost

With the team’s added requirement, they were able to achieve 0.3 foot-pounds of torque, far surpassing the goal of less than 7.5 foot-pounds.
Joseph Goudzwaard grew up listening to his father talk about his work as a materials science engineer. Intrigued by the problems his father faced on a day-to-day basis, Goudzwaard always knew he’d go to Michigan Tech to be an engineer like his father and grandfather before him, but his field of study was yet to be determined. “I looked at several options, but I felt the ME degree was broader, with career options in consumer products and the automotive industry. It gives me the flexibility to enter any industry with a discipline of interest to me,” he says.

By building an understanding of the core engineering principles early on, Goudzwaard was able to achieve success both in and out of the classroom. “Mechanics of Materials, Statics, and Dynamics are all a huge foundation for everything in ME,” he says. “Every course would have an overview of what was previously taught, so we couldn’t lose the information learned early on. It was reinforced and then built upon.”

The strong foundation he gained led to early internship opportunities. “Going into internships, there are so many things that are company-specific factors, but Michigan Tech prepares you with a solid foundation to think rationally and absorb the knowledge at any company,” Goudzwaard says.

Goudzwaard’s abilities were put to the test when he joined another Senior Design team also sponsored by Stryker Corporation, and he set out to improve a surgeon’s experience with Stryker tools.

“The beauty of mechanical engineering is being able to understand the universal truths and using those to solve problems.”

**Joseph Goudzwaard**

**THE PROBLEM**

Drills that are used in surgical procedures to cut and remove bone run at high speeds, which frequently causes them to become hot in the hands of medical professionals. Goudzwaard, together with mechanical engineering student Don Bowlby and electrical engineering students Ken Barr and Kyle Rautio, developed a testing system to help Stryker determine temperature profiles for commercial bearing configurations used in the drill.

**System specifications:**
- Spin a size 3332 bearing at speeds from 75,000 to 100,000 rpm
- Apply a radial or axial load to the bearing
- Meet a load application of 0.125 to 0.25 pounds
- Measure and collect temperature data during the test while running and loaded
- Be self-contained and portable
SENIOR DESIGN EXPERIENCE

Thanks to sponsors like Stryker, students like Goudzwaard are able to work on projects that make a difference.

“Anytime someone is working with good tools, their focus can be on the surgery and not on their hand overheating. In a way, we have helped to improve the healthcare delivery process,” he says.

Goudzwaard will begin his work on capital projects, installing components and communicating with contractors on the shop floor in a full-time position with Kimberly-Clark.

THE RESULTS

The team created a testing system capable of storing data for each bearing test, easily downloadable via USB. While the team’s primary goal was to spin a size 3332 bearing, the system is also compatible with 518s and 418s with various configurations to collect temperatures and to permit recommendations as far as ideal bearings for each application being tested.

At the close of the project, the team met all of Stryker’s specifications with collaboration across departments. “Kyle and Ken did a wonderful job with the wiring and the programming for the user interface, learning the Python language, and completing the programming,” says Goudzwaard. “On the ME side, I bounced ideas back and forth with Don, who did a lot of the CAD work for the system.”
BRIDGING SUCCESS

The remnants of Winter Carnival, hum of snowmobile engines in the distance, and endless snow are what first drew Nick Brodowski to Michigan Tech. Combine this with the fact that he had his first snowmobile at 10 and that he spent time rebuilding it with his dad, and it was clear that there was no better school for him. “I couldn’t imagine going to school anywhere else, where I wouldn’t be able to snowmobile almost every weekend,” he says.

Once on campus, Brodowski was excited by the opportunities to get involved in Enterprise, especially Clean Snowmobile, but he had to wait until the beginning of his second semester to join. “It’s a whole new experience; learning what we can work on and what improvements we can help make,” Brodowski says. “Right before competition, so much needed to be done. I’d get a task that needed to be done right away and focus on that.”

Despite the team’s efforts, their fully electric snowmobile did not pass technical inspection in Brodowski’s first semester in Enterprise. Brodowski was elected co-president of the zero-emissions snowmobile team the following year, and his mission was clear. “That year was the first year with the snowmobile, so we had two years left in the competition cycle. I was determined to keep the same snowmobile, make it work, and pass technical inspection, something the zero-emissions team had not yet accomplished,” he says.

The following season, having redesigned the snowmobile and reconfigured components, the team didn’t pass technical inspection on day one, but they came back and passed it the next day, taking second place overall and winning an event.

“Enterprise prepared me well to work with a company, allowing me to budget, and also work with a team through an extensive project. I’ve found that Enterprise and my internships have both contributed to each other.” Nick Brodowski
INVALUABLE EXPERIENCES

Building on his Enterprise experiences, Brodowski has been able to apply his knowledge in the workforce, landing an internship last summer with Evinrude (the parent company of Ski-Doo snowmobiles) working on outboard boat motors and an internship this summer working at GM as a manufacturing engineer at an assembly plant.

“For as long as I can remember, I’ve been passionate about Chevy trucks and Ski-Doo snowmobiles, so I’ve fulfilled my dream jobs with these two internship experiences,” he says.
MAKING AN IMPACT

Seeking a small school environment with a big impact, Lorne Newhouse knew from the minute he came to Michigan Tech that he was in the right place. Where else could he combine his love of the outdoors with his passion for numbers? On the tour, he heard about students working with client projects through the Enterprise Program. Once enrolled, he looked forward to joining the Aerospace Enterprise team.

After several semesters in the Aerospace Enterprise, Newhouse decided to take on a new challenge last fall when he learned about the newly formed Strategic Education through Naval Systems Experiences (SENSE) Enterprise. “I’ve always wanted to work on projects with the Department of Defense, facing new challenges in planes and boats. When I saw the flyer for SENSE, I knew it would be a great fit,” he says.

The first major SENSE project, the development of a powered flotation device for rescue scenarios, was sponsored by the Office of Naval Research, the Keweenaw Bay Indian Community, and the Great Lakes Research Center.

“Products similar to our device, like Project Emily, are on the market, but come with a cost of around $10,000,” says Newhouse. “We want to make our system affordable for more communities.”

**PROJECT KICKOFF**

After meeting with project sponsors, the SENSE team—comprised of Newhouse, Charles Hatch, and Kyle Pinozek (far right)—set to work developing a design to meet the set requirements:

- Cost less than $2,000
- Rescue two victims at once with 22 pounds of buoyancy per person
- Set-up and deploy in less than 30 seconds
- Weigh less than 25 pounds
- Storage size of less than 6’ x 2.5’
- Built from readily available components

Ranking the requirements in order of importance, the team conducted research on current market designs, then brainstormed concepts to see if the proposed design met, exceeded, or failed to meet the sponsor specifications. They chose the top design and began prototyping.

**PRODUCING TEAMWORK**

With the design phase complete, the team started production of the Nearshore Emergency Rescue Device (NERD). They used a PVC skeleton surrounded by two-part boating foam which allowed them to meet the low cost design requirement while providing the necessary buoyancy. Since the operator turns on and drives NERD directly to the victim using an RC controller, it is easy to use and intuitive to drive. The device uses battery power to run three thrusters housed in the PVC; mesh grates are used to protect the thrusters from debris.

“Right at the end of the year, we were able to test the system on the Portage. It was incredible to see something we spent so much time on operating like we’d expected,” says Newhouse, who is looking forward to continuing his work on the device as he begins his fourth year. “This fall we’ll focus on improving it from a structural standpoint, reducing the weight, improving the manufacturability, and then looking at new control systems.”
READY TO DELIVER

After the fall Career Fair, Newhouse met with representatives from Nexteer Automotive. Impressed with his involvement in the Enterprise program, they offered him a position as an intern in their global supply management division.

Newhouse is interning now at Williams International, a manufacturer of small jet turbines. “I’m in the engineering department doing tool design and CAD work to reduce quality issues and find solutions for issues on the floor,” he says. Ultimately he is hoping for a career with the US Department of Defense.

SOMETHING FOR EVERYONE

“From first year students to graduating seniors, everyone is a part of the team and has an impact,” says Newhouse. “With projects like this in Enterprise, students can bring concepts from the classroom, pulling from experience and providing multiple approaches to solve a single problem. The open-ended problems we face and the way we solve them as a team are invaluable for success in the job market.”
THE STORY INSIDE

With a passion for mystery, Ryan Logan was drawn to the Enterprise program at Michigan Tech due to the hands-on, practical application of the concepts discussed in classes.

In his fourth semester at Michigan Tech, Logan found a team that aligned with all of his interests: the math and science behind engineering and boards (skateboards, snowboards, and longboards).

“Boarding has always been a hobby, so when I heard about the BoardSports team, I was sold instantly,” says Logan. He enjoys applying classroom concepts to the world of boarding. “I remember while taking the Strengths of Materials class, we’d be looking at equations and I’d go back and look at a snowboard in pieces to see the layering inside and use those mysterious equations to understand how materials flex under forces applied to the whole system.”

Boarding is often considered a creative world, but the BoardSports Technologies Enterprise allows students to participate in both aspects: the creative coupled with the facts and theories. “We work in both dimensions, looking to industry for the creative aspect—changing elements of a design and putting numbers to it to see where the hard limits are,” he says.

The team’s work covers a range of board sports, but this year brought on a new challenge: designing a modular skatepark to use when demonstrating their board designs at recruiting events.

“We wanted a design that would allow people to take the product anywhere while still giving the end-user the full range of accessibility,” says Logan. “Houghton doesn’t have its own skatepark, and even if it did, being able to move it around and only use features you want gives a customizable experience.”

THE DESIGN

Logan and his teammates—Daniel Hammerstrom, Jacob Prochnow, and Kody Nutting (pictured wearing a hat)—worked together over the course of several weeks finding an optimal solution for linking the modules together. The team also looked at designs of modular systems already in place.

“We looked at what others had done for skateparks, as well as dance floor style linking, to define a solution that was both cost effective and practical,” says Logan.

With support from the Enterprise Manufacturing Initiative funded by the GM Foundation, the end goal was to have a product to take to market, not only for Enterprise, but also for rural communities where skateboarding is desired but not accessible.

“We had design reviews with GM engineers, who helped us with feedback. Everyone involved on the GM side grew up skateboarding, so they understood what we were trying to accomplish and gave helpful advice,” he says.
**ENTERPRISE PROCESS**

With help from the machine shop staff, the team took their design into manufacturing, following tight tolerances and ensuring accurate connections. “The most enjoyable part was going through the process—ordering the material and then watching the ramp and panels come together,” says Logan. “Eight months ago we had nothing, just an idea on paper, and now we have something that works!”

After several semesters in Enterprise, Logan is grateful for the opportunities allowing him to combine his passions and enabling him to use his hands. “I learn something along the way in every process by working with different people on different projects, each with different mindsets and backgrounds. It’s been the most valuable experience at Michigan Tech,” he says.

**CAREER PATH**

Logan accepted a position at Suncast Corporation, an injection molding facility near Chicago. “I have the opportunity to go through a rotation in each of their engineering departments: quality design, manufacturing and industrial, and tooling; spending two to three months with each to find the best fit for me,” he says. He feels ready for both the design and build phase of any project that comes his way.

“It’s a great career development opportunity to work with people having different ideas and backgrounds than your own. Enterprise did that for me.” **RYAN LOGAN**
FEATURED STUDENTS

18: Ahammad (Basha) Dudekula
19: Saeedeh (Donna) Ziaeefard
20: Joe Oncken
21: Arash Jamali
22: Kyle Price
23: Xian Li

FEATURED STUDENTS

24: Joe Tripp
25: Xiucheng (Sheldon) Zhu
26: Jon Furlich
27: Edward De Jesús Rivera
28: Miles Penhale

29: Will Larsen
30: Mike Cook
32: Matt Radue
33: Kishan Bellur
34: Menghan Zhao
35: Muhammed Rifat Imam

“Our graduate students are driven. Accepted from among the top applicants worldwide, they choose the courses and technical focus that best fit their interests and career goals. They prepare for successful careers through a rigorous and laboratory-rich program built on the practical applications of mechanical engineering.”

DR. CRAIG FRIEDRICH
ME-EM graduate students, guided by experienced faculty, often shape the world we live in (and sometimes disrupt it!).

From improved gas mileage in hybrid electric vehicles to aerospace reaction kinetics, our students push the limits of what’s possible.

READ THEIR STORIES →
TRAINING HYBRIDS

Engineers are frequently at the cutting-edge of technology and that's exactly where Ahammad (Basha) Dudekula wants to be in the automotive industry. Always interested in understanding how vehicles work, Dudekula found his drive for engineering in hands-on applications.

After completing a bachelor’s at Narasaraopeta Engineering College, AP and a master’s at the Indian Institute of Technology-Madras, Dudekula conducted bore-cylinder engine design analysis and ran engine size tests using 2D and 3D modeling tools at Hero Honda. Looking ahead, he saw the growth of the hybrid electric vehicle market and decided to seek research opportunities through an advanced degree.

“I want to be in a field always looking ahead, not in the past or the present,” he says. “I investigated grant recipients and found that Michigan Tech was well funded by the US Department of Energy, and their facilities at the APS Labs were top-notch, so I applied and never looked back.”

Conducting research prior to his arrival on campus, he read about hybrid electric vehicles and saw an opportunity to improve fuel efficiency. His proposal impressed not only his advisor, Dr. Jeff Naber, but also GM, who later hired him for a year-long co-op position to develop control logic and models for autonomous vehicles and steering systems.

“On co-op, I got to see what happens in the automotive industry and see what problems could best be solved in my PhD,” says Dudekula. “Hybrids were introduced for fuel efficiency, but there are still places where we lose energy because we aren’t optimally controlling the engine and battery operation.”

The basis of his research will be to utilize his understanding of vehicle to cloud (V2C) and vehicle to vehicle (V2V) communication gained at GM in developing algorithms for various scenarios.

“As part of the ARPA-E project, we’ll use route and driving condition data about the vehicle’s destination to proactively adjust the powertrain control behavior to ultimately develop a package that has 20 percent energy efficiency over the Gen 1 Chevy Volt,” he says.

Responsible for building the engine model, Dudekula has made customized drive cycles, comparing models to calibrated experimental data to ensure the engine is operating in an efficient zone and to aid in efficient recovery of regenerative energy during driving situations.

His experiences with GM in developing lateral and longitudinal controllers with model predictive control techniques for autonomous vehicles has been his crowning achievement to date. But Dudekula will continue to advance the technologies of vehicle dynamics with a long-term goal of supporting agricultural applications in India, improving lives in rural communities.
She has been enhancing the glider’s ability to maneuver and glide in the water by changing its buoyancy and to steer by shifting its center of gravity. “We’re determining the minimum turn radius it can hold, along with the pitch, roll, and speed of the glider, with plans for designing new flight patterns,” says Ziaeefard.

With a wide range of applications, the ROUGHIE underwater glider was developed specifically for shallow water situations, maneuvering through obstacles without propulsion to remain stealthy. While under water the glider must operate without GPS, and so it uses accelerometers to estimate velocity and a digital compass and pressure sensors for dead reckoning location estimates.

Ultimately, the team hopes to conduct an endurance test. The glider will be deployed from the Portage waterway and followed for 50 miles to Isle Royale to test its response with greater depth changes and currents and to validate its maneuverability.

With her own childhood dream fulfilled, she now plans new ones: sharing her passion through Michigan Tech’s Summer Youth Program to guide students to build and test mini-gliders. Concluding her research, she is considering underwater vehicle development opportunities while remaining open to serving in education. For Ziaeefard, either path is sure to become a bold adventure.
Traffic information will be provided to Oncken through collaboration on the ARPA-E research project with the Department of Civil and Environmental Engineering to determine target vehicle speed and optimal acceleration to minimize friction breaking.

“We will look at various situations, including highways with hills. The engine revs when you need extra power to climb a hill; the controller can proactively divert engine power to the battery and when it arrives at the hill, the car uses battery instead to provide electric power,” says Oncken, who has enjoyed applying advanced mathematics to a real system.

Testing will consist of both computer simulations and field testing. In computer simulations, Oncken will have full control over the vehicle and will be able to determine the largest theoretical improvements. This will be followed by physical testing with a driver and a passenger; the passenger runs the control software to provide direction to the driver. “We are able to think about the design of the car from the start with this type of control enabled to visualize and put numbers to the improvements,” he says.

While Oncken is unsure of the specific industry he hopes to work in after completing his dissertation, he is confident his future is in energy. “We need to bend the carbon curve. We can’t eliminate fossil fuel consumption without a better market option; we need to develop electric cars that outperform gas cars in every way.”
Because Jamali can adjust his CFD calculations on the fly using the reactivity adjustment (ReAd) method, engine combustion can be simulated with multi-component fuel sprays and compared to simulations with a mechanism considering surrogate components. This leads to greater accuracy and reduced computational time through simplified chemical reactions.

Once finished with the first phase of the model, he will validate the results against benchmark models and other experimental engine tests. “We are validating that these models work well under controlled conditions, focused on spray of the fuel, but ultimately we believe it should work for any case,” Jamali says.

Amazed by the power of computation, Jamali hopes his work will one day be used in commercial software to aid other engineers. “This research is something no one has done before, and I enjoy it. I know it’s going to help engineers conducting engine modeling improve their results,” he says.

Never truly finished learning, he would like to continue his career as a CFD code developer in a national lab, sharing the methods with peers who are likewise enchanted by the poetry of motion.
MOBILITY

POWER IN THE DETAILS

Kyle Price discovered his academic path in the precisely prepared and detailed course materials presented by Dr. Scott Miers. Initially matriculating into biological sciences, Price found a better fit in biomedical engineering but was intrigued by the coursework of his friends in mechanical engineering. “I took a summer of mechanical engineering courses to gauge my interest and I loved it, so I ended with a dual major in mechanical engineering and biomedical engineering,” says Price.

But it was his Heat Transfer class with Miers that made all the difference. “He is extraordinarily prepared for classes, engaging with the students, and has an energy that he brings to class. His passion for the subject matter has made a huge difference for me in understanding to the topics,” Price says.

In preparing for graduation, Price visited Miers during office hours to ask a question about Intermediate Thermodynamics, leading to a discussion about his future. Miers described a new project he was leading to develop a small displacement, high power density engine operating on heavy fuel. “He mentioned he was looking for students to support the research, so I immediately asked if he would consider me. While I didn’t have direct engine experience, the attention to detail he saw in my coursework allowed me to join the project,” he says.

Currently six months into the project, Price’s first step was to select a base engine to handle the unique properties of jet propellant 8 (JP-8) fuel. This led the team to explore off-the-shelf diesel engines designed to run on a variety of fuel properties without forcing changes to the fuel injection system. “We selected the Kohler diesel engine, which uses an indirect injection system with a pre-chamber that vaporizes the heavy fuel and improves combustion,” says Price.

The primary challenge of running JP-8 in an engine is vaporization. He is exploring methods of atomization in which the fuel is broken up into smaller droplet sizes to be vaporized and combusted. “We are hoping to make minor modifications to the fuel injection and fuel pumps to keep engine costs economical,” says Price. “We’re also exploring the addition of a turbocharger or supercharger to increase air flow and thus achieve the power density target while keeping emissions at an acceptable level.”

