STUDENT-CENTERED CURRICULUM REVISION

[ 2017-18 ] ANNUAL REPORT
This year we present a decade-long journey that our Department commenced upon in 2009. In the fall of that year, I asked our faculty to redefine our undergraduate curriculum to align with the ASME Vision 2030 and the NAE Grand Challenges for students to receive practice-oriented education with increased flexibility. My involvement was limited, and I left the solution and the pathway forward open for them to create.

A committee was formed, and our faculty took full ownership of the process, finding ways to pair hands-on application with theory, combining and removing courses, to make way for innovation.

I believed the process would be challenging for a department of our size, and I solicited funding from our donors and corporate partners to support the revision effort.

Now fully implemented, we convey both how our faculty approached the problem and the resulting curriculum changes.

The positive impact we are seeing as our students begin their careers would not have been possible without the commitment to education from the faculty and the dedication of our staff—who were and still are critical to keeping all the dynamic practice session materials updated and equipment operational.

I look forward to sharing voices of committee members, staff, and industry, while also highlighting the success of ME-EM alumni and ME-EM faculty members. I am equally proud to feature the awards and nominations we have received, and to welcome new faculty and staff members.

Finally, I must express our deep gratitude to the alumni, donors, and corporate partners who make our mission possible.

William W. Predebon, PhD
J.S. Endowed Department Chair & Professor • wwpred@mtu.edu
Research builds innovation

Over the course of the last year, our emphasis has continued to focus on securing international leadership positions in all of our Department’s research thrust areas, including establishing research centers and institutes on campus.

We currently have three research centers or institutes, including the Institute for Ultra-Strong Composites by Computational Design (US-COMP), the Center of Agile and Interconnected Microgrids (AIM), and the Advanced Power Systems Labs (APS LABS).

Continuing in year two with funding from NASA, US-COMP (based at Michigan Tech), gathers top experts from 11 universities, two partner companies, and the US Air Force Research Lab, to complete computational, manufacturing, material synthesis, and testing for the next generation of space exploration.

Under the direction of Dr. Gregory Odegard, US-COMP will bring in $15 million over a five year period (see page 24).

Dr. Gordon Parker, along with Dr. Ossama Abdelkhilik, and Dr. Guy Meadows, are paving the way for new research opportunities in AIM with the wave energy conversion tank. The wave energy converter offers potential beyond energy conversion with industry interest in behavioral patterns in schools of fish and unmanned underwater vehicles (see page 28).

Research continues at APS LABS on advanced control systems for light-duty hybrid electric vehicles, through a $3.5 million project from the US Department of Energy’s Advanced Research Projects Agency-Energy (ARPA-E). Research teams, in partnership with GM, have completed models and instrumentation for test vehicles running mapped routes with a goal of reducing total energy consumption by 20 percent.

The project is led by principle investigator, Dr. Jeff Naber, with support from researchers, graduate students, and faculty in the ME-EM Department, the Department of Electrical and Computer Engineering, and the Department of Civil and Environmental Engineering (see page 26).

American Society for Engineering Education
- 8 in BSME enrollment, 27 in BSME degrees awarded
- 10 in MSME enrollment, 6 in MSME degrees awarded
- 23 in PhD enrollment, 33 in PhD degrees awarded

National Science Foundation
18 in research expenditures ($14.152M) among all mechanical research in the US

US News & World Report America’s Best Graduate Schools
59 among the top 179 (top 33%) doctoral-granting ME departments

Research expenditures are an estimate at publication time and are corrected in the next annual report.
Beginning in academic year 2014-15, we eliminated labs and replaced them with Mechanical Engineering Practice (MEP) courses. We also combined several courses, added technical electives, and opened up those electives to 4,000+ courses in any discipline. If you are wondering why and how we did this, read on.

**STEP ONE**
Replace all labs with adaptable practice courses that flex to the demands of industry through open-ended questions.

- MEEM2500 Integrated Design & Manufacturing Lab
- MEEM2901 Mechanical Engineering Practice I (MEP I)
- MEEM3220 Energy Lab
- MEEM2911 Mechanical Engineering Practice II (MEP II)
- MEEM3900 Engineering Design Processes
- MEEM3901 Mechanical Engineering Practice III (MEP III)
- MEEM3000 Mechanical Engineering Lab
- MEEM3911 Mechanical Engineering Practice IV (MEP IV)

**STEP TWO**
Combine courses as needed to ensure needed concepts and skills are covered in lecture to support MEP I through IV.

- MEEM3210 Fluid Mechanics
- MEEM3230 Heat Transfer
- MEEM3501 Product Realization I
- MEEM3502 Product Realization II
- MEEM3700 Mechanical Vibrations
- MEEM4700 Dynamic Systems & Controls w/Lab
STEP THREE

Add two additional technical electives, allowing students the ability to specialize or broaden their skillset, or to add a minor without additional courses.

- MEEM3201 Introductory Fluid Mechanics & Heat Transfer
- MEEM3400 Mechanical System Design & Analysis
- MEEM3750 Dynamic Systems
- Technical Elective + Technical Elective
- Technical Elective + Technical Elective
- Technical Elective
THE BEGINNING

It was the summer of 2009. The faculty members at the retreat grew quiet, as Dr. Bill Predebon posed the open ended question that would trigger a years-long journey and impact thousands of students: “Where do we take our curriculum next?”

All movement ceased.

They sensed it was a critical moment in the future of the Department and carefully considered their response. Routinely educating engineers, their answers were clear and direct: Practice, Application, and Simulation. Students needed guided, direct application of engineering principles, greater fluency using industry tools, and experience with simulation and systems engineering.

The broad objectives of a new curriculum were defined, but the map to get there was a blank sheet.

Using the open approach, the faculty was tasked with shaping the curriculum however they saw fit to accomplish these goals. The only constraint: the changes should not increase the total number of credits or time to graduate. The road was open and the journey began.

The Curriculum Revision Committee looked for inspiration from the ASME’s Vision 2030 and the NAE Grand Challenges, forming their own requirements as follows:

1. Improve hands-on solving of engineering problems
2. Give students greater opportunity to specialize
3. Allow students to solve problems that matter
4. Engage in cross-disciplinary projects
5. Push boundaries with new teaching approaches.

Throughout the planning process, the committee sought to focus on open-ended challenges that graduates would encounter on the job. After months of discussion, the committee envisioned four practice-based courses spanning sophomore and junior years.

Beyond the practice courses, work began to determine what classes to modify or combine.

“We wanted to help students more fully become engineers. This process brought modern tools and thought leadership into the classroom, while also building flexibility for specialization or diversification with more technical electives,” says Dr. Jim DeClerck.
The committee uses the ME Practice courses to increase opportunities for application.

As students move through the ME Practice courses, the ratio from application to discovery increases to give students hands-on experience using industry tools, improving experience with simulation and systems engineering.
THE JOURNEY

Keeping in mind the requirements they set for themselves, the committee plotted a course to expand on the hands-on approach to learning while getting students comfortable with industry-standard tools and processes through ME Practice courses. To develop skills objectives for each of the four practice courses, the committee analyzed the degree flow chart to determine the common topics in the curriculum, including:

1. Application of Thermal Fluids
2. Application of Design & Manufacturing
3. Application of Solid Mechanics
4. Application of Dynamic Systems
5. Programming, Modeling, & Simulation
6. Instrumentation, Measurement, Controls, & Data Acquisition
7. Structured Design Process
8. Making & Tinkering
9. Communication & Collaboration

These nine topical areas were then presented to the faculty, EAB, and select students, who participated in exercises to identify the theories and applications from these topical areas to be covered in each class.

The faculty lounge served as the common sharing space with Post-it Notes™ mapping concepts to courses. With feedback and buy-in from the faculty, the committee reconvened to define high-level learning and skills objectives for the four ME Practice courses before handing the course planning and implementation over to the course coordinators.

THE COURSES

Dr. Paul van Susante took the lead on ME Practice I, where students spend time discovering problems and solutions through reverse engineering, data acquisition, and one-dimensional finite element analysis (FEA). They then build a system model of the ME-EM elevator, and compare it to their accelerometer measurements. This course is also the student’s first interaction with customer requirements and the engineering design process (see page 14).

“We take what students already know and build on it, adding in previews for what is coming in other courses. The ME Practice courses are a tightly woven tapestry of concepts, content, and skills.”
—Dr. Paul van Susante

Led by Drs. Jeff Allen and Jason Blough, students in MEP II move from 1D to 2D FEA, using a robotic arm mini-crane and an air handling unit for a neonatal intensive care unit to develop their skillset. While students learn calibration and how to measure flow rate, they witness how their engineering effort makes a difference in problems that really matter (see page 16).

“We help shift their mindset from problem solver to problem analyst. That’s what they need to be an engineer.”
—Dr. Jeff Allen

The effort to get industry standard simulation tools into the hands of young engineers prior to graduation is brought to the forefront in MEP III by course coordinators Dr. Jim DeClerck and Professor Chuck Van Karsen.

As students transition from the second to third year, there is also a shift in the ME Practice courses from primarily discovery to more direct application.
Held in the renovated “Fishbowl,” now the Active Learning Center, students develop skills in modeling and analysis with a focus on 3D FEA, energy modeling, and rigid body dynamics.

Tying in the engineering design process and elevator simulations from MEP I, students are given a set of requirements on acceleration, mass, and lifecycle and challenged to move people and goods along a duty cycle (see page 18).

“We give students the freedom to define their specific application, make case studies, and find customers and users, and that’s given us greater flexibility.”
—Dr. Jim DeClerck

Using simulation and controls is the emphasis in MEP IV, led by Drs. Brad King and Jason Blough. The course challenges students to build a cross disciplinary understanding that serves as the foundation for their upcoming Senior Design and Enterprise team projects.

In a highly collaborative semester, the students learn system integration, system dynamics and characterization, and controls while working on a bicopter conducting drone surveillance for Tony Stark. Using relatable scenarios and equipment, the faculty are helping students create a connection to the task at hand (see page 20).

“We with the open-ended nature of the courses, we did and still do tweak the challenges to improve student experiences. We iterate with our support staff, by having them work a second shift, they start late in the afternoon and work late into the evening to adjust the lab hardware to improve the practice session for the next day.”
—Dr. Jason Blough

THE DESTINATION
One constant objective throughout the courses was to better prepare students through the incorporation of technical communication.

“We were finding that students need to make a connection in their writing, learning how to apply it in the workforce rather than standalone courses.”
—Dr. Nancy Barr, Director of Engineering Communications

Barr met with each course coordinator to enhance assignments and seamlessly integrate communication into the course practice sessions. In each session, students create content they would be expected to write on the job: a memo, a presentation, or a formal recommendation with the opportunity to address various audiences.

“Written communication is important, but we also made it our goal to teach students how to work with each other through teaming exercises and constant group collaboration.”
—Dr. Greg Odegard, Director of Undergraduate Studies

Transitioning from always having a single correct answer in traditional recipe labs, to the open approach in the ME Practice courses, is a greater challenge for everyone involved: the faculty, staff, and students each have to think harder, work harder, and communicate in greater context. But it’s worth it.
The faculty and staff involved look back with pride knowing today’s students are demonstrably better prepared to hit the ground running as contributing engineers.
Building a curriculum with practice-based courses was a challenge, especially when the faculty examined the flow chart and gauged the credit load, finding ways to reduce without eliminating required material.

“There were challenges when we started to talk about what courses to remove and what to combine.”

—Dr. Michele Miller, previous Director of Undergraduate Studies during the curriculum revision process

Ultimately, some material needed to be condensed to allow specialization through technical electives. “In order to make room for these four ME Practice courses, all technical areas had to give up required science course credits,” says Dr. Jeff Allen. “This was a difficult effort for faculty and the committee to work out.”

With voting support of the faculty, the committee decided to combine MEEM 3501: Product Realization I and MEEM 3502: Product Realization II to form MEEM 3400: Mechanical System Design & Analysis, reducing credit requirements from six to three.

The next challenge was to merge MEEM 3700: Mechanical Vibrations and MEEM 4700: Dynamic Systems and Controls to create MEEM 3750: Dynamic Systems, bringing the credit count from seven to four.

“We've found that while the topics are different, students are using the same math—exploring heat transfer systems and electrical systems using same order differential equations.”

—Dr. Jim DeClerck

Dr. Gordon Parker led the effort; finding a textbook, preparing lectures, and reviewing topics to ensure students leave prepared to begin Senior Design.

In Dynamic Systems, students are trained to solve for control parameters rather than the guess-and-check methodologies used in MEP I, II, and III. The course enhances the cross-disciplinary requirement set in place by the committee, showing the analogous principles between mechanical and electrical engineering.

An additional six credits were reduced to four when the committee created the MEEM 3201: Introduction to Fluid Mechanics & Heat Transfer by bringing together MEEM 3210: Fluid Mechanics and MEEM 3230: Heat Transfer, under the direction of Dr. Jeff Allen.

