A SHOWCASE OF ENTERPRISE AND SENIOR DESIGN STUDENT PROJECTS
Welcome to Michigan Tech’s Design Expo. If this is your first visit, you’ll be astounded at the creativity and sophistication of the demonstrations and displays. These Enterprise and Senior Design Student Projects reflect everything that goes into an engineer’s education and preparation at MTU – a dedicated and involved faculty and staff, a laser-focused administration and tremendously supportive alumni, donors and corporate benefactors. It all adds up to an environment that produces top-tier engineers who are fully prepared to take on and master the most difficult real-world challenges.

Jon E. Jipping, PE
Executive Vice President and Chief Operating Officer
ITC Holdings Corp.
MTU class of 1991 – MS, Electrical Engineering
Table of Contents

Welcome ............................................. 5
Leonard Bohmann, Associate Dean, College of Engineering
Rick Berkey, Director, The Enterprise Program

Student Projects
Enterprise ...................................... 6
Senior Design ................................. 30

Scope
Design Expo highlights hands-on, discovery-based learning at Michigan Tech. More than 600 students on Enterprise and Senior Design teams showcase their work and compete for awards. A panel of judges, made up of distinguished corporate representatives and Michigan Tech staff and faculty members, critique the projects. Many team projects are sponsored by industry, which allows students to gain valuable experience through competition, as well as direct exposure to real industrial problems. Design Expo is hosted by the College of Engineering and the Pavlis Honors College.

Student Awards

Black & Veatch Building a World of Difference® Student Design Awards

Senior Design Awards
• Based on poster
• First place—$150
• Second place—$100
• Third place—$75
• Honorable mention—$50 (three to be awarded)

Enterprise Awards
Based on poster and presentation
• First place—$300
• Second place—$150
• Third place—$100

Design Expo Image Contest
• Photo or non-photo graphics
• First place—$100
• Second place—$50

On the cover
Winner of the 2015 Design Expo Image Contest, this photo submitted by Jordan Pontoni, Calvin Nitz, Shane Anderson, and Austin DePottey (Materials Science and Engineering) shows Nitz in the Michigan Tech foundry as the team works to improve the microstructure of standard E357 aluminum alloy for sponsor Eck Industries.

More Special Thanks
To the distinguished judges who give of their time and talents to help make the Design Expo a success, to the faculty advisors who generously and richly support Enterprise and Senior Design, and to all the behind-the-scenes superstars—you know who you are—thank you for your dedication to our students.
On behalf of our faculty, staff, and students, welcome to Design Expo 2016!

Thank you for joining us for one of the most exciting days of the year. Today, our students take center stage and showcase the projects and experiences that have become so much more than a class assignment. Design Expo shines a spotlight on the foundations of a Michigan Tech education: experiential learning; interdisciplinary teamwork; application of theory to open-ended problems; leadership and communication; and design and innovation. The Enterprise and Senior Design teams you meet today are evidence that these foundations are stronger than ever.

This year, we are pleased to acknowledge ITC Holdings as our Directing Partner Sponsor along with Black & Veatch as our Supporting Partner Sponsor. Collaborating Partner Sponsors include American Transmission Company, Kimberly-Clark, and Michigan Tech’s Office of Innovation and Industry Engagement. Our Innovating Partner Sponsors include Michigan Tech Alumni Relations, Miller Electric, and Plexus. We thank all of our sponsors for their support and commitment to Design Expo.

Michigan Tech’s innovative Enterprise program is open to all majors and facilitates interdisciplinary learning, leadership development, and team-based project work. Diverse teams of first-year through graduate-level students develop products, processes, and services within their market space. Multyear participation in a businesslike environment provides a unique opportunity for students to maximize personal and professional growth. Faculty advisors coach and guide, while industry sponsors serves both clients and mentors. Enterprise has been recognized as a national best practice and is revolutionizing our approach to undergraduate education at Michigan Tech. Experience the revolution as you meet with many of the 650 students who have chosen the Enterprise pathway.

Senior Design challenges teams of highly-dedicated, senior-level students to explore and address real-world design challenges in their final year. Our program connects students and industry through open-ended projects where teams follow the complete design process from ideation to realization. Senior Design marks the capstone experience in our engineering curricula—and as we often say, it’s more like a ‘first job’ than a ‘last class’. Our seniors will show you their readiness to lead and contribute on ‘day one’ as they make the final transition into their early careers.

We also would like to thank the more than 120 partners and sponsors who generously support our educational mission by providing meaningful project experiences, financial support, and mentorship for our students. The benefits of industry and academia working together as partners are clearly evident at Michigan Tech’s Design Expo.

As you visit with our students today, be sure to engage them by questioning, challenging, encouraging, and inspiring. They are certain to return the favor. Enjoy your Design Expo experience, and Go Huskies!

Rick Berkey
Director, Enterprise Program

Leonard Bohmann,
Associate Dean, College of Engineering
Team Leaders
Garrett Mitchell and Dan Schlais, Mechanical Engineering

Advisor
Kevin Johnson, Mechanical Engineering–Engineering Mechanics

Sponsors
3M, Denso, GM, Aramco, Ford, FCA, Alcoa, Nexteer, Miller Electric, Team Tech, Gates, Penco, GLSV, ArcelorMittal, Milwaukee Tool, KA Wood, John Deere, Maritor, Polaris, Oshkosh, Mitsubishi Electric, Hayes Performance, Snap On

Background
Michigan Tech's Blizzard Baja Enterprise builds a single seat, off-road competition vehicle to compete in the SAE Collegiate Design Series-Baja SAE events held in various locations across the US. The team prepares and presents a written design report, cost analysis and sales presentation for a panel of SAE judges. After passing a rigorous safety and technical inspection, we compete with other collegiate teams on acceleration, hill climb, maneuverability, suspension and endurance. The Blizzard Baja Enterprise also organizes and hosts the Winter Baja Invitational event, a long-standing University tradition dating back to 1981.

Project Highlights
This year the Blizzard Baja team has built a brand new vehicle from the ground up. Notable innovative projects include a lightweight gearbox, re-designed transmission, re-designed front knuckles, re-designed rear hubs, trailing arm suspension, modular drive train, custom ergonomic carbon fiber seat, custom steering rack, carbon fiber skid plate, and an optimized lightweight frame. We also tested the durability of some of the new design upgrades by competing in two invitational events (Midnight Mayhem and Backwoods Baja) and plan to compete nationally in Tennessee and California.

First, Second, and Third Place at Backwoods Baja
Team Leaders
Chad Smith and Nicholas Brodowski, Mechanical Engineering

Advisor
Jason Blough, Mechanical Engineering–Engineering Mechanics

Sponsors

Background
Michigan Tech’s Clean Snowmobile Challenge Enterprise builds snowmobiles to compete in the SAE Collegiate Design Series Clean Snowmobile Challenge held at the Keweenaw Research Center in Houghton, Michigan. As part of the competition, we submit an engineering design paper, determine a justified MSRP (Manufacturer’s Suggested Retail Price), and present an oral design presentation outlining the team’s approach to the clean snowmobile conversion. Following a comprehensive technical inspection, our vehicles undergo dynamic testing including acceleration, handling, cold start, noise and emissions. Michigan Tech’s Clean Snowmobile Challenge Enterprise typically competes in both the Internal Combustion (IC) and Zero Emissions (ZE) classes.

Project Highlights
Clean Snowmobile Enterprise’s 2015–2016 projects include a variety of improvements to each of the team’s two snowmobiles. In order to improve the overall noise and emissions without reducing performance of the IC snowmobile, our team has improved the rear idler wheel assembly, made a custom air box, designed new rear brackets and isolated drivers, built a custom muffler and selected a new catalytic converter. Projects for the ZE snowmobile include an improved motor mount, improved skid mounting for the touring skid, and a new circuit board.