Committed to maximizing power output without adding significant weight, Price will focus his efforts on the experimental side, conducting simulations as needed to determine expected performance and efficiency. His future goals remain open, but, for now, Price looks to complete the tasks set before him while learning and gaining valuable skills in the world of engine testing and development.

“Dr. Miers is extraordinarily prepared for classes, engaging with the students, and has an energy that he brings to class. His passion for the subject matter has made a huge difference for me in understanding to the topics.”

Kyle Price
While offering opportunities for self-power, the TriboWalk system will be useful in physical rehabilitation, medical therapy, and sports training as well as in detecting fall risk in the aging population. “Our system can monitor gait through measurement of step and stride length, weight shift, symmetry, and stability,” says Li. “Because of its unique setup, it can be used to remotely monitor patients, helping to decrease rehabilitation costs for those in remote areas.”

In the next venture, the team working on the TriboWalk system will explore new materials and a Bluetooth low-energy connection to couple the device directly to a phone. His dissertation will take his experience in developing the TriboWalk sensors and apply it more generally to self-powered health monitoring systems.

Li’s path forward will impact many individuals struggling with personal mobility and will broaden patient access to advanced health monitoring.

“**This research has changed the way I recognize opportunities for improving health systems and self-powered devices. Eventually I’d like to continue my research in biomedical engineering as a faculty member at a university.**” XIAN LI
OPTIMIZING INTELLIGENT COMMUNICATION

Engines run the world we live in. Understanding first principles that flow through each system is critical to delivering engineering improvement and minimizing energy consumption. Most analyses stop there.

But when Joe Tripp visualizes a powertrain, he starts at the principles, continues toward the whole vehicle, and goes another level up to how vehicles nearby affect performance.

Once the team has developed an understanding of the minimal energy consumption for a single vehicle, the group will transition to minimizing consumption for multiple vehicles. “Right now, our work is focused on a single vehicle, before we compute energy consumption for eight cars in common traffic situations. For a single vehicle, a distributed control architecture sits on top of the system, so if the vehicle performs a maneuver and we manipulate it slightly, we see how consumption changes,” says Tripp.

The NEXTCAR project team has members working on high fidelity engine physics and battery and engine physics, but Tripp will be responsible for the reduced order to pull all components into one unified model.

“Our model will account for high fidelity physics in each subsystem model. We will capture charging and discharging events in the battery, airflow through the throttle body, and reaction torques,” says Tripp, establishing models in MATLAB/Simulink. “We are currently testing the proof of concept behind the model, mirroring realistic vehicle behavior, and will then move on to validation,” says Tripp.

The NEXTCAR project team is laying the foundation for autonomous vehicles, establishing energy efficiency with optimal control. Tripp hopes this will help build a career in intelligent systems.

“I’d like to become a ‘technical guru,’ communicating with other engineers to make things happen,” he says. “The principles we develop during the NEXTCAR project will be applicable to the energy management of any connected vehicle fleet, including personal use vehicles, construction equipment, and military fleets. Research groups around the world are developing safety-based fleet operations; we’re developing the energy management architecture that will sit on top.” For Tripp, visualizing a successful future is much like his analyses: connecting small actions to broad goals.

Tripp came to Michigan Tech seeking a PhD in mechanical engineering with a focus in optimization after earning a bachelor’s degree in mechanical engineering and an MBA from the University of Denver. After a year of studies, he secured a research position at the Air Force Research Lab, focusing on distributed controls. His experience with controls optimization motivated him to return to focus on controls and energy management under Dr. Mahdi Shahbakhti.

“The NEXTCAR team is tasked with developing an algorithm to minimize energy consumption,” says Tripp. “I’m developing software to compute energy consumption for a given vehicle maneuver.”
THE FIRE INSIDE

Working in a nuclear power plant for one year, Xiucheng (Sheldon) Zhu discovered what he did not want for a career: the routine of checking pressure gauges and following checklists day after day. That experience taught him he wanted to be creative and learn something new, and graduate research in the automotive industry offered precisely that kind of challenge.

Early in his graduate career, in-class participation led to research opportunities for Zhu. “I took the Advanced Combustion course with Dr. Seong-Young Lee, who recognized me for sitting in the front row and raising my hand, giving me the opportunity to speak with him outside of class on combustion physics,” says Zhu, who joined Dr. Lee’s research team at the Alternative Energy Research Building (AERB) in his second year.

After touring the facility, Zhu was excited about the research possibilities with access to a 1.1 liter optically-accessible constant-volume combustion chamber, utilized to study ignition, fuel injection, and spray and emissions. This very rare device allows researchers to see the entire combustion process through a four inch sapphire window. “Few people have a chance to work with this type of equipment. There are only two of these combustion vessels in the US, one here and one at Sandia National Labs,” says Zhu.

Zhu captures high resolution videos of the combustion process and plays it back frame by frame to dive into the smallest details, identifying every region of the flame. “We use different techniques to examine the combustion of diesel injection to determine where combustion starts,” says Zhu.

“Few people have a chance to work with this type of equipment. There are only two of these combustion vessels in the US.”

XIUCHENG (SHELDON) ZHU

Using new laser technology, Zhu hopes to understand the reactions between the particles at various stages of combustion to determine the process boundaries and ultimately optimize overall combustion performance through improved fuel injection and better nozzle design. “In the research, we are building our understanding of the physics of the process and developing an accurate CFD model to match, which will make simulation more efficient with reduced computation time,” says Zhu.

“Once we complete the simulation, we’ll look at changing the injection configuration, the piston head design, the injection strategy, and the ambient conditions,” he says. The open-ended development has sparked a passion in Zhu, who now hopes to continue research and development through a post-doc position focused on lowering emissions and improving efficiency.
When driving down the interstate, most consumers notice the features that engineers produce—automatic speed control or collision avoidance systems. But for some engineers, success means their work is intentionally unnoticed: it’s not what they add, it’s what they remove that counts. A smooth, quiet ride means engineers like Jon Furlich have effectively reduced the noise and vibration of the vehicle and lays the foundation for a positive consumer experience.

After taking courses in vibrations and completing a co-op at Mercury Marine, a passion was ignited in Furlich for noise, vibration, and harshness that only continued to grow through participation in acoustics and modal analysis courses at the undergraduate level. He couldn’t get enough and sought to deepen his understanding of this discipline.

The stars aligned during an internship with Ford Motor Company when he was able to reconnect with a contact on the NVH team there, whom he’d met during a mock interview day at Michigan Tech. This contact went on to develop a research proposal to fund Furlich’s graduate studies under the direction of Drs. Jason Blough and Darrell Robinette.

“Through the proposal, I secured funding for my research on understanding the causes and how to reduce transient driveline noise and vibration when a manual transmission in a sport coupe is disengaged using the clutch,” says Furlich.

His research employs both in-vehicle testing and benchtop tests. Through a vehicle loan from Ford, Furlich was able to operate a sample car, instrumenting it with data acquisition equipment, microphones, accelerometers, and tachometers to collect the initial data.

“This data was what I used to structure a model representative of the vehicle. Once I was able to tune it and experimentally match the two, I overlaid the results onto the other and then was able to take the model, adjust the input parameters, and develop a strategy to reduce vibrations,” says Furlich.

The results of my research are all going back to Ford, so I look forward to seeing how this may be implemented into a vehicle.”  

Jon Furlich

He is currently setting up a test bed in the lab to recreate and implement the solutions generated from the simulation without testing on a full-scale vehicle. “Much like industry, we use CAE simulation to prove out our concepts to keep large prototype development costs down,” says Furlich, who adds that his hands-on experience in the undergraduate program in mechanical engineering and the SAE program at Michigan Tech have greatly contributed to his experimental work as a graduate student.

“When I came into my internships and then my graduate studies, I was prepared to handle what was needed both at the abstract level and the hands-on,” says Furlich. “At Mercury Marine, I did a lot of hands-on testing, developing test rigs and fixturing, performing data acquisition, and having that hands-on experience taught me to work autonomously.”

A true learner, Furlich understands that learning and research are never truly complete. “I hope to finish the research by the end of summer or early fall but would like to continue my studies beyond a master’s to a PhD with Drs. Blough and Robinette,” he adds. Furlich is well suited to continue his educational journey and recognizes the value of his efforts—for while his research focuses on removal, his knowledge and experiences are something that cannot be taken away.
INSTRUMENTING THE FUTURE

There is a distinct satisfaction seeing a product you had a role in designing, building, and testing coming off the line to be delivered to customers. This experience is something Edward De Jesús Rivera knew well during his 11-year history with Caterpillar, developing and enhancing torque converters.

“It’s been very gratifying to see the torque converters I helped design go to market, but last July, I reached a point at Caterpillar that I wanted to be able to predict the hydrodynamic performance for the converters,” says De Jesús Rivera.

He set out contacting universities around the US. When he completed his master’s degree at Michigan Tech 11 years earlier, no one was working on computer modeling of torque converters. On a hunch, he emailed Dr. Darrell Robinette, a recent addition to the ME-EM faculty, who was completing his PhD at Michigan Tech while De Jesús Rivera was working on his master’s.

“Dr. Robinette explained he was looking for two students, one to perform testing and one to do computer modeling of the torque converter; it was a matter of luck he was looking for students for what I was hoping to accomplish,” says De Jesús Rivera, who left his job at Caterpillar to pursue research with Robinette.

Having worked on torque converters for over 13 years, he had knowledge of what needed to be done to create a computer model but was looking for ways to make the model more precise.

“I have a computer model that predicts performance relatively well, but it only works for one particular design. I want to find out why it only works for one torque converter and develop a model that is general and works with any geometry,” says De Jesús Rivera.

The model he has established is based on one dimensional theory. This code will eventually predict input and output torques accurately over a wide range of speed ratios and will serve as a quick verification tool during early stages of design.

“My master’s degree focused on torque converter testing, measuring pressure distribution on a blade using wireless transmitters. For my PhD, we’ll gather a fresh set of data using a new instrumented torque converter now in development.”

EDWARD DE JESÚS RIVERA

Although he wrapped up his master’s at Michigan Tech years ago, he always knew he’d come back for a PhD. “There was no doubt in my mind I wanted a PhD, the real question was always when,” says De Jesús Rivera, who thanks perfect timing at Caterpillar and a colleague-turned-advisor.

After he completes his dissertation, he will remain in the torque converter industry and remains open to opportunities in industry or academia. Regardless of that choice, De Jesús Rivera will again know the satisfaction of seeing vehicles operate using his designs or the results of his analyses.
During a co-op position with Mercury Marine, Miles Penhale had a lightbulb moment that illuminated his future in noise, vibration, and acoustics. As an undergraduate pursuing a degree in mechanical engineering, Penhale’s co-op allowed him to work on a new product line with a V8 engine with intake noise issues. “I worked on the intake silencer to reduce noise where air enters the engine. During the co-op, I designed, tested, and developed the silencer and for someone who had limited knowledge of acoustics at the time, that was huge for me,” says Penhale. “When I returned from my co-op, I knew noise and vibration was something I wanted to pursue.”

Beyond the numerous electives offered to undergraduates in noise, vibration, and acoustics, Penhale realized an advanced degree would be necessary to gain an in-depth background. “For me, it made sense to stay and continue my work at Michigan Tech for both a master’s and PhD because of the Department’s strong background in the field,” says Penhale, who is focusing his research on arctic acoustics. Taking an experiment-based approach, Penhale’s data is immediately useful in detecting and tracking polar sound sources. Penhale and his advisor, Dr. Andrew Barnard, traveled to Barrow, Alaska (north of the Arctic Circle) to complete the tests. “We were able to take data a mile off the coast on the ice sheet, using microphones, geophones, and hydrophones to sense sound in the air, ice, and water,” says Penhale. “To ensure accuracy, the sonograms were recorded synchronously in real-time time using GPS signals on all receiver locations. We measured the source levels at the input and responses at the receiver locations and took the ratio of those two to find the frequency response function to characterize the acoustic path.”

After completing his PhD, he hopes his extensive experience in NVH will lead him to a career in consulting, where he can shine the light of acoustics analysis on a variety of subjects like musical instruments, concert halls, industrial equipment, vehicles, and even arctic ice sheets.

“"The more I do with engineering, the more I like it. The problem solving and hands-on experiences offered at Michigan Tech are a huge part of that." 

MILES PENHALE
ENGINEERED SHOCK

Surrounded by a family of automotive engineers, Will Larsen always knew he’d follow his family’s footsteps, but the journey was not one he expected. “During my undergraduate career, I was a teaching assistant for Dr. William Shapton, who encouraged me to stay for graduate school,” says Larsen. “I left to work in industry, but after a few encouraging emails from Dr. Shapton, I decided to come back for a master’s and work on a new project.” Although Shapton retired before Larsen came back to campus, he is surrounded by noise and vibration experts, including Dr. Jason Blough and Professor Chuck Van Karsen. “When I first got to campus, I met with Dr. Blough about the projects he was currently working on and selected one that wasn’t automotive to broaden my experience,” says Larsen. “This project offered the unique opportunity to learn alongside Dr. Blough to understand shock responses.” Larsen is developing a resonant mechanical shock test process that would allow Honeywell to shoot at the test plate fitted with a test fixture to understand the exact shock profile and ultimately determine how geometry and impulse times impact the shock response spectrum. “Because the current system has some level of variability, we are working to make a more precisely repeatable test with reliable results that would allow Honeywell to test and evaluate various designs for impact,” he says.

Several methods are being combined to produce a repeatable system, including experimental, theoretical, modeling, and analysis. “We’re developing the FEA models to understand what is happening with different geometries,” says Larsen. “In post-processing, we’re looking at what the sensors are experiencing and our experimental results lead to analyses, looking at the spectrum of vibration and essentially the degree of damage.” Seeing the project through from start to finish has been the most enjoyable aspect for Larsen. “We learned how to solve problems in undergrad, but now, I get to see everything come together from the modeling to the experiments and analysis,” he says. “I have a great team to work with—Dr. Blough on the signal processing side, Professor Van Karsen on the modeling, and Dr. DeClerck with the experimental and analytical processing.”

Looking to return to his family’s automotive engineering business one day, Larsen is grateful for the opportunity to expand his knowledge in the noise and vibration sector, continuing to improve on the transducers his family brings to market.

“Earlier this year, we went to Honeywell and got to see their test in action. Getting to meet the technicians and knowing the work I’m doing will make a difference in their work has been the most rewarding.”

WILL LARSEN
MICROGRID

Every engineer studies energy, but few have witnessed it from the many perspectives held by Mike Cook over the course of his career. Many of his most poignant observations were gained while serving as a second lieutenant in the Marine Corps.

While leading troops in Falluja, Iraq, his team coaxed generators through severe environments, and he pondered the risks to fuel trucks on the supply line. Having joined the Marines after completing a degree in electrical engineering at the University of Wisconsin, Cook would note the varied quality of energy infrastructure in Japan, Thailand, Morocco, and the Philippines.

“While serving, I was able to see how energy is an important factor in life all around the world and how it is consumed and generated in large, small, and inefficient ways,” says Cook. “Those inefficiencies are something that we worked on because inefficiencies require you to make more supply trips, which could be dangerous, and that drove home how precious energy can be.”

Living with the locals during his tours, Cook experienced first-hand how sand and the environment can impact power.

“The locals had huge power issues and that was our role on the ground, to restore power and return them to normalcy. You can’t have normalcy without a consistent source of power, and that experience left me wanting to learn more,” he says.

After completing his service, Cook decided to pursue a career in education; he has been teaching AP Physics at Libertyville High School in Illinois for six years. Still interested in further analyzing and understanding energy distribution opportunities, he decided to pursue a master’s and PhD at Michigan Tech through the distance learning program.

“Coming back and going into education was much like being in the Marine Corps, where I was a teacher, a coach, and a mentor. All these roles contribute to society, just from different realms, and that’s something I’ve really enjoyed being able to continue.” MIKE COOK

This innovative program at Michigan Tech was a strong draw for Cook because it allowed him to continue teaching full-time while conducting research after hours and during the summer.

Because of Cook’s background with the military and his degree in electrical engineering, he was a match for the controls and energy systems research for microgrids that Dr. Gordon Parker was developing.

“He knew my aspirations to get a PhD someday. When he won a grant from the Army Research Lab for microgrids, involving electronics power management, it was a match with my background,” says Cook. “My research focused on a novel way to handle decentralized control that is robust and dependable while gaining the benefits of centralized control.”
Together his advisors, Parker and Dr. Rush Robinett, have developed a Hamiltonian-based feedback control method that analyzes the storage with each source and the load; from that, the entire energy balance state of the system can be determined.

“If we are pulling energy out of the load storage, the sources aren’t supplying enough, and if we are sinking, our sources are supplying too much. We found a decentralized control method that exploited this fact; outperforming droop control while giving us the benefits normally assigned to centralized control,” says Cook of his research.

Cook modeled the system and connected all sources to the bus, with one storage unit for the bus load and storage for each individual source, thereby reducing information flow.

“By giving everyone storage, the entire system can collaborate with distributed intelligence on the nodes,” says Cook. “There is no single point of failure; you can keep adding nodes to the network or have nodes, like solar power, go offline as needed.”

After finalizing his control scheme for DC power, Cook also found an approach that would work for AC inverter microgrids to finalize his dissertation research. Cook plans to continue his career in academia, pursuing a university research position and sharing his global perspectives on energy with the next generation.

“I enjoy solving problems. Gordon and Rush made it seemingly simple and fun to discuss complex problems. They gave hints but let me experience discovering the solution on my own.” Mike Cook
In mastering mathematics, equations may be understood as beautiful, but often the related applications are missing.

Transitioning to the world of mechanical engineering, where the math is always applied, was an exciting and practical switch for Matt Radue. “Sometimes in pure math it’s difficult to trace the ideas to a practical application, but with engineering classes, it’s always focused on how you use the math to achieve a tangible result,” says Radue, seeking a PhD in mechanical engineering under Dr. Gregory Odegard.

Since graduating from Michigan Tech with a degree in mathematics, he has been working at Bay College doing supplemental instruction, assisting students with algebra and other math courses, and thinking about furthering his educational portfolio.

“We start off with individual monomers, modeling a mixture using molecular dynamics simulations and then moving to Python to execute a polymerization reaction. We go back to the molecular dynamics simulation and let the newly-formed polymer relax, and then jump back to Python to perform additional reactions,” he says.

Radue focused his work around modeling carbon fiber composites; addressing their weaknesses, including low thermal conductivity, low compressive strength, and low impact damage tolerance, to develop the next generation of strong, lightweight structural composites for aerospace applications. “To address the mechanical and thermal weaknesses, we looked at incorporating nano particles, like carbon nanotubes, with high mechanical and thermal properties,” says Radue. “I also developed molecular models of the epoxy with carbon nanotubes to see which epoxies were best enhanced with carbon nanotubes forming strong, lightweight composites.”

In comparing three types of epoxies from his molecular modeling, two were markedly enhanced by the carbon nanotubes and were very close in performance. “We started with a liquid model and polymerized the epoxies, solidifying with the carbon nanotubes inside. We found that, depending on the chemical-structural characteristics, the epoxy can have either strong interaction with the nanotube and bind well or not, and that factor is the key to improving the composite properties,” says Radue.