“In an area encompassing thermodynamics, fluid mechanics, and heat transfer, we were tasked with eliminating two credits from our nine credit structure. We decided to combine fluid mechanics and heat transfer, focusing on internal flows, while developing a follow-up technical elective that pairs fluid mechanics and heat transfer with a focus on differential analysis and external flows,” he says.

With the combining of related course topics, the committee cross fertilized concepts and enabled greater specialization.
With the reduced course credits achieved in step two, the committee accomplished their goal to introduce opportunities for both specialization and diversification by creating space for an additional six credits of technical electives.

“We increased their technical electives from three courses to five. This gives students the freedom to choose a focus area. They can specialize in one topic, like biomechanics, engines, or aerospace, or diversify with classes on five different topics.”

—Dr. Greg Odegard, Director of Undergraduate Studies

Previously loaded with required courses, the committee sought to create flexibility in the final two semesters.

The guiding effort of the committee was to ultimately give students the tools and experiences to become effective engineers,” says Dr. Jim DeClerck.

INTERDISCIPLINARY
To accommodate for the subjects that were combined, faculty created courses and expanded the options to include 4000-level courses across departments, strengthening students’ creative and interdisciplinary cognition.

“While the curriculum revision placed an emphasis on practice, the expansion of the technical electives motivates students to think critically and specialize, helping them prepare for graduate school.”

—Dr. Jeff Allen

Expanding the technical electives in the flow chart from three courses to five, with opportunities to choose across departments provides a greater range of options.

“We encourage students to explore courses in materials, biomech, chemical, electrical, or civil engineering to continue to build on their practical problem-solving skills,” Odegard says.

“With the expanded technical electives, minors within the department require no additional course work. As a result, we’ve seen a significant increase in the number of students pursuing a minor, helping them stand out in recruiting.”

—Ryan Towles, academic advisor
MECHANICAL ENGINEERING PRACTICE (MEP) COURSES
Critical thinking skills are the key to becoming an effective engineer. ME Practice I lays the foundation with discovery and exploration of hands-on problem solving and skill building such as data acquisition, one-dimensional finite element analysis (FEA), and reverse engineering.

Students begin week one with safety in the practice session, as well as in laboratory and manufacturing environments on the job. Week two introduces the basics and practice of data acquisition, reinforcing how experimental and simulated data drive decisions.

Bringing in cross-disciplinary aspects, students learn about material properties and the standard procedures used to measure physical properties before transitioning to reverse engineering. “They pick a consumer product; think about how it functions, learning about user needs, engineering requirements, and the design process. Then they take it apart to document how it actually functions, how it was manufactured, and review the assembly process. Finally, they look at online reviews and pick a portion to redesign in CAD, based on customer feedback,” says Dr. Paul van Susante. The students continually practice their data acquisition skills; this time, to measure acceleration of the ME-EM elevators with a transducer, learning about accelerometers and calibration before modeling in AMESim.

“The students validate the model we provide using data they take. We know the model is not a perfect match, so they need to determine its limits. Then they try to speed up travel by adjusting the parameters in the model using a simplified control system.”

—Dr. Paul van Susante

To practice their modeling skills, they create a bridge model using 1D FEA, tying in connections from statics using nodal equilibrium or method of sections for truss structures.

**OBJECTIVES**

- **DISASSEMBLE A COMPONENT OR SYSTEM** and evaluate design functions and manufacturing processes.
- **USE BASIC DATA ACQUISITION SYSTEMS** and apply principles, such as samples, quantization, and aliasing, to collect data, understand calibration and uncertainty, and evaluate data quality and limitations.
- **BUILD CAD MODELS OF PARTS AND ASSEMBLIES**, use Matlab to solve engineering problems, perform and analyze tension and torsion tests on a range of materials.
- **CREATE A DESIGN** that meets a set of requirements and utilize machine tools and 3D printing systems in the design and build process, while working safely and clearly communicating conclusions.
“We developed the ME Practice courses as a whole, they build on each other with the final goal to build the skills of a mechanical engineer in a logical and time progressive fashion. We want the students to see how the other courses they’re taking connect to this one. They can’t compartmentalize the course and forget about it.”

Dr. Paul van Susante
MEP I course instructor

“They hand calculate the concentrated and distributed loads of a bridge truss structure and compare that to the load sensor data from the bridge.”

They subsequently follow the design process to 3D print a beam with no safety factor, based on their measured material properties and loads.

“When they put the printed beam into the bridge for testing, they see that it doesn’t always fail at the load it was designed for. They reflect and write on possible causes, which builds an understanding of the manufacturing process and the importance of factors of safety,” van Susante says.

Integrating hands-on learning with group projects and communication, students have a unique opportunity to discover the roles engineers play.

The ME Practice I course combines 110 minute practice sessions with 50 minute lectures and outside prep time to build an understanding of topics covered in each practice session.

5,040
MINUTES SPENT IN LEARNING, PRACTICING, AND PREPARING.
In moving from MEP I to MEP II, students see a shift in time spent in discovery to additional time spent in application—a trend that continues as they move through the ME Practice courses.

“Everyone’s answer is slightly different. Having students deal with open-ended solutions where there isn’t a single right answer, is part of the design of the course. Throughout the process, they make mistakes without realizing it and then they learn how to recover.”

Dr. Jeff Allen
MEP II course instructor
Following the plan set by the committee, ME Practice II increases opportunities for application, while keeping discovery at the core. Drs. Jeff Allen and Jason Blough build students’ data acquisition skills, introduce 2D FEA, and create open-ended problems. “There are two engineering design activities spread over the course of the semester, developing skills that ultimately tie back to the final designs, which they must defend,” says Allen.

With a set of requirements, students operate a mini-crane that swings through 90 degrees within a fixed time interval while keeping max force below a set value. Improving on their simple controller experience from MEP I, students explore proportional and integral gain parameters. They determine appropriate closed loop control parameters and design a safety link with a safety factor of 1.0, so it theoretically breaks upon operation. Their decision is based on professional plots, 2D FEA design, and validation of their 3D-printed safety link.

Beginning with visible inertia in the crane’s motion, the students end by measuring invisible thermal lag. “The underlying theme of the course is inertia and how it may impact controls using various fixtures to demonstrate the concept,” says Blough.

The final project reflects the committee’s requirement to focus on problems that matter by designing an air handling unit that delivers warm air at a precise flow rate to a neonatal intensive care unit (NICU). “This project emphasizes that attention to detail is crucial. It’s about more than just getting through the course,” Allen says.

Complementing the skills from MEP I, the students use monometers to calibrate pressure transducers and explore the effect of time constants on transducers.

“These lessons get students thinking on a systems level,” he says. “Ultimately, they guess and iterate, like engineers on the job, coding their process in Matlab.”

Students rely on data analysis and experimental methods to determine the optimal fan speed to achieve the desired air flow rate for the NICU. “They adjust control parameters to get the system to respond in a stable manner,” Allen says.

ME Practice II provides the skills and mindset needed to instill confidence in open-ended problem solving, changing the way they approach engineering.

**OBJECTIVES**

- **PROCESS AND ANALYZE DATA** using method of least squares, propagation of uncertainty, data correlation, and sensor calibration.
- **UTILIZE COMPUTATIONAL, SIMULATION, AND DATA ACQUISITION TOOLS**, including MATLAB, Simulink, LabView, as well as CAD and 2D FEA.
- **MEASURE PRESSURE, TEMPERATURE, AND FLOW RATES** while determining sensor response.
- **COMMUNICATE EFFECTIVELY** through written and graphical data analysis.
- **UNDERSTAND CONSERVATION OF MASS AND ENERGY** with an emphasis on mechanical energy, mechanical energy dissipation, dynamic response during changes in energy or state, control and stability of dynamic response, and mapping performance to system response.
When planning for the ME Practice courses began, faculty knew industry was looking for greater fluency with industry tools and more experience with simulation and systems engineering.

ME Practice III, directly addresses that while focusing more on direct application.

“In MEP III, students start on systems engineering at a high level approach, getting more specific on simulation as it becomes more granularly defined through the process,” says Professor Chuck Van Karsen, co-course coordinator.

Working with a suite of industry-standard software tools, MEP III students grapple with requirements at the beginning of the design process with system-level energy modeling and multi-body dynamics.

These energy models and control concepts are tied to other engineering fields, reflecting the committee’s desire to deliver interdisciplinary insights.

“We build on their experiences in MEP I, with the elevator models, by creating an AMESim model to characterize the elevator movement and impose multi-body dynamics,” says Dr. Jim DeClerck, co-course coordinator.

“Once we have that information, we bring it into MotionView to get the force and apply that in 3D FEA to get the load case, deflection, stress, and fatigue.”

MODELING TOOLS TAUGHT

To better prepare to be immediately contributing engineers, students learn to use industry standard simulation and modeling software, including AMESim, SolidThinking, MotionView, NX and PART solutions, and HyperWorks.

OBJECTIVES

- **APPLY TOOLS** to execute the engineering design process. Use teamwork, follow the requirements structure, and manage the tasks effectively.

- **USE SIMULATION** to select design strategy and determine subsystem requirements. Cascade subsystem requirements to component requirements and apply energy balance and estimate losses.

- **SELECT COMPONENTS** to meet subsystem requirements using simulation. Use AMESim to apply energy balance and estimate losses, SolidThinking for morphing technology, MotionView for multi-body dynamics.

- **OPTIMIZE COMPONENT DESIGNS** to meet system requirements. Build system assemblies from standard parts and few custom parts. Perform and interpret finite element simulations in HyperWorks.
Then the students return to the requirements and their software to move their object according to a duty cycle. “It’s evolved from a ‘sideways elevator’ to where they need to move materials horizontally over a specific length with stops along the way. They must protect the contents against excessive acceleration. This brings in stress, strain, fatigue, deflection, energy, and sometimes circuitry,” says Van Karsen.

The requirements are defined, but the choice of application (i.e. a trolley, boat, or conveyor) and the path the container takes are selected by the students. To fully immerse themselves in the design process, they develop case studies for a variety of users and end the course with a presentation and self-assessment against their initial requirements.

“We bring ethics in at the end. Did you meet your requirements? Do your results make sense?” says DeClerck.

Using industry standard software, including HyperWorks and MotionView, the course coordinators are continuing to deliver on their core mission: creating meaningful challenges that demand hands-on engineering.

“When we get students in MEP III, we solidify the engineering design process, while working in teams and connecting requirements. They look at their task, conceptualize the process, gather details, simulate, and show what the system will look like. They also do a complete design analysis of one of the parts in the system to understand how it works on the job as an engineer.”

Professor Chuck Van Karsen, MEP III course instructor
Inspired by the vision and requirements of the committee, Drs. Brad King and Jason Blough pushed boundaries to develop a course that seamlessly integrates all major threads of mechanical engineering. The challenge was finding a single activity or set-up that incorporated both elements. “We made a list of everything we wanted to accomplish in the course and thought hard about something that could help students fully grasp the myriad aspects involved in designing a machine,” says Blough. The duo wanted to find something that would excite the students; something like the quadcopters that were growing in popularity. “After building a prototype and conducting several tests, we realized flying the quadcopters, even in a cage, introduced too many degrees of freedom. We effectively limited them, while still ‘flying,’ by mounting bicopters to vertical rails,” says King, course coordinator. “We use the bicopter to examine system dynamics from the frame to the motors, batteries, controls, noise, and vibrations. Behind the scenes, the students report to Tony Stark regarding their mission to conduct surveillance over an area,” says Dr. Darrell Robinette, course instructor. As the course begins, students conduct modal analysis, order tracking, shape deformation, and sound radiation; fully characterizing the system being engineered. It then shifts to system engineering; looking at requirements and how they translate to verification and validation. “We then start a subsystem-level verification and validation of motor performance, propeller thrust, torque, and power before modeling the system in Simulink to verify,” says Robinette. The practice sessions include experimental methods to compare the model with reality by building closed-loop controls around altitude maneuvers. “They use the basic PID controllers from previous ME Practice courses tracking, shape deformation, and sound radiation; fully characterizing the system being engineered. It then shifts to system engineering; looking at requirements and how they translate to verification and validation. “We then start a subsystem-level verification and validation of motor performance, propeller thrust, torque, and power before modeling the system in Simulink to verify,” says Robinette. The practice sessions include experimental methods to compare the model with reality by building closed-loop controls around altitude maneuvers. “They use the basic PID controllers from previous ME Practice courses

“We’re teaching them to expand their toolbox of capabilities. It’s about the synthesis tools, the techniques, methodologies, data processing, and communication. We teach them to tell the story with a single plot; how to be a doer and a thinker at the same time. We’re teaching them how to be effective engineers.”

Dr. Darrell Robinette
MEP IV course instructor
and add in virtual sensors to get altitude with a lidar scanner and compare that to their model in LabView,” Robinette says.