Completing some noise testing after making modifications to the competition sled
Team Leaders
Joshua Matiash, Mechanical Engineering and Joshua Dillon, Electrical Engineering

Advisor
James DeClerck, Mechanical Engineering-Engineering Mechanics

Sponsors
3M, Denso, GM, Aramco, Ford, FCA, Alcoa, Altair, Cummins, John Deere, Meritor, Polaris, Oshkosh, Milwaukee Tool, Miller Electric, Nexteer, Yamaha, ArcelorMittal, Mitsubishi Electric, Hayes Performance, TeamTech, Snap On, Vans Pattern, FEV North America

Background
Michigan Tech's Formula SAE Enterprise builds a competition vehicle based on the concept of an affordable race car geared towards the weekend autocrosser. The team competes in SAE Collegiate Design Series Formula SAE events held in various locations across the country. For the competition, we prepare a written design report, a cost analysis and a business case to present to a panel of judges. After passing a technical inspection our vehicle competes in a series of dynamic events, including acceleration, skid pad, autocross, endurance, and efficiency. Michigan Tech Formula SAE has a long history of top-performing cars and we have gained a reputation for developing cutting-edge designs that help shape the future of racing.

Project Highlights
Over this recent academic year the Formula team has pursued new technologies, including the development of a continuously variable transmission (CVT), as well as 3D and simulation modeling, a dynamic four wheel steering system, advanced development of the intake system, and aerodynamic improvements. These engineering projects have been made possible by improving our design, testing, and knowledge transfer processes. Some examples of these include implementing a design approval and review process, and accurate real-world testing at the local airport. By developing race cars we are developing our team and our members.
Team Leaders
Pierce Jensen, Mechanical Engineering and Electrical Engineering, Andrew McMichael, Electrical Engineering, and Christian Romans, Mechanical Engineering

Advisor
Rick Berkey, Pavlis Honors College

Sponsors
3M, Danso, GM, PCB Piezotronics, Ford, FCA, John Deere, Meritor, Milwaukee Tool, Mitsubishi Electric, Cummins, Snap On, Oshkosh, Alexander Technologies, Donald Engineering, ArcelorMittal, Advanced Sleeve

Background
Michigan Tech’s Supermileage Systems Enterprise builds a single seat, high efficiency vehicle that competes in either the SAE Collegiate Design Series or the Shell Eco-marathon. The powertrain utilized by the vehicle is determined by the competition and is either a small displacement internal combustion engine or a battery electric design. Regardless of the event, our team must engineer a competitive vehicle and submit a written report detailing our vehicle design. We must also deliver an oral presentation that demonstrates our understanding of the engineering principles that support the design. Following a technical inspection, the vehicle must complete a dynamic performance event where miles per gallon (MPG) or mile per gallon equivalent (MPGe) is measured.

Project Highlights
This year, Supermileage Systems Enterprise will compete in Shell Eco-marathon’s Prototype division with a battery electric propulsion system. Our team has designed and constructed a custom motor controller for a 300W Brushless DC (BLDC) motor. Additionally, we have redesigned the steering system to reduce the weight and integrate ergonomic driver controls. A new drivetrain system complements the steering changes with a large reduction in weight. Our goal for competition is to achieve a fuel economy of over 9,000 MPGe.

Competing at the 2015 SAE Supermileage Competition hosted by Eaton Corporation in Marshall, MI. Our team placed 4th overall with a performance of 793 miles per gallon.
Husky Game Development

Team Leaders
Sarah Clements, Management Information Systems and Mitch Davis, Computer Science

Advisor
Scott Kuhl, Computer Science

Sponsor
Pavlis Honors College, Michigan Technological University

Background
Husky Game Development (HGD) is a student-run enterprise focused on developing video games. Each year, Husky Game Development breaks up into subteams of around six students who experience a full game development cycle including ideation, design and end product. We explore a wide variety of video game engines and platforms including Windows, Android, Xbox, and an experimental Display Wall.

Project Highlights
This year, HGD has four “Arcade Teams” comprised of all first-year students. We take responsibility for our own learning while challenged to recreate a beloved “retro” arcade game, and give it our own personal touch. These games are usually made with Java. Additionally six teams of returning HGD members work on more difficult and complex games. Some of these games may be made with Unity or Unreal. We also have a dedicated sound team that creates custom sound effects and music for all HGD games.

Screen shot of HGD original game “Tiny Dragon”—original artwork!
106
Blue Marble Security

Team Leaders
Jonathan Jerred, Mechanical Engineering and Alfredo Soto, Electrical Engineering

Advisor
Glen Archer, Electrical and Computer Engineering

Sponsors
ArcelorMittal, Halla-Mechatronics, Oshkosh, and Caterpillar

Background
Blue Marble Security (BMS) Enterprise is a student-led enterprise that focuses on securing the future through the thoughtful use of technology. Our team specializes in engineering design and product development. We have developed a culture that fosters high professional standards, creativity and productivity. At BMS, we define the word “national security” through the provision of technological support to the defense, the corporate economy, and the personal wellbeing of the nation and all of its people.

Project Highlights
This past year has been one of growth. BMS has nearly doubled its member count from previous years. Our team has 10 unique projects this year, including three sponsored teams. The Autobot team designed and built a new autonomous robot, “Charlie”, which will be competing this spring. The ArcelorMittal team refined and validated their steel ductility detection device. The Outreach team hosted a number of interactive STEM education activities for students. The Mechatronics team designed, prototyped, and will soon test their new, cutting edge electro-mechanical braking design. Other teams include CAT/SWE, Counter-UAV, Website, Recycling, Radio Control, and Project X.

Working on “Charlie”, our autonomous robotic vehicle
Team Leader
Kory Wegmeyer, Computer Network and System Administration

Advisor
Russell Louks, School of Business and Economics

Sponsors
Target, Ford, and Kyocera

Background
ITOxygen is a cross-disciplinary, student-run enterprise that specializes in information technology (IT) for student organizations and businesses, with a focus on developing information system and information technology solutions. Our team members work on real-world projects that foster skill development and business savvy. Areas of interest include systems and information analysis, software development, database design, and web-based application development.

Project Highlights
ITOxygen currently has multiple teams working on projects for corporate partners. Our projects include making a chat bot and deploying code using infrastructure as code services, as well as using cross-platform tools to partner with two sponsors to develop and deploy a tool to communicate with a driver’s vehicle and mobile phone. Michigan Tech has also partnered with our team to develop a mobile and web application to better assist those in the campus community. Our team also designs, develops, deploys, and manages its own in-house IT infrastructure. ITOxygen continues to manage a wide range of projects that cover many innovative technologies.
Team Leaders
Julie Karl, Biomedical Engineering and Rachel Nankervis, Scientific and Technical Communication

Advisor
Michele Miller, Mechanical Engineering-Engineering Mechanics

Sponsor
Pavlis Honors College

Background
Innovative Global Solutions (IGS) pursues solutions for the needs of developing countries, making contributions towards solving Grand Challenges. We improve our technical skills and gain hands-on experience with an international engineering project. Our typical project areas focus on energy, water, health, education, entrepreneurship, transportation, infrastructure, and more.

Project Highlights
A typical ventilator found in a hospital costs about $40,000, which is normally not affordable for a medical facility in a developing country. Even when ventilators are donated, they are often too difficult to use. IGS is developing a low-cost ventilator that is a simplified form of a major hospital ventilator. The current model costs about $850 and uses pressure sensors to give feedback and control the patient’s breathing using three variable inputs: breaths per minute, maximum pressure, and PEEP (pressure left inside the lungs at the end of a breath). Our simple design allows local engineers to fix any problems that arise and provide maintenance locally.

Internal layout of the components of our Pandemic Ventilator
Team Leaders
Carly Joseph, Biomedical Engineering and Dean Johnson, Mechanical Engineering

Advisor
Brett Hamlin, Engineering Fundamentals

Sponsors
Pavlis Honors College and The Outdoor Adventure Program

Background
The focus of the General and Expedition Adventure Research (GEAR) Enterprise is to design, model, test, prototype, and manufacture a wide variety of goods and equipment used in recreational outdoor and commercial expedition endeavors. Our team members analyze and develop innovative solutions on both internal and industry sponsored projects. We have worked on soft and hard goods related to backpacking, camping, climbing, snowshoeing, kayaking, canoeing, mountaineering and military applications.