He is currently seeking a post-doc position to continue his research on bulk epoxy properties in an academic, governmental, or national laboratory setting, creating complex polymers equal in beauty to the underlying math.
Cryogenic propellant management offers logistical aerospace challenges for researchers. "Our ultimate goal is to address the issue of rocket fuel storage in space. Commonly used fuels, liquid hydrogen and liquid methane, are stored in metallic containers at temperatures as low as -260°C. The liquid fuel vaporizes with even minute amounts of heat and results in a liquid-vapor mixture," says Bellur. "This increases the pressure in the container, requiring ventilation to avoid over-pressurization, resulting in significant fuel loss, limiting opportunities for long-term space missions."

Fundamental physics was something that always interested Kishan Bellur: uncovering the hidden mechanisms of everyday phenomena. After graduating with a bachelor’s in mechanical engineering from Milwaukee School of Engineering, he put the pursuit of that passion on hold to work at an electric forklift company. "I decided to work in industry until I secured admission into a graduate program of my choice. My job involved modeling hydraulic systems and conducting research in energy efficiency," says Bellur. Once accepted at Michigan Tech, he tutored in the engineering learning center, making a difference for students struggling with engineering concepts. During his first semester, a faculty member noticed his drive and talked to Dr. Jeff Allen about Bellur.

“When I first met my advisor, he talked to me about his research opportunity in cryogenic propellant evaporation and condensation,” he says, joining Allen’s research team shortly after.

“We spoke about the accommodation co-efficient, a fundamental property that describes the probability of evaporation and/or condensation and that no one has measured it for cryogenic propellants. I realized after my first meeting with him that there is so much I don’t know, but I was deeply interested in learning more,” he says.

Bellur’s research explores the nanoscale interactions in liquid-vapor interfaces to understand the fundamental physics of evaporation and condensation by determining the accommodation coefficient.

“We use neutron imaging to look inside opaque metallic containers and image the liquid-vapor mixture behavior at its normal operating temperature, similar to how an x-ray is used to look at bones inside the human body. The images we’ve obtained are most likely the first ever images of hydrogen and methane,” says Bellur.

While the team conducted neutron imaging experiments at the National Institute of Standards and Technology, Bellur’s research combines the data from the experiments with computational modeling to determine the accommodation coefficient.

“The computational efforts are twofold: a macroscale CFD model and a microscale phase change model,” says Bellur. “By comparing the modeling results with the experimental data, the coefficient can be determined.”

Bellur is thrilled to be in pursuit of fundamental data for his dissertation and believes his future lies in research. “I like industry, but fundamental research is my real passion,” he says.
While we often refer to technology development with the phrase, “cutting edge,” Menghan Zhao is focused on the soft beauty of microscale droplets and their power to fly and fuse. His research on ink droplet behavior is conducted under the direction of Dr. Kazuya Tajiri.

After completing a bachelor’s degree in thermal engineering in China and graduating from Michigan Tech in 2013 with a coursework master’s, Zhao is leveraging his thermal fluids understanding to enable optimization of the catalyst layer formation of fuel cells. This technology could reduce the material costs and create a cost-effective option for automotive manufacturers. “In my master’s I focused on thermal fluids through simulation of compressible fluids using CFD analysis,” says Zhao. “I wanted to continue doing research, so I came back to pursue a PhD in 2014.”

By analyzing the 3D structure formation in the fabrication of fuel cell electrodes with inkjet printing and spray methods, Zhao hopes to understand the formation of the catalyst layer. For these studies, he will use high-speed cameras and post analysis of the dried porous electrode via electron microscopy. “We want to find the mechanism of the droplet interaction on the surface using inkjet printing to print the catalyst on the fuel cell mapping surface,” says Zhao.

He will optimize the printing process by exploring how the first droplet deforms across the surface and is impacted by the secondary droplets forming a contiguous layer.

“As these droplets touch, the surface tension will govern the shape changes and viscosity of the whole,” says Zhao. “We examine this using a high-speed camera to analyze the process. It is a beautiful thing to witness.”

Zhao measures and analyzes the parameters of the droplet each time to revive the mechanism of droplets’ interaction on the PEM’s surface, a “battle” between surface tension and viscosity, using a scanning electron microscope to understand the membrane structure.

Because fuel cells use platinum as a catalyst, this is not a cost-effective option for automotive applications; however, it is an attractive solution when it comes to fuel efficiency. “Minimizing the use of expensive materials through better control would improve feasibility of fuel cells on the marketplace,” says Zhao, who utilizes colored powder (dissolved in water and alcohol) on a smooth surface to study the catalyst layer where the chemical reactions take place. For Zhao, helping give rise to this highly efficient technology is an even finer form of beauty.
N O N L I N E A R  R A M P - U P

Finding a way to make an impact on society is something nearly every engineer strives to achieve. That opportunity first introduced itself to Muhammed Rifat Imam following his undergraduate studies at Bangladesh University of Engineering & Technology. Imam was supervising two student groups in the design of three- and four-wheeled vehicles using motorcycle engines to achieve fuel efficiency.

During that work a spark was ignited for Imam; he wanted to learn more about how the structures around him—from vehicles to machinery—bear loads.

After reading about Dr. Trisha Sain’s research in designing materials that are strong and can dissipate energy, Imam decided he wanted to study solid mechanics at North Carolina A&T State University.

“With nonlinear mechanical properties, there are combinations of conflicting properties. You cannot have high stiffness and damping together and that made me really stop and think.” MUHAMMED RIFAT IMAM

“When I arrived, I started looking more into architectured materials, similar to what civil engineers do when designing bridges and buildings,” says Imam. “We look at the same concept, just applied to materials, exploring energy absorption in the microstructure to get the desired properties.”

Sain used polyurethane to dissipate the strain energy, but then began examining gel-type material alternatives. When Sain decided to transition to Michigan Tech, Imam chose to follow. “What happens when you want to design materials to be both strong and to absorb energy? The materials we’re using are nonlinear. We need something strong and something jelly-like to absorb the shock: a stiff material and a soft material with an interface between the layers,” says Imam.

Architectured materials are a challenging research area because of the competing properties required to make it work. “With nonlinear mechanical properties, there are combinations of conflicting properties. You cannot have high stiffness and damping together and that made me really stop and think,” he continues.

“This challenge has allowed me to combine my interest in computational modeling with my strong mathematics background,” says Imam.

His role has been to develop a model for the interface behavior and implement that as a subroutine for the FEA code Abaqus to analyze virtual test samples.

“From a high-level perspective, we are developing a subroutine, running it on the test object, determining the properties and starting points for the structured material, and eventually we will create the actual material and test it,” says Imam, who hopes to print microstructured objects with a bi-material 3D printer and use them to conduct physical tests.

With improved toughness and absorbency, these materials could improve life here and in outer space. “We are creating a material with a microstructure designed to withstand sudden impact,” he says. Whether for the Mars Rover or for athletes, Imam hopes his impact will reach far beyond his PhD.

“With nonlinear mechanical properties, there are combinations of conflicting properties. You cannot have high stiffness and damping together and that made me really stop and think.” MUHAMMED RIFAT IMAM
A CROWNING ACHIEVEMENT

Coal was once king. But the energy industry is morphing into a royal family of power sources: natural gas has surpassed coal while solar and wind are ascendant renewables. Stas Zinchik is exploring a renewable coal fuel replacement using a thermal process called torrefaction.

“If we want to replace coal in the power generation industry, we want to use something renewable. I’m exploring options to replace coal with wood or any other by-product of a biomass facility,” says Zinchik.

In the torrefaction process, biomass is rapidly heated in a low oxygen environment using a controlled process to remove the optimal proportion of volatiles from the wood. “If you remove the volatiles, you leave only char, but if you stop between, you get a product that has better grinding and a higher energy value, like coal,” says Zinchik, “In the torrefaction process, it’s about maintaining temperature for a given time period and a cooling process to prevent combustion.”

After completing his bachelor’s degree in Israel, Zinchik was introduced to the torrefaction process during an internship. He later worked in a pilot facility in Portland, Oregon replacing their 300 tons an hour of coal with biocoal. He was responsible for developing the control logic of the facility and the user interface to visualize the system temperatures, pressures, and other critical parameters.

While in Portland, Zinchik worked with Dr. Ezra Bar-Ziv on the operation of the facility before Bar-Ziv asked him to join APS Labs as a research engineer on the new torrefaction facility, which motivated Zinchik to pursue a PhD.

Building on his understanding of torrefaction, Zinchik is exploring pyrolysis, a similar thermal process lacking oxygen to produce biofuels for transportation and power generation facilities. “With pyrolysis the final product is different from torrefaction. It’s not a solid, but a liquid to replace fuels for transportation to improve the quality or application for the final products,” he says.

While pyrolysis for fuel generation has been explored, there are limitations. “We are working to reduce the technology cost in both machinery and processes to expand the feasible applications,” says Zinchik. “We accomplish this by combining torrefaction and pyrolysis, providing a variety of applications previously considered unpractical for pyrolysis oil.”

Hoping to make a positive impact and a step toward a solution for global warming, Zinchik is grateful for the intellectual challenges Bar-Ziv has assigned him and his teammates: Dr. Jordan Klinger, Yashwanth Donepudi, Ankith Ullal, Chintan Desai, Austin Putnam-Johnson, and Shreyas Kolapkar. “He encourages us to see the bigger picture to make the technology a positive realization,” says Zinchik, who hopes to one day see the torrefaction and pyrolysis processes coronate biofuels as competitive members of the energy royalty and reduce our net carbon emissions.
Optimizing Wave Energy Control

Jiajun Song has a remarkable relationship with water. Having nearly drowned in a boating accident as a child, he deeply respects the power and mystery of this vital resource. Song now researches wave energy conversion, spending years focusing on water and how it interacts with buoys and reaction frames. Hailing from a region of China known for its tourism, his work fuels a broader connection to the environment and its natural resources, seeking to protect the marine world by harvesting its energy.

“After completing my bachelor’s degree at Beijing Institute of Technology, I planned on seeking a master’s degree, but then I met Dr. Ossama Abdelkhalik in Intermediate Dynamics and Optimization and heard about his wave energy conversion project with my now advisor, Dr. Umesh Korde,” says Song. “The focus of the research was interesting: harvesting ocean waves through optimization and controls, focusing on clean energy.”

With help from his advisors, Song came to realize that wave energy converters are large-scale spring-damper systems. He went on to determine that information from the wave energy converter can be used without prediction to employ proportional-integral-derivative controllers, achieving optimal energy conversion. Because wave energy converters are exposed to harsh and hazardous environments, researchers avoid using large-scale, computer-connected wave energy converter devices.

“We aren’t changing the control method, rather the way we calculate force, which is simple and more energy efficient. We aren’t wasting computer power having eliminated the need to run the prediction calculator with an optimized controller,” says Song.

In his research, Song is analyzing shapes of buoys to improve hydrodynamic interaction, leading to improved energy gain during wave changes.

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In his research, Song is analyzing shapes of buoys to improve hydrodynamic interaction, leading to improved energy gain during wave changes.

“Wave prediction is an important topic in wave energy conversion, but if we begin thinking of the wave energy converter as a large scale spring damper system, we can optimize our controller for better performance, which helps to protect our environment. Hopefully, harvesting waves efficiently will one day reduce our reliance on other forms of energy.”

JIAJUN SONG

“We’ve looked into many buoy shapes and are analyzing hydrodynamic coefficients and shape profiles for better performance before running simulations to compare the designs and finding the ideal radius to see if there is an optimal length,” says Song.

Real waves have spectrum sizes, introducing a hydrodynamic challenge which requires tuning to the natural frequency of the design, providing a range of frequencies to capture energy efficiently. While his research is making great strides in integrating cost-effective and dependable wave energy conversion into oceanographic buoys, Song admits that one PhD in this area may not be enough.

“Right now we are only optimizing performance on heave motion, only one of six degrees of freedom. There are always opportunities to optimize shape design for other locations and as other degrees of freedom are added, the systems might need to change shape again,” says Song. “I’d like to continue research in the field of wave energy conversion, either through additional degrees or through research in industry.” As wave energy converters begin to come online, Song’s research plans will extend his bond with water far into the future.
THE WINDS OF CHANGE

Choosing a university was a very personal experience for Anurag Rajan; selecting the ME-EM Department was an easy choice because of its reputation and high ranking, as well as the small-school feel coupled with advanced research. But it was a big change from India.

“After completing my bachelor’s degree, I started working as a maintenance engineer at a steel plant but realized I wasn’t getting the theoretical knowledge, so I started exploring my options. I came here and have no regrets; I can’t think of leaving here and going anywhere else.”

Once accepted, Rajan sought an advisor who would allow him to apply his strong mathematical background. He found that Dr. Fernando Ponta was analyzing fluid-structure interaction, allowing him to explore both the math and science sides of the problem. “When I came here, I did not have experience in coding or computational work. I just liked math, but Dr. Ponta let me learn the codes and explore solutions from there,” says Rajan.

While his master’s degree focused on a novel mathematical model to solve flow problems, using advanced CFD modeling to simulate flow in an accurate way, for his doctoral work, his focus shifted to designing complex wind turbine simulation models.

“We developed our own code that simulates a wind turbine with the structural deflections of the turbine blades with the aerodynamic responses incorporated into the model. Computing the dynamic relationship between the two is necessary to understand the coupled effects,” says Rajan. “We developed a single solution that solves both the flow field and the structural response.”

The structural analysis of the turbine blade is a finite element analysis-based system developed to update the shape and aerodynamic forces across the blade at each time step, delivering a continuously variable topology and aerodynamic force distribution.

“I focused on improving the existing tool, working with other team members involved with developing better control strategies and blade design, while building an understanding of the impact of wind conditions on the model wind turbine,” says Rajan.

Working from a known set of data, the team ran their simulations and compared results. “We can see improvement in the tool we designed. It is more sensitive and more accurate than the previous version,” says Rajan, who hopes the results of their studies will lead to improved wind turbine scenarios.

Grateful for the opportunity Ponta provided to him in continuing his research beyond fluid dynamics to the complex structures of wind turbines, Rajan hopes he can make a similar impact on students one day, bringing positive change to the next generation.

“We can see improvement in the tool we designed. It is more sensitive and more accurate than the previous version.”

ANURAG RAJAN
**Flow Efficiencies**

Engine efficiency and emission regulation are challenges the automotive industry must face as it confronts new regulations to combat climate change. A lack of suitable technology continues to hold the industry back, but for master’s student Aamir Ibrahim, applying computational fluid dynamics (CFD) to diesel engines offers the vision of a breakthrough.

“I was investigating master’s research options with CFD and fluid mechanics when I had a course with Dr. Yang. He introduced us to the lattice Boltzmann method, an advanced topic taught at only a few universities nationwide,” says Ibrahim. “I approached Dr. Yang, and he got me involved with transitional models and transport phenomenon.”

This area of study allows Ibrahim to combine his interest in applied mechanics and mathematics while also developing solutions for diesel engine emission requirements.

“Using the lattice Boltzmann method, you create a fictitious fluid at the molecular level and work your way upward in contrast to the conventional approach. The virtual fluid is made to follow certain rules in agreement with the physics of real fluids, including momentum and mass conservation,” says Ibrahim. “With that understanding, the interactions of the molecules are simplified into a model based on collision and propagation, allowing us to see how they evolve with time and space.”

Led by Yang, another graduate student developed an algorithm for the lattice Boltzmann method simulating transient flows, creating opportunities beyond steady-state responses to understand soot deposition and optimal catalyst placement. After this, Ibrahim re-derived the incompressible lattice Boltzmann algorithm for a particular case to be all encompassing to simulate flows with any densities.

“Once I had the incompressible lattice Boltzmann model, I focused on applications of the method and porous media to understand the correlation between porosity and permeability in particulate filters,” says Ibrahim.

“Unlike traditional methods that follow an empirical top-down approach where the fluid is in a continuum medium, we start at the molecular level and work our way upward for numerical simulation of flow through porous media.”  

AAMIR IBRAHIM

While the lattice Boltzmann method is being used in commercial applications for aerodynamic and aero-acoustic modeling, Ibrahim hopes his research will be incorporated into commercial modeling software to aid in emissions and porous media filter design. He hopes to make an impact beyond the automotive industry, working as a software developer using the lattice Boltzmann method with a software code of his own.

“We can develop more efficient clinical and medicinal devices using the lattice Boltzmann method to understand bio-fluidics like simulating the flow of blood in the human body to analyze the formation of aneurysms in specific patients,” says Ibrahim. While that breakthrough may be years away, it is clear that Ibrahim has the kind of vision that brings focus to even the most distant solutions.
GAINING CONTROL

Controls is a mathematics-intensive discipline that has always intrigued Shangyan Zou, who came to Michigan Tech to find a specialty within the broad field of mechanical engineering. After completing his first semester, Zou leveraged his advanced math abilities and began speaking to ME-EM faculty with expertise in controls.

“I spoke with Dr. Ossama Abdelkhalik regarding his research and could hear his passion for controls and optimization. I began working with him on the topic of spacecraft control,” says Zou. “In my second year, we decided to transition from spacecraft to wave energy converter controls.”

The shift to wave energy conversion was a positive change for Zou, who is excited about the new research opportunities coming in the field of wave energy. “This topic is fascinating to me because every day new papers are published and studies released. We are often citing papers from the current year, so it shows it’s an active research field,” says Zou.

To begin the project, Zou applied knowledge imparted by Abdelkhalik and Dr. Rush Robinett that wave energy converters are like a spring-damper system. This allows researchers to compute the behavior by comparing the movement of a buoy to the movement of a mass-spring-damper system and then applying controls analysis to the system.

“My research focuses on optimal control for wave energy converters. We are developing several different controllers for the wave energy converter, including a linear quadratic controller, singular bang controller, pseudo spectral, nonlinear model predictive control, proportional derivative complex cognitive control (PDC3), and optimal switching control,” says Zou.

The next step is to analyze the potential control schemes and determine which control mechanism is the best for a given objective. But Zou’s research extends beyond a single body system to a two body system, with the first buoy floating and a second buoy submerged.

“The two buoys will have the same interaction due to wave radiation, and the wave generated by the upper buoy will create a radiated wave that will influence the motion of the other,” says Zou. “This radiation will connect the buoys, enabling us to apply controls. We use this data to explore how systems impact one another, and, once we know the mechanism of interaction of the buoys, we can design a controller to optimize energy harvesting for this behavior.”

Much of the controls analysis for a wave energy conversion system has to do with speed, how fast the system can adapt in real-time and the additional computational load ‘cost.’ “In more complex controllers, additional calculation is required, so computational costs are increased,” says Zou, who notes there are pros and cons to each control scheme. Once a system is defined, however, it becomes purely mathematical.

Eventually, Zou hopes his research will lead to improvements in energy structure: defining multi-body buoy systems, extracting the math, and using it to design controls for stable energy storage systems and generation in wave energy conversion systems. Focused on the water, Zou sees opportunities beyond the horizon designing complex controls.
EFFICIENCY FROM FLUCTUATIONS

Michael Kivisalu’s passion for engineering grew from working with his hands; it grew from Legos and Lincoln Logs to designing and building his own hydroelectric generator from an automotive turbocharger. Interested in energy systems and engineering, Kivisalu completed his bachelor’s degree and decided to continue toward a PhD. His work with Dr. Amitabh Narain started as an undergraduate, working on a two-phase flow loop for thermal management. His emphasis was on the system hardware of the condenser as well as data collection and analysis.