The course was an investment on the part of the Department and generous industry sponsors. Students benefit by using Siemens LMS software and other industry-standard tools.

“It’s the more expensive way of doing things, but it makes a big difference when they go to look for a job,” says Blough. “It’s not just hands-on; it’s hands-on with the same hardware and software they’ll see in industry.”

**2. UNDERLYING OBJECTIVES**

1. Teach students how to decompose, design, and evaluate complex engineered systems using a structured approach.
2. Reinforce core technical concepts by conducting and analyzing physical demonstrations.

**OBJECTIVES**

- **APPLY ENGINEERING DESIGN PROCESSES, SYSTEM INTEGRATION, AND SYSTEM ENGINEERING PRINCIPLES** to a complex system as a team, interpreting a sensitivity analysis.

- **ANALYZE PERFORMANCE** of a thermal, fluid system.

- **USE KNOWLEDGE OF DYNAMIC SYSTEMS** to obtain and interpret frequency response functions, identify mode shapes and natural frequencies from the data, understand the impact of mass, stiffness, and damping, recognize linear and non-linear behaviors, and build open and closed-loop control systems.

- **RECOGNIZE THE USES AND LIMITATIONS OF SIMULATION,** including the need to validate and verify.

- **OBTAIN DATA IN THE TIME FREQUENCY DOMAIN,** evaluating the quality and its limitations.
HANDS-ON ABILITY

Just as the students do throughout the ME Practice courses, the faculty took a step back from the revision to validate that they met their self-imposed requirements.

The first objective was that ME Practice courses should yield students with the ability to work at a higher level. The new courses moved toward effective application of theory; pushing students to think about their techniques and methodologies to obtain the accurate results needed for informed decision making.

Industry feedback recognizes this improvement through interactions with students, both on the job and in the Senior Design Capstone projects.

“Students now arrive in Senior Design with a familiarity of more engineering tools and with the ability to use the software and measurement technologies that improve function and system-level design,” says Dr. Bill Endres, Senior Capstone Design Director.

“Students now arrive in Senior Design with a familiarity of more engineering tools and with the ability to use the software and measurement technologies that improve function and system-level design,” says Dr. Bill Endres, Senior Capstone Design Director.

BREADTH OR DEPTH

The second goal was the reformatting of core ME courses to create room in the curriculum for greater specialization or an opportunity for students to build a broader understanding of several topics.

“Twenty years ago, engineering tasks were broken into smaller segments, where people only did design or only thermal, but today’s engineer is responsible for many aspects of creating, testing, and launching a new project,” says Michael Davenport ’93 of US Steel.

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CREATING IMPACT

The third requirement was to show students the impact their engineering can have on the world around them, but the students have also realized the impact the tools have on them.

“The demand for the equipment from the MEP courses for use in Senior Design was so high, the Department purchased additional equipment to meet the needs of the students,” says Dr. Darrell Robinette.

“It is exciting to see students realize the value in doing testing and analysis and then incorporating that into their projects.”

And industry realizes the impact the students have, too.

“For a Senior Design project, we had existing hardware in our lab at US Steel that had several opportunities for improvement. The students posed various ideas, boiled it down to one approach, did testing, built it, made changes, and rebuilt it all with enough time in the semester. Then they handed us a new piece of hardware that we use on a daily basis to run tests on materials.”

—Michael Davenport ’93 US Steel

“We recognize an increase in design iteration, optimization, and refinement potential for the final deliverable.”

—Dr. Bill Endres

“These courses help build the next generation of mechanical engineers. Students see how the courses build on one another and are continually using the tools from ME Practice in class to prepare for a job in industry.”

—Al Frank ’89 Ford Motor Co.
The fourth requirement was to help students become more effective engineers by building cross disciplinary elements into the courses. Control of hardware is the cornerstone for industry hiring today and it goes beyond mechanical studies alone.

The focus on instrumentation, simulation, and systems engineering tools meets this objective.

“Engineering today is a more systems-level approach. It’s not just a mechanical engineer working in front of a machine. It’s about controls, energy transfer, integrating both mechanical and electrical elements. Students need to be up to speed on multiple disciplines. MEP and capstone bring it all together.”

—Christopher Duke ’95 Fiat Chrysler Automobiles

The faculty sought to push boundaries through the new ME Practice courses; framing them to be practice sessions similar to what they will see in industry and moving away from recipe-based laboratory courses.

These open-ended practice sessions don’t offer students a single right answer. Instead, they introduce challenges engineers face every day on the job—finding an answer that isn’t in the back of a book.

“ME Practice courses give students the ability to do simulation and develop problem-solving skills through open-ended questions.”

—Al Frank ’89 Ford Motor Co.

“As an engineer on the job, you have a problem and have to find a way to solve it. Once students start to embrace it, you can see their capabilities expand,” says Frank.

“Communication around the engineering world is crucial, whether speaking in front of a group, putting together a concise presentation, or asking for guidance on a project. You have to be able to talk about what you’ve done and that’s where I see a difference through MEP.”

—James Heldt ’86 Mercury Marine

“Communication today is a more systems-level approach. It’s not just a mechanical engineer working in front of a machine. It’s about controls, energy transfer, integrating both mechanical and electrical elements. Students need to be up to speed on multiple disciplines. MEP and capstone bring it all together.”

—Christopher Duke ’95 Fiat Chrysler Automobiles

The impact is also felt in graduate programs. “Our students are also heading to graduate studies in high numbers,” says Department Chair Dr. Bill Predebon. “Their experiences prepare them for rigorous research in an MS or PhD program.”

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—James Heldt ’86 Mercury Marine
Advancing the future of deep space exploration, the Institute of Ultra-Strong Composites by Computational Design (US-COMP) has pushed forward in the first year of five, to develop strong and lightweight materials consisting of carbon nanotubes and polymer resins.

To start the process, NASA gave the US-COMP team specific requirements. The developed material needs to:

- Show a three-fold increase in strength over traditional composite materials
- Demonstrate a 50 percent increase in fracture toughness
- Meet specific unit density objectives

“Ultimately, the final material needs to increase in modulus and strength, without going overboard on mass,” says principal investigator, Dr. Gregory Odegard.

“For our work, cost is not an objective because the money saved on fuel will make up for the difference.”

“And because we are modeling, we can invent the materials and build the material structure we want it to follow. We’ll work with our team of experts to figure out how to produce it, first in small quantities and then scale up manufacturing.”

The US-COMP team has been able to narrow down the list of polymer resins to only a few that possess compatible wetting properties with carbon nanotubes. This accelerates the research across the four primary research areas of the team: computation, manufacturing, material synthesis, and testing.

“We’re using the data obtained from each of the four teams and relying on models to narrow down the resin composition,” says Odegard. “The modeling is instrumental—looking at the bulk and structural level, to analyze the specific resins and their characteristics. We’ve also started down the road of prototyping, fabricating the materials, and conducting preliminary tests.”

The team’s next major step is construction of test panels in foot-by-foot square segments to understand its tensile behavior.

“It’s innovative. Even if it doesn’t match the properties NASA is looking for, no one has made anything with such high carbon nanotube density on such a large length scale.”
Michigan Tech leads the computational efforts with help from Florida A&M University, Johns Hopkins University, University of Minnesota, Pennsylvania State University, University of Colorado, and Virginia Commonwealth University. The modeling team explores the materials on various scales and structural levels.

“We are developing machine learning technologies to optimize the material parameters for structures and properties to speed up the process.”

The modeling team’s results will then be handed off to the material synthesis teams at Massachusetts Institute of Technology and Georgia Institute of Technology. Their findings will be turned over to the manufacturing team at Florida State University before panel testing begins at the University of Utah.

US-COMP’s partner companies, Nanocomp and Solvay, will provide the raw carbon materials and polymer resins to build the composite, with support from the US Air Force Research Lab.

Collaborating across 11 universities, two partner companies, and a lab and communication between teams is a challenge, but it’s also a rewarding process.

“Projects like this are rare, but they are also a lot of fun, especially for the students involved,” says Odegard.

“The team realizes their work improving space exploration can also make an impact here on Earth. “This work directly contributes to our ability to design new structures and components, involving both thermal and mechanical requirements. Providing a new structural material not just for rockets to Mars, but also for traditional toolsets in automotive or aerospace applications,” he says.

The faculty, scientists, and partners involved are shaping the future of space exploration, not only through their material development, but also through their expertise in educating students for advanced materials development.

“We support 22 faculty and scientists, four post-doctoral graduate students, 27 PhD candidates, five master’s students, and nine undergraduate students.”

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RAISING THE BAR.
LOWERING CONSUMPTION.

With over 100 years of engineering evolution, improvements to automotive energy consumption are typically measured in fractions of a percent. The NEXTCAR team is facing a challenge to reduce energy consumption by 20 percent in light-duty hybrid electric vehicles, funded with $3.5 million from the US Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E).

Since the project kicked off in March 2017, team NEXTCAR has fully instrumented two vehicles in their suite of eight Gen II Chevy Volts, with another pair of vehicles ready to go this summer. Students are heavily involved in the research, as they regularly operate the instrumented vehicles through carefully mapped routes, including a 24-mile test loop in the local Houghton-Hancock area.

The 24-mile loop incorporates city, highway, rural, urban, and elevation changes to conduct maneuvers in specific traffic scenarios, identifying realistic energy saving opportunities. While the goal is to achieve a 20 percent reduction in energy consumption, the team realizes it will not all come from a single element in vehicle dynamics and powertrain control. "It's going to be a range of pieces that get us there; three percent from velocity profile optimization, another one to two percent in integration of traffic behavior, another five to ten in propulsion system and scheduling optimization, and on down the list. The Gen 2 Volt is a highly complex propulsion system, affording our team numerous potential optimization areas. If we do the optimization right, we can get to the 20 percent," says Dr. Darrell Robinette, assistant professor.

"As we move into year three, all of our tools will mesh together to integrate and achieve the reduction."

—Dr. Darrell Robinette

Starting with the detailed physics of every energy producer and consumer in the vehicle and working down to an encompassing model, the team developed algorithms to represent a comprehensive energy simulation. They are now validating the performance simulations. "It all comes back to what we can model and observe: models can tell us so many things, but they don’t tell us what is truly achievable in the real world. Real world, on-road driving is the key to our program," says Dr. Jeffrey Naber, principle investigator. "We’ve built the models to understand the uncertainties, now we’re working..."
on integration and testing. We’ll go back to simulation, then integrate those controls and test again several times before concluding.”

The primary focus of the project is centered on control and optimization of the propulsion system and vehicle dynamics in real-world driving scenarios, whether in isolated selfish vehicle operation, or cohort driving with other “smart” vehicles. “We have a whole matrix of maneuvers, anywhere from a single vehicle to using all eight with cloud vehicle-to-vehicle computing.

Our application is eco-routing and coordinated platooning with vehicle-to-traffic communication (V2X),” Naber says.

“Testing has shown some improvements based on rules and other work is being implemented into vehicle controls with our V2X efforts just coming online.”

What initially began as a competition to secure funding from ARPA-E for universities across the nation, has turned into collaboration between the selected universities.

“We all have a different scope with the goal to take a blend of the developed ideas and technologies at the end of year three to commercialize.”

—Dr. Jeffrey Naber

With any new technology comes the difficulty to get the public to buy in and adopt it, as such, technology transfer and outreach is a significant component of the NEXTCAR project. In April, the NEXTCAR team traveled to Texas Motor Speedway for the O’Reilly Auto Parts 500, with the Mobile Lab and a range of Gen 2 Volts and displays.

The objective: create an easy environment to talk to automotive enthusiasts about the new technology, and survey them on their willingness to adopt; but more importantly, figure out how non-engineers think about connected and automated vehicles, energy usage, and under what conditions they might use NEXTCAR technology in vehicles in the future.

Working with ARPA-E and industry partner, General Motors, the NEXTCAR team knows their results will have an impact.

“We’re creating value-added algorithms and technologies that can go into embedded controls, providing a clear pathway for commercialization.”

—Dr. Darrell Robinette

“Beyond the technology, our partner will have an opportunity to work with and recruit students who are focused on value-added engineering principles.”
GOING BEYOND WAVE ENERGY CONVERSION

What started as a wave tank focused on the research efforts to optimize energy extraction from waves, has expanded to support varying research efforts across the Michigan Tech campus.

“We originally were focused on wave energy conversion, but now we are also looking at ship ramp control, unmanned underwater vehicle (UUV) launch and recovery, surface vessels, point to point wave dodging, fish schooling, and dampers in the sea environment.”

—Dr. Gordon Parker

“We’ve worked to get research flowing into the tank and have seen potential for the opportunities to broaden,” says Parker.

The wave tank, located in the R.L. Smith Mechanical Engineering-Engineering Mechanics Building, is three meters wide by 10 meters long with a three meter beach for dissipating wave energy. While wave tanks are not uncommon, this tank is wider than most, creating opportunities for maneuverability across the tank through variable and complex 3D wave generation with excellent visibility through a glass side.