Project Overview
GEAR Enterprise is working on three projects this year: the Base Camp Water Filtration System, the Avalanche Rescue Beacon, and the Portage Paddle. We have developed the Base Camp Water Filtration System to supply clean drinking water using a gravity fed system, designed especially for remote groups, such as those on extended backcountry camping trips and rural communities without access to clean water. Our Avalanche Rescue Beacon team seeks to create an affordable beacon for use in practice rescue scenarios, and eventually to create a fully-functional backcountry beacon with innovations that will aid in the search and rescue process. Our Portage Paddle team is putting the finishing touches on a kayak paddle that allows two kayaks to be carried without additional gear.
Team Leader
Matt Radke, Scientific and Technical Communication

Advisor
Erin Smith, Humanities

Sponsors
Pavlis Honors College and Jackson Center for Teaching and Learning

Background
Our team, the Cin/Optic Communication and Media Enterprise, enables students to develop skills in video design and production. By balancing the creative and technical aspects of video, our primary goal is to focus on our clients’ needs and expectations, while developing artistically-engineered products. We broaden our education in the media industry through real-world business experiences, and by capitalizing on our creative and technical strengths.

Project Highlights
Cin/Optic is currently working on a project with Thomas Oommen, Assistant Professor of Geological and Mining Engineering and Sciences. We are developing a video about a new remote sensing system that aids in predicting certain consequences of wildfires. We are also creating an instructional video about professional writing in the engineering workplace. CinOptic completed some informational videos, and a video for Green Campus Enterprise. We also conducted virtual reality demonstrations at the 41 North Film Festival to broaden our team presence on Michigan Tech's campus.
Team Leaders
Mark Mason and Nick Minarich, Mechanical Engineering

Advisor
Glen Archer, Electrical and Computer Engineering

Sponsors
Pavlis Honors College and Great Lakes Research Center

Background
Industry-driven, the Robotic Systems Enterprise focuses on seamlessly integrating exceptional knowledge in electronics, robotics, and programming to solve real-world engineering problems. All majors are welcome—our team depends on more than just the skills and talents of engineering and science majors. We produce solutions that contribute to industry, recreation and medical research.

Project Highlights
This year our Enterprise has three project teams. One team is currently working on extending the lifespan of the Great Lakes Research Center buoys into the later months and adding a soft reset. The team has identified a way to turn off unnecessary sensors, thus conserving power. Another team is continuing to work on a submersible capable of reaching the bottom of Torch Lake to take soil samples. This team has already completed a mobile underwater platform. The final team is working on a test platform for safely disabling a drone with minimal damage. They plan to do this by cooling the battery which will force the drone to land.
Team Leader
Tyler Brose, Materials Science and Engineering

Advisors
Paul Sanders and Russ Stein, Materials Science and Engineering

Sponsors
ArcelorMittal, General Motors, Eck Industries, Waupaca Foundry, CN Rail, DTE Energy, Gerdau Jackson

Background
Advanced Metalworks Enterprise (AME) is composed of a diverse team of students who execute research and development projects for industrial sponsors. Interdisciplinary teams of 4-5 students model, fabricate and characterize metallic systems such as aluminum, iron, zinc, titanium and nickel-based alloys. AME helps industry sponsors increase productivity, identify causes of material failures, design near net castings, and develop advanced material modeling techniques, and more.

Project Highlights
We have worked with a variety of industry sponsors on highly technical, multidisciplinary projects in the 2015-2016 school year. Projects titles include Weld Toughness of Solution-Strengthened Ductile (SSD) Iron, Dye Penetrants for Rail Defects/Inspection Methods, Hearth Nodule Reduction in Pusher Slab Reheat Furnaces, Pitting of Heat Exchanger Tubing in Power Plant Applications: Causes and Countermeasures, The Role of Si Level on the Elongation of E357 alloy, TRIP780 Tandem Roll Wear Sceland with Alumina Formation during Rolling, and Elevated Temperature Deformation of Furnace Rolls. Our team members engage in projects that directly reflect an industry experience.

AME students utilizing the Michigan Tech Foundry
Alternative Energy Enterprise

Team Leaders
Lucia Li, Chemical Engineering and Elliot Vickers, Mechanical Engineering

Advisors
Jay Meldrum, Keweenaw Research Center and David Shonnard, Chemical Engineering

Sponsors
Pavlis Honors College, JLG, National Park Service, ArcelorMittal, Richard and Bonnie Robbins Endowment, and Keweenaw Research Center

Background
Alternative Energy Enterprise (AEE) provides opportunities for students in multiple academic disciplines to research and develop alternative energy sources. Projects, research, and development are done in conjunction with industry sponsors to produce viable solutions to real-world energy problems. Each of our teams in interdisciplinary, and receives a rewarding hands-on experience while working on challenging problems and seeking innovative solutions.

Project Highlights
AEE focuses on designing and implementing alternative energy solutions for use in the community. This year our members were assembled into four teams: Solar, Biofuels, Fuel Cell, and Geothermal. The Solar team assisted the Alberta Ford Forestry Center in determining the optimal locations for PV solar panels. The Biofuels team discovered methods to improve heat transfer in a pyrolysis reactor, therefore improving biofuel yields, which could be further upgraded for transportation fuel. The Fuel Cell team integrated a hydrogen fuel cell into a battery-powered electrical ladder, donated by JLG, to extend its operating time. The Geothermal team is developing an educational display on geothermal heating and cooling with heat pumps for the Keweenaw National Historic Park Visitor Center in Calumet, Michigan.
Team Leaders
Allen Prince, Environmental Engineering and Alex Kispert, Civil Engineering

Advisor
Lynn Artman, School of Technology

Sponsor
Pavlis Honors College and School of Forest Resources and Environmental Science

Background
Our mission is to work with communities to implement energy-efficient designs into new and existing construction projects. ETEC is a multi-disciplinary team of highly motivated students focused on developing, solving and redefining today’s engineering problems. We are dedicated to the principles of efficient design, social impact, environmental stewardship and value to our sponsors.

Project Highlights
ETEC worked this year to design a water distribution system to replace the current system for the Village of Alberta, Michigan. Our new system must integrate with and support a completed analysis of the water quality, with recommended updates to the proposed treatment system. We have developed a five-phase plan to completely modernize the water treatment system at the Ford Center: changing the primary water source; centralizing the treatment process; designing and installing new pipe network and reservoir house; as well as implementing a water quality monitoring program.
Team Leaders
Chloe Sult, Computer Engineering and Bob Elsey, Electrical Engineering

Advisor
Christopher Cischke, Electrical and Computer Engineering

Sponsors
Ford, Kyocera, and Michigan Tech Broomball Committee

Background
In the Wireless Communication Enterprise (WCE) we focus on wireless, optical, renewable energy, user interface, and biomedical technologies. Our enterprise functions much like an engineering company with a variety of different project teams. These small project teams allow our team members to be very involved in project work, and provide ample opportunity to gain technical skills, business presentation skills, and leadership experience.

Project Highlights
This year WCE worked on a variety of projects, including the continuation of Ford-sponsored projects such as the EV Coach, which determines ways to improve someone’s driving by taking data from the electric vehicle, and Wireless Battery Monitoring, which aims to reduce vehicle weight and complexity by eliminating a traditional wiring harness. The Broomball Scoreboard, an ongoing sponsored project, has resulted in fully-functioning boards that are now in use on Michigan Tech’s ever-popular broomball rinks. Our Visual Performing Arts project has been a new addition this academic year and involves using MIDI systems to create wireless triggers for on-stage effects. This semester also saw the beginning of a Kyocera-sponsored project involving use of Google Eddystones for indoor and outdoor geofencing and data collection. WCE has also been hard at work on numerous internally-sponsored projects this year.
116

Consumer Product Manufacturing

Team Leaders
Abbey Senczyszyn, Mechanical Engineering

Advisors
Tony Rogers and Sean Clancey, Chemical Engineering

Sponsors
Wisconsin Southern Railroad, Caterpillar, Fives Cinetic Corporation, Worham Acres LLC, Keweenaw Economic Development Alliance (KEDA), Michigan Technological University, The State of Michigan Research Excellence Fund, Michigan Department of Agriculture and Rural Development (MDARD), nanoMAG—A Thixomat Company, and Razor Edge Systems

Background
Consumer Product Manufacturing (CPM) Enterprise aspires to empower students with the entrepreneurial, technical, and professional skills to conceive, develop, and market successful products in a company-like setting. Students on our team come from many disciplines and use hands-on experiences to identify and solve real-world engineering problems. CPM aims to exceed the expectations of company sponsors, improve the lives of consumers through innovation, and develop our team members into highly marketable professionals.