“When we were analyzing the sensitivity of condensing flows to exit pressure, there was a shift in the way we processed and understood things because we found the compressor was introducing pulsations in flow-rate and pressure associated with the thin film flows,” says Kivisalu. “We found that the observed changes in local heat transfer rates were coming from the pulsations induced by the compressor, and that changed the focus of investigations to sensitivity of these condensing flows to the pressure or flow-rate fluctuations introduced at the inlet.”

Kivisalu further analyzed the responses of thin film flows in condensers and boilers, operating in novel arrangements, to various pulsation frequencies and amplitudes introduced in the incoming vapor and liquid flows. He then mapped the effect of resonant frequencies on heat transfer rates across these domains.

The inlet pulsations were introduced with the help of modified wobble piston and diaphragm compressors. These results significantly increased the heat fluxes and are further supported by experimental work from graduate students, Patcharapol Gorgitrattanagul and Soroush Sepahyar.

“There had been no earlier systematic approach—under conditions relevant to applications of our interest—for characterizing the influence of pulsations on the time averaged rate of the local heat-flux,” says Kivisalu. “Through observing and analyzing the data, we found that pulsations in the local pressure and liquid film thickness change the surface phenomena associated with thin film flow-boiling and flow-condensation, improving heat transfer rates in or out of the heat-exchange surface.”

Through this research, the group has found substantial improvements in local heat-flux for condensing and boiling flows and is expanding the approach so the entire device sees similar improvements. The expanded approach is expected to contribute to innovations needed for the cooling of data centers, super computers, laser weapons, and other devices. Having completed his PhD, Kivisalu hopes to make engineering exciting for young engineers as an assistant professor at LeTourneau University in Texas.
ENERGY SYSTEMS

SHAPING THE FUTURE

The landscape of energy use and storage has changed greatly with technology advancements, from the growth of renewable to the way our automobiles intelligently determine optimal drive parameters. Batteries surround us, yet Mehdi Jafari can identify many factors about their performance which remain a mystery.

After completing his bachelor's in electrical engineering in Iran and his master's in power engineering, Jafari decided to continue his education and research on batteries at Michigan Tech under the guidance of Dr. Lucia Gauchia.

“My initial research planned to focus on power electronics, but after speaking with Dr. Gauchia regarding her research on batteries and energy storage systems, I decided that direction was most fitting,” says Jafari, who is now focusing on electrical vehicle battery performance and aging.

The first step in his research was to develop a software tool called the Real Electric Vehicle Cycle Analyzer (REV-Cycle) to simulate electric vehicle (EV) battery performance and aging in real-world driving patterns.

“This tool was expected to run an EV model with user-desired properties on a selected driving cycle and evaluate the energy consumption and battery aging,” says Jafari.

To develop this tool, he needed a foundational model, validated with experiments, to develop an equivalent circuit model for the battery. “While connected to a computer, we ran time domain testing, charging and discharging the battery to measure its capacity and to determine the relationship between the state of charge of the battery and the output voltage of the battery,” says Jafari.

In the second phase, he hopes to find the impedance of the battery; this cannot be completed in time domain tests but must be done through frequency domain testing using electromechanical impedance spectroscopy (EIS) to fully characterize the system behavior.

The results indicate that aggressive drivers age the battery 33 percent faster and demand 18 percent more power compared to gentle drivers. Considering the probabilistic nature of the effecting factors on battery aging, Jafari ultimately hopes to develop a Bayesian model for aging.

His software will then provide a probability distribution for battery aging for a more realistic understanding of battery conditions, improving the future of electric vehicles.

What started out as a simple tool to run one driving cycle has transformed into a tool to run a vast number of drive cycles, with potential for recharging and utility aspects to further impact the industry. “Every car company is moving toward electrified versions for their vehicles and they need new fresh battery research and experts,” he says.

He hopes to continue his research on electric vehicle batteries after he completes his dissertation. With so many electric vehicles entering the market, no doubt Jafari will have plenty of mysteries to solve.

“With the simulation tool we can select hundreds of drive cycles based on the real driving behavior of consumers in Ann Arbor ranging from gentle to mild to aggressive, and see how those differences impact overall battery consumption.” Mehdi Jafari
SOAKING UP ENERGY

Homeowners are frequently searching for ways to lower energy bills, but those in cold climates have reaped only limited benefits from heat pumps. Mojtaba Hosseinnia is changing that with a new absorption heat pump system that offers high efficiency in low ambient temperatures.

With a passion for fluid mechanics, he completed his master’s in ME at Iran University of Science & Technology and came to America to enhance absorption chiller technology under Dr. Sajjad Bigham.

All heat pump or refrigeration systems operate on a coefficient of performance (COP), the ratio of net desired or useful energy to the energy provided to the system. Offering a theoretical COP of less than one, gas-fired furnaces are often selected by homeowners, but Hosseinnia’s research determined that new absorption heat pumps can deliver a COP of about 1.3 at -13°F, introducing a substantial cost savings over gas-based heating systems.

“Existing heat pumps lose their performance in very cold climates because the main component of the cycle, the absorber module, functions poorly in the cold air,” he says. “We are changing the current technology and improving performance, so the system can operate better in the cold.”

Specifically focused on absorption systems rather than vapor compression, Hosseinnia also sees environmental benefits. “Unlike vapor compression systems, absorption systems don’t use chlorofluorocarbons or hydrochlorofluorocarbons. In the cycle, we can use several materials—a solution like water, plus a salt, which can be lithium bromide or lithium chloride. Unlike water, the salt can’t vaporize, so the water vapor is the coolant providing the conditioned air.”

Hosseinnia is hopeful his system will find a new material to act as the absorptive salt, which will require a shift in the heat exchanger design.

To accomplish this, Hosseinnia is conducting thermodynamic cycle performance analysis as well as CFD simulations. “We are doing extensive simulations for the coupled heat and mass transfer for each component of the cycle,” he says. “The CFD code we create will require additional user-defined functions on top of the commercial software to define appropriate terms for momentum, energy, and mass transfer equations.”

Because the technology could also work in reverse—cooling homes in hot climates—Hosseinnia’s fundamental research should eventually introduce cost savings to homeowners across many latitudes. His passion for meaningful R&D will continue after his PhD, as he seeks a position in industry or a university setting.
Much like engineering, orthopedics explores the forces on the body and its structures for the entire musculoskeletal system. For this reason, the leap from engineering to the world of orthopedics was a logical step for Dr. Erin Baker, who recently completed her PhD.

After completing her bachelor’s in materials science and engineering, Baker stayed at Michigan Tech to work on a master’s degree under Dr. Craig Friedrich. The opportunity to stay for a PhD was available, but Baker was ready to get hands-on practical experience, so she accepted a position at a steel mill in Detroit. While working in the steel mill, Baker missed research and jumped at the chance to work as a research engineer in the orthopedic department at Beaumont Health.

“In my role in the lab, I run the implant retrieval program. When orthopedic implants are taken out of patients, they come here and we investigate them for unusual failures, wear, and damage, and make recommendations based on those findings,” says Baker, whose passion for her work impacts patient care. “I think when you go to engineering school, it’s great to be developing new technology, but it’s really exciting to research and develop technology that impacts and improves patient care,” she says.

Baker reconnected with Friedrich after hearing he had developed a nanotube surface treatment but hadn’t applied it clinically. She began her PhD studies at Michigan Tech through the distance learning program while staying at Beaumont for her research.

“Through work with implant retrieval, we know there are issues with getting an implant to osseointegrate with the bone, so we started out looking at the structure under a microscope and it looked favorable to bone, creating opportunities for an implant surface treatment,” says Baker.

Although some implants use cement or other surface coatings, the materials can break down into small particles and cause tissue damage. Testing of the nanotube surface treatment on laboratory rats found superior bone implant and bone contact in a model of simulated joint replacement. “Results show early bone-implant contact on nanotube surfaces at four weeks, and, at 12 weeks, we saw greater bone-implant contact on nanotube surfaces compared to controls,” says Baker.

Working at Beaumont, Baker sees some technology implemented immediately and also works on technology that is 50 years out from clinical use. She is hopeful that her research using titanium dioxide, a material already approved by the FDA, will have a more immediate impact on orthopedic patients receiving implants.
MESSAGING MECHANICS

The beauty in mechanical engineering is that the applications are quite broad, from the outer reaches of space to intracellular communication. Shuo Wang has established a niche helping those who suffer from osteoarthritis. “As an undergraduate, I studied mechanical engineering at Beijing Institute of Technology, but I have always been interested in biology. For graduate school, I wanted to combine mechanical engineering with my interests in biomedical or biomechanical engineering applications,” says Wang.

Before joining Dr. CK Choi in his research on cartilage and tissue engineering, Wang enrolled in a variety of courses to better understand the work of ME-EM faculty. “Dr. Choi and I worked together from the ground up based on one key question: how cells receive mechanical signals and how they respond to such stimuli to understand mechanical transduction or biomechanics,” says Wang, who developed his background in this area through courses in biomechanics, biomaterials, and microfluidics.

Initially exploring how cells react to fluids and fluid flow shears in cartilage, they transitioned to focus on fluid flow shear applications to improve cellular protein generation. “We wanted to solve real issues people face in cartilage tissue engineering,” says Wang. “We focused on pericellular matrix (PCM) and how fluid flow shear plays a positive role in improving cellular functions in vitro and in vivo.”

Experts are currently treating osteoarthritis with grafts of stem cells and cells from other sources. However, these sources lack PCM and existing methods cannot regenerate biomimetic PCM (called neoPCM), resulting in reduced cellular function.

“We took our expertise in microfluidics to attempt a new method to regenerate PCM by encapsulating individual cells in microgels instead of bulk gels, so the boundary of the gels confines PCM regeneration,” says Wang.

To achieve this goal, Wang and Choi are devising a new microfluidic technology to generate microgels using a photocrosslinkable material, oxidized methacrylated alginate (OMA). As it flows, OMA is pinched into microdroplets and photo-polymerized into microgels under UV light.

This method is simpler than existing methods used to generate non-spherical alginate microgels. “This will help cartilage regeneration and growth because the presence of biomimetic PCM not only protects cells from harmful stress, but also provides a good microenvironment for the chondrocytes to maintain their phenotype,” says Wang.

“We expect to provide a new cell source for cartilage tissue engineering to help the patient receive a better graft with cells that have physiological mechanical properties, improving healthcare opportunities.”

“I’ve experienced firsthand the importance of being open minded when coming across issues, always being willing to go back to first principles to rethink the problem, and remaining a learner in the field.” SHUO WANG

Starting from ground zero in the research with Choi helped Wang gain a new perspective on research, iterating back and forth throughout the funding process. Through this highly adaptive design experience, he is confident about continuing as an academic researcher. While the niche he occupies may change, two things are certain for Wang: he will be helping people with biomechanical engineering, and he will not fear circling back to a new beginning.
ON SOLID GROUND
Walking is a fundamental form of human mobility. Restoring a fellow human’s ability to walk with confidence makes two dreams come true: first, those of the recipient of a prosthesis, and, second, those of PhD student Guilherme Ribeiro, who combines his background in mechatronics with machine vision systems to create next generation robotic ankle-foot prosthetics.

“Because we want to capture the presence of a stair, we cannot use one line of range data. We had to use two regular cameras, find common points between their images, and estimate a matrix of depth points via triangulation,” says Ribeiro. To process the data, a powerful computer with a graphical processing unit was required; however, Ribeiro is now exploring time-of-flight sensors to reduce the required computational resource load.

This system requires a complete understanding of the dynamic response of the ankle and its trajectory, as well as the ability to modulate the impedance of the robotic ankle.

“With impedance, we think of the ankle having a spring with varying stiffness acting at pitch and roll directions. We want to add these two degrees of freedom to the prosthesis,” says Ribeiro. To estimate this impedance, the team uses the angle of the ankle and ground reactional torque and force generated by a vibrating platform.

Through the characterization of a healthy foot and ankle, Ribeiro can determine how the prosthesis should mimic gait cycle for walking, turning and standing still—benefitting not only those with prosthetics, but also the elderly and visually impaired who rely on mobility assistance in traversing terrain.

He plans to continue to advance the world of robotics and vision systems through research once his doctorate is complete. He also hopes to encourage a new generation of engineers. Along with his colleagues, Ribeiro brings the dream of advanced prosthetics one step closer to reality.

“Our team is the first to properly characterize impedance of the ankle in two degrees of freedom using an apparatus that is not attached to the subject. This allows a more natural gait replication.”

GUlHERME RIBEIRO

To make his dream a reality, Ribeiro joined Dr. Mo Rastgaar, who has been spearheading prosthetic engineering for six years, after studying under him during a year-long study abroad program. “When I graduated, he offered me a position, allowing me to begin my doctoral studies,” he says.

Writing processing programs for motion capture data and managing motion software for vision analysis, his PhD research takes the technology further. Ribeiro focuses on ranging sensing system development for prosthetics to map the ground. “The idea is to measure the inclination of the ground to tell the robotic prosthesis you’re about to come to a steep surface, stairs, or irregular ground and may want to change your ankle properties,” says Ribeiro.

Ribeiro has adapted the terrain-sensing device over the course of his studies to first establish proof of concept and then to make it smaller.
BUILDING STABILITY

Enthusiastic about problem solving, Xin He enjoys finding solutions for tough engineering concepts. This has included her master’s work exploring heat transfer at New Mexico State University (NMSU) as well as her latest challenge at Michigan Tech: studying rarefied gas flow effects and electric sprays for micro-propulsion.

In her master’s, she conducted experimental work coating a copper surface to generate a velocity leap to improve convective heat flux. Following her advisor, Dr. Chunpei Cai, from NMSU to Michigan Tech, she is utilizing her understanding of convection boundaries to examine boundary layer stability in the near continuum flow. “We typically see rarefied gas flow conditions in high altitudes with high velocity vehicles operating at supersonic or hypersonic speeds. We perform simulations around the wing, tip, or head of the vehicle to characterize the chemical reactions not typically found in subsonic conditions,” she says.

She is validating simulation data against experiments from NASA or AFRL. “In our simulations, we look at the components for chemical reactions. For example, when we have one cell with a certain amount of nitrogen and after a period of time it is reduced, we know part of the nitrogen reacted with something or transferred to another cell. We find a mass balance on every cell to determine when a change occurs,” she says.

Understanding the rarefied behavior of compression and expansion as high speed aircraft pass through the atmosphere has potential to improve the manufacturing process of these vehicles, determining whether material thickness can be reduced. “We’re hopeful if we obtain correct analysis, our C++ code might be commercialized. Right now, we’re focused on improving the performance and accuracy of the code-base, adding in subroutines for the chemical reactions,” she says.

“"We’re hopeful if we obtain correct analysis, our C++ code might be commercialized. Right now, we’re focused on improving the performance and accuracy of the code-base, adding in subroutines for the chemical reactions."  
XIN HE

Through collaboration with Dr. Brad King, she is expanding her studies into the world of electric sprays for micro-propulsion. Her focus will be baseline modeling of ferrofluids to demonstrate their tendency to create instability at injection, forcing particles to stick to the anode ring and causing failure.

“Our work will ultimately be to understand and improve the performance of thrusters using ferrofluidic emitter surfaces," she says. She hopes to eventually bring her enthusiasm for coding and aerospace application knowledge to the classroom, introducing future generations of engineers to topics like heat transfer and computational fluid dynamics.
PROPELLING THE FUTURE

After completing an internship at the NASA Propulsion Academy, Brandon Jackson realized how much more he could learn about space propulsion. While studying at the Milwaukee School of Engineering, Jackson attended a graduate school fair and learned about Dr. Brad King’s spacecraft propulsion research at Michigan Tech. “My internship at NASA focused on solid propulsion, but we got to see electric propulsion during our lab tours, so I jumped at the opportunity to do research in that field,” says Jackson.

Initially working on a coursework-only master’s, Jackson joined King’s research team. He assisted on the altitude determination and control program for the Aerospace Enterprise satellite project before shifting into research mode in spring 2015.

“With the growing popularity of small satellites, a market has grown for thrusters which can enable these satellites to maintain an orbit or move into a new orbit. We’ve found that traditional thrusters don’t scale down to the size these satellites need, and that’s where the electrospray comes in,” he says.

Jackson is working with ionic-liquid ferrofluid (ILFF) electrospray, a discovery made at Michigan Tech and known for its electrical conductivity, magnetism, and non-evaporative properties. These fluids contain suspended nanometer-scale iron particles, making the liquid magnetically responsive and enabling it to change shape and be emitted.

“When using a magnetic fluid with an electric field, the fundamental physics controlling the electrospray changes,” says Jackson. “I developed a computer model to simulate how these fluids behave and distort when exposed to magnetic and electric fields.”

As part of the model development phase, Jackson captured images of the droplets of fluid to overlay on his model to characterize model accuracy. As he continues his research, he will investigate how changes to the strength of the magnetic field affect the emitted plume angle. “We are going to map the angle and understand the relationship between spray and the divergence angle,” says Jackson. “We seek to concentrate our spray into the smallest possible angle so we aren’t wasting energy by spreading the materials out.”

On the cutting edge, Jackson is excited to be working at one of the few labs in the country exploring satellite propulsion. “There isn’t a lot of research published on magnetic spray. Every day we come to work, we’re developing something new,” says Jackson. “I appreciate Dr. King’s work in new areas, getting to impact the future of satellite propulsion.” Hoping to widen that impact after he completes his PhD, Jackson would like to focus on educating future engineers in a university setting.

“There isn’t a lot of research published on magnetic spray. Every day we come to work, we’re developing something new.” BRANDON JACKSON
CODING LUNAR LANDING

Colonization on the moon or Mars has introduced countless challenges to experts at NASA, but the Mining INnovation Enterprise (MINE) is hoping to solve a few of those issues through the development of a rover capable of changing attachments based on payload jacks.

In addition to building a buffer wall around the landing pads in lunar environments, the goal of the Enterprise team’s rover is to operate as a plug-and-play system that can easily swap out payloads to complete a multitude of tasks.

When Daniel Wagner first heard about the MINE project, he was excited to combine his passion for robotics with his background in software engineering.

“Working on a big project like this—across disciplines from mechanical to electrical, celebrating the milestones we accomplish as a team—has been exciting.”

DANIEL WAGNER

“I took industrial robotics in high school, so I developed scripts to operate the robotic arm and from there my interest in coding grew,” says Wagner, who later sat down with Dr. Paulus van Susante to discuss the Enterprise.

“He talked about the need for control logic development of the large robotic rover system. I saw this as an opportunity to work with mechanical engineering students and to lead from the software side,” says Wagner.

As the team’s only software engineer, Wagner brainstorms adaptive solutions to meet the system’s evolving requirements. “We wanted the software to be able to run on any computer we needed. We selected Java as the base because we could build an effective user interface and integrate it with our back-end operation built on Arduino’s C language,” says Wagner.

Responsible for defining the architecture, developing the code, and deploying it, he is thriving in his role.

“To ensure airtight communication between the rover and the program, we have a professional-grade long-range wifi router on the rover connected to a base control station,” he says.