“Wave complexity benefits anyone who is looking to understand how the ocean works. This system is set-up to produce choppy waves that can vary across the crest based on wind patterns.”

—Dr. Guy Meadows

“We can create real ocean scenarios that are repeatable with a high degree of wave quality and a wave field frequency response of 0.8 to 3.3 seconds through the presence of eight paddles,” says Meadows.

The wave tank will also allow the Department to stay true to its roots in developing immediately contributing engineers through research involvement both at the graduate level and, through potential competitions, at the undergraduate level.

“There is potential for a wave energy conversion contest where undergraduate student teams build a gizmo for harvesting energy from waves and come to test them during a competition at Michigan Tech,” says Meadows.

“Beyond that, Dr. Andrew Barnard also has a grant from the Office of Naval Research to train students in support of naval needs for anything from satellites to submarines with courses that introduce them to ocean environments, like the wave tank.”

Michigan Tech has an Educational Partnership Agreement with the Naval Surface Warfare Center, Carderock that can help develop the competition.
In addition to Parker, Meadows, and Barnard, other contributing researchers utilizing the wave tank include Dr. Hassan Masoud, Dr. Nina Mahmoudian, and Dr. Wayne Weaver (Electrical & Computer Engineering).

Masoud will focus on fluid dynamics and transport phenomena to develop novel underwater dampers and to investigate collective swimming of fish robots.

Mahmoudian’s efforts will be in the area multimodal control of marine and aerial robots, while Weaver will explore power electronics development for energy harvesting.

“Pairing the wave tank with Parker’s historical work using motion platforms for sea-based research, users have the potential to test on land before testing in water. ‘We have several motion platforms, one that can do large motion with three degrees of freedom and two six degree of freedom devices that can do small motion,’ says Parker.

“Our motion platforms allow us to mimic wave fields to conduct land-based testing before a test model design is finalized. From a research standpoint, this will reduce risk, result in better final models, and increase our ability to test new concepts.”

—Dr. Gordon Parker

Weaver’s wave tank testing is expensive because researchers often start with a concept, simulate, and then build a water-hardened prototype that is placed into a tank for testing. Once in the tank, the design iteration loop ends.

While the focus areas have expanded for the wave tank, researchers will still explore wave energy conversion, combining the small scale models in the wave tank with full scale opportunities on the nearby Great Lakes.

“In smaller wave energy conversion systems, providing energy supplies at sea, there is a lot of theoretical work for widely spaced arrays of converters; however, we are analyzing the potential of exploiting the interactions between converters in compact arrays. After small scale tank testing we could potentially look at testing in the Great Lakes,” says Parker.

“Wave tank testing is expensive because researchers often start with a concept, simulate, and then build a water-hardened prototype that is placed into a tank for testing. Once in the tank, the design iteration loop ends.

While the focus areas have expanded for the wave tank, researchers will still explore wave energy conversion, combining the small scale models in the wave tank with full scale opportunities on the nearby Great Lakes.”

—Dr. Gordon Parker
After completing a BS and master’s degree in Mechanical Engineering and wanting to deepen his understanding, Dr. Yongbin Yuan ’91 enrolled in the PhD program at Michigan Tech in the ME-EM Department under advisor, Professor Gary Viegelahn. He studied crashworthiness of metal and composite materials, specifically polymer-based fiber composites, in experimental and simulated environments. A highly disciplined student, he added a business degree to broaden his abilities.

Seeking a position that would allow him to tie his experiences with crashworthiness of composites, Yuan applied to Abex Friction Products because they worked in composite materials.

While not directly related to his work, Yuan built a connection between crashing and braking, as both deal with energy dissipation and materials. “I was in the Virginia location for seven years working on brake noise, vibration, and harshness, testing, and friction material formulation,” says Yuan.

“This experience paved my path to TRW Automotive in Detroit. Friction related performance is the most complex part of the braking system and they were having difficulties, so they put me in charge of friction material selection.”

Yuan, who considers friction material the centerpiece of the braking system, conducted material selection, carefully considering friction behavior such as friction coefficient, wear, and conductivity.

“When I joined TRW, I was a brake engineer with expertise in friction products. I had never designed complete brakes before, but grew my knowledge working with colleagues on the entire system from calipers to actuation and electronic control,” says Yuan.

“I left TRW in 2004 and founded Bethel Automotive Safety Systems (Bethel), and our first brake module assembly prototype was completed in 2005 for a car that was still under development by Chery Motors,” he says.
“This was a big moment, both challenging and rewarding. Up to this point, I had only done product performance related jobs, but now I had to go through the process of hiring people, deciding what machines to buy, how to build the factories, and how to design and release a product.”

After the successful development of brake modules, Yuan and his team transitioned to brake systems, stability control systems, and integrated electronics.

“We started with simple mechanical components and in 2013, our first ABS went into production. This was a major milestone because of the hydraulics, precision mechanical parts, and electronic control units that go into the assembly,” he says.

But Bethel’s largest accomplishment to date came earlier this year, nearly 30 years after completing his PhD, when Yuan issued 40.86 million shares on the Shanghai Stock Exchange.

“We will continue to be market-oriented through technological innovation and strive to build the company into a leader and internationally renowned supplier of automotive brake systems,” says Yuan.

The process to become a publicly traded company in China is quite stringent, with careful examination of the company’s finances, financial performance, competition, sales, revenue, earnings, patents, and industrial rankings.

“We are doing well in the Chinese market, with nine production plants, four sales offices, and a technology center with 227 patent applications and 84 invention patents.”

With product lines in passenger and commercial vehicles, Bethel expects a sales revenue of $430 million USD in 2018.

“In the Chinese market, we are currently serving GM Global, Shanghai GM, Volvo Global, Chery Automobile, and Geely Automobile to name a few,” says Yuan.

“We hope in the future we can also supply to automakers in the US.”
30M
VEHICLES MADE IN CHINA IN 2018

50%
ENGINE THERMAL EFFICIENCY GOAL

$200
MILLION IN SALES AS A START-UP
A thirst for knowledge pushed Dr. Li Fan '95 to continue his education beyond his bachelor’s degree in energy and power engineering at Xi’an Jiaotong University. He sought a research university with a strong emphasis on thermodynamics and combustion, and was quickly connected with the experts at Michigan Tech, including his advisor, Dr. Jason Yang.

“I started working toward my master’s with Dr. Yang on a project with applications in aerospace and engines, reducing the nitrogen dioxide emission from combustion,” says Fan. “For nitric oxides emission, the most important thing to control is the flame temperature. You want it to burn efficiently, but you don’t want the flame temperature too high. We took a different approach.”

Using combustion simulation technology, Fan worked to find the temperature of the flame in an aircraft engine and then located the area with the highest temperature to inject water. “We adapted the approach used in industrial boilers for aircraft engines, injecting water at the hottest location to reduce the chemical reaction rate.”

After wrapping up his master’s degree and looking to build on his knowledge of injection, he chose to pursue a PhD from the University of Wisconsin with a focus on gasoline direct injection.

His background was highly sought after, allowing him to secure a job as a product design engineer with Ford Motor Co. prior to completing his PhD in 1999. The gasoline direct injection engine experience enabled him to rise from product design engineer to a technical expert working on engine combustion. Seeking a new challenge, he left Ford to become an entrepreneur.

“We started the business making mufflers and then moved to catalytic converters and variable valve timing systems,” says Fan. Now a business man as much as an engineer, Fan and his partners continually look for opportunities to improve products on the market.

“Our research indicates there are ways to improve the efficiencies of automotive engines. We are developing products for engine subsystems, which will enable operation at higher levels of thermal efficiency.”

“We also see the fuel cell as the long-term future of powertrain, specifically for heavy duty vehicles, and are using the similarities between fuel cells and engines to help reduce costs. Even as the Chinese market continues to grow, we are seeking opportunities to partner with companies in the US,” he says.

Today Fan faces a broad array of business challenges but still oversees the development work conducted by his engineers at JAPHL.

This oversight serves as a steady reminder of his research at Michigan Tech, even as his team aims to influence the future of automotive engines by reducing emissions, boosting power, and decreasing fuel consumption.
Grit and determination are the key characteristics **George Backes '53** possessed that pushed him from his laborer role in the Mather B Mine in Negaunee, Michigan, toward a career as an engineer. “I used to tell people that was the best job I ever had in my life. It gave me the impetus to get through engineering school,” says Backes, who began his education at Michigan Tech in 1950, after working in the mine to fund his education.

Declared exempt from the Korean War draft by scoring high on an exam, Backes continued his uphill climb, landing a job with Pratt & Whitney as a jet engine engineer prior to graduation. “I always had an interest in airplanes as a young boy, building models by the dozen.”

“I was at Pratt for three years before I decided to explore my options in California, where I started at Solar Aircraft,” says Backes. Solar Aircraft provided high temperature sheet metal work for aircraft companies and began development of small gas turbine engines. “We won a contract in 1958 with the US Navy to build a one-man helicopter engine (military designation T62), and that really catalyzed the aerospace efforts of the company.”

After the one-man helicopter program was discontinued because of cost and flying technicalities, Solar adapted the engine for military aircraft auxiliary power applications. This launched Backes’ transition from test engineer to project engineer and ultimately to product line manager. Over this period, Solar was growing in commercial turbomachinery applications with sales and field service offices all over the world. The military and aerospace businesses were becoming a smaller part of the overall Solar business, and further the manufacturing specifications required for those lines were causing a drain on company resources.

“**I was given six months to come up with a solution.**”

“With knowledge of the industry and after investigating various options, I set out to create a separate division and started lining up engineers and manufacturing facilities to handle the operations,” says Backes.

This new division enabled the freshly renamed company, Turbomach, to become more competitive in the marketplace. Under the direction of Backes, Turbomach formed a partnership with Sundstrand Corporation to secure a contract to build auxiliary power units for the F16 aircraft.

“In this project, we supplied Sundstrand with the turbine engine for the starter system of the F16 plane. It’s one that is still flying today and is used by countries all over the world,” says Backes. “Early on, there was a perceived problem with the turbine wheel of the engine and we faced a true challenge in proving that it was, in fact, a faulty customer supplied speed control system. It was a six month battle that nearly ended the program, but we persevered.”

Backes’ career came full circle following his retirement, when United Technologies Corporation – Pratt & Whitney Division purchased Turbomach. His career thus included work on fighter planes, helicopters, commercial airliners, military aircraft, and business jets. Despite the ever-changing landscape of engineering work, from a single focus on aerodynamics or testing to a broad focus, where engineers need to function across a wide range of scenarios, problem solving remains at the core.

“**While at Michigan Tech, I learned duplicating the problem was the crucial step. If you could make it happen again, you were 90 percent of the way to solving the problem.**”

Backes’ lifetime of success was forged by carrying the solution all the way to 100 percent, thanks to his unyielding grit and tenacity.
$0.80
HOURLY WAGE IN THE MINE

6
MONTHS TO CREATE A NEW DIVISION

50
HOUR REQUIRED TEST FLIGHTS
**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.
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McGill University
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Department of Kinesiology and Integrative Physiology
Spectral Analysis and Device Development for Assessment of Traumatic Injury

Dr. Zhen Liu
Department of Civil and Environmental Engineering
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ORDER OF THE ENGINEER

FALL 2017
Denise M. Rizzo ‘14
Senior Research Mechanical Engineer
Powertrain Modeling & Simulation Team
US Army Tank Automotive Research, Development, and Engineering Center (TARDEC)

SPRING 2018
Jolyn L. Russell ‘98
Deputy Program Manager
Satellite Servicing Projects Division
NASA Goddard Space Flight Center

GRADUATE STUDENT FELLOWSHIPS

FALL 2017 - SPRING 2018
Doctoral Finishing Fellowships
Kishan Bellur
Shadi Darani
Brandon Jackson
Meng Tang
Xiucheng (Sheldon) Zhu

Outstanding Graduate Student Teaching Award
Mahsa Asgarisabet
Apurva Baruah
Ashley Hendricks
Arash Jamali
Rohit Sunil Pandhare
Sagar Umesh Patil
Miles Penhale
Chethan Ramakrishna Reddy
Saeedeh Ziaeefard

Dean’s Award for Outstanding Scholarship
Kishan Bellur
Sorayot Chinkanjanarot
Shadi Ahmadi Darani
Brandon Jackson
Vinaykumar Konduru
Sathya Prasad Potham
Sandesh Subhaschandra Rao
Le Zhao
Saeedeh Ziaeefard
BS GRADUATES (265)

SUMMER 2017 (14)
Steve T. Alvey
Richard M. Bennett
Cayman E. Berg-Morales – Cum Laude
Marissa M. Flowers
Todd W. Krieger
Jerad A. Marble
Justin D. McPherson
Luke D. Peters
Michael M. Pfaff
Brenda L. Sauer
DJ R. Shaner
Jiaqi Tang
Elliot S. Vickers