Project Highlights
Our team members have valuable opportunities to lead and manage projects that solve real-world engineering problems. Current CPM projects address three areas of focus: process improvement, sustainable service, and consumer innovation. In the area of process improvement, we are increasing the reliability of an industrial automotive parts-washing machine, designing an operator interface for earth moving machinery, and developing a dryer to help small-scale hops growers. In the area of sustainable service, we are modeling more accurate flooding predictions for the Midland, Michigan area, and utilizing food waste as an alternative energy source at Michigan Tech. In the area of consumer innovations, we are integrating energy absorbing material into athletic equipment, and brainstorming innovative product ideas from within CPM.

Anaerobic digestion research of campus food waste for potential energy source
Team Leaders
Landen Tacoma and Luke McCloskey, Mechanical Engineering

Advisor
Ibrahim Miskioglu, Mechanical Engineering-Engineering Mechanics

Sponsors
3M, Michigan Technological University

Background
BoardSport Technologies (BST) focuses on the engineering, design and manufacturing of skis, snowboards, skateboards, longboards, wakeboards, and other products related to the board sports industry. We strive to produce new, refined and attractive boards by making them lighter and stronger using innovative materials.

Project Highlights
BoardSport Technologies continues to improve the manufacturing methods for boards and skis to increase process efficiency and the quality of the end product. Our team members have been experimenting with different composite material systems for the snowboards, skis, skateboards, wake boards and their respective bindings in an effort to decrease the overall weight and keep up with industry trends. To that end, we are creating a data bank of test results for different material systems in order to better quantify future material selection decisions.
Team Leaders
Ian Connick, Mechanical Engineering
Advisor
Steve Lehmann, Mechanical Engineering
Sponsor
Pavlis Honors College and Department of Kinesiology and Integrated Physiology

Background
Velovations is a bicycle design enterprise dedicated to collaborating with the bicycle industry to develop new products and processes. Our goal is to educate our team members in the fundamentals of product development—from customer need through product and process design and testing, manufacturing, supply chain management, marketing and distribution. We leverage multiple majors including mechanical, electrical, business and technical communications to deliver product and process innovations to the bicycle industry.

Project Highlights
At Velovations we have been developing five different projects. First is the Ferro Pedal, which allows the user to clip into their pedals by actuating a magnetic attachment with a Bluetooth button on the handlebars. Next is an arm ergometer that is developed specifically for the Department of Kinesiology and Integrated Physiology to use in testing of their RENEW-U exercise concept. We also completed a functional prototype of a wheel hub that allows the user to alter the pressure in their bicycle tires while riding. The next project for the hub device will focus on quieting vibrations in road bike disc brakes. We are also studying the effects of rim and tire width on mountain bike performance.
Team Leaders
Denzil Cotera and Charles Hatch, Mechanical Engineering

Advisor
Paulus Van Susante, Mechanical Engineering-Engineering Mechanics

Sponsors
Pavlis Honors College, Highland Copper, HONEYBEE Robotics, and the Department of Geological and Mining Engineering and Sciences

Background
In the Mining Innovation and Engineering (MINE) Enterprise, we seek to design, test, and implement mining innovation technologies for industry partners. We work in interdisciplinary subteams to solve current and future challenges in the traditional mining industry as well as the emerging mining fields of deep sea and space mining. Opportunities include the improvement of safety and working conditions, increasing productivity and efficiency, as well as mine and equipment design and optimization.

Project Highlights
Robotics Landing Pad: We are working on developing a process to construct landing areas using on-site rocks and other materials on Mars and the Moon. We are currently designing an excavation testbed to analyze the force requirements necessary to obtain building materials to properly size and design landing area construction equipment. In another subteam, we are focused on the Transportation Feasibility Study for the transportation of copper ore for the planned 543S mine located in the vicinity of Lake Gratiot to the White Pine Mill. We are performing an economic transportation feasibility study on possible methods of transporting the ore.
Humane Interface Design Enterprise (HIDE)

Team Leaders
Stephen Radachy, Computer Science and Erin Richie, Mechanical Engineering
Advisor
Robert Pastel, Computer Science
Sponsor
Pavlis Honors College

Background
At Humane Interface Design Enterprise (HIDE) we come together to design, develop, and evaluate interfaces. Our goal is to make daily work more efficient and easier to manage. As a whole, we all work together to design and test different applications for industry sponsors that can be used on Android, iPhone, and other devices. We accomplish these projects by combining knowledge from multiple disciplines (e.g., computer science, psychology, and human factors). HIDE team members can get involved in various stages of the design process, from developing an app by programming to evaluation by designing usability tests and analyzing data.

Project Highlights
Proponents of Google Glass argue that Head-Up Displays (HUD) are less distracting than the Head-Down Displays (HDD) of smartphones. To study this theory, we recruited students on campus to participate in a simulated driving study using a lane change task. A secondary task was introduced to these students via either a Smartphone or Google Glass and the results showed a greater impact on driving performance with the Smartphone (HDD) vs the Google Glass (HUD). Our current study builds upon this initial simulation by having participants navigate populated city roads in a low fidelity driving simulator guided by a maps smartphone/google glass application. Programmers within HIDE are making the apps that communicate with the driving simulator and create the driving simulator scenario. Our human factors team is preparing to analyze data the apps collect along with user accounts to assess the safety of HUD or HDD devices used while driving.

Running our Google Glass Study
Team Leaders
Sam Baxendale, Mechanical Engineering and Derek Gheller, Computer Engineering
Advisor
L. Brad King, Mechanical Engineering-Engineering Mechanics
Sponsors

Background
The Aerospace Enterprise was established to provide hands-on aerospace education and experience to Michigan Tech undergraduate students. We work together on innovative and relevant aerospace related projects with all members contributing towards achieving specific project goals. We place an emphasis on space mission design and analysis, vehicle integration, systems engineering, and comprehensive ground-testing and qualification.

Project Highlights
Under the guidance of Dr. Lyon King, the Aerospace Enterprise has been involved with three nanosatellite development efforts over the past several years, sponsored by the Air Force Research Laboratory (AFRL)’s University Nanosat Program (UNP-3, UNP-5, and UNP-6). Our UNP-6 entrant, the Oculus-ASR, won first place in the competition in 2011. We are presently readying Oculus-ASR for a January 2017 launch on a SpaceX Falcon Heavy. This past December, the Aerospace Enterprise’s Cubesat Mission, Auris, was a winning entry in the AFRL’s UN-9 Competition. This victory has granted us the necessary funding and support to mature the mission concept of Auris and prepare for a Flight Selection Review in December 2017, where Auris could be selected for flight.

The various elements of the team’s first-place Oculus-ASR satellite.
**Team Leaders**
Albert Cowsky, Electrical Engineering

**Advisors**

**Sponsors**
General Motors, Snap On, Miller Electric, Milwaukee Tool

**Background**
Members of the Hybrid Electric Vehicle (HEV) Enterprise research, design, build and test state-of-the-art hybrid electric vehicles. Our current project vehicle is based on a 1949 Chevrolet truck. We learn about the performance trade-offs of different types of hybrid powertrain architectures while fabricating and assembling various vehicle components and subsystems. We develop and use skills in leadership, project management, and vehicle calibration.