While Wagner leads the effort on the software development side, the Enterprise team has designed the rover robot with a completed frame over two semesters. “The next challenge will come with testing as the fall semester begins, refining the code and any design feature flaws we find during our experimental tests,” Wagner says.

For Wagner, the experience goes far beyond coding. “Working on a big project like this—across disciplines from mechanical to electrical, celebrating the milestones we accomplish as a team—has been exciting,” says Wagner. Following on his experience with MINE and internship experiences, Wagner hopes to one day start his own software development company.
DESIGN

QUANTIFYING FAILURE

The advanced technology utilized in most of today’s engineered systems was designed for passive and fixed design capacities, causing issues for devices that face extreme conditions and widely ranging inputs, like solar panels and wind turbines. Consumers expect robust systems with resiliency to detect, predict, and manage the impact of these conditions.

Mingyang Li, under the guidance of Dr. Zequn Wang, has made it his mission to enhance these engineered systems to improve reliability and manage cost.

Paired with his knowledge in materials science, Li is exploring failure design in the behavior of materials to optimize the structure through improved high-level analysis.

“For example, in a pressure vessel, we need to consider the variability of all inputs and conditions. Nothing is a single value. Uncertainties of input variables are considered; in most cases, they are treated as following a normal distribution. We need to minimize the cost while guaranteeing the vessel will not deform,” Li says. “We need to consider which inputs we can cost-effectively constrain and which inputs would be too costly.”

To conduct these investigations, Li is creating an algorithm that considers the uncertainties involved in system design, manufacturing, and operations.

“If the material is weak, we can connect problems to predict failure. We can also say: if we make this more reliable with tighter controls on materials and forming process, we can prevent failure,” he says.

“I like code; all you need is your computer, your brain, and your hands.” MINGYANG LI

Using finite element analysis to obtain the system response, the algorithm takes input variables and constraint functions to compute the optimal design inputs. Currently working on macro-design, Li is looking forward to the next steps exploring at the microstructure level and adding time variant cases, focused on materials structure design.

Creating the code in MATLAB has introduced Li to a new world of technologies and presented him with the opportunity to acquire a new skill set.

“As a materials science engineering student, I hadn’t ever heard about reliability, but it’s so closely tied to probability and coding and that has been enjoyable for me. I like code; all you need is your computer, your brain, and your hands,” says Li.

Li is committed to creating a generalized method that can later be applied to any design and ultimately reduce computation costs. He plans to later apply his coding abilities and knowledge in reliability to a career in research.
SENSE OF POSSIBILITY

While teaching science in Tanzania as part of the Peace Corps Master's International program, Ben Savonen witnessed firsthand the limitations students face in rural parts of the developing world. “With an annual budget of $50 to teach 600 students physics and chemistry, we often had to improvise with equipment, and yet, there were some things you just couldn’t improvise, and high shipping costs and complicated transit scenarios made acquiring these items near impossible,” he says.

Savonen saw these same issues with shipping and budget constraints throughout his service in the Peace Corps. While writing his thesis back at Michigan Tech, he began to explore these challenges with one of his committee members, Dr. John Gershenson. “We discussed the possibility of using 3D printing technology to cut down the cost of specialty items,” says Savonen. “I met with Dr. Joshua Pearce (MSE/ECE), who helped us pair the dilemma with 3D printing solutions, ideating and making things happen.”

After completing his first year of PhD studies, Savonen spent the summer interviewing doctors and nurses in hospitals in Kenya, discussing logistics and possibilities while demonstrating a 3D printer from Pearce’s lab. “We saw the greatest impact in hospitals, where medical implements and diagnostic equipment are often donated but experience a breakdown. It is never used again because getting a replacement part is too expensive or the manufacturer is unavailable. Sometimes they just need a five- or ten-cent part to get it running again,” he says.

Following his remote exploration, Savonen returned to Michigan Tech to analyze the discussions, to begin finding solutions for communicating with people in the field, and to understand the barriers preventing overall application.

“Internet access is prevalent, even in these areas, so there is a potential solution where someone could put in a request for a part, and an engineer could send them a CAD file to 3D print themselves, eliminating the shipping barriers.” BEN SAVONEN

But with 3D printers, environment plays a huge role. “We need to combat a variety of environmental factors, like dust, heat, and humidity, which result in printer clogs. There are big issues in reliability and usability of the machines we need to address, but by reaching out to the very collaborative 3D printing community for help, we could change the way manufacturing works,” he says.

Fluent in English and Swahili, Savonen has enjoyed sharing the opportunities 3D printers provide to people in Kenya, Uganda, Tanzania, and South Sudan. “It’s fun to see people’s faces the moment they understand the technology and start taking it upon themselves to see the potential and the sense of possibilities it brings,” he says. With more work to be done, potentially lasting beyond his PhD, Savonen hopes to foster this generational change for developing countries in education and healthcare.
NOTE: In a few cases, the BS enrollment data shown above differs from past publications because the official, final enrollment data is only available after this publication goes to press.
ME-EM: DEGREES

**BS DEGREES**

![Bar chart showing BS degrees](chart1)

**MS DEGREES**

![Bar chart showing MS degrees](chart2)

**PHD DEGREES**

![Bar chart showing PHD degrees](chart3)
GRADUATE SEMINAR SERIES

EXTERNAL SPEAKERS

Dr. Sushant Anand, University of Illinois at Chicago, From Sustainability to Healthcare

Dr. Steven Anton, Tennessee Technological University, Microsecond State Detection for Real-Time Structural Health Monitoring in Highly Dynamic Environments

Dr. Peter Avitabile, University of Massachusetts Lowell, Recent Advances in Measured Data Expansion for Full-Field Dynamic Response and Dynamic Strain for Linear and Non-Linear Systems

Dr. Sourav Banerjee, University of South Carolina, AcoustoUltrasonics

Dr. Aimy Bazylak, University of Toronto, Tailoring Transport in Fuel Cells and Electrolyzers for Clean Transportation

Dr. Hoseinali Borhan, Cummins Inc., Model-Based Control System Engineering of Powertrain Systems, Beyond Simulation

Dr. Athanasios C. Bourtsalas, Columbia University, Managing the Urban Solid Wastes in the 21st Century

Dr. Ruey-Hung Chen, New Mexico State University, Effects of Insoluble Nano-Particles on Nanofluid Droplet Evaporation

Dr. Shawn Chester, New Jersey Institute of Technology, Multiphysics Mechanics of Polymeric Materials

Mr. Jeffrey Eaton, Exotic Metals, Seminar on Exotic Metals

Dr. Rani Elhajjar, University of Wisconsin-Milwaukee, The Future of Composite Manufacturing

Dr. Randy Ewoldt, University of Illinois at Urbana-Champaign, Sticky Droplets and Sinking Bubbles

Dr. Jaal Ghandhi, University of Wisconsin-Madison, Some Observations About Knock in Spark Ignition Engines

Dr. Manish Khandelwal, GE Aviation, Introduction to GE Aeroderivatives

Mr. Abhishek Manekar, Cummins Power Systems, A Glimpse into Professional Life after Graduation

Dr. Paramita Mondal, University of Illinois at Urbana-Champaign, Linking Concrete Chemistry with Performance under Stresses

Dr. P. K. Panigrahi, Indian Institute of Technology (IIT), Kanpur, Droplet Internal Hydrodynamics During Evaporation and Condensation

Dr. Keunhan Park, University of Utah, Recent Progresses in Near-Field Thermal Radiation for Energy Recycling Applications

Dr. David Pratt, Wright-Patterson Air Force Base, Capillary Pumped Heat Transfer Devices

Dr. Meredith Silberstein, Cornell University, Mechanics and Chemistry in Designing Polymers

Dr. Chae Hoon Sohn, Sejong University in Seoul, Korea, On Mechanism and Suppression of Spontaneous Ignition of Coal Stockpiles

Dr. Sibendu Som, Argonne National Laboratory, Towards Predictive Simulations of the Internal Combustion Engine Enabled by High-Performance Computing

Dr. Tom Tzanetakis, Aramco Research Center, Aramco Fuel Technology

MICHIGAN TECH SPEAKERS

Dr. Houman Dallali, Michigan Technological University, The Role of Robotics in Advancing Assistive Walking

Dr. Susanta Ghosh, Department of Mechanical Engineering-Engineering Mechanics, A Novel Multi-scale Atomistic-continuum Model for Multilayer Graphene Materials and Carbon Nanotubes

Dr. Darrell Robinette, Department of Mechanical Engineering-Engineering Mechanics, Trends in Automotive Power Transfer Engineering

Dr. Trisha Sain, Department of Mechanical Engineering-Engineering Mechanics, Constitutive Theory and Multiphysics Behavior of Polymer Curing
ORDER OF THE ENGINEER

FALL 2016
Nancy J. Cragel ’86
Senior Program Manager,
Automotive Seating Metals and
Mechanisms Business Unit, Adient

SPRING 2017
Dr. Robin Johnson-Cash ’15
Technical Training Manager,
Ford Motor Company

GRADUATE STUDENT FELLOWSHIPS

FALL 2016-SPRING 2017
Dean’s Award for Outstanding Scholarship
Piyush Aggarwal
Sachin M. Bhosle
Ming Cheng
Akshada Shirish Joshi
Ahmed Abdul Moiz
Ali Solouk
Shuo Wang
Wentao Yao

Outstanding Graduate Student Teaching Award
Mohammad Reza Amini
Pradeep Krishna Bhat
Sarah Jalal
Lauren Knop
Jianyang Lyu
Muraleekrishnan Menon Menon
Muraleedharan Nair
Joseph E. Oncken
Ali Solouk
Jiajun Song
Nathan D. Spike
Shuo Wang
Wentao Yao
Xiang Zhou

Doctoral Finishing Fellowships
Shuo Wang
Le (Emma) Zhao
Wentao Yao
Mohammad Reza Amini
Muraleekrishnan Menon Menon
Muraleedharan Nair
BS GRADUATES (200)

SUMMER 2016 (12)
Baskins, Michael
Goudreau, Adam
Graham, Travis
Greene, Terry
Hart, Riley
Heller, Luke
Jagger, Tessa
Julio, Lawson
Lueck, Kevin
Marttila, Owen - Cum Laude
Schaefer, Bethany

FALL 2016 (98)
Abbott, Kelsey
Anderson, Patrick
Ansingh, Isaac
Applegate, Scott
April, Alex
Babcock, Kiernan
Ballor, JoAnn - Magna Cum Laude
Banker, Brendan
Barron, Ty
Benjamin, Tyler
Brand, Macabe - Summa Cum Laude
Brechting, Tony
Brook, Brian - Summa Cum Laude
Brose, Tyler
Campbell, Tucker
Ciesla, Alex
Cipriano, Kathrine
Coder, Mitch
Cooper, Oliver
Corrado, Brianna
Curtis, Max
Daavettila, Timothy
Engman, Ryan
Flachs, Brian
Folkerts, Jeremy
Ford, John
Fordahl, Joey - Cum Laude
Frank, Daniel
Goetz, Thomas - Summa Cum Laude
Gorecki, Peter
Gotts, Jessica - Cum Laude
Goupille, Hailey
Gralowski, Spike
Hallman, Michael
Hartman, Jordan - Magna Cum Laude
Helmke, Mike
Hutchings, Bryton
Jensen, Andrew
Jirovec, Taylor
Kast, Wayne
Kaus, Joe
Kinder, Bryce - Cum Laude
Kline, Chris
Knipp, Jordan
Kovach, Tori
Kuefner, Peter
Kurtz, Jacob - Summa Cum Laude
LeBrun, Jacob
Lehmann, Maxx
Lemmer, Mitchell
Long, Mike
Martinez, Mauricio - Cum Laude
May, Reagan - Cum Laude
McCloskey, Luke - Magna Cum Laude
McIntosh, Daniel
McLain, Vincent
Moreira Mendes, Fernando
Morris, Andrew - Summa Cum Laude
Mucinski, Josh
Nelson, Eric
Nelson, Walker - Cum Laude
Parks, Evan
Patwa, Parshwa
Pennala, Tyler
Peterson, Vance - Magna Cum Laude
Price, Kyle
Pscheid, Matthew - Cum Laude
Rady, Megan
Raisanen, John - Cum Laude
Ramon, Nick
Risch, John
Robards, Adam
Robinson, Michael - Cum Laude
Roth, Nate
Sankey, Brad
Sauter, Alec
Schmied, Kyle
Schnader, Emily
Seefried, Korinne
Shah, Kush
Sladek, Dylan
Sloboda, Ryan
Slovak, Jacqueline
Solk, Austin
Strzałkowski, AJ
Swanson, David
Tacoma, Landen - Magna Cum Laude
Tice, Kyle
VanDerLinden, Tyler
VanderRoest, Chad
Veihl, Steve - Magna Cum Laude
Vieau, Joseph
Vincent, Jack
Vogel, Dan - Magna Cum Laude
Welton, Libby - Summa Cum Laude
White, Aurora
Zill, Michael
Zuccaro, Dante
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<td>Zhang, Kun</td>
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**SUMMER 2016 (21)**

**Arora, Jayant Kumar**  
Advisor: Mahdi Shahbakhti  
Design of Real-Time Combustion Feedback System and Experimental Study of an RCCI for Control

**Bhasme, Sharayu S.**  
Advisor: Amitabh Narain  
Shear Driven Suppressed Nucleation Annular Flow-Boiling in Millimeter-Scale Channels: Direct Numerical Simulations

**Erri Pradeep, Abhishek Sai**  
Advisor: Mahesh Gupta  
Design Features and Optimization of Profile Extrusion Dies

**Famuyiwa, Abayomi A.**  
Advisor: Jeremy Worm  
Integration and Testing of an Advanced Conformable CNG Tank in a Full-Sized Light-Duty Pickup

**Gupta, Saksham**  
Advisor: Jeffrey Naber  
An Experimental Investigation into the Effect of Particulate Matter on NOx Reduction in a SCR Catalyst on a DPF

**Gustafson, Erik A.**  
Advisor: Jeffrey Naber  
An Experimental Investigation Into NO2 Assisted Passive Oxidation With and Without Urea Dosing and Active Regeneration of Particulate Matter for a SCR Catalyst on a DPF

**Iyengar, Hampapur Raghavan Ranganath Vedanth**  
Advisor: Craig Friedrich  
Course work only

**Kalurkar, Rohan Milind**  
Advisor: Jeremy Worm  
Design, Fabrication, and Analysis of an Auxiliary Power Unit on a Heavy-Duty Truck to Power the HVAC Systems of the Truck During Driver Off-Duty Conditions

**Kannan, Kaushik**  
Advisor: Mahdi Shahbakhti  
An Experimental Investigation of Low Temperature Combustion Regimes in a Light Duty Engine

**Kondipati, Naga Nithin Teja**  
Advisor: Mahdi Shahbakhti  
Experimental Study, Modelling, and Controller Design for an RCCI Engine

**Liu, Zongyue**  
Advisor: Kazuya Tajiri  
Course work only

**Merchant, Reem Sadruddin**  
Advisor: V.C. Komaravolu  
New Model to Predict Heat Transfer Coefficient for Flow Boiling in Microfin Tubes

**Ovist, Grant J.**  
Advisor: Craig Friedrich  
Course work only

**Pawale, Rohit Rajabhau**  
Advisor: Gregory Odegard  
Finite Element Analysis of CNG Tank Drop Tests

**Philip, Abhijith Geo**  
Advisor: John Beard  
Design and Fabrication of a Suspension Rig

**Ramaraju, Lakshmi Narasimha S.**  
Advisor: Craig Friedrich  
Course work only

**Tankella, Nagendra Gautam**  
Advisor: Joshua Pearce  
Mechanical Testing of Fused Filament 3-D Printed Components for Distributed Manufacturing

**Thyagarajan, Abhishek**  
Advisor: Andrew Barnard  
Evaluation of Angular Distribution of Incident Field at the Transmission Loss Window in Michigan Tech’s Reverberant Chamber

**Verma, Saumitra**  
Advisor: Kazuya Tajiri  
Proton Exchange Membrane Characterization at Subzero Temperatures

**Yazdani, Arya**  
Advisor: Jeffrey Naber  
Air Charge Estimation in SI Engine Using In-Cylinder Pressure Sensor

**FALL 2016 (52)**

**Zhu, Xiucheng**  
Advisor: Seong-Young Lee  
Course work only

**Adepu, Dharma Teja**  
Advisor: Craig Friedrich  
Course work only

**Aggarwal, Piyush**  
Advisor: Bo Chen  
Development of an Open Source OpenADR-Based Demand Response System for the Charging Control of Plug-in Electric Vehicles

**Anil Raju, FNU**  
Advisor: Craig Friedrich  
Course work only

**Anithottam, Basil James**  
Advisor: Craig Friedrich  
Course work only

**Asgarisabet, Mahsa**  
Advisor: Andrew Barnard  
Multi Physics Modeling and Validation of Carbon Nanotube Loudspeakers
Bongir, Sumit Shekhar  
Advisor: Gregory Odegard  
Drop Test Simulation of a Conformable CNG Tank by Finite Element Analysis Using HyperMesh/RADIOSS

Busireddy, Sai Kumar Reddy  
Advisor: Craig Friedrich  
Course work only

Desai, Chintan Kaushik  
Advisor: Ezra Bar-Ziv  
Experimental Investigation of Fast Pyrolysis of Arundo Donax in a Novel Paddle Reactor

Dhanoa, Simranjit Singh  
Advisor: Craig Friedrich  
Course work only

Diao, Xin  
Advisor: Craig Friedrich  
Course work only

Dice, Paul W.  
Advisor: Jeffrey Naber  

Hanson, Kyle D.  
Advisor: Craig Friedrich  
Course work only

Janga, Rakshith Kumar  
Advisor: Craig Friedrich  
Course work only

Jasti, Barath Chand  
Advisor: Craig Friedrich  
Course work only

Joseph, Jithin  
Advisor: Craig Friedrich  
Course work only

Joshi, Akshada Shirish  
Advisor: Jeffrey Naber  
Formulation of a Numerical Model for Predicting the PM Oxidation in the Cake Layer of a CPF

Joshi, Akshay R.  
Advisor: Craig Friedrich  
Course work only

Kadam, Vaibhav  
Advisor: Jeffrey Naber  
An Experimental Investigation of the Effect of Temperature and Space Velocity on the Performance of a Cu-Zeolite Flow-Through SCR and a SCR Catalyst on a DPF With and Without PM Loading

Kagolanu, Saimanojkumar  
Advisor: Craig Friedrich  
Course work only

Kalan, Pankaj N.  
Advisor: Gregory Odegard  
Finite Element Analysis and Topology Optimization of Differential Case and Control Arm for Static and Fatigue Loading

Kamble, Vaishnavee  
Advisor: Craig Friedrich  
Course work only

Kosuri, Sachin  
Advisor: Craig Friedrich  
Course work only

Kotagiri, Akash  
Advisor: Craig Friedrich  
Course work only

Kulkarni, Amruta V.  
Advisor: Gregory Odegard  
Finite Element Analysis of Conformable CNG Tank - Topology Optimization and Drop Test Simulation

Li, Dian  
Advisor: Craig Friedrich  
Course work only

Li, Zhenpeng  
Advisor: Craig Friedrich  
Course work only

Maddi Reddy, Nithesh  
Advisor: Craig Friedrich  
Course work only

Mahesh, Prajwal  
Advisor: Craig Friedrich  
Course work only

Manurkar, Adit Atul  
Advisor: Gregory Odegard  
Normal Modes Analysis of Chassis Structure and Static Analysis of Non-Cylindrical CNG Tanks and Supporting Brackets Using Finite Element Analysis

Matiash, Joshua N.  
Advisor: Scott Miers  
Competition Vehicle Based Intake Manifold Design

Miller, Kevin R.  
Advisor: Craig Friedrich  
Course work only

Naman, Apurv  
Advisor: Craig Friedrich  
Course work only

Naram, Sainath  
Advisor: Craig Friedrich  
Course work only

Oturkar, Sanika Jay  
Advisor: Craig Friedrich  
Course work only

Page, Brian R.  
Advisor: Nina Mahmoudian  
Design of a Mobile Underwater Charging System

Pawar, Ajit Ramchandra  
Advisor: Craig Friedrich  
Course work only

Phadke, Mohit Milind  
Advisor: V.C. Komaravolu  
Course work only
MS GRADUATES (CONT.)