FALL 2017 (100)
Cody J. Aardema
Matthew J. Adams – Cum Laude
Alison M. Alexsy
Matt R. Anderson – Cum Laude
Rachel L. Arthur
Anthony C. Bacon – Cum Laude
Trevor J. Banas
Anders L. Bjorn
Nick A. Blaze
Jake R. Bohl
Sullivan P. Brock
Jake R. Bures
Jonathan Burke
Andrew C. Burns
Mario A. Calabria – Cum Laude
Scott A. Cannon
Caitlyn N. Case
Matt J. Caspers – Cum Laude
Kevin Chen
Brendan T. Collins
Elle E. Cook
Luke T. Cordes
Jared M. DeBoer
Jessica K. Doney
Levi M. Drumm – Summa Cum Laude
Nick C. Dubiel
Maddy R. Duensing – Cum Laude
Jennifer L. Dzurka
Alessandro T. Fitzsimmons
Sean C. Fitzsimmons
Evan R. Frank
Spencer J. Gander
Nathan M. Gangle
Matt G. Gleason
Alden T. Groen – Magna Cum Laude
Matt W. Gustman
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Deven A. Hall
Erica M. Jacobson – Magna Cum Laude
Jake M. Jarvi – Cum Laude
Justin R. Jasman
Helen M. Karsten – Cum Laude
Neil R. Kauppila
Zach S. Klassen
Zach A. Klein
Erik H. Kocher
Stephen R. Krease – Cum Laude
Christopher A. Laes
Chad D. Laiho
Jeff J. Ley – Magna Cum Laude
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Christopher M. Matetich – Magna Cum Laude
Cody A. McGrath – Magna Cum Laude
Shane L. McGrath – Magna Cum Laude
Ben J. McKeith
Aaron C. Mead – Summa Cum Laude
Brett M. Michaud
Eric J. Miller – Cum Laude
Andrew M. Mills
Paul J. Moeggenborg – Cum Laude
Nic J. Olbrantz – Summa Cum Laude
Jesse J. Olson – Magna Cum Laude
Corey J. Ortiz – Summa Cum Laude
Benjamin K. Paxson
Carlos M. Perez
Spencer J. Phillips
Hans M. Pietila – Cum Laude
Kyle D. Pinozek

GEORGE S. PLATZ
Buck J. Poszywak
Rebecca A. Ralph
Daniel J. Ratkos
Billy A. Reck
Matthew A. Rennell
Alex L. Repke
Erin N. Richie – Cum Laude
Jake L. Rosio
David T. Ruggles
Jason A. Scott
Logan M. Sheffield – Magna Cum Laude
Tj J. Slabaugh
Brody K. Smith
Dallas J. St. Arnaud
Mark A. Staley
Reid R. Sturos
Cody M. Sutton
Joe A. Szczap
Zac J. Taylor
Paige K. Thermos
Evan T. Tsuchiya – Magna Cum Laude
Evan R. Turney
Benjamin J. VanDyke
Jason S. Voytovich
Erik M. Wade
Alex S. Waitsen
Alex J. Walla
Caitlin B. Weaver
Nick J. Wise
Tyler A. Wolak
Jim R. Woodford – Magna Cum Laude

SPRING 2018 (151)
Nathan L. Ackerman – Magna Cum Laude
Andrew M. Aerts – Summa Cum Laude
Jayson D. Allison
Eli A. Anderson
Adam J. Augustyniak – Summa Cum Laude
James R. Baker
Josh T. Balcom
Sam E. Baxendale-Wilson – Magna Cum Laude
R. J. J. Bedore
Andrew J. Berg
Conor T. Berndt
William R. Bland
Ian T. Boettner
Paul T. Bosko
Cade J. Bowman
Sam L. Brayman
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Mark E. Brouwer
Ethan P. Brown
Bruce Brunson Jr.
Kayla J. Buczkowski – Cum Laude
Ryan W. Buske – Summa Cum Laude
Harrison L. Cannon
Mark D. Casamer
Elaine L. Cook
Denzil Cotera Berndt
Claire M. Couture
Stuart A. Crewdson
Hannah M. Daavettila
Mark R. Daavettila
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Cy A. DeLeeuw
Daniel J. DeVries – Magna Cum Laude
Reid H. Deckebach
Jocelyne R. Denhof
Shveta V. Dhamankar – Magna Cum Laude
Dan J. Domitrovich
Cam R. Dulong – Magna Cum Laude
Daniel S. Freed
Julian J. Gabriel
Nathan J. Goering – Summa Cum Laude
Austin J. Gongos
Christopher A. Haferman – Cum Laude
Chet J. Halonen – Magna Cum Laude
Alex M. Hanson
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Keegan G. Harrington – Magna Cum Laude
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Justin M. Heil
Alec M. Holm – Magna Cum Laude
Ryan D. Hopper – Magna Cum Laude
Austin C. Hower
Logan E. Hunter
Eric D. Hupf
Matt D. Iltenich
Kyle W. Janowicz
Lillian A. Johnson
Carl H. Holma
Carl E. Kangas
Chiressy I. Kaub
Luke W. Kearby
Dan J. Killick
Ian T. Kramer
Matt T. Krawczyk
Kalvin W. Krompetz
Jacob A. LaPonce
Spencer B. Lacy
Ryan M. Larson – Cum Laude
Jesse L. Lassila – Summa Cum Laude
Keith R. Lemley
Jake N. Len
Yvonne M. Lewsley
Drake M. Lindberg
Matt P. Ludkey
Erik T. Lund
Benjamin J. Maat
Seth P. Mares – Cum Laude
Michael M. Mashevsky – Magna Cum Laude
Robert S. Massar – Summa Cum Laude
Curtis J. McKenney
Erik P. Meeks
Emily R. Meuers
Jaci K. Mielke
George M. Mietelka
Theo F. Mikrut
Nils A. Miron – Magna Cum Laude
Nick J. Monette
Jose M. Montano
Cody D. Mouton
Nalen S. Nadarajah – Cum Laude
Colin M. Neuman
Lorne S. Newhouse – Magna Cum Laude
Brennan B. O’Brien
Neil B. Olson – Summa Cum Laude
Brett D. Opel – Summa Cum Laude
Zack G. Papciak
Jacob W. Parzycki
Zak R. Parker
J. P. P. Parzuchowski
Cooper J. Pedersen – Magna Cum Laude
Scott A. Pederson
Steven M. Peltier
Carl A. Pietila
Alexis C. Pinson
Cameron J. Potter
Jordan D. Powers
Jacob A. Prins – Magna Cum Laude
Jacob A. Prochnow – Cum Laude
Joseph C. Reiter
Jared A. Richards – Summa Cum Laude
Cody J. Rietveld – Cum Laude
Josh R. Rzeppa
Dylan J. Scholten
Zach R. Scholzen
Amelia M. Schweikart
Josh L. Sell
Lukas C. Sencyzsny
Shane M. Severn
Derek L. Severson
Marcus D. Shamber
Sarah E. Smaby – Magna Cum Laude
Joe F. Smies – Magna Cum Laude
Josh F. Smies – Magna Cum Laude
Julia C. Smit – Cum Laude
Jeff B. Staten – Magna Cum Laude
Dylan J. Stemman – Summa Cum Laude
Riley L. Stroven – Magna Cum Laude
Claire C. Sullivan – Cum Laude
Tyler S. Swanson
Conner T. Swindell
Kevin J. Tillman
Ethan H. To
Gabe T. Toczynski
Jack T. Torborg
Amanda L. Travis – Magna Cum Laude
Daanish S. Tyrewala – Summa Cum Laude
Jason L. VanDoornik – Cum Laude
Emily A. Vigil – Magna Cum Laude
McKenna A. Wagner
Alex M. Weber
Kyle W. Wehmanen – Summa Cum Laude
Kyle M. Wellman
Cory K. Williams
Johnny M. Williams
Lily A. Williams
Teddy J. Wollner
Yifei Wu
Chris G. Young
Phil J. Zambon
**SUMMER 2017 (34)**

**Aamir Ibrahim, FNU**  
Advisor: Song-Lin (Jason) Yang  
On Transport and Deposition Phenomena in Diesel Particulate Filters Using the Incompressible Lattice Boltzmann Method

**Agshikar, Mihir Ramchandra**  
Advisor: Craig Friedrich  
Course work only

**Aramizo Ribeiro, Guilherme**  
Advisor: Mo Rastgaar  
Control of a Powered Ankle-Foot Prosthesis: From Perception to Impedance Modulation

**Bansal, Shivit**  
Advisor: Craig Friedrich  
Course work only

**Barik, Biswajit**  
Advisor: Bo Chen  
Designing a Real-Time Velocity Predictor for Powertrain Optimization of Connected and Automated Vehicles

**Brajak, Nicholas S.**  
Advisor: Craig Friedrich  
Course work only

**Castelino, Leslie**  
Advisor: Mo Rastgaar  
Simulation of Human Ankle Trajectory During Stance Phase of Gait

**Chundru, Venkata R.**  
Advisors: Gordon Parker and John Johnson  
Development of a High-Fidelity Model and Kalman Filter Based State Estimator for Simulation and Control of NOx Reduction Performance of a SCR Catalyst on a DPF

**Deshpande, Varun Govind**  
Advisor: Craig Friedrich  
Course work only

**Dutta, Trinoy**  
Advisor: Andrew Barnard  
Performance of Hard Disk Drives in High Noise Environments

**Dwivedi, Jayesh**  
Advisor: Craig Friedrich  
Course work only

**Gandhi, Sandesh Suresh**  
Advisor: Gregory Odegard  
Simulation of Crack Pattern on Borosilicate Glass Cylinder on Pellet Impact

**Gortho, Satyavenkata Naga Sai Sharath**  
Advisor: Jeffrey Naber  
Simulation Study on Effect of Gas Charging and EGR on Dual-Fuel Engine

**Gupta, Neelesh**  
Advisor: Craig Friedrich  
Course work only

**Hasija, Vinay**  
Advisor: Craig Friedrich  
Course work only

**Hayes, Robert A.**  
Advisors: John Gershenson and Michele Miller  
Human Centered Design of an Open-Drum, Treadle Thresher for Quinoa Farmers in the Andes of Northern Peru

**Ingavale, Vishal Shashikant**  
Advisor: Gregory Odegard  
Drop Test Simulation of Conformable CNG Tank by Finite Element Analysis Using ANSYS

**Joshi, Sushrut Vasant**  
Advisor: Craig Friedrich  
Course work only

**Kasina, Gana Venkata Chiranjeevi**  
Advisor: Craig Friedrich  
Course work only

**Knop, Lauren**  
Advisor: Mo Rastgaar  
Using Lower Extremity Muscle Activations to Estimate Human Ankle Impedance in the External-Internal Direction

**Kshirsagar, Siddharth Shripad**  
Advisor: Craig Friedrich  
Course work only

**Lodaya, Dhaval Bhikhubhai**  
Advisor: Craig Friedrich  
Course work only

**Mhatre, Sanil**  
Advisor: Ossama Abdelkhalik  
Application of a Linear Optimal Estimator on a Wave Energy Converter Using Bang-Singular-Bang Control

**Pasula, Nikhil Reddy**  
Advisor: Craig Friedrich  
Course work only

**Penhale, Miles B.**  
Advisor: Andrew Barnard  
Multi-Modal and Short-Range Transmission Loss in Ice-Covered, Near-Shore Arctic Waters

**Prem, Apoorv**  
Advisor: Craig Friedrich  
Course work only

**Rane, Omkar Dilip**  
Advisor: Ossama Abdelkhalik  
Multi Resonant Feedback Control of Wave Energy Converters Using Recursive Least Squares Parameter Estimation

**Raut, Akshat Abhay**  
Advisor: Mahdi Shahbakhti  
Model-Based Control of an RCCI Engine

**Salian, Varun P.**  
Advisor: Craig Friedrich  
Course work only
Sharma, Aditya Ashok  
Advisor: Craig Friedrich  
Course work only

Sharma, Hemant K.  
Advisor: Craig Friedrich  
Course work only

Sharma, Sagar  
Advisors: Jeffrey Naber and John Johnson  
The Emission and Particulate Matter Oxidation Performance of a SCR Catalyst on a Diesel Particulate Filter with a Downstream SCR

Truskolaski, Dylan T.  
Advisor: Craig Friedrich  
Course work only

Ziaeefard, Saeedeh  
Advisor: Nina Mahmoudian  
Extending Maneuverability of Internally Actuated Underwater Gliders, An Attempt to Develop an Open Platform for Research and Education

Gupta, Ankur  
Advisor: Jeffrey Naber  
Single Cylinder Engine Studies with Impinging Direct Injection Fuel Injector