**Project Highlights**
Our hybrid electric truck project, based off a 1949 Chevrolet, is mostly functional. We completed the installation and integration of the engine, electric motor, transmission, clutch and driveshaft into the vehicle earlier this year. Current projects on the hybrid electric truck include developing a control system for gear shifting, developing a general vehicle control system, installing low voltage wiring components and installing mounting provisions for all the major components. Other project teams within the HEV Enterprise are focusing on vehicle modeling as we lay the foundation for future projects.
Team Leaders
Lucas Wilder, Electrical Engineering and Handy Chandra, Mechanical Engineering
Advisor
Joshua Pearce, Materials Science and Engineering
Sponsors
The Ford Motor Company Fund through the Ford College Community Challenge, ArcelorMittal, The Upper Peninsula Recycling Coalition, and Michigan Technological University

Background
At Open Source Hardware, we specialize in building low-cost alternatives to expensive hardware/software, and then sharing the designs with the commons so that collaborative improvements can be rapidly made. Anyone who so desires can make changes or updates to the designs the Enterprise team creates and through this process, our designs are improved at a much higher rate than would be possible within the Enterprise alone. Open Source is all about collaboration.

Project Highlights
Open's Source's Ford C3 project team has constructed a plastic granulator to break down recyclables into feedstock for their own filament extruders. The team is optimizing filament extruders to transform a variety of plastics into recycled 3D printer filament. Additionally, our Eye/Head Tracking User Interface team is working with a local resident with ALS disease to develop a reliable user interface for web browsing, based on either eye or head tracking technology.
**Green Campus**

**Team Leaders**
Matt Annala, Environmental Engineering and Madison Olmstead, Civil Engineering

**Advisor**
Christopher Wojick, Civil and Environmental Engineering

**Sponsor**
Pavlis Honors College

**Background**
The goal of the Green Campus Enterprise is to annually measure the carbon footprint of Michigan Tech, and design and implement projects to improve the sustainability of our campus. We work closely with the Michigan Tech administration to effectively engage the university community in reducing its carbon footprint.

**Project Highlights**
Green Campus Enterprise consists of six teams. Here’s what we do: The Clean Air-Cool Planet team calculates the carbon footprint of the entire university. Our Wind team is currently calculating the feasibility of powering Michigan Tech’s ski lodge with a wind turbine. Our Compressed Natural Gas team is investigating the feasibility of converting the campus transportation fleet to run on CNG. Our Great Lakes Research Center team is exploring a way to cool the GLRC using the Portage Waterway. Our Solar Buildings team is testing ways to preheat the makeup water for the boilers using solar energy. Our Campus Culture team is striving to create a more sustainable mind set throughout the entire campus.
201
Subject-specific Orthopedic Wrist Cast

Team Members
Tobias Mahan, Kathleen Moyryla, Konner Westerhouse, and Nathan Wilkinson, Biomedical Engineering

Advisor
Jingfeng Jiang, Biomedical Engineering

Project Overview
Our team designed a 3D printed subject-specific orthopedic wrist cast for the immobilization of wrist fractures. We designed, built, and utilized a photogrammetric scanner to obtain the surface geometry of the subject's arm. Two different designs were tested on human subjects to determine the feasibility of the designs.

202
Ultrasound Pressure-Volume Loop Catheter

Team Members
Sam Richards, Brigitta Hammond, Mitchell Tahtinen, and Patrick Wolfer, Biomedical Engineering

Advisor
Michael Neuman and Smitha Rao, Biomedical Engineering

Sponsors
Helen DeVos Children’s Hospital and Spectrum Health Innovations, LLC

Project Overview
Our goal is to demonstrate a feasible method for measuring pressure and volume in near real-time without the need for calibration or excessive exposure to radiation. Location of the catheter and volume will be found using ultrasound modules in an A-scan orientation. Ultrasound modules will provide distance while pressure sensor will measure the pressure. This data will be relayed to Matlab for processing using the open-source prototyping platform Arduino. The distance data will be used to calculate the volume of the heart using an equation developed by the team. Then volume is plotted alongside pressure to obtain the Pressure-Volume loop.

203
Multi-functional Bracelet to Monitor Hand Hygiene and Noise Compliance in Healthcare Environments

Team Members
Nick Brajak, Zhongtian Zhang, Jaclyn Mayrose, and Kyle Scheck, Biomedical Engineering

Advisor
Bruce Lee, Biomedical Engineering

Sponsor
Aspirus Keweenaw

Project Overview
Our objective is to develop a bracelet to be worn by healthcare staff that monitors hand hygiene compliance and noise levels in a healthcare environment. The hand hygiene component tracks compliance to hospital regulations of hand sanitation by alerting users when hand washing is needed. The bracelet also tracks and reports individual user compliance to management to show if the user is following the hand hygiene requirements of the health care facility. The noise component registers decibel levels, differing for daytime and nighttime, and alerts the user when they exceed the set limit.
Senior Design

204 Lab-Scale Autonomous Haul Truck for Underground Mine Operation

A lab-scale haul truck and a lab-scale underground mine

Team Members
Loryn Becker and Ted Wierzba, Electrical Engineering Technology, Laura O’Connor, Geological Engineering, and Ryan Livernois, Geology

Advisors
Seyyedmohsen Azizi and Aleksandr Sergeyev, School of Technology and Ebrahim Tarshizi, Geological and Mining Engineering and Sciences

Sponsors
Research Excellence Fund—Research Seed (REF-RS) Grant, School of Technology and Department of Geological and Mining Engineering and Sciences

Project Overview
Mines are one of the most labor-intensive workplaces. Automation in the mining industry can significantly improve sustainability, enhance the utilization of heavy and expensive equipment, and increase productivity and health and safety in the mining environment. Our team designed and developed a lab-scale autonomous underground haul truck for underground mines. Using a microcontroller, an imaging camera and ultrasound sensors, this autonomous haul truck is capable of finding its path along an underground tunnel in the presence of obstacles. We assessed the impact of the developed autonomous truck in the haulage operation of a virtual underground mine. We also analyzed cycle-time improvement using the discrete-event system simulation and animation technique.

205 Incremental Forming

CAD design model

Team Members
Zion Schaub and Richard Guinn, Mechanical Engineering Technology

Advisor
Scott Wagner, School of Technology

Sponsors
ArcelorMittal and School of Technology

Project Overview
A need exists for a repeatable method to form complex sheet metal structures with minimal cost and maximum production rate. Our task is to design, develop, and test a tooling set to be used in a CNC milling machine in order to incrementally form sheet metal. Current methods of sheet metal forming include deep-drawing and manually stretching and shrinking. The desired method is an easy, repeatable process to accurately form complex sheet metal parts using a CNC mill. Constraints of the solution include a moderate budget, physical dimensions of the mill, methods of attaching tooling to the mill, and materials available to create the tooling.

206 Hand Cycle Cockpit Systems Improvement

GM-Achilles team members cross the finish line at the 2015 Detroit Marathon

Team Members
Joshua Greib, Ryan Gentner, Nick Saur, Scott Klein, and Travis Graham, Mechanical Engineering

Advisor
Paul van Susante, Mechanical Engineering-Engineering Mechanics

Sponsors
General Motors and Achilles International

Project Overview
Achilles International is a charity that aims to enable people with all types of disabilities to participate in mainstream athletics in order to promote personal achievement, enhance self-esteem, and lower barriers to living a fulfilling life. Achilles, with the support of General Motors, tasked our team to develop improvements for the cockpit of the Invacare Force RX hand cycle. We set our focus on designing systems that enable wounded veterans to compete in racing events with greater ease. The new designs include a clamp-on strapless restraint that will reduce fore/aft motion, an adaptable shifter/braking mounting mechanism, and an easily removable front spray prevention system.
543S Mine Design Project

Team Members
Carly Siko, Benjamin Kramka, Laura O’Connor, Benjamen Pletcher, and Paul Mueller, Geological Engineering

Advisor
Paul van Susante, Mechanical Engineering-Engineering Mechanics

Sponsor
Highland Copper Co.

Project Overview
The 543S Mine Design project is a design and trade-off study focusing on the economic feasibility of the historic 543S deposit located in the heart of the Keweenaw Peninsula. This copper-sulphide deposit would be the first of its kind to be mined in this region, and could bolster future mining activities in the area. Using the latest mine design software, our team has created a model of the deposit as well as a mine layout for surface infrastructure of the operation in order to optimize the selected mining method.