FALL 2016 (CONT.)

Qiu, Gaosihao
Advisor: Craig Friedrich
Course work only

Rangoju, Deekshith
Advisor: Craig Friedrich
Course work only

Ren, Zhehao
Advisor: Craig Friedrich
Course work only

Sierakowski, Tyler J.
Advisor: Jason Blough
Course work only

Sirimalla, Dheeraj
Advisor: Craig Friedrich
Course work only

Soloukmofrad, Ali
Advisor: Mahdi Shahbakhti
Test Setup Design, Experimentation, and Model-Based Control of Hybrid Electric Powertrains Integrated with Low Temperature Combustion Engines

Tankersley, Stephanie L.
Advisor: Gregory Odegard
Alloying of Thin-Wall Ductile Iron Castings

Tymrak, Brennan M.
Advisor: John Gershenson
Comparative Analysis of Locally Available Materials for Treadle Pump Seals in Senegal, West Africa

Vaghani, Binikumar Madhavjibhai
Advisor: Craig Friedrich
Course work only

Vemuri, Venu Gopal Naidu
Advisor: Craig Friedrich
Course work only

Walter, David L.
Advisor: Craig Friedrich
Course work only

Yin, Qinyuan
Advisor: Bo Chen
Lithium-Ion Battery Cell Performance Study with Battery in the Loop Testing and Equivalent Circuit Model

Yu, Te
Advisor: Craig Friedrich
Course work only

Zheng, Qichen
Advisor: Craig Friedrich
Course work only

Zou, Shangyan
Advisor: Ossama Abdelkhalik
Course work only

SPRING 2017 (76)

Anbazhagan Vignesh, Tejeshwar
Advisor: Craig Friedrich
Course work only

Ankith Ullal, FNU
Advisor: Ezra Bar-Ziv
Heat Transfer Analysis in a Paddle Reactor for Biomass Fast Pyrolysis

Badarmanahalli Siddegowda, Ranjith
Advisor: Craig Friedrich
Course work only

Badhe, Amey Sanjay
Advisor: Gopal Jayaraman
A 3D FEM Comparative Study on the Impact Response Between Human Head and NOCSAE Head Due to Free Fall

Bamane, Swapnil Sambhaji
Advisor: Craig Friedrich
Course work only

Bangera, Chirag
Advisor: Craig Friedrich
Course work only

Chellappa, Saravana Kumar
Advisor: Craig Friedrich
Course work only

Coldren, Mark A.
Advisor: Craig Friedrich
Course work only

Darji, Mayank Rajesh
Advisor: Craig Friedrich
Course work only

Daavettula, Benjamin H.
Advisor: Craig Friedrich
Course work only

Deshpande, Sourabh Prashant
Advisor: Craig Friedrich
Course work only

Deshpande, Swarup Shrikant
Advisor: Craig Friedrich
Course work only

Dhankani, Karankumar Chandrakant
Advisor: Craig Friedrich
Course work only

Dhawan, Prateek
Advisor: Craig Friedrich
Course work only

Doke, Aniket Ajit
Advisor: Craig Friedrich
Course work only

Emmadi, Vinay Kumar
Advisor: Craig Friedrich
Course work only

Freundl, Michael L.
Advisor: Craig Friedrich
Course work only
Harsulkar, Jaideep  
Advisor: Craig Friedrich  
Course work only

Holur, Rakshin A.  
Advisor: Craig Friedrich  
Course work only

Hook, Rachel A.  
Advisor: Craig Friedrich  
Course work only

Hynninen, Richard J.  
Advisor: Craig Friedrich  
Course work only

Jacob, Kewin S.  
Advisor: Craig Friedrich  
Course work only

Jalal, Sarah  
Advisor: Fernando Ponta  
Course work only

Joseph, Jeffy  
Advisor: Craig Friedrich  
Course work only

Kamandar, Yuvraj Sambhaji  
Advisor: Craig Friedrich  
Course work only

Karde, Puja Kishor  
Advisor: Craig Friedrich  
Course work only

Komma, Rahul  
Advisor: Craig Friedrich  
Course work only

Kumar, Avi  
Advisor: Craig Friedrich  
Course work only

Lal, Ayush  
Advisor: Craig Friedrich  
Course work only

Larson, Brock R.  
Advisor: Craig Friedrich  
Course work only

Li, Xiaohong  
Advisor: Craig Friedrich  
Course work only

Loesche, Jon G.  
Advisor: Scott Miers  
Impact of E20 Fuel on a High-Performance, Two-Stroke Engine

Lurie, Alexander M.  
Advisor: Craig Friedrich  
Course work only

Mahadik, Saurabh Sanjay  
Advisor: Craig Friedrich  
Course work only

Manjunath, Datta Sandesh  
Advisor: Gregory Odegard  
Frontal Crash Analysis of a Conformable CNG Tank Using Finite Element Analysis

Mehra, Shravan  
Advisor: Craig Friedrich  
Course work only

Mensì, Amit Mohan  
Advisor: Craig Friedrich  
Course work only

Pahwa, Romil  
Advisor: Craig Friedrich  
Course work only

Palo, Matthew Z.  
Advisor: Craig Friedrich  
Course work only

Panchal, Rohit Ishvar  
Advisor: Craig Friedrich  
Course work only

Parmar, Siddharth Yogesh  
Advisor: Craig Friedrich  
Research and Development of Industrial Integrated Robotic Workcell and Robotrun Software for Academic Curriculum

Patel, Harsh Pravinkumar  
Advisor: Craig Friedrich  
Course work only

Patil, Sagar Sunil  
Advisor: Craig Friedrich  
Course work only

Phalke, Sagar  
Advisor: Craig Friedrich  
Course work only

Pradhan, Nitin Krishna  
Advisor: Craig Friedrich  
Course work only

Rajput, Oudumbar  
Advisor: Craig Friedrich  
Course work only

Ramanathan, Gautham Surya  
Advisor: Craig Friedrich  
Course work only

Rao, Kishan Sudhakar  
Advisor: Craig Friedrich  
Course work only

Reshamwala, Saumya Rajeshbhai  
Advisor: Craig Friedrich  
Course work only

Roehm, Paul M.  
Advisor: Gregory Odegard  
Minimizing Run Time of Finite Element Analyses: Applications in Conformable CNG Tank Dynamic Impact
Shinde, Rahul Ramakant
Advisor: Craig Friedrich
Course work only

Shrivastava, Sparsh
Advisor: Craig Friedrich
Course work only

Singh, Nishant
Advisor: Craig Friedrich
Course work only

Shinde, Rahul Ramakant
Advisor: Craig Friedrich
Course work only

Shrivastava, Sparsh
Advisor: Craig Friedrich
Course work only

Singh, Nishant
Advisor: Craig Friedrich
Course work only

Shinde, Rahul Ramakant
Advisor: Craig Friedrich
Course work only

Vartak, Nikita Ajit
Advisor: Craig Friedrich
Course work only

Vellanki, Midhulesh
Advisor: Craig Friedrich
Course work only

Wohra, Kunal
Advisor: Craig Friedrich
Course work only

Wakodikar, Anup Vijay
Advisor: Craig Friedrich
Course work only

Wang, Xin
Advisor: Bo Chen
Course work only

Wang, Yakun
Advisor: Craig Friedrich
Course work only

Yajnik, Nishchal
Advisor: Craig Friedrich
Course work only

Yameen, Md Bani
Advisor: Craig Friedrich
Course work only

Zhang, Jianfeng
Advisor: Craig Friedrich
Course work only

Sahasrabudhe, Amber Ramesh
Advisor: Craig Friedrich
Course work only

Salunke, Pranav R.
Advisor: Craig Friedrich
Course work only

Samavedam, Deepak
Advisor: Craig Friedrich
Course work only

Sankalp, FNU
Advisor: Craig Friedrich
Course work only

Shah, Hardik M.
Advisor: Craig Friedrich
Course work only

Shah, Kahaan Paresh
Advisor: Craig Friedrich
Course work only

Sharma, Anshul
Advisor: Craig Friedrich
Course work only

Sharma, Udit
Advisor: Jeffrey Allen
A Study of High Temperature Heat Pipes and the Impact of Magnetic Field on the Flow of Liquid Metal
**PHD GRADUATES (14)**

**SUMMER 2016 (4)**

Asayesh Ardakani, Hasti  
Advisor: Reza Shahrbanian-Yassar  
_in Situ STEM Study of Metal Oxides Nanowires for Nanoelectronics and Energy Storage Systems_

Patel, Sweetu B.  
Advisor: Tolou Shokuhfar  
_Mechanically and Electrochemically Stable Multifunctional Nanotubes for Biomedical Applications_

Razmara, Meysam  
Advisor: Mahdi Shahbakhti  
_PREDICTIVE CONTROL OF POWER GRID-CONNECTED ENERGY SYSTEMS BASED ON ENERGY AND EXERGY METRICS_

Reynolds, Craig D.  
Advisor: Jason Blough  
_Characterization of Torque Converter Cavitation Sound Power Level Over Varying Speed Ratio_

**FALL 2016 (3)**

Ahmed Abdul Moiz, FNU  
Advisor: Seong-Young Lee  
_Low Temperature Split Injection Spray Combustion: Ignition, Flame Stabilization, and Soot Formation Characteristics in Diesel Engine Conditions_

**Baker, Erin A.**  
Advisor: Craig Friedrich  
_Enhancing Osseointegration of Orthopaedic Implants with Titania Nanotube Surfaces_

Kolati, Madhu K.  
Advisor: Craig Friedrich  
_Methodology for Analyzing Epoxy-CNT Phononic Crystals for Wave Attenuation and Guiding_

**SPRING 2017 (7)**

Bhosle, Sachin M.  
Advisor: Craig Friedrich  
_Nanotextured Titanium Surfaces for Implants: Manufacturing and Packaging Aspects_

Cheng, Ming  
Advisor: Bo Chen  
_Study of Battery Health Conscious Powertrain Energy Management Strategies for Hybrid Electric Vehicles_

Labyak, David M.  
Advisor: Gopal Jayaraman  
_Computational Studies on Biomechanics of Concussion and on Efficacy of Football Helmets_

Lawyer, Kristina M.  
Advisor: Jeffrey Naber  
_Incorporation of Higher Carbon Number Alcohols in Gasoline Blends for Application in Spark-Ignition Engines_

Rajan, Anurag  
Advisor: Fernando Ponta  
_Analysis of Aeroelastic Effects on the 3-Dimensional Interference of Wind-Turbine Rotors_

Singalandapuram Mahadevan, Boopathi  
Advisor: John Johnson  
_Development of a Multi-Zone Catalyzed Particulate Filter Model and Kalman Filter Estimator for Simulation and Control of Particulate Matter Distribution of a CPF for Engine ECU Applications_

Soloukimofrad, Ali  
Advisor: Mahdi Shahbakhti  
_Model-Based Control of Hybrid Electric Powertrains Integrated with Low Temperature Combustion Engines_
When batteries drain, people say they’re dead. Recharging them is not the only way to bring them back to life. Dr. Lucia Gauchia studies what’s called a battery’s second life, when it is repurposed for a new use.

For her creative and in-depth interdisciplinary work, Gauchia earned a CAREER Award from the National Science Foundation. The $500,000 grant covers five years of research. As the US looks to update its electrical grid infrastructure, Gauchia plans to help by investigating how ecological systems can inspire improved battery design and scalability.

“In engineering, we often take the fish out of the pond and expect to be able to tell how it’s going to live in the pond; ecologists do not extract their subjects from their environment,” she says. Instead, Gauchia turns to systems design and population analysis in order to quantify battery individuals, groups, and their interactions with their environment.

With her NSF CAREER award Gauchia will test a large number of batteries in first and second life stages under a variety of conditions—driving style, weather patterns, and energy pricing—taking into account where and how they are used.

She will then use Bayesian networks to inform ecology-based methods to discern patterns in the data; with those patterns she can do cross-level testing to see what holds true from batteries to packs to modules. The analyses should help better predict when a battery might fail in any of its life stages.

Gauchia’s batteries and data will also be used in her undergraduate classes; students will be able to work hands-on and through online courses to run short-term tests that mirror Gauchia’s own long-term ones. During the summer, she plans to mentor young Hispanic women through the MICUP program that brings students from community colleges in downstate Michigan to Houghton for six-week internships.

Gauchia has joint appointments with the Departments of Electrical and Computer Engineering and Mechanical Engineering-Engineering Mechanics. She holds an endowed position as a Richard and Elizabeth Henes Assistant Professor for Energy Storage Systems.
Dr. Scott Miers believes effective teaching means getting students excited about the material and making connections to experiences they’ve already had. He also believes students must be able to relate to their instructors and see that instructors sometimes make mistakes too.

Some of the best examples that Miers shares with his classes involve mistakes he’s made, how he learned from them, and how they were corrected. He believes this dual focus keeps him humble, increases his effectiveness as a communicator, and instills a similar humility in his students.

This approach has earned Miers, a ME-EM associate professor, the Michigan Tech 2017 Distinguished Teaching Award.

Dr. Scott Miers

Not only is Miers a member of the Michigan Tech faculty, he is also an alumnus, earning a bachelor’s in mechanical engineering in 1995, a master’s in engineering mechanics in 2001, and a PhD in Mechanical Engineering in 2004, all from Michigan Tech. After several years at Argonne National Laboratory in the Engines and Emissions Research section, he returned to campus in 2008.

Miers’ teaching interests directly relate to his research in experimental internal combustion engines, which allows him to share real-world, experimental results in the classroom. He also guides undergraduate students in real-world situations through the Clean Snowmobile, Formula Car, and Super Mileage Enterprises.
AWARDS

DR. NANCY BARR presented at the Conference on College Composition and Communication 2017 in Portland, Oregon.

DR. JOHN BEARD celebrated 25 years of service to Michigan Tech.

DR. JASON BLOUGH was promoted from associate professor with tenure to professor with tenure.

DR. CHUNPEI CAI was elected Associate Fellow of the American Institute of Aeronautics and Astronautics (AIAA).

JULIE FOSTER, office assistant, was nominated by Dr. Craig Friedrich for the Michigan Tech Staff Council Making a Difference Award for Best Rookie.

DR. GOPAL JAYARAMAN (retired) celebrated 35 years of service to Michigan Tech.

DR. JACLYN JOHNSON was named ME-EM Department Teacher of the Year, Spring 2017.


DR. NINA MAHMOUDIAN was promoted from assistant professor without tenure to associate professor with tenure.

DR. SCOTT MIERS was recognized with an Outstanding Faculty Award at the 11th Annual Fraternity and Sorority Life Awards Ceremony.

DR. ANEET NARENDRANATH presented at the Wolfram Tech Conference 2016 during which he solved a fourth order nonlinear PDE live and manipulated the results towards control of liquid film structures.

ROBERT PAGE, manager laboratory facilities, was nominated by Dr. William Predebon for the Michigan Tech Staff Council Making a Difference Award for Outstanding Supervisor.

DR. GORDON PARKER participated in a University of Edinburgh panel session, “Future Research Challenges for Smart Grid” for the ADVANTAGE Research workshop held at the Royal Society of London.

HENRY SCHMIDT, research engineer, was nominated by Dr. Jeff Naber for the Michigan Tech Staff Council Making a Difference Award for Serving Others.

DR. MAHDI SHAHBAKHTI was promoted from assistant professor without tenure to associate professor with tenure.

DR. PAUL VAN SUSANTE presented at the NASA Solar System Exploration Research Virtual Institute In-Situ Resource Utilization (ISRU) seminar series. ISRU is a suite of concepts and technologies that can enable safer and more cost-effective use of space by exploiting local resources rather than bringing everything from Earth.

DR. KAZUYA TAJIRI was promoted from assistant professor without tenure to associate professor with tenure.

BOARD OF CONTROL SILVER MEDAL
Alumnus John Drake ’64 BS Mechanical Engineering, ’68 MS Business was awarded the Michigan Tech Board of Control Silver Medal, presented to persons who, through personal and professional achievement, are outstanding examples to Michigan Tech’s more recent graduates.

WOMEN LEADERS AWARD
Dr. Denise M. Rizzo ’14 received the 2017 J. Cordell Breed Award for Women Leaders at the SAE World Congress in Detroit. Rizzo is a Research and Mechanical Engineer in Powertrain Modeling and Simulation at the US Army Tank Automotive Research Development and Engineering Center (TARDEC).

JOHN JOHNSON AWARD
SAE International presented the John Johnson Award for Outstanding Research in Diesel Engines to Dennis L. Siebers, PhD, a retired diesel researcher at Sandia National Laboratories. Earlier this year Noud Maes, Eindhoven University of Technology won the award for his paper, “Penetration Under Heavy-Duty Diesel Engine Conditions,” along with co-PI’s Bart Somers, Eindhoven University of Technology; Tommaso Lucchini, Politecnico di Milano, Gianluca D’Errico, Politecnico di Milano, and Gilles Hardy of FPT Industrial. The award is funded through contributions from ME-EM professor emeritus Dr. John Johnson. Nominations can be made online at sae.org.
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. JASON R. BLOUGH
Design & Dynamic Systems Area Director

DR. WILLIAM J. ENDRES
Manufacturing & Industrial Director

DR. IBRAHIM MISKIOGLU
Solid Mechanics Area Director

DR. AMITABH NARAIN
Energy Thermofluids Area Director

DR. CRAIG R. FRIEDRICH
Associate Chair & Director of Graduate Studies

DR. GREGORY M. ODEGARD
Associate Chair & Director of Undergraduate Studies

PAULA F. ZENNER, MS
Director of Operations & Finance

DR. RUSH D. ROBINETT
Research Director

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

ENTERPRISE WINS ASME INNOVATION AWARD

In April, the American Society of Mechanical Engineers (ASME) selected Michigan Tech for the Donald N. Zwiep Innovation in Education Award.

Rick Berkey, Director of the Enterprise Program, and Dr. William Predebon, ME-EM Department Chair, nominated the Enterprise Program for the award. They accepted in Washington DC at the Mechanical Engineering Education Leadership Summit Awards Luncheon.

Donald N. Zwiep, ASME member from 1947-2012, was a pioneer of project-based, experiential learning in mechanical engineering. The Innovation in Education Award that bears his name recognizes innovative educational programs that foster and contribute to the advancement of collaborative and multi-disciplinary learning within the field of mechanical engineering.