Jain, Kshitiz Kumar  
Advisor: Song-Lin (Jason) Yang  
Simulation of Diesel Particulate Filter Regeneration Using Lattice Boltzmann Method

Joshi, Abhay Shrinand  
Advisor: Scott Miers  
Effect of Spark Advance and Fuel on Knocking Tendency of Spark Ignited Engine

Malatpure, Diptesh Deepak  
Advisor: Craig Friedrich  
Course work only

Mehta, Rujai Jayant  
Advisor: Craig Friedrich  
Course work only

Nayar, Siddharth Paresh  
Advisor: Craig Friedrich  
Course work only

Nichols, Samuel M.  
Advisor: Craig Friedrich  
Course work only

Pandey, Swapnil Awdhesh  
Advisor: Gregory Odegard  
FEA Analysis and Optimization of Differential Housing for Fatigue Stresses and Fatigue Test Design to Study Skin Effect in Ductile Iron

Patel, Harsh Balkrshuna  
Advisor: Craig Friedrich  
Course work only

Potham, Sathy Prasad  
Advisor: Seong-Young Lee  
Development of an Evaporation Sub-Model and Simulation of Multiple Droplet Impingement in Volume of Fluid Method

Ranga Prasad, Hrishikesh Prasad  
Advisor: Amitabh Narain  
Assessment of Annular Flow Boiling in the Context of Computational Fluid Dynamics (CFD) Simulations, Experiments, and Existing Correlations

Rao, Sandesh Subhaschandra  
Advisor: Jeffrey Naber  
An Experimental Investigation on the Effect of Dual Coil Ignition Discharges on Dilute Combustion in a Spark Ignition Engine

Rehan, Sooraj  
Advisor: Craig Friedrich  
Course work only

Sharma, Anshul  
Advisor: Craig Friedrich  
Course work only

Singh, Ritik  
Advisor: Craig Friedrich  
Course work only

Thanati, Vijay  
Advisor: Craig Friedrich  
Course work only

Tripp, Joseph C.  
Advisor: Craig Friedrich  
Course work only

Vijay, Shubham  
Advisor: Craig Friedrich  
Course work only

Walvekar, Suryanshu  
Advisor: Gopal Jayaraman  
A 3D FEM Study on the Stress Distributions in the Skull of Pediatric Head Due to Impact from Free Fall

Wang, Zhi  
Advisor: Craig Friedrich  
Course work only
Apine, Ashish Ashok  
Advisor: Gregory Odegard  
Course work only

Bains, Harmanpreet Singh  
Advisor: Craig Friedrich  
Course work only

Bajpai, Vatsal  
Advisor: Craig Friedrich  
Course work only

Borghate, Yash  
Advisor: Jeffrey Naber  
Cold Start Analysis and Modeling of a Direct-Injection Gasoline Engine

Chaudhary, Pranav Mahesh  
Advisor: Craig Friedrich  
Course work only

Dahiya, Siddharth  
Advisor: Craig Friedrich  
Course work only

Dange, Siddhant Yogesh  
Advisor: Craig Friedrich  
Course work only

Dawani, Harshul Sushil  
Advisor: Craig Friedrich  
Course work only

Devagiri, Harsh Madhurao  
Advisor: Craig Friedrich  
Course work only

Dsouza, Alston Louis  
Advisor: Craig Friedrich  
Course work only

Durgam, Gnana Vishnu  
Advisor: Sajjad Bigham  
Capillary-Assisted Enhanced Condensation Heat Transfer for Low Surface Tension Liquids

Furlich, Jon E.  
Advisors: Jason Blough and Darrell Robinette  
Experimental and Analytical Evaluation of Six Speed MT Shift Transient Vibrations

Gadre, Ninad Ravindra  
Advisor: Craig Friedrich  
Course work only

Ghumare, Paras Ravindra  
Advisor: Craig Friedrich  
Course work only

Gopujkar, Siddharth Bharat  
Advisor: Jeremy Worm  
Assessing the Impact of Cylinder Pressure Reference Error and Determining Mitigation Strategies in a Turbocharged Spark Ignition Engine with VVT

Goyal, Ankit  
Advisor: Craig Friedrich  
Course work only

Gupta, Akarsh  
Advisor: Craig Friedrich  
Course work only

Gupta, Prasoon  
Advisor: Craig Friedrich  
Course work only

Kamaraj, Rajiv  
Advisor: Craig Friedrich  
Course work only

Kamat, Sagar Jayant  
Advisor: Craig Friedrich  
Course work only

Khanna, Kartik  
Advisor: Craig Friedrich  
Course work only

Kulkarni, Shrinivas Shashikant  
Advisor: Craig Friedrich  
Course work only

Lakhani, Prince Anis  
Advisor: Mahdi Shahbakhti and Darrell Robinette  
Modeling and Analysis for Driveline Jerk Control

Leach, David C.  
Advisor: Michele Miller  
Kinesthetic Learning Experience Simulation Using an Online Intervention to Improve Hands-On Ability

Mane, Chirag Balasaheb  
Advisor: Craig Friedrich  
Course work only

Mantalwad, Venkatesh Narsingrao  
Advisor: Craig Friedrich  
Course work only

Marathe, Omkar Amrit  
Advisor: Craig Friedrich  
Course work only

Menucci, Tyler J.  
Advisor: Jeffrey Naber  
Development of Bosch Rate of Injection Measurement Procedure and Results

Modi, Akash  
Advisor: Craig Friedrich  
Course work only

Moradia, Hemang Ishwarbhai  
Advisor: Craig Friedrich  
Course work only
<table>
<thead>
<tr>
<th>Name</th>
<th>Advisor(s)</th>
<th>Title</th>
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<tbody>
<tr>
<td>Mordorski, Eric R.</td>
<td>Jason Blough and Darrell Robinette</td>
<td>Development of a Dynamic Torsional Actuator for Torque Converter Clutch Characterization</td>
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<td>Mutha, Sambhav Rajendra</td>
<td>Craig Friedrich</td>
<td>Course work only</td>
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<td>Ogale, Arjun Amol</td>
<td>Craig Friedrich</td>
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<td>Paranjape, Sarvesh Ramesh</td>
<td>Craig Friedrich</td>
<td>Course work only</td>
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<tr>
<td>Prabhu, Kaushik</td>
<td>Jason Blough</td>
<td>Sensor Fusion for Spark-Ignition Engines</td>
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<td>Rathod, Smruti Babusing</td>
<td>Craig Friedrich</td>
<td>Course work only</td>
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<td>Rodrigues, Vineet Felix</td>
<td>Craig Friedrich</td>
<td>Course work only</td>
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<td>Rui, Siddhant Dipak</td>
<td>Craig Friedrich</td>
<td>Course work only</td>
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<td>Sachdeva, Kovid</td>
<td>Bo Chen</td>
<td>Development of Optimal Operating Point Maps and Mode Shift Strategy for Chevrolet Volt Gen II Plug-In Hybrid Electric Vehicle</td>
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<td>Sehgal, Vaibhav</td>
<td>Craig Friedrich</td>
<td>Course work only</td>
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<td>Senczyszyn, Steven A.</td>
<td>Andrew Barnard</td>
<td>Commercialization of the Carbon Nanotube Thermophone for Active Noise Control Applications</td>
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<td>Shah, Siddhant Shailesh</td>
<td>Craig Friedrich</td>
<td>Course work only</td>
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<td>Sharma, Prakhar</td>
<td>Craig Friedrich</td>
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<td>Sharma, Shashank</td>
<td>Craig Friedrich</td>
<td>Course work only</td>
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<td>Shetty, Shrishanth Rathnakar</td>
<td>Craig Friedrich</td>
<td>Course work only</td>
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<td>Singh, Arjun</td>
<td>Craig Friedrich</td>
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<td>Singh, Rahul Pratap</td>
<td>Craig Friedrich</td>
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<td>Sirangi, Karthik</td>
<td>Craig Friedrich</td>
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<td>Tendolkar, Sarvesh Satish</td>
<td>Craig Friedrich</td>
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<td>Trikha, Paras</td>
<td>Craig Friedrich</td>
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<td>Umat, Akhil</td>
<td>Craig Friedrich</td>
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<td>Verma, Hemant</td>
<td>Craig Friedrich</td>
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<td>Yadav, Abhinav</td>
<td>Craig Friedrich</td>
<td>Course work only</td>
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<td>Yadav, Rajeshwar</td>
<td>Mahdi Shahbakhti and Darrell Robinette</td>
<td>Modeling and Analysis of Energy Consumption in Chevrolet Volt Gen II Hybrid Electric Vehicle</td>
</tr>
</tbody>
</table>
**PHD GRADUATES (20)**

**SUMMER 2017 (6)**

**Amini, Mohammad Reza**  
Advisor: Mahdi Shahbakhti  
Easily Verifiable Controller Design with Application to Automotive Powertrains

**Cook, Michael D.**  
Advisors: Gordon Parker and Rush Robinett  
Decentralized Optimal Exergy Destruction Control Strategy for DC and AC Microgrids

**Menon Muraleedharan Nair, Muraleekrishnan Menon**  
Advisor: Fernando Ponta  
The Role of Active Flow-Control Devices in the Dynamic Aeroelastic Response of Wind Turbine Rotors

**Radue, Matthew S.**  
Advisor: Gregory Odegard  
Molecular Modeling of Aerospace Polymer Matrices Including Carbon Nanotube-Enhanced Epoxy

**Sevik, James M.**  
Advisor: Scott Miers  
Impact of Natural Gas Direct Injection on Thermal Efficiency in a Spark Ignition Engine

**Shen, Michael Z.**  
Advisor: Gregory Odegard  
Military Assault Bridging Structural Analysis and Load Testing

**FALL 2017 (9)**

**Ansari, Ehsan**  
Advisor: Jeffrey Naber  
Combustion, Emissions, and Performance Optimization in a DI/PFI-RCCI Diesel/Natural Gas Turbocharged Engine

**Chinkanjaron, Sorayot**  
Advisor: Gregory Odegard  
Multiscale Modeling: Thermal Conductivity of Graphene/Cycloaliphatic Epoxy Composites

**Donepudi, Yashwanth**  
Advisors: Ezra Bar-Ziv and Jordan Klinger  
Impact of Pretreatment Methods on Fast Pyrolysis of Biomass

**Gorgitattanagul, Patcharapol**  
Advisor: Amitabh Narain  
Experimental Investigations of Temperature Controlled Innovative Annular Flow-Boiling of FC-72 in Millimeter Scale Ducts—Steady and Enhanced Pulsatile Realizations

**Konduru, Vinaykumar**  
Advisor: Jeffrey Allen  
Modeling Mass and Thermal Transport in Thin Porous Media of PEM Fuel Cells

**Murdock, John R.**  
Advisor: Song-Lin (Jason) Yang  
Turbulent Transition Simulation and Particulate Capture Modeling with an Incompressible Lattice Boltzmann Method

**Smith, Adam K.**  
Advisor: Nina Mahmoudian  
Electromagnetic Signal Feedback Control for Proximity Detection Systems

**Terhune, Kurt J.**  
Advisor: Lyon (Brad) King  
Influence of Magnetic Nanoparticles and Magnetic Stress on an Ionic Liquid Electrospray Source

**Worm, Jeremy J.**  
Advisor: Jeffrey Naber  
The Impact of Water Injection on Spark Ignition Engine Performance Under High Load Operation

**SPRING 2018 (5)**

**Jackson, Brandon A.**  
Advisor: Lyon (Brad) King  
Meniscus Modeling and Emission Studies of an Ionic Liquid Ferrofluid Electrospray Source Emitting from a Magneto-Electric Instability

**Wang, Shuo**  
Advisor: Chang Choi  
Regeneration of Pericellular Matrix of Human Chondrocytes Cultured in Oxidized Methacrylated Alginate Microgels

**Wang, Yanyu**  
Advisor: Jeffrey Naber  
The Interaction of Ignition and In-Cylinder Flow on Flame Kernel Development and its Impacts on Combustion in an Optically Accessible Direct Injection Engine

**Zhao, Le**  
Advisor: Seong-Young Lee  
An Experimental and Computational Study of Fuel Spray Interaction: Fundamentals and Engine Applications

**Ziaeefard, Saeedeh**  
Advisor: Nina Mahmoudian  
Extending Maneuverability of Internally Actuated Underwater Gliders, an Attempt to Develop an Open Platform for Research and Education
NEW FACULTY

CAMERON HADDEN, PHD
Dr. Cameron Hadden joins the ME-EM Department as a lecturer. He earned a BS in Biomedical Engineering in 2008 and a PhD in Mechanical Engineering in 2014, both at Michigan Tech. Hadden was previously a lecturer in the University’s Department of Engineering Fundamentals, a student advisor to the Advanced Metalworks Enterprise team, and an optimization engineer at Boise Paper. His research interests include molecular modeling, design and manufacturing of composite materials, and mechanical behavior of composite materials, nanomaterials, biomechanics, and finite elements.