Automated Bolt Feeder

Team Members
Michael Carroll, Chris Doig, Jonathan Drake, Jerry Tozer, and Lauren Trump, Mechanical Engineering

Advisor
Aneet Narendranath, Mechanical Engineering-Engineering Mechanics

Sponsors
Fiat Chrysler Automobiles (FCA), Misumi, and ArcelorMittal

Project Overview
Our team has been working on a bolt feeder project for Fiat Chrysler Automobiles. Operators at one section of their assembly line are required to screw bolts to the engine. In the current process, they grab bolts from a container by hand, causing bolts to be dropped. This design will provide a place to drop the bolts off on the other side of the assembly line and then transport them to be sorted and dropped back over the line and into the operator’s hand in a repeatable sequence.

Galvanic Corrosion Reduction in an Aluminum Copper Couple

Team Members
Erik Bain, Thomas Korejsza, Eli Gooding, and Josh Ellis, Materials Science and Engineering

Advisor
Steve Kampe, Materials Science and Engineering

Sponsor
Yazaki North America

Project Overview
Due to federal Corporate Average Fuel Economy (CAFE) standards, the main goal of many automotive manufacturers and suppliers is to design and build lightweight vehicles. The use of aluminum conductors can reduce the weight of a wire harness by up to 48 percent. This project focuses on the issues of replacing copper conductors with aluminum. When aluminum and copper are in contact, differing potentials between aluminum conductors and copper connectors cause galvanic corrosion and reduce the lifetime of the product. By alloying aluminum with tin, the potential difference between aluminum conductors and copper connectors will be reduced. Doing so will mitigate corrosion and increase the lifetime of Yazaki’s products.
210  
Scaled Electrical Leak Location Solution

Testing the ES38 probe

Team Members
Charlie Stone, Nathan Bryant, and John Marsh, Electrical Engineering and Qinzhe Zhang, Computer Engineering

Advisor
Jeff Burl, Electrical and Computer Engineering

Sponsor
Electroscan Inc.

Project Overview
Electroscan has developed a method for leak detection in non-conductive water pipes (clay, PVC, concrete etc.) to replace traditional visual inspection methods. This is done by measuring electric current sent through defects in the pipe. Electroscan’s current technology is limited to a maximum of 30-inch pipes. Our task was to create a larger scale version of the current E-38 measurement probe, model the electric field of the device, and test the device. This design will expand capability to test pipe diameters from 30 to 60 inches.

211  
Exploring Friction Stir Back Extrusion

Initial test and validation of process

Team Members
Brandon Finney, Zachary Solka, and Alexander Holihan, Mechanical Engineering Technology

Advisor
Scott Wagner, School of Technology

Sponsors
ArcelorMittal and Michigan Technological University

Project Overview
Research in new and innovative manufacturing processes may require micro-tubes. Aluminum micro-tubes aren’t commercially available at the present time; therefore, the goal of this project is to develop and build a research fixture and tooling that allows the characterization of the friction stir-back extrusion process as well as the mechanical properties of the extruded tubes. A successful product/research fixture will allow the characterization of the friction stir-back extrusion process. Proper characterization will allow the process to be manipulated in such a way as to create micro-tubes with desirable mechanical properties.

212  
Visualization of the Biofilm Layer on Orthopedic Implants During Surgery

Peristaltic pump and reactor vessel used to grow biofilms in the lab

Team Members
Elizabeth Shumaker, Annaliza Hagman, Alanie Harmon, and Megan Petrich, Biomedical Engineering

Advisor
Megan Frost, Biomedical Engineering

Sponsors
Department of Biomedical Engineering and Dr. Jennifer Bow, Surgical Consultant

Project Overview
Our project involves the development of a method for orthopedic surgeons to visualize the biofilm layer present on the surface of infected orthopedic implants during typical hip and knee replacement revision surgeries. Biofilms are communities of bacteria embedded in a matrix of extracellular polymeric substances that present a high degree of robustness due to their three-dimensional, layered structure. This new method of visualizing these biofilms involves the use of a disclosing dye, similar to the type of disclosing dye used in children’s oral hygiene. The dye will make it easier for surgeons to effectively scrub away and remove the biofilm layer.
High Pressure Test Fixture Development

Team Members
Travis Redman, Matthew Tourville, Thomas Kivisto, and Thomas Koontz, Biomedical Engineering

Advisor
Sean Kirkpatrick, Biomedical Engineering

Sponsor
ACIST Medical

Project Overview
ACIST manufactures high-pressure contrast injection pumps and the high-volume disposable kits that go along with them. Our goal is to build a test fixture capable of pressure cycling at a rapid rate to simulate system use and should be customizable for different pressures and cycle settings. The pressure system will be used to test the syringe barrels in the disposable kits. This will aid in failure analysis as well as in design change verification and validation. It will also allow ACIST to resolve potential issues faster while also allowing for cost saving projects to be fully verified prior to implementation.

Sleep Apnea Device

Team Members
Nina Pacella, Emilee Philson, Nathan Dills, and Luke Schwerin, Biomedical Engineering

Advisor
Orhan Soykan, Biomedical Engineering

Sponsor
Michigan Technological University

Project Overview
Our team was tasked with improving sleep-assisting devices for patients with a mild form of obstructive sleep apnea. The desired device will maintain jaw protraction (forward jaw movement). This was found to increase the pharyngeal space, therefore increasing airflow to the patient. Viability is extremely important in this project because if the device does not provide enough force on the jaw to maintain protraction, it will be ineffective. There are many commercially available chinstrap devices to keep the mouth closed that could be incorporated into this device.

RAM Electrification and Idle Management

Team Members
Jared Brender, Tucker Alsup, Angela Rubeck, and Charles Quinn, Electrical Engineering

Advisor
Duane Bucheger, Electrical and Computer Engineering

Sponsor
Fiat Chrysler Automobiles (FCA)

Project Overview
The commercial trucking industry requires their vehicles to power electrical loads like work-site lighting, hydraulic pumps, and electric cranes. However, the industry also seeks to reduce operating costs by reducing engine idle time. Our team seeks to develop a software model that determines optimal additional energy storage capacity while maximizing fuel savings. A Ram 4500 truck was fitted with a battery pack of varying energy storage capability. A series of low and high load power and fuel consumption tests were performed in order to see the effects of the additional batteries. The results of this project will aid in future vehicle battery design and show the effectiveness of the idle-off power strategy.
216 Silicon Reduction in E357 Aluminum Alloys

Mold designed by our team to test fluidity and hot-tear resistance

Team Members
Tessa Burgess, Karl Freier, and Nathaniel Wickliff, Materials Science and Engineering and Riley Hart, Mechanical Engineering

Advisors
Tom Wood and Russ Stein, Materials Science and Engineering

Sponsor
Eck Industries

Project Overview
Our project focuses on reducing the amount of silicon in the E357 aluminum alloy. The target of this reduction is to increase ductility from two percent to five percent, which will make the alloy more versatile. While reducing the silicon, the castability properties, such as hot tear resistance and fluidity, must be maintained.

217 Residual Stresses in Steering Racks and Impacts to Bending Fatigue Performance

Steering rack

Team Members
Matthew Pscheid, Mechanical Engineering and Daniel Casciani, Bryan Stout, John Gatewood, Anthony Orza, and Connor Knudson, Materials Science and Engineering

Advisor
Dan Seguin, Materials Science and Engineering

Sponsor
ZF TRW—ZF Friedrichshafen AG

Project Overview
Residual stresses are known to have an effect on the fatigue life of steels. Our project involves characterizing the magnitude of surface residual stress of a mild steel. These values will then be related to fatigue life in order to justify enhancements to the product and manufacturing process. Our teams used X-ray diffraction (XRD) to determine the presence of residual stresses. Testing consists of at least three samples from each location of the manufacturing process. A residual stress versus fatigue life curve is used to relate the two properties. Possible countermeasures will be presented to the sponsor if any of the manufacturing process steps are discovered to produce residual stresses.