Founded in 2000, the Enterprise Program at Michigan Tech is comprised of student-driven, multidisciplinary teams that operate like companies on real-world, client-sponsored projects.

Whether the deliverable is an innovative product, a pioneering solution, or a much-needed service, the hallmark of the Enterprise Program is the experiential learning it provides to Michigan Tech’s students. Many teams design, manufacture, and test their own prototypes, which provides students with an end-to-end project development experience.

Enterprise teams prepare designs for national competitions, and some projects will even take teams abroad. The collaborative and interdisciplinary Enterprise Program consists of 26 teams and 800 students representing 35 different majors.

EXPERIENCE ENTERPRISE

Enterprise at Michigan Technological University is when students—of any major—work on real projects, for real clients. It’s a lot like working for and running a company. Together with a faculty mentor, Enterprise teams work to invent products, provide services, and pioneer solutions.

LEARN MORE: mtu.edu/enterprise
If you were challenged to quiet the loud auxiliary power unit on a large Abrams tank to protect soldiers in battle, would minute carbon nanotubes come to mind?

Probably not, but that is exactly the solution ME-EM assistant professor Andrew Barnard presented at the finals of the ninth annual Global Automotive & Mobility Innovation Challenge (GAMIC)—and won.

The event took place at the SAE World Congress in the Cobo Center, Detroit in April 2017. Barnard’s company, Barnard Acoustics, won the Vehicle Electrification and Advanced Mobility category, one of four. GAMIC identifies innovative companies, cultivates new technologies and solutions, and hastens their adoption into the automotive industry.

Barnard’s technology, coaxial active exhaust noise control system, is based on using a thin film of carbon nanotubes as a thermophone, a loudspeaker that makes sound using surface temperature variation instead of a moving diaphragm. What that means is no moving parts, which results in higher reliability.

“Carbon nanotubes make this possible because they can oscillate their surface temperature almost instantaneously to produce canceling sound waves,” he explains.

Barnard was encouraged to participate in GAMIC through his involvement in the Michigan Translational Research & Commercialization (MTRAC) program at Michigan Tech, which helps University faculty fast track their technology to a commercial stage.

Barnard’s GAMIC coaches included John Diebel, MTRAC Commercialization Director; Steve Tokarz, Michigan Tech mentor-in-residence; Christophe Gaillard, principal engineer at Tier 1 automotive supplier Aisin; and Michael Brooks, a consultant in business development for material based technologies.

Barnard came to Michigan Tech from Pennsylvania State University in 2014. He earned a bachelor’s and master’s in Mechanical Engineering at Michigan Tech and a PhD in Acoustics from Penn State.
NEW FACULTY

SAJJAD BIGHAM, PHD
Dr. Sajjad Bigham joined the ME-EM Department as an assistant professor in October 2016. He is a heat transfer and energy systems specialist focused on understanding the fundamental transport science of important energy carriers at micro, nano, and molecular scales. He directs the Multiphysics Energy Research Lab. Bigham earned his PhD in Mechanical Engineering from the University of Florida, where he worked as a research assistant in nanostructure energy systems.

SUSANTA GHOSH, PHD
Dr. Susanta Ghosh joins the ME-EM Department as a research assistant professor. Ghosh received a PhD in Civil Engineering at the Faculty of Engineering, Indian Institute of Science in Bangalore, India, in 2008. Before coming to Michigan Tech, he worked for the Department of Materials Science and Engineering at the University of Michigan as a visiting research investigator. He also worked for the Department of Civil and Environmental Engineering at Duke University.

PARISA ABADI, PHD
Dr. Parisa Abadi joins the ME-EM Department as an assistant professor. She comes to Michigan Tech from Harvard Medical School, Brigham and Women’s Hospital, where she was a NIH Postdoctoral Research Fellow. Her research interests include the mechanical behavior of materials and their applications in tissue engineering and medical devices. Abadi earned a PhD in Mechanical Engineering from Georgia Tech in 2013.

UMESH KORDE, PHD
Dr. Umesh Korde joined the ME-EM Department in December 2016 as the Richard & Elizabeth Henes Chair Professor in Wave Energy. Korde investigates ocean wave energy utilization. He comes to Michigan Tech from the South Dakota School of Mines and Technology, where he was a professor who held the Pearson Chair in Mechanical Engineering. He earned his PhD in Mechanical Engineering from the University of Notre Dame.
TRISHA SAIN, PHD
Dr. Trisha Sain joins the ME-EM Department as an assistant professor. She earned her PhD in the Department of Civil Engineering, Indian Institute of Science, Bangalore India in 2008. She has worked as an assistant professor at North Carolina A&T State University, Greensboro, North Carolina. She was a post-doctoral researcher at the University of Michigan in Ann Arbor, and worked as a consultant in the mechanics division of Honeywell Technology Solutions Lab in Bangalore, India.

ZEQUN WANG, PHD
Dr. Zequn Wang joins the ME-EM Department as an assistant professor. He earned a PhD in Industrial Engineering at Wichita State University in Kansas in 2014 and worked as a postdoctoral researcher in the Integrated DEsign Automation Laboratory (IDEAL) of the Department of Mechanical Engineering at Northwestern University. Before coming to Michigan Tech, Wang was an instructor for the engineering design optimization iSIGHT lab at Northwestern. His research interests include design for reliability and system resilience.

HASSAN MASOUD, PHD
Dr. Hassan Masoud joined the ME-EM Department in July 2017 as an assistant professor. Previously he was a lecturer at the University of Nevada, Reno, a lecturer at Princeton University, and a post-doctoral fellow at Princeton’s Courant Institute of Mathematical Sciences. Masoud leads the Complex Fluids and Active Matter Lab, investigating the interaction of fluid flows with dynamically changing boundaries at a wide range of length and time scales. He earned a PhD in Mechanical Engineering at Georgia Tech in 2012.

DARRELL L. ROBINETTE, PHD, P.E.
Dr. Darrell Robinette joins the ME-EM Department as an assistant professor after a nine-year career at General Motors, where he worked as an advanced hybrid and electrification architecture engineer. He received his PhD in Mechanical Engineering-Engineering Mechanics from Michigan Tech in 2007. His research interests include advanced propulsion and power transfer systems, automatic transmission systems design, integration and control, and hybrid electric propulsion systems.

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KATHY GOULETTE

STAFF SPOTLIGHT:

KATHY GOULETTE

Kathy Goulette assisted ME-EM Department Chair Bill Predebon for 13 years before retiring last April. Then, setting what may be a Michigan Tech record, Goulette was back at work the very next day, at his special request. But just for a few months. She is now 100 percent retired, enjoying a lot more family time.

Goulette was a temporary employee in the Budget Office when the posting came out for her position. “I applied for it and thankfully was chosen,” she recalls.

“Staff always have a lot on their plates to support our faculty and students. We pull together and had fun doing it. Dr. Predebon supports many Department activities. We have had potluck lunches, ice cream socials, chili cook-offs, picnics, bowling nights; really any excuse to get together.”

The most rewarding part of her job? “Dr. Predebon encouraged us to grow. The Department has changed dramatically since I started 13 years ago, with a lot of opportunity to advance.”

“I hired Kathy as my assistant at a critical early time in my tenure as Department chair. I had recently started the ME-EM Phase II Campaign,” recalls Predebon. “With Kathy’s unwavering dedication and hard work, as well as her caring and friendly demeanor; she was essential to our success. I cannot thank her enough and will be forever grateful for her contributions and friendship.”

Time management was her biggest challenge. “In a Department as large as ours, with a chair as busy as Dr. Predebon, there was always something unexpected that needed attention immediately, on top of mountains of day-to-day work.”

Setting up alumni visits for Dr. Predebon was no small job. “Our alumni are extremely busy people. Sometimes I would make 10 to 20 contacts to arrange one meeting,” Goulette says. Alumni relations made her position exciting and rewarding. “Our alumni are so down-to-earth and pleasant,” she says.
“The most fun was working with our faculty and staff. They are all fantastic.”
KATHY GOULETTE

NEW STAFF

EVANDRO FICANHA, PHD
Dr. Evandro Ficanha is a research engineer in the Human-Interactive Robotics Lab (HIRoLab) in the ME-EM Department, developing steerable, powered ankle-foot prosthetic robots that mimic human ankle functions. He earned a BS in Mechanical Engineering in 2011 and a PhD in Mechanical Engineering in 2015, both from Michigan Tech.
Winning was only the beginning. After taking first place in the nationwide 2011 University Nanosat 6 competition, the Aerospace Enterprise earned the opportunity to launch their Oculus-ASR satellite into orbit.

With a mission to become an imaging target for ground-based telescopes, the satellite can change the way it appears to observers—its ‘optical signature’—to mimic the way other satellites might look from the ground. “Ground observers will attempt to decipher what Oculus is doing by analyzing its optical signature through telescopes and we will provide them with ‘truth’ data of what the spacecraft is actually doing,” says Aerospace Enterprise advisor, Dr. Brad King.

Going from a general design to an Air Force-approved version, Enterprise students faced a daunting array of challenges with software and assembly. “The overall development path has been strewn with obstacles just like a typical industry or government spacecraft program,” says King. “Our students have grown accustomed to handling a steady stream of technical, schedule, and cost crises; knowing we will ultimately solve the problem and persevere.”

Overcoming these obstacles, a small group of Aerospace Enterprise students remained on campus after the spring semester ended to assemble the Oculus-ASR for shipment and final launch preparations; set to launch on a SpaceX Falcon Heavy, as one of 32 separate vehicles.

“Before launch, Oculus-ASR will travel to Kirtland Air Force Base in Albuquerque for rigorous mechanical and thermal testing. From there, it will be repackaged and shipped to Cape Canaveral for launch integration with the stack,” says King.

In addition to the Oculus-ASR, the Aerospace Enterprise has two other satellites in development: Auris and Stratus. With independent teams working on the payloads for these satellites, a third team is developing a core set of functions, including power, computers, and communication systems.

“When we meet with our government and industry review teams, they are echoing the experiences students have in Enterprise, working in crisis mode. They see first-hand that everyone faces severe pressure building space hardware.”

DR. BRAD KING
A team of Michigan Tech and University of Michigan students led by ME-EM associate professor Ossama Abdelkhalik placed 16th in the European Space Agency’s ninth Global Trajectory Optimization Competition. Sixty-nine teams participated worldwide.

The event takes place every few years over the course of a month. Aerospace engineers worldwide solve a nearly impossible problem of interplanetary trajectory design. The challenge began like this: “It is the year 2060 and the commercial exploitation of Low Earth Orbits (LEOs) went well beyond the trillion of Euros market size. Following the unprecedented explosion of a Sun-synchronous satellite, the Kessler effect triggered further impacts, and the LEO environment was severely compromised…”

“This year our team moved up in ranking to finish 16th,” said Abdelkhalik. “Our design removed 122 pieces of space debris. The details of our solution will be published in a special issue of Acta Futura.”

King hopes the Enterprise will grow along this structure, with at least one satellite in space while others are in development. Although funding opportunities are rare and competition between universities is fierce, the Enterprise team has effective leaders and a strong method of systems engineering.

“Our students are choosing their leadership from within and training their successors. They run the Enterprise. It’s great to see an email circulate within the team about an issue and watch the leadership come together and solve it on their own,” says King.

With a membership base of over 100 students across many disciplines, the Aerospace Enterprise is a testament to the success of Michigan Tech’s Enterprise Program, continually attracting new and highly qualified students.

“We are unique in that we have the labs to build the satellites and the academic plans in place to reward and encourage students to stick with the Enterprise. Participation contributes toward our students’ degrees and keeps them on a path to graduation,” says King.

Many graduates have gone on to secure coveted positions with aerospace companies, such as SpaceX and Blue Origin. For them, as with the Oculus-ASR, Aerospace Enterprise was just the beginning.
Michigan Tech researchers are shaping the future of the electric vehicle industry, driving changes in energy management through development of connected and autonomous vehicle systems. The development is funded through a $3.5 Million award from the US Department of Energy’s Advanced Research Projects Agency-Energy (ARPA-E) for their newest program, NEXT-Generation Energy Technologies for Connected and Automated On-Road-Vehicles (NEXTCAR).

Tasked with creating a general solution to eventually achieve a 20 percent energy reduction in light-duty hybrid electric vehicles, the modeling team at APS Labs will develop a sophisticated model of vehicle performance and energy management based on information provided by project partner, General Motors, utilizing eight Gen 2 Chevy Volts.

“We’re only three months into the program and we already have vehicles on the road. GM was a crucial partner in securing this award; providing us with the platform necessary to test our technologies and integrate into a market scenario quickly.”

DR. JEFF NABER

Operating on a parallel timeline with vehicle modeling, the traffic team will simulate route and traffic scenarios, exploring projected horizons and timing for a path and utilizing those together to determine how to best operate the vehicle.

“Examining traffic density, vehicle speed, and construction, we are virtually determining the impact of vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) data on vehicle energy consumption,” says Naber. “Using predictive control, we’ll use speed horizon projections to recapture as much energy as possible while ensuring all maneuvers follow traffic laws.”

The controls, modeling, and traffic teams already have vehicles on the road for data latency testing, after only officially beginning the project on March 1.

Utilizing the technology of the Michigan Tech Mobile Lab as a mobile cloud computing center, the ultimate test will be when all eight vehicles are connected and communicating with one another for various traffic situations. “Working with GM got us to this point on the road more quickly than if we were on our own,” says Naber.
“Right now, we are running drive scenarios and capturing data with powertrain information and GPS data and streaming that from the vehicle to our servers, which will go into developing more accurate real-time models,” says Naber.

The ARPA-E NEXTCAR team at Michigan Tech is made up of faculty researchers Dr. Darrell Robinette and Dr. Mahdi Shahbakht in the ME-EM Department; Dr. Bo Chen with a dual appointment in the ME-EM Department and the Department of Electrical and Computer Engineering; and Dr. Kuilin Zhang in the Department of Civil and Environmental Engineering. The project is further supported by Chris Morgan, Chris Pinnow, Jeremy Worm, and several graduate student researchers, including: Ahammad Basha Dudekula (pg. 18), Joe Oncken (pg. 20), and Joe Tripp (pg. 24).

While the researchers and graduate students working on the project will be utilizing driver instructions to execute the vehicle commands, the end goal would be for GM and other automotive manufacturers to integrate the technology into their vehicle controller to advance autonomous vehicle performance, carrying out the program.

“Michigan Tech has a strong applied ethic and Dr. Naber and his team exemplify that through their development of real solutions, applicable to the real world by end users, like GM,” says Jim Baker, Executive Director of Innovation and Industry Engagement at Michigan Tech.

“The team is completing fundamental first principles research and bringing it toward market, manufacturing, and end-user reality,” Baker says.

As part of the contract, the research team will release the general approaches and methodologies in publications, while GM-specific technologies will be transferred to GM for improvements as a viable solution. The specific control algorithms and technologies developed will be available for license from Michigan Tech to enhance V2I integration and control.

“APRA-E is a selective program, so this funding is a gold star and evidence of the fact that ARPA-E and the DOE believe Michigan Tech can deliver a solution,” says Baker. “This all reflects back to the research conducted at APS Labs; delivering industrially-relevant and innovative solutions—on budget and on schedule.”

“Often we work with researchers to commercialize their existing technology, but with the ARPA-E project, we began with a specialized team and will develop solutions with the same outcome: commercialization.”

JIM BAKER
The future of deep space exploration relies on the development of strong and lightweight materials for use in exploration transit vehicles, habitats, and power systems. To develop these composite materials, NASA has announced funding of the Institute of Ultra-Strong Composites by Computational Design (US-COMP), led by principal investigator, Dr. Gregory Odegard.

While experts at the university level have been working to develop new composite materials for aerospace applications for many years, it was only recently that the technology became available to revise the development paradigm away from the traditional laboratory-based trial and error approach through the use of high performance computers. Simulation technology now allows researchers to efficiently obtain predicted properties of nanocomposite materials and iterate until a material design appears promising enough to fabricate and test in the lab.

This collaborative institute will publish the results, creating a database of properties to share with the public domain to ultimately broaden worldwide understanding of reliable nanostructured materials. US-COMP is a compilation of faculty members from Florida State University, University of Utah, Massachusetts Institute of Technology, Florida A&M University, Johns Hopkins University, Georgia Institute of Technology, University of Minnesota,

“I am looking forward to having the material manufactured, the panels made, and seeing the final tests conducted. The climax will be achieving the material properties NASA requires, and knowing we completed our mission.” Dr. Gregory Odegard
Pennsylvania State University, University of Colorado, and Virginia Commonwealth University with industry partners; Nanocomp Technologies and Solvay; and collaboration from the US Air Force Research Lab. “Each university and partner plays a specific role. US-COMP has gathered the greatest minds in the field to rapidly develop technology that will change the way we develop new materials,” says Odegard.

The teams will collaborate in four areas: computation, manufacturing, material synthesis, and testing, allowing each team to build on their existing technology and enhance it through exchange with partner universities. “We have everything broken down into individual tasks, all with interdependencies between the teams. This cooperative teamwork will result in rapid material design and experimental validation,” he says.

The US-COMP team is focusing their initial efforts on improving the strength, toughness, and stiffness of carbon nanotubes through a new process and scaling it up to make full-size structural panels for tensile testing.

“We’re developing a hybrid composite using layers of traditional carbon fibers and carbon nanotube sheets. In the end, in addition to physical samples of the new material, there will be publications on what the material is, how we made it, and what the properties are,” says Odegard. Following the mission of the Materials Genome, US-COMP hopes their results will help others around the world develop strong, lightweight materials for use in deep space missions, commercial aircraft, ground vehicles, or prostheses; anything that can benefit from lightweight, high strength properties.

Beyond sharing the methods and properties behind the development of new lightweight, high strength materials, NASA is funding these institutes as a way to broaden the national talent base in materials research and development. “They want us to focus on preparing students to work for NASA or in industry, further developing the materials for use either here or in deep space,” says Odegard.
Faculty and researchers at Michigan Tech have always prided themselves on training the next generation of automotive engineers with the latest tools and technology. When GM and SAE announced the AutoDrive Challenge to advance autonomous vehicle controls, the Electrical and Computer Engineering and Mechanical Engineering-Engineering Mechanics Departments made a collaborative application, opening new doors for their engineering students.

The goal of the competition is to outfit a Chevy Bolt with sensors, controls, and computer processors to operate at SAE level four by the end of the competition in the third year; navigating in an urban driving course in automatic mode with a driver present to intervene as necessary. The competition will introduce students to the challenges of requirements management, systems engineering, product development, and testing of controls and programming for an autonomous system.

“The autonomous vehicle will need to stop at stop signs, negotiate tight curves, and complete some lane change maneuvers to avoid static objects in the roadway, along with a mapping challenge and a presentation on the social and ethical implications of autonomous vehicles,” says Robinette.

As one of only eight universities selected to participate in the competition, the project will be run through the Robotic Systems Enterprise, led by Dr. Jeremy Bos, in close collaboration with Dr. Darrell Robinette.

“The Enterprise Program puts us in a unique position for getting a broad range of students involved from the engineering, business, social responsibility, and product leadership sides, pulling students from many disciplines from sophomore through graduate student level,” says Bos.