STEPHEN MA, PHD
Dr. Steven Ma joins the ME-EM Department as a professor of practice. He has a 24-year career in industry working for Strippit/LVD, Parker Hannifin, Atlas Copco, Caterpillar and Kobelco. He earned a PhD in 1991 from SUNNY Buffalo, an MS in 1986 from Beijing Polytechnic University, and a BS in 1983 from Beihang University. Ma was an adjunct professor at University of Texas-Arlington and University of Akron. He is a certified Professional Engineer (PE) in the state of New York.

GUY MEADOWS, PHD
Dr. Guy Meadows joins the ME-EM Department as a research professor. He has been serving as director of the Great Lakes Research Center (GLRC) since joining Michigan Tech in 2012. Meadows was a Professor of Physical Oceanography at the University of Michigan for 35 years, where he was Director of the Ocean Engineering Laboratory, Director of the Cooperative Institute for Limnology and Ecosystems Research (NOAA, Joint Institute), Director of the Marine Hydrodynamics Laboratories, and founding Academic Director of M-STEM Academies. Meadows earned a PhD in Marine Sciences at Purdue University. His research interests include large scale field experimentation in the inland seas of the Great Lakes and coastal oceans.

STEPHEN MORSE, PHD, PE
Dr. Stephen Morse joins the ME-EM Department as an assistant professor with a joint appointment in the Department of Civil & Environmental Engineering. He earned a PhD in Civil Engineering from Texas Tech University, where he was an assistant professor in the Department of Civil, Environmental, and Construction Engineering. He has extensive experience in model scale and full scale testing, numerical modeling, and software development. His research interests include window glass strength, wind loads on structures, and finite element analysis. For over 10 years he has served as technical adviser on the ASTM subcommittee responsible for national window glass standards.
TUCKER ALSUP
Tucker Alsup is an electronics and instrumentation engineer in the Advanced Power System Research Center, responsible for the design, development, fabrication, commissioning, use, training, and maintenance of custom electronic and instrument solutions. He earned a BS in Electrical Engineering in 2017.

WILLIAM ATKINSON
William Atkinson is a research engineer in the Optical Spray and Combustion Lab and the APS Labs. He earned a BS in Mechanical Engineering at Michigan Tech in 2010.

JOEL DUNCAN
Joel Duncan is a research associate bringing fabrication/experimentation, design, and analysis skills to the APS Labs. He is currently pursuing a BS in Mechanical Engineering at Michigan Tech.

BRIAN EGGART, PHD
Dr. Brian Eggart is a research engineer/grant writer in the small engine test cell in the APS labs. He earned a BS in Mining Engineering and a master’s and PhD in Mechanical Engineering, all at Michigan Tech.

KRISTI KESTI-PIETI
Kristi Kesti-Pieti is an office assistant administrative aide responsible for reception, purchasing, payroll, assisting with faculty recruitment, textbook requisitions, teaching evaluations, and more. She worked in Michigan Tech’s Office of Sponsored Programs and in manufacturing along with engineers of many stripes.

DEBRA LINN
Debra Linn is an office assistant responsible for reception, payroll, and purchasing. She worked previously in the Department of Physics and Payroll Services at Michigan Tech, as well as the Baraga-Houghton-Keweenaw (BHK) Child Development Board.
ANTHONY PINAR, PHD
Dr. Anthony Pinar is a research engineer in the APS Labs with a joint appointment in the Department of Electrical and Computer Engineering. He worked as a test equipment hardware engineer at GE Aviation for six years, and earned a BS in Electrical Engineering in 2011 and a PhD in Electrical Engineering in 2017, both from Michigan Tech.

TRICIA STEIN
Tricia Stein is an academic advisor. She earned her BS in Mechanical Engineering at Michigan Tech in 1987 and brings with her a wealth of experience gained from previous positions held in both industry and engineering recruiting.

CINDY WADAGA
Cindy Wadaga is an office assistant, administrative aide, and assistant to the director of graduate studies with extensive experience in bookkeeping, payroll, and exceptional administrative support.
Prototype of a flexible electronic circuit. Stitch schematics such as this one can be used to create health-monitoring fabrics. The stitches themselves become the electronic circuit.

EARLY IMPACT
SUN WINS NSF CAREER AWARD

Health monitoring devices—FitBit or Garmin accelerometer watches, apps on cell phones, heart monitors—are becoming ubiquitous, but they have their drawbacks. In some climates, these devices can rub irritatingly against skin. Some are heavy and bulky. So imagine if embroidery on clothing could replace these devices altogether.

Ye Sarah Sun, an assistant professor in Mechanical Engineering-Engineering Mechanics, has received a $500,000 National Science Foundation CAREER Award, which recognizes outstanding achievement by early career faculty. The research and development grant is for Sun’s “System-on-Cloth: A Cloud Manufacturing Framework for Embroidered Wearable Electronics.”

By using conductive thread and passive electronics—tiny semiconductors, resistors and capacitors—Sun is able to design flexible embroidery to turn logos into wearable electronics to monitor health signals.

“Any embroidery company has the potential to manufacture embroidered health monitors.”

In addition to improving embroidered electronics, the award enables Sun to build a manufacturing network and cloud-based website where stitch generation orders can be made.

“I hope flexible, wearable electronics will interest a new generation of engineers by appealing to their artistic sides.”

Dr. Ye Sarah Sun
ME-EM Assistant Professor

Prototype of a flexible electronic circuit. Stitch schematics such as this one can be used to create health-monitoring fabrics. The stitches themselves become the electronic circuit.
AWARDS

Dr. Lyon (Brad) King founded Orbion Space Technology, a Houghton-based startup company that won top prize at the Accelerate Michigan Innovation Competition of $500,000.

Dr. Hassan Masoud was named associate editor of the European Journal of Computational Mechanics.

Ed Trinklein, research engineer, won the Unsung Hero Award during the 2017 Making a Difference Staff Awards.

Charles D. Van Karsen, associate professor, received the D. J. Demichele Award from the Society for Experimental Mechanics.

Dr. Nancy Barr presented at the International Writing Across the Curriculum Conference 2018 on the campus of Auburn University in Alabama, and at IEEE’s Professional Communication Society (PCS) annual conference in Madison, Wisconsin.

Dr. Radheshyam Tewari was named Mechanical Engineering Teacher of the Year at the ME-EM Spring 2018 Senior Recognition Banquet and Order of the Engineer Ceremony.

Dr. Fernando Ponta, Muraleekrishnan Menon, Dr. Qingli Dai, and Xiao Sun (CEE) co-authored “Design and Simulation of Active External Trailing-edge Flaps for Wind Turbine Blades on Load Reduction,” which won the 2017 Journal of Aerospace Engineering Best Paper Award.

Dr. Andrew Barnard was chosen as a finalist of the 2018 Michigan Tech Distinguished Teaching Award.

Dr. Nina Mahmoudian was selected by Michigan Tech and donors, who wish to remain anonymous, to be the first holder of the Lou and Herbert Wacker Associate Professor in Autonomous Mobile Systems. This is an endowed professorship through a generous cash gift of $1,000,000.

Kimberly Foster ’94, a mechanical engineering professor from the University of California at Santa Barbara, has been hired by Tulane University as the new dean of the School of Science and Engineering.

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 MISKOGLU
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
The purpose of the Academy is to honor outstanding graduates of the ME-EM Department. Selection into the Academy recognizes excellence and leadership in engineering and civic affairs. Portraits and a brief biography of Academy members are prominently displayed in the R.L. Smith Building to serve as inspirational role models for our students.
THOMAS BRONZ BSME ’89

Thomas Bronz graduated with a BS in Mechanical Engineering from Michigan Tech in 1989, later earning an MBA from Northwestern University. After graduating from Tech, he worked in the commercial vehicles industry in a variety of management positions overseeing suspensions controls processes. In 2006, he served as the director of high performance product development at Brunswick Corporation, where he improved development processes for freshwater boat lines.

In 2007, he led the development of a new fiberglass product line for the Lund Boats brand.

That project relied on his keen understanding of the consumer durables market, strong dealer relationships, and a deep appreciation for the voice of the customer in product development. The fiberglass product line remains a success for Lund today.

Bronz returned to the commercial vehicles market in 2010, helping a start-up business—Sloan Transportation Products—become a successful standalone within four years. He then moved on to become President and CEO of Hadley Products, once again returning to the suspensions controls field, before ending up as director of aftermarket sales at SAF Holland, where he supports hitches and suspensions for trucking fleets across North America.

He resides in Holland, Michigan, with his wife, Susan and their two children. Their daughter, Hanna, will be studying pre-pharmacy in 2018. Their son, Kurtis, is destined to be an engineer and will graduate high school in 2022. In his spare time, Bronz enjoys Michigan’s great outdoors. He is a licensed US Coast Guard Master Captain, and occasionally finds time to fill in for salmon and steelhead charter captains on Lake Michigan.

CHRISTINE ROBERTS (PRZYBYSZ) BSME ’91

Christine Roberts graduated from Michigan Tech with a BS in Mechanical Engineering in 1991, later going on to earn a master’s in project management from George Washington University and her MBA in International Business at DePaul University in 2000.

Roberts began her career at Motorola, Inc., where she worked for 20 years, rising from production manager to vice president of product management for Motorola Mobility. She has also held positions at Google and Netflix. Currently, Roberts works at cloud communications services pioneer Twilio, as vice president and general manager of Twilio’s Super Network, and chairman of the board for the Twilio Sweden Group.

Roberts is an active proponent of engaging girls and underrepresented minorities in STEM.

Roberts has volunteered her time and expertise in several worthy causes, including RAFT (Resource Area for Teaching), the Math and Science Conference in SW Michigan for young women; the University of Illinois sponsored summer camp “GAMES” (Girls Adventures in Math, Engineering and Science); Junior Achievement; the Day of Science for Girl Scout Troops; and Women in Science and Engineering (WISE).

Roberts was inducted into the Michigan Tech Presidential Council of Alumnae (PCA) in 2009. She has been an active member of the ME-EM External Advisory Board (EAB) since 2010. She and her husband, Eric (also a Michigan Tech Mechanical Engineering alumnus), and daughter Kylie, followed the sun from Chicago to the Silicon Valley in 2013.

She notes, however, that much of her heart still belongs to the UP.

XINTAN CHANG PHD ’88

Xintan Chang earned his master’s in mining engineering and PhD in Engineering Mechanics at Michigan Tech.

Before coming to Tech, Chang worked in Chinese coal mines for 11 years, after earning his BS in Mining Engineering from Xi’an Mining Institute (now Xi’an University of Science and Technology) in 1969.

While at Tech, he co-authored the Transient State Mine Ventilation Simulation Program MFIRE for US Bureau of Mines.

It remains the most popular mine fire ventilation simulation software in the world.

Chang returned to Xi’an University in 1988, working his way up to full professor within five years. His research focused on mine ventilation, mine/civil fire simulation and fire-fighting, and public safety/safety management, earning a National Reward for his simulation accomplishments.

Chang became President of Xi’an University in 2003, leading several expansions and improvements for the university during his tenure.

Chang has been a committee member of the China Coal Industry Society, an executive committee member of the China Coal Academy, the chair of the Consultative Committee in Public Safety of Shaanxi Province, and group leader of the High Education Assessment Committee of Shaanxi Province.

Xintan resides in Xi’an, Shaanxi province, China, with his wife of 45 years, YunZhi, (Yoon-zgee), a B-scan ultrasonography doctor, now retired. Their two sons, Zheng (Chung) and Liang (Lee-ang), are both graduates of Michigan Tech in Mechanical Engineering. Proud grandparents, Xintan and YunZhi, have two grandsons and one granddaughter.
# Academy Members

*Only Michigan Tech degrees listed*

<table>
<thead>
<tr>
<th>Name</th>
<th>Degree</th>
<th>Year(s)</th>
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<tr>
<td>Frank Agosti</td>
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<td>Xintan Chang</td>
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<td>Dean Diver</td>
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<td>John Drake</td>
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<td>John Eastman Sr.</td>
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<td>Theodore Edwards</td>
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<td>Harold Schock</td>
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<td>Anthony Raimondo</td>
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<td>Kamlakar Rajurkar</td>
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<td>Jack Real</td>
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<td>Christine Roberts</td>
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<td>Paul Rogers</td>
<td>BSME '88, PhD ME-EM '04</td>
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<tr>
<td>Vijay Sazawal</td>
<td>PhD ME-EM '75</td>
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<td>James Sorenson</td>
<td>BSME '60, MSEM '61</td>
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<td>Fred Spagnoletti</td>
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<td>James Stone</td>
<td>BSME '40</td>
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<td>Martha Sullivan</td>
<td>BSME '80</td>
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Paul Swift  
BSME '33

Maurice Taylor  
BSME '68

Camiel Thorrez  
BSME '70

Robert Thresher  
BSME '62, MSME '67

Raymond Trewhella  
BSME '56

William Turunen  
BSME '39

James Vorhes  
BSME '47

Thomas Walker  
BSME '68

Donald Wheatley  
BSME '62, MSME '63

Harold Wiens  
BSME '68

Stephen Williams  
BSME '86

Terry Woychowski  
BSME '78

Hussein Zbib  
BSME '81, MSME '83, PhD ME-EM '87
The Presidential Council of Alumnae (PCA) at Michigan Tech, recognizes successful Michigan Tech women graduates for their educational excellence, past student service, professional accomplishments, and community contributions.