218 Epicardial Pacemaker Fixation

The Epicardial Pacemaker Fixation team

Team Members
Joe Nugent, Kate Boyles, Beth Sickles, and Dani Blake, Biomedical Engineering

Advisor
Rupak Rajachar, Biomedical Engineering

Sponsor
Medtronic

Project Overview
Our team will design and prototype a mechanism to fixate a 1 cc pacemaker to the left ventricle epicardial layer of the heart. The method must be compatible with a delivery tool that can be used to deploy, position, and attach the pacemaker through a subxiphoid incision, and the method must allow for the pacemaker to be repositioned. Key reasons for developing this technology are the greater benefit that heart failure patients may have from attaching a pacemaker to the left side of the heart and the reduced risk of thrombus due to removing the pacemaker from the bloodstream.
Optimization of Machinability for 15-5PH Stainless Steel

Team Members
Dylan Cromell, Amanda Messina, and Olin Johnson, Materials Science and Engineering

Advisor
Dan Seguin, Materials Science and Engineering

Sponsor
GE Aviation

Project Overview
GE Aviation is using 15-5 PH stainless steel on the edge of their composite fan blade rather than the previously used titanium alloys. Due to the relatively rare nature of 15-5 PH in industry, GE has limited knowledge on the steel. The 15-5 PH alloy must be machined to fit the composite fan blade. Our team is conducting an investigation of the microstructure and heat treatments of the alloy to gain an improved understanding of the steel. This was all done to enhance the machinability and is measured by tool wear as a function of time.

Utility UAV—Specification Performance Team

Team Members
Shayle Murray and Obdiel Pesina, Computer Engineering, Jon Phillips and Spencer Leivo, Electrical Engineering, and Ricardo Gonzalez Rodriguez, Mechanical Engineering

Advisor
Duane Bucheger, Electrical and Computer Engineering

Sponsor
ITC Holdings Corp.

Project Overview
An unmanned aerial vehicle (UAV) outfitted with a payload of suitable inspection equipment could reduce the environmental impact of utility inspection activities, shorten the time needed in difficult-to-access locations, and reduce the costs associated with transmission infrastructure inspection. An opportunity exists to assess the ability of commercially available UAVs to perform infrastructure inspections utilizing an inspection payload package. Our team is preparing a procurement specification detailing the UAV requirements needed to perform infrastructure inspection versus performance, including maneuverability and flight time. We are also developing methods that maximize the UAV functionality within the constraints of FAA regulation. We are also working to optimize UAV energy consumption and safe weather conditions operation by establishing UAV inspection protocols.

Corrosion Mitigation of 90-10 Cu-Ni Heat Exchangers

Team Members
Tyler Gould, Adam Pringle, and Michael Oyervides, Materials Science and Engineering and Laura Gazza, Materials Science and Engineering and Biomedical Engineering

Advisor
Cam Hadden

Sponsor
DTE Energy

Project Overview
DTE Energy is aiming to improve the lifespan of heat exchanger tubing. When 90-10 Cu-Ni was installed, it corroded via pitting, causing failure within two years. Our team has identified the source of pitting in the 90-10 Cu-Ni utilizing literature and confirmed the results with replicate corrosion testing. Several corrosion tests were performed on potential alternative materials in order to determine the optimal material for the system. This led to the determination of a recommended material for DTE Energy to use, including all precautions that must be taken with the proposed material.
222
Optimum Cooling Rate of Chill Cast Aluminum for Automotive Structures

Team Members
Emily LaPine, Conor Cocking, and Nate Peterson, Materials Science and Engineering

Advisor
Paul Fraley, Materials Science and Engineering

Sponsor
Fiat Chrysler Automobiles (FCA)

Project Overview
Within the automotive “Body in White” structure, crush zones are utilized to make the frame deform in known ways when impacted. The materials for these zones need to be able to maintain minimum strength while also demonstrating high ductility. Replacing the current material with an aluminum alloy will reduce the weight of the vehicle and improve fuel economy. Utilizing chill casting and aluminum alloys (5xxx, 6xxx, and 7xxx series), these properties can be optimized for this application.

223
Traveling Wave Fault Location

Team Members
Kevin Schoenknecht, Jacob Marshall, and Troy Johnston, Electrical Engineering

Advisor
John Lukowski, Electrical and Computer Engineering

Sponsor
American Transmission Co. (ATC)

Project Overview
The team’s goal is to use travelling wave fault location technology to accurately predict where a fault has occurred on an ATC transmission line. The SEL-411L relay is capable of recording times when traveling waves, which are created by a fault, arrive at the relay. This should allow ATC to identify the causes of faults faster, resulting in reduced outage times and shorter, more cost-effective investigations. The team needed to design a panel to store the SEL-411L relay and its related components. The team also worked on developing a procedure for the implementation and use of the panel.

224
Blubber-Only Implantable Satellite Tag Anchoring System

Team Members
Megan Ahnen, Rachel Altscheffel, Caleb Vogt, and Danielle Wick, Biomedical Engineering

Advisors
Rupak Rajachar and Bruce Lee, Biomedical Engineering

Sponsors
Biomedical Engineering Department and the Office of Naval Research

Project Overview
The tracking of whale migration and movements are done through satellite telemetry tags to provide researchers information about humpback whale ecology and conservation. However, current tag designs are falling out prematurely after only 2-3 months. Furthermore, tissue swelling and muscle trauma are frequently observed at the implantation site. There is a need for a new anchoring system for attaching tracking devices to humpback whales to address these issues. Our team is developing a tag that transmits data to a satellite. These tags must stay on the whales long enough for researchers to gather the appropriate data.
**NC16W Nickel-Based Superalloy Characterization**

**Team Members**
Joshua Krugh, Sara Schellbach, Katherine Fletcher, and Anna Polk, Materials Science and Engineering

**Advisor**
Dan Seguin, Materials Science and Engineering

**Sponsor**
Alcoa Howmet

**Project Overview**
NC16W is a nickel-based superalloy selected by Alcoa Howmet to replace the current Super 22H® material utilized for furnace trays. NC16W was chosen based on potential improved material properties, which will be applied in Alcoa Howmet’s new state-of-the-art facility. The trays experience high stress levels and undergo cyclic heating with temperatures up to 2250°F, which ultimately leads to undesired mass loss due to oxidation. The trays are replaced after approximately 50 percent mass loss leading to higher costs. Our team characterized the material properties of NC16W in order to economically justify the choice of replacing Super 22H®.

---

**Transcatheter Single Ventricle Device for Treatment of Hypoplastic Left Heart Syndrome**

**Team Members**
Amani Gillette, Esther Gilliland, Roger Guillory, and Patrick Malone, Biomedical Engineering

**Advisors**
Jeremy Goldman and Feng Zhao, Biomedical Engineering

**Sponsors**
Helen DeVos Children’s Hospital and Spectrum Health Innovations, LLC

**Project Overview**
Each year about 960 infants are born with hypoplastic left heart syndrome, a congenital heart defect that results in a severely underdeveloped heart. Four surgeries are needed to fix the defect, the first of which involves stenting of the ductus arteriosus and pulmonary artery banding. Due to the invasive nature of this first procedure at such an early developmental stage, an alternative method is desired to minimize the risk to the infant. Our team has begun development of a device that will help minimize risk while keeping the ductus arteriosus open and reducing the pressure of blood flow to the lungs.

---

**Railroad Car Wheel Contamination Detection**

**Team Members**
Dylan Etelamaki and Wayne Helminen, Electrical Engineering and Josh Manela and Joel Yauk, Computer Engineering

**Advisor**
Duane Bucheger, Electrical and Computer Engineering

**Sponsors**
Norfolk Southern Corporation and Michigan Tech Rail Transportation Program/NURail Center

**Project Overview**
A hump yard is used in the rail industry to separate incoming railroad cars onto one of several outgoing tracks. The lead track into the yard is built over a hump. The railroad cars are uncoupled at the crest of the hump and use gravity to roll to their designated track. A track-mounted, mechanical brake called a retarder regulates the speed of the uncoupled cars. The retarder’s ability to control the speed of an uncoupled railroad car is occasionally compromised due to contaminants on the wheels. Our team is developing a way to identify contaminated wheels and alert yard personnel prior to decoupling at the crest of the hump.
228
Manipulative Models

Team Members
Jack Piper and Tyler Sobers, Mechanical Engineering Technology

Advisor
John Irwin, School of Technology

Sponsors
ArcelorMittal and Michigan Technological University

Project Overview
The School of Technology is in need of manipulative models based on different dynamic mechanisms for use in the mechanical engineering technology laboratory. These mechanisms and models will recreate typical textbook problems in order to further student education by allowing students to visually see what is occurring within each problem. Our objective is to design, build and create virtual simulations of as many of the listed mechanisms as possible. Each mechanism will have a physical model as well as a simulation using 3D modeling software. Both the physical model and simulation will represent the problem at hand and will output data that can be used to solve it.