In addition to the advantages of the Enterprise Program, the AutoDrive team leadership has experience in sensors and programming directly from GM.

“Both Jeremy and I are former GM employees, where I was in systems engineering and he worked on sensors for autonomous systems, telematics, and vehicle-to-vehicle communication, which aligns us well with the requirements,” says Robinette.

When approaching the application process, Bos and Robinette treated it like an automotive manufacturer, focused on the systems engineering involved from start to finish.
This project goes beyond engineering to tie in education through collaboration across ME, EE, and ECE in systems engineering. We have the opportunity to bring multiple departments together to produce highly qualified engineers for the workforce.

Dr. Jeremy Bos
CALLED TO SPACE

It was a quest for the core principles of engineering that drew Galen Ojala to mechanical engineering. After visiting several engineering schools, Ojala found his home at Michigan Tech.

“When I came to Tech, I was with people who got it. I’m like a Swiss army knife, and mechanical engineering is like that with heat transfer, vibrations, and other courses that prepare you for a career where you can tackle anything,” he says.

“Senior Design wasn’t a lab where everything was designed for us. They gave us a real problem and we needed to do the heavy lifting to find a solution. That’s something I use daily.”

GALEN OJALA

Initially planning on completing one tour with the Air Force before returning to Roush Technologies or finding another job in industry, Ojala was introduced to the magic of space at the Air Force Research Lab (AFRL).

“There I fell in love with space. At the time commercial space had just started to be profitable outside government contracts. Now we have rockets landing themselves on barges, companies launching 900 nanosatellites the size of toasters for worldwide connectivity, and other small satellites taking pictures of Earth daily. I wanted to make a difference in space,” he says.

His courses at Michigan Tech prepared him for the field because not only were the courses and projects theoretical, but they were also practical.

“As a project manager and then a team lead at the AFRL, I needed to take a problem, break it down to the end goal, and then look at all the options,” he says.

A second generation mechanical engineer at Michigan Tech moving through the Air Force ROTC program, Ojala had dreams of becoming an aeronautical engineer.

“My dad had me sit down with a chief engineer for the space shuttle’s orbiter. He recommended I get an aerospace master’s with a bachelor’s in mechanical engineering. He said mechanical engineers can always be retrained for something else in electrical, civil, or materials because they have the basic building blocks and companies keep people that are versatile,” says Ojala.

The Senior Design program was crucial in developing the critical thinking skills Ojala has utilized throughout his career. “In one project, Special Ops Command was told by the Navy they wanted all gasoline off their ships, so our team was tasked with finding a solution for cold-start diesel for outboard motors,” he says.

“Senior Design wasn’t a lab where everything was designed for us. They gave us a real problem and we needed to do the heavy lifting to find a solution. That’s something I use daily,” says Ojala.
His practical engineering knowledge has allowed him to collaborate with people of various backgrounds, starting with his space operations position at AFRL Rome Labs training classical aircraft electronics engineers to design for space.

"With the integrated coursework of my mechanical engineering background, I was able to easily communicate with operators, electrical engineers, and computer programmers," Ojala says.

His thirst for knowledge fed his motivation to seek two master’s degrees; the first from Embry-Riddle Aeronautical University and the second from Air Command and Staff College, before returning to flying satellites as the Director of Mission for constellations of government satellites.

Lieutenant Colonel Ojala is currently serving as the Commander of the Space Analysis Squadron for the National Air and Space Intelligence Center.

"Everything I’ve ever done has led to this current position. The projects I worked on and the people I worked with at Michigan Tech, in class and in extracurricular activities, helped me learn to work with others to get the mission completed, even in harsh environments," he says.

Leading the 122 military and civilian Airmen to overcome challenges, Ojala finds enjoyment in building understanding and empowering younger engineers.

“I help these Airmen understand the informational needs of the warfighters downrange; ensuring they are well taken care of, and the missions are completed,” he says.

He was once asked by a senior officer where in the Air Force he’d like to go. He declined to answer, explaining that his preferences were not a factor in the decision.

“I go where called to serve,” was his response. Having started his odyssey with engineering principles, Ojala has become a living example of principled service.

"Everything I’ve ever done has led to this current position. The projects I worked on and the people I worked with at Michigan Tech, in class and in extracurricular activities, helped me learn to work with others to get the mission completed, even in harsh environments."

GALEN OJALA
<table>
<thead>
<tr>
<th>Name</th>
<th>Degree(s)</th>
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<tbody>
<tr>
<td>Frank Agosti</td>
<td>BSME 1958</td>
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<tr>
<td>Carl Avers</td>
<td>BSME 1962</td>
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<td>Richard Bayer</td>
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<td>John M. Beattie</td>
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<td>Wilfred Bobier</td>
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<td>John Calder</td>
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<td>Dean Diver</td>
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<td>John Drake</td>
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<td>John T. Eastman Sr.</td>
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<td>Dr. James Gerdeen</td>
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<td>John Hallquist</td>
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<td>Douglas Hamar</td>
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<td>Pete Knudson</td>
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<td>Harold Schock</td>
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<td>Stephen Williams</td>
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<td>Dr. Terry Woychowski</td>
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<td>Hussein Zbib</td>
<td>BSME 1981, MSME 1983, PhD 1987</td>
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James '56 & Esther Fox
James '59 & Wanda Gerdeen
Richard '69 & Sharon Gilbert
Kathleen & Wayne Goulette
Thomas '69 & Kathleen Gunning
Ruihua Han '98 & Linhui Shi
Robert Heger '80 & Keiko Kasahara
Ronald '77 & Diane Henning
Paul '74 & Tracy Hewelt
George '70 & Carol Hicks
Jimmy '03 & Beth Hill
Joanne Hofman
David & Cindy Houghtaling
Scott '00 & Katherine Houle
Robert '55 & Janis Howard
Robert '65 & Phyllis Hughes
Marvin '58 & Jacquelyn Hyma
Leo '71 & Bernice Jarema
Mark '80 & Diane Jarmus
Gopal & Manimegalai Jayaraman
Julian D. John '91
Lorraine '81 & Jay Johnson
Adam S. Johnson '04
Richard '84 & Gleice Jones
Jason A. Jones
Brian '88 & Dena Kacynski
Keith Kauffmann '90 & Gwen Bonnee
Robert '58 & Shigeko Keefer
Dale & Joan Kero
Gary & Vernelle Klecka
John '71 & Mary Klobuchar
James '94 & Megan Koski

$100–$499
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Mark '90 & Karen Alexander
Dr Robert '58 & Patricia Alperi
Olanrewaju Aluko
Richard '78 & Sharon Amato
Wayne '72 & Cheryl Anderson
Sheryl Arneson
Darrell A. Bacon '67

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DONORS (CONT.)

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James ’70 & Linda Mattson
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Wendy ’94 & Kurt Munson
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Ying F. Pang ’98
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Thomas Seel ’85 & Heidi Jackson-Seel
Ronald ’61 & Katherine Settimi
John ’58 & Dolores Sheringer
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Stuart ’59 & Gail Simpson
Frank ’68 & Mary Slama
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William E. Smith ’73
Dennis ’74 & Mary Stark
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Edward ’86 & Susan Stehulak
Donald ’83 & Suzanne Sterling
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David ’56 & Beverly Stromquist
Narasipur & Pramila Suryanarayana
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Judy ’83 & Tod Swann
David L. Swanson ’62
Mary E. Symons
Chester J. Taylor ’43
Radheshyam Tewari ’07
Robert ’62 & Mary Thresher
Harvey ’68 & Glenna Toppen
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Phillip ’56 & Nancy Walters
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Gilbert & Joan Wirkner
William ’64 & Barbara Worman
Michael ’68 & Dorothy Wozniak
Colin ’99 & Laurie Yager
James ’70 & Diane Zechlinski
COMPA NIES

$200,000–$1,000,000
MTS Systems Corp

$100,000–$199,999
Ford Motor Company

$25,000–$99,999
MacLean Power LLC
MacLean-Fogg Company Inc

$10,000–$24,999
GHSP
Polaris Industries Inc
Fidelity Charitable Gift Fund
BETA Fueling Systems Inc
MacLean-Fogg Component Solutions

$5,000–$9,999
Thermetrics LLC
Community Foundation for Southeast MI

$2,500–$4,999
EVolution Electric Vehicle Systems LLC
Marathon Petroleum Company LP

$1,000–$2,499
Clipper Creek Inc
KAM Plastics Corp
Morley Foundation
Renaissance Charitable Foundation Inc
RJJDRJ I LLP

$100–$999
Honeywell International Charity Matching
Milwaukee Electric Tool Corp
Koford Engineering LLC
Beach & Associates LLC
Boss Products
DonateWell
Caterpillar Inc
Yooper Performance LLC
Yamaha Motor Corp U.S.A.
## Contracts & Grants

### Advanced Power Systems

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<td>Rapid Screening with Paddle Fast Pyrolysis Systems</td>
<td>Ezra Bar-Ziv</td>
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<td>Battelle Energy Alliance LLC</td>
<td>$108,995</td>
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<td>Tailorable Resonant Plate Testing</td>
<td>Jason Blough</td>
<td>Charles Van Karsen, James DeClerck</td>
<td>Honeywell Federal Manufacturing &amp; Technologies LLC</td>
<td>$204,000</td>
<td>2016-2017</td>
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<td>Development of Advanced Modeling Tools for Diesel Engines</td>
<td>Youngchul Ra</td>
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<td>Korea Institute of Machinery and Materials</td>
<td>$188,515</td>
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<td>Reduced Ambient Temperature Emissions Testing for Arctic Cat</td>
<td>Scott Miers</td>
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<td>Arctic Cat Inc.</td>
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<td>Development of Advanced Model for Pre-Ignition Prediction in Gas Engines</td>
<td>Youngchul Ra</td>
<td>Jeffrey Naber</td>
<td>Mitsubishi Heavy Industries LTD</td>
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<td>Cold Intake Air Emissions Testing for Arctic Cat</td>
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<td>Arctic Cat Inc.</td>
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<td>Cold Intake Air Emissions Testing for Yamaha</td>
<td>Scott Miers</td>
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<td>Yamaha Motor Corporation</td>
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<td>Yamaha Single Cylinder Engine Performance and Emissions Testing</td>
<td>Scott Miers</td>
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<td>Yamaha Motor Corporation</td>
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<td>High Speed Single Cylinder Engine Torsional Dynamics Analysis</td>
<td>Darrell Robinette</td>
<td>Jeremy Worm</td>
<td>Raven Engineering</td>
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<td>Engine Dynamometer System Build for 1kW Generator Engine Application</td>
<td>PI: Christopher Morgan</td>
<td>MAHLE Powertrain LLC</td>
<td>$24,500</td>
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<td>Sensor Evaluation and Fusion for Closed Loop Combustion Control (CLCC) for SI Engines</td>
<td>PI: Jeffrey Naber Co-PI: Jason Blough, Bo Chen, Mahdi Shahbakhti</td>
<td>Ford Motor Company</td>
<td>$165,000</td>
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<td>Engine Heat Transfer Analysis</td>
<td>PI: Scott Miers</td>
<td>IR Telemetrics Inc.</td>
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<td>Continuation of Engine Ignition Studies</td>
<td>PI: Jeffrey Naber</td>
<td>Ford Motor Company</td>
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<td>Experimental and Modeling Studies of Mahle Smart Heat Injector Concept</td>
<td>PI: Jeffrey Naber Co-PI: Seong-Young Lee, Youngchul Ra, Henry Schmidt</td>
<td>MAHLE Powertrain LLC</td>
<td>$226,438</td>
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<td>Delivery of Professional Development Courses in Propulsion Systems</td>
<td>PI: Christopher Morgan Co-PI: Darrell Robinette, Jeremy Worm</td>
<td>US Department of Defense, Army-TARDEC</td>
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<td>Use of 2014 Unspent Funds</td>
<td>PI: Jeffrey Naber</td>
<td>Ford Motor Company</td>
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<td>Evaluation of Additive Manufactured Part Integrity</td>
<td>PI: Jason Blough</td>
<td>Honeywell Federal Manufacturing &amp; Technologies LLC</td>
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<td>Performance and Emissions Evaluation of a Yamaha Engine</td>
<td>PI: Scott Miers</td>
<td>Yamaha Motor Corporation</td>
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<td>Agile Interconnected Microgrids</td>
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<td>JHSV Crane Requirements Review</td>
<td>Gordon Parker</td>
<td>Craft Engineering</td>
<td>$18,330</td>
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<td>Making Small Wave Energy Converters Cost-Effective for Underwater Microgrids Through a 10-Fold Improvement in Year-Round Productivity</td>
<td>Ossama Abdelkhalik, Mark Vaughn</td>
<td>South Dakota School of Mines and Technology</td>
<td>$38,830</td>
<td>2016-2017</td>
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<td>Robotic ISRU Construction of Planetary Landing and Launch Pad</td>
<td>Paulus van Susante</td>
<td>Honeybee Robotics, National Aeronautics and Space Administration</td>
<td>$54,000</td>
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<td>Advanced Controls in Wave Energy Conversion</td>
<td>Ossama Abdelkhalik</td>
<td>Sandia National Laboratory</td>
<td>$99,682</td>
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<td>CAREER: An Ecologically—Inspired Approach to Battery Lifetime Analysis and Testing</td>
<td>Lucia Gauchia in conjunction with Electrical &amp; Computer Engineering</td>
<td>National Science Foundation</td>
<td>$592,243</td>
<td>2017-2022</td>
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<td>On Integrating Object Detection Capability into a Coastal Energy Conversion System</td>
<td>Umesh Korde, Rush Robinett, Ossama Abdelkhalik</td>
<td>US Department of Defense, Office of Naval Research</td>
<td>$776,231</td>
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<td>Collaborative Research: On Making Wave Energy an Economical and Reliable Power Source for Ocean Measurement Applications</td>
<td>Umesh Korde</td>
<td>National Science Foundation</td>
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<td>HVDC Distribution Study of Intelligent Power System</td>
<td>Wayne Weaver, Gordon Parker</td>
<td>University of Dayton Research Institute</td>
<td>$220,244</td>
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<td>Meta-Stability of Pulsed Load Microgrids</td>
<td>Wayne Weaver, Sandia National Laboratory</td>
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<td>Modeling and Control Development for Electric Vehicle and Smart Grid Integration</td>
<td>Bo Chen</td>
<td>Argonne National Laboratory</td>
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<td>Senior Design: Multi-Lever Mechantronic Gearshift Design</td>
<td>William Endres</td>
<td>Gear Vendors Inc.</td>
<td>$25,650</td>
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<td>Enterprise: Bauer Pit Project</td>
<td>Paulus van Susante in conjunction with Center for Leadership and Innovation for Transformation (LIFT)</td>
<td>Stoneco of Michigan</td>
<td>$26,021</td>
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<td>Enterprise: Priage</td>
<td>Michele Miller in conjunction with Center for Leadership and Innovation for Transformation (LIFT)</td>
<td>Stryker Medical</td>
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<td>Senior Design: Improved Snow Bucket</td>
<td>William Endres</td>
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<td>Senior Design: In-Cab Airborne Compound Sensing System</td>
<td>William Endres</td>
<td>Richard E. Job</td>
<td>$27,509</td>
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<td>Senior Design: Non-Sterile Oral Solution Dosing System</td>
<td>William Endres</td>
<td>Jazz Pharmaceuticals Inc.</td>
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<td>Senior Design: Exhaust Aftertreatment Substrate Heater Design</td>
<td>William Endres</td>
<td>Cummins Inc.</td>
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<td>Senior Design: Versatile Test Die Design</td>
<td>William Endres</td>
<td>United States Steel Corporation</td>
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<td>Senior Design: Multi-Lever Mechatronic Gearshift Design - Phase II</td>
<td>Pt: William Endres</td>
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<td>Mass Measurement of an Electrospray Beam from a Single Emitter ionic Liquid Ferrofluid Electrospay Source</td>
<td>Pt: Lyon B. King Co- Pt: Kurt Terhune (ME-EM PhD Candidate)</td>
<td>National Aeronautics and Space Administration</td>
<td>$284,000</td>
<td>2013-2017</td>
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<td>I/UCRC: Novel High Voltage/Temperature Materials and Structures</td>
<td>Pt: Gregory Odegard</td>
<td>National Science Foundation</td>
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<td>Novel Ionomers and Electrode Structures for Improved PEMFC Electrode Performance at Low PGM Loadings</td>
<td>Pt: Jeffrey Allen Co- Pt: Kazuya Tajiri, Ezequiel Medici</td>
<td>3M Company</td>
<td>$813,925</td>
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<td>I/UCRC: Novel High Voltage/Temperature Materials and Structures</td>
<td>Pt: Gregory Odegard Co- Pt: Paul Sanders (Materials Science Engineering), Julia King (Chemical Engineering)</td>
<td>Colorado Seminary - University of Denver</td>
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<td>Antibacterial Orthopedic Implant Commercialization</td>
<td>Pt: Craig Friedrich</td>
<td>University of Michigan</td>
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<td>Carbon Nanotube Speaker for Exhaust Active Noise Control</td>
<td>Pt: Andrew Barnard</td>
<td>Faurecia Emissions Control Technologies</td>
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<td>3-D Printed Nano-Bioactuators and their Application in Navigation of Endovascular Catheters</td>
<td>Pt: Parisa Abadi</td>
<td>American Heart Association</td>
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<td>ICorps: Software for Aircraft Analysis and Design</td>
<td>Pt: Chunpei Cai</td>
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<td>IN-SITU Resource Utilization (ISRU) on Mars</td>
<td>Pt: Paulus van Susante</td>
<td>Jet Propulsion Laboratory, California Institute of Technology</td>
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## Space Systems

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<td>Auris: A CubeSat to Characterize and Locate Geostationary Communication Emitters</td>
<td>PI: Lyon B. King, Co-PI: Ossama Abdelkhalik, Michael Roggemann (Electrical &amp; Computer Engineering)</td>
<td>Utah State University Research Foundation, Space Dynamics Lab</td>
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<td>Stratus Meteorological CubeSat: Payload Integration and Mission Level Design</td>
<td>PI: Lyon B. King, Co-PI: Marcello Guadagno (ME-EM Undergraduate)</td>
<td>University of Michigan, Michigan Space Grant Consortium</td>
<td>$5,000</td>
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<td>Institute for Ultra-Strong Composites by Computational Design (US-COMP)</td>
<td>PI: Gregory Odegard, Co-PI: Ravi Pandey (Physics), Julia King (Chemical Engineering), Trisha Sain</td>
<td>National Aeronautics and Space Administration</td>
<td>$14,999,995</td>
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## Additional Research Topics

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PATENTS


BOOK


BOOK, CHAPTER IN


**JOURNAL ARTICLES**


The steady growth and development of the ME-EM Department through collaboration across campus reflects the vision we have for success at Michigan Tech. I am proud of their student involvement in research and for taking the lead with Human Centered Engineering.”

DR. GLENN D. MROZ
PRESIDENT, MICHIGAN TECHNOLOGICAL UNIVERSITY
MILES PENHALE TRAVELED TO BARROW, ALASKA FOR ANSWERS ON SOUND PROPAGATION TO COMPLETE HIS PHD ➔ PAGE 28