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

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

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Hussein ‘81 & Marcia Zbib

The following list encompasses the many people who have generously shared their treasure to create an outstanding ME-EM Department. We are extremely grateful for their ongoing support.

Those contributing from June 1, 2017 to May 31, 2018 directly to the ME-EM Department are listed below. Note: Employee matching gifts are listed among Individuals, below.
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<th>Title</th>
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<td>$115,000</td>
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<tr>
<td>Combustion Sensing and Control (CLCC)</td>
<td>Jeffrey Naber</td>
<td>Bo Chen</td>
<td>Ford Motor Company</td>
<td>$130,482</td>
<td>2018</td>
<td>$130,482</td>
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<td>Pilot Program In-Service Monitoring for Snowmobiles</td>
<td>Scott Miers</td>
<td></td>
<td>International Snowmobile Manufacturer's Association (ISMA)</td>
<td>$87,299</td>
<td>2018</td>
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<tr>
<td>Ignition System Characterization for Chrysler</td>
<td>Naber, Jeffrey</td>
<td>Seong-Young Lee, Henry Schmidt, Jaclyn Johnson</td>
<td>FCA US, LLC</td>
<td>$28,822</td>
<td>2016-2018</td>
<td>$119,428</td>
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<tr>
<td>Development and Delivery of a Professional Development Course in Inverter Design</td>
<td>Jeremy Worm</td>
<td></td>
<td>US Department of Defense, Army, TARDEC</td>
<td>$20,422</td>
<td>2017</td>
<td>$20,422</td>
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<tr>
<td>MTU Consortium in Diesel Aftertreatment Research, Phase II, Year 2</td>
<td>John Johnson</td>
<td>Jeffrey Naber, Gordon Parker</td>
<td>Cummins Emission Solutions, Isuzu Technical Center of America, Inc.</td>
<td>$166,323</td>
<td>2013-2019</td>
<td>$1,385,258</td>
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# Advanced Power Systems

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Quiet Driveline</td>
<td>PI: Jason Blough Co-PI: Darrell Robinette</td>
<td>Ford Motor Company</td>
<td>$70,028</td>
<td>2017-2018</td>
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<tr>
<td>Fixture Design and Damage Potential</td>
<td>PI: Jason Blough Co-PI: Charles Van Karsen, James DeClerck</td>
<td>Honeywell Federal Manufacturing &amp; Technologies, Inc.</td>
<td>$60,000</td>
<td>2018</td>
</tr>
<tr>
<td>Development, Validation, and Integration Support for a HIL VD&amp;PT Vehicle Model</td>
<td>PI: Jeffrey Naber Co-PI: Mahdi Shahbakhti, Chris Morgan</td>
<td>Hitachi America, Ltd.</td>
<td>$59,600</td>
<td>2018</td>
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<tr>
<td>Improved Clunk Parameterization and Rig Development</td>
<td>PI: Darrell Robinette Co-PI: Jason Blough, Mahdi Shahbakhti</td>
<td>Ford Motor Company</td>
<td>$240,964</td>
<td>2018</td>
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<tr>
<td>Bio-Oil as a Feedstock in a Petroleum Refinery</td>
<td>PI: Ezra Bar-Ziv</td>
<td>Michigan State University</td>
<td>$70,763</td>
<td>2018-2019</td>
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# Agile Interconnected Microgrids

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<tr>
<td>Modeling and Control Development for Electric Vehicle and Smart Grid Integration</td>
<td>PI: Bo Chen</td>
<td>Argonne National Laboratory</td>
<td>$161,184</td>
<td>2016-2017</td>
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<tr>
<td>HVDC Distribution Study of Intelligent Power System</td>
<td>PI: Wayne Weaver (Electrical &amp; Computer Engineering) Co-PI: Gordon Parker</td>
<td>University of Dayton Research Institute</td>
<td>$50,000</td>
<td>2016-2018</td>
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<tr>
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<td>AGILE INTERCONNECTED MICROGRIDS (CONT.)</td>
<td></td>
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<td>$4,082,263</td>
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<tr>
<td>Agent-Based Control of Agile Energy Networks</td>
<td>PI: Gordon Parker Co-PI: Wayne Weaver (Electrical &amp; Computer Engineering), Laura Brown (Computer Science), Steven Goldsmith</td>
<td>US Dept. of Defense, Army Research Laboratory</td>
<td>$150,000</td>
<td>2017-2020</td>
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<tr>
<td>Grid-Scale Energy Storage Systems</td>
<td>PI: Lucia Gauchia (Electrical &amp; Computer Engineering)</td>
<td>ITC Holdings Corporation</td>
<td>$36,979</td>
<td>2017-2018</td>
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<tr>
<td>Magnetic Sensor Suite for Remotely Operated Vehicles for Littoral Threat Characterization in Complex Seabed Environments</td>
<td>PI: Nina Mahmoudian</td>
<td>Twinleaf, LLC</td>
<td>$50,466</td>
<td>2017-2018</td>
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<tr>
<td>ENGINEERING EDUCATION INNOVATION</td>
<td></td>
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<td>$586,125</td>
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<tr>
<td>Senior Design: Trailed Agricultural Equipment Braking System</td>
<td>PI: William Endres</td>
<td>Richard E. Job</td>
<td>$25,530</td>
<td>2017-2018</td>
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<tr>
<td>Senior Design: DCCV Housing Process Improvement</td>
<td>PI: William Endres</td>
<td>Nexteer Automotive</td>
<td>$25,530</td>
<td>2017-2018</td>
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<tr>
<td>Senior Design: Sustainable Door Seal Design</td>
<td>PI: William Endres</td>
<td>Whirlpool Corporation</td>
<td>$25,530</td>
<td>2017-2018</td>
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# Engineering Education Innovation (Cont.)

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<tbody>
<tr>
<td>Senior Design: Object Detection and Classification System</td>
<td>Pi: William Endres</td>
<td>Bobcat Co.</td>
<td>$25,530</td>
<td>2017-2018</td>
<td>$25,530</td>
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<tr>
<td>Senior Design: Bi-Directional Actuator</td>
<td>Pi: William Endres</td>
<td>GHSP, Inc.</td>
<td>$25,530</td>
<td>2017-2018</td>
<td>$25,530</td>
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<tr>
<td>Senior Design: Power Seat Efficiency Improvement</td>
<td>Pi: William Endres</td>
<td>Adient US, LLC</td>
<td>$17,760</td>
<td>2017-2018</td>
<td>$17,760</td>
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<tr>
<td>Senior Design: Swirl Generator Design for DRT Mixer</td>
<td>Pi: William Endres</td>
<td>Cummins, Inc.</td>
<td>$25,530</td>
<td>2018</td>
<td>$25,530</td>
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<tr>
<td>Senior Design: Aftertreatment Body Joint</td>
<td>Pi: William Endres</td>
<td>Cummins, Inc.</td>
<td>$25,530</td>
<td>2018</td>
<td>$25,530</td>
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<tr>
<td>Senior Design: Passenger Car Seat Frame Structural Improvement</td>
<td>Pi: William Endres</td>
<td>Adient US, LLC</td>
<td>$17,760</td>
<td>2018</td>
<td>$17,760</td>
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<tr>
<td>Senior Design: Snowmobile Sound Attenuation</td>
<td>Pi: William Endres</td>
<td>Polaris Industries, Inc.</td>
<td>$26,640</td>
<td>2018</td>
<td>$26,640</td>
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<tr>
<td>Senior Design: Electrically Conductive Circuit Development on a Polymer Substrate</td>
<td>Pi: William Endres</td>
<td>Covestro, LLC</td>
<td>$20,424</td>
<td>2018</td>
<td>$20,424</td>
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<tr>
<td>Senior Design: Auto Reciprocating Blade Test Rig Improvement</td>
<td>Pi: William Endres</td>
<td>Milwaukee Electric Tool Co.</td>
<td>$20,424</td>
<td>2018</td>
<td>$20,424</td>
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<tr>
<td>Senior Design: Shell Core Dip Oven</td>
<td>Pi: William Endres</td>
<td>AAM - American Axel &amp; Manufacturing</td>
<td>$20,424</td>
<td>2018</td>
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### MULTISCALE TECHNOLOGIES INSTITUTE

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<th>PERIOD</th>
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<tbody>
<tr>
<td>I-Corps: Carbon Nanotube Coaxial Noise Control</td>
<td>Andrew Barnard</td>
<td>National Science Foundation</td>
<td>$56,700</td>
<td>2017-2018</td>
<td>$56,700</td>
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<tr>
<td>Technology Review for Li-Ion and All Solid-State Battery Materials</td>
<td>Kazuya Tajiri</td>
<td>Tosoh Corporation</td>
<td>$4,595</td>
<td>2017-2018</td>
<td>$4,595</td>
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<tr>
<td>Low Mass, Low Power, Non-Mechanical Excavation of Gypsum and Other Evaporites and Water Production on Mars</td>
<td>Jeffrey Allen, Paulus van Susante, Timothy Eisele (Chemical Engineering), Ezequiel Medici</td>
<td>National Aeronautics and Space Administration</td>
<td>$411,674</td>
<td>2018-2020</td>
<td>$520,481</td>
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### SPACE SYSTEMS

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<tr>
<td>Electrospray from Magneto-Electrostatic Instabilities</td>
<td>PI: Lyon (Brad) King</td>
<td>US Department of Defense, Air Force Office of Scientific Research</td>
<td>$200,000</td>
<td>2014-2018</td>
<td>$1,121,051</td>
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<tr>
<td>Institute for Ultra-Strong Composites by Computational Design (US-COMP)</td>
<td>PI: Greg Odegard, Co-PI: Ravi Pandey (Physics), Julia King (Chemical Engineering), Trisha Sain</td>
<td>National Aeronautics and Space Administration</td>
<td>$1,999,999</td>
<td>2017-2022</td>
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### ADDITIONAL RESEARCH TOPICS

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<tbody>
<tr>
<td>Developing a Talent Pipeline: Inspiring Future Naval Engineers and Scientists Using Real-World Project Based Instruction</td>
<td>PI: Andrew Barnard, in conjunction with the Great Lakes Research Center (GLRC), Co-PI: Nina Mahmoudian, Guy Meadows (GLRC)</td>
<td>US Department of Defense, Office of Naval Research</td>
<td>$205,958</td>
<td>2015-2018</td>
<td>$643,954</td>
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<tr>
<td>ONR Graduate Traineeship Award: Multi-Modal, Near-Shore, Ice-Covered Arctic Acoustic Propagation Measurement and Analysis</td>
<td>PI: Andrew Barnard, in conjunction with the Great Lakes Research Center (GLRC)</td>
<td>US Department of Defenses, Office of Naval Research</td>
<td>$59,405</td>
<td>2018-2019</td>
<td>$59,405</td>
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<tr>
<td>CAREER: System-on-Cloth: A Cloud Manufacturing Framework for Embroidered Wearable Electronics</td>
<td>PI: Ye (Sarah) Sun, in conjunction with the Institute of Computing and Cybersystems (ICC)</td>
<td>National Science Foundation</td>
<td>$361,626</td>
<td>2018-2023</td>
<td>$602,410</td>
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<tr>
<td>Enterprise: Chairless Chair Technology for Military Ground Vehicles</td>
<td>PI: Andrew Barnard, in conjunction with the Center for Leadership and Innovation for Transformation (LIFT) Co-PI: Nina Mahmoudian, Joseph Thompson (Pavlis Honors College)</td>
<td>General Dynamics Land Systems (GDLS)</td>
<td>$25,899</td>
<td>2017-2018</td>
<td>$10,149</td>
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</table>
**PATENTS & PUBLICATIONS**

**PATENTS**


**BOOK, CHAPTER IN**


JOURNAL ARTICLES


Khan, Khalid, Jafari, Mehdi, Gauchia Babe, Lucia, "Comparison of Li-ion Battery Equivalent Circuit Modelling using Impedance Analyzer and Bayesian Networks," IET Electrical Systems in Transportation, online first Mar 2018. DOI: 10.1049/iet-est.2017.0087


THE RECENTLY DEVELOPED WAVE TANK ALLOWS RESEARCHERS TO CREATE REPEATABLE, REAL OCEAN SCENARIOS