229
Implantable Bluetooth Low Energy (BTLE) Device

Team Members
Alex Benson, Tyler Jubenville, Nick Jones, and Joe Kristofik, Biomedical Engineering

Advisors
Orhan Soykan and Keat Ghee Ong, Biomedical Engineering

Sponsor
Medtronic

Project Overview
Bluetooth Low Energy (BTLE) is a low cost, low power specification of the Bluetooth wireless communication protocol. This makes it ideal for use in medical applications such as a patient-controlled, pain moderation device. Sponsored by Medtronic, our team seeks to evaluate the efficacy of BTLE as an implantable interface. The project goals are to evaluate factors such as bit-error rate and signal attenuation. This knowledge will aid in future research into the efficacy of BTLE as an implantable interface.

230
Ford Transmission Efficiency Team

Team Members
Zach Lemke, Trever Denstaedt, Mitchell Coder, Matt Peltier, and Mikhail Putintsev, Mechanical Engineering

Advisor
Kevin Johnson, Mechanical Engineering-Engineering Mechanics

Sponsors
Ford and ArcelorMittal

Project Overview
The Environmental Protection Agency (EPA) is raising the current standard for fleet-wide fuel efficiency to 34.5 miles per gallon for 2016, and to 54.5 miles per gallon by 2025. To meet these requirements, manufacturers will have to reduce losses in various drivetrain systems. Our team, working with Ford, was tasked with designing a transmission testing setup to be used for testing Ford’s 6f-35 front-wheel-drive transmission. It has been designed for a no-load spin test to measure the torque that is required to spin the transmission in different gears and speed ranges. This testing apparatus will help in measuring the effectiveness of changes made with the design of the transmission to improve efficiency.
Ungrounded System Protection

Team Members
David D’Ambrosio, Jake Hardin, Grant Hurford, and Jordan LaFontaine, Electrical Engineering

Advisor
John Lukowski, Electrical and Computer Engineering

Sponsor
DTE Energy

Project Overview
DTE Energy has decided to apply grounding transformers to their 4800V ungrounded distribution system. Our design team is using ASPEN software to model DTE Energy distribution circuits and analyze potential solutions for this project. Faults of various impedances are applied at different locations on the circuit and tests are run to find the most accurate and reliable means of grounding an ungrounded 4800V delta system. Our project goal is to provide a case study of electrical characteristics, reliability criteria, and an economic analysis of the selected test circuits, along with gaining a higher understanding of grounded and ungrounded distribution systems.

Surf’s Up Buoy

Team Members
Jennifer Pilibosian, Sean Minch, and Jason Weaver, Mechanical Engineering and Cody Helson, Electrical Engineering Technology

Advisors
David Wanless and Ted Anderson, School of Technology

Sponsor
Great Lakes Research Center

Project Overview
There are times in the year when the GLRC research buoys cannot receive power, typically during storms. This is because the sole source for energy is collected through solar panels. The goal of our project is to find a way to convert wave energy into electricity within the size constraints of the buoy while providing adequate power to on-board systems. This will provide a constant source of power for all on-board research equipment.

Hand Cycle Frame Design

Team Members
Charlie Davis, Jacob Gefroh, Wil Jakeway, Alexander Niemi, and Donald Rogers, Mechanical Engineering

Advisor
Antonio Gauchia, Mechanical Engineering-Engineering Mechanics

Sponsors
General Motors and Achilles International

Project Overview
Our team is designing and prototyping an improved hand cycle frame, focusing on integrating 700c rear wheels into an Invacare Force RX frame. Currently, replacement parts for hand cycles are not readily available, have higher associated costs, and can require custom wheel builds. Existing manufacturers offer only threaded rear axles, similar to those used in wheelchairs, limiting the range of compatible wheel types. A frame re-design is needed on the Top End Force RX model to accommodate a wider use of more readily available parts. Project Achilles Freedom is in need of a more competitive race cycle to enable disabled veterans to pursue racing. As the sport is becoming more competitive, faster and lighter designs of hand cycles are needed.
Jeep Wrangler JK: Smart Direct Air Exhauster

Team Members
Neil Feliksa, Derek Grogg, Kayla Branton, Victoria Kovach, and Andrew Ross, Mechanical Engineering

Advisor
Antonio Gauchia Babe, Mechanical Engineering-Engineering Mechanics

Sponsors
Fiat Chrysler Automobiles (FCA), Christopher Duke

Project Overview
Fiat Chrysler Automobiles has tasked our team with providing a fresh design and prototype of a new, automotive smart direct air exhauster (SDAE) for mitigating the effects of air bind in door closing effort (DCE). This device is designed for the JK Jeep Wrangler, two-door hardtop model. The Jeep Wrangler JK (2007–present, as well as past models), have classically suffered from high DCE. The successful implementation of an effective SDAE on the two-door JK Wrangler hardtop will help boost sales, improve customer satisfaction, and maintain the high quality reputation of the Jeep brand.

Forestry and Environmental Resource Management (FERM)

Team Members
Kollin Long, Devin Kohn, Mitchell Beach, Brian Martell, Nia Becker, and Michelle Gross, Forestry

Advisor
James M. Schmierer, School of Forest Resources and Environmental Sciences

Sponsor
School of Forest Resources and Environmental Science

Project Overview
Our team of forestry and applied ecology students work with faculty, staff, and an advisory committee to implement sustainable resource management plans developed by other students on the School Forest lands. This work is done through the Forestry and Environmental Resource Management (FERM) program, which is designed to provide a variety of hands-on experiences in realistic field and management settings that incorporate research and conservation objectives. Our specific activities include marking timber and sale preparation in Ford Forest Unit 1, jack pine growth and biomass sampling in Units 22 and 23, and sawing and strength/stiffness testing of Pinus ponderosa timbers for a bridge.

AFRL Rapid Descent System

Team Members
Ashley Pedrotte, Alec Getchel, Jen Holthouse, Jarad Weeks, Arthur Kangas, and Nalani Taniguchi, Mechanical Engineering

Advisors

Sponsor
Air Force Research Lab (AFRL)

Project Overview
Our team is working to design an apparatus that will improve the descent of United States Air Force (USAF) Special Operations Force (SOF) personnel from medium and heavy lift helicopters, and tilt rotor aircraft from altitudes in the range of 20–90ft. The design must safely, rapidly, and effectively move personnel to the ground so that they are ready to complete their mission.

Performing a door closing effort (DCE) test on a JK Jeep Wrangler

Tilly Behrmann (l) and Brian Martell (r) prune trees at Mont Ripley for a FERM partnership project in urban forestry and arboriculture.
Stryker High Speed Drill Collet

Team Members
Shane Blystone, Austin Ross, Phillip Romback, and Tessa Jagger, Mechanical Engineering and Sarah Skelton, Biomedical Engineering

Advisor
William Endres, Mechanical Engineering-Engineering Mechanics

Sponsor
Stryker Instruments

Project Overview
Our team is designing a new collet that will be able to securely grip Stryker’s new geometry on the company’s cutting accessory while being able to fit within the constraints of the S2 drill attachments. The goal would allow Stryker’s customers to continue using their current S2 drill without having to spend the capital to upgrade to the latest drill models. The collet uses ceramic balls to secure the geometry on the cutting accessory. The collet will be operating in a cutting attachment connected to Stryker’s high speed drills, used for neurosurgeries, spinal surgeries and E.N.T (ear, nose, and throat) surgeries to cut and remove bone.

Proposed design of new collet

Split Hopkinson Pressure Bar Launch Mechanism

Team Members
Korey Erickson, Chet Daavettila, Timothy Daavettila, Joel Larson, and Steven Helminen, Mechanical Engineering

Advisor
Kevin Johnson, Mechanical Engineering-Engineering Mechanics

Sponsor
REL, Inc.

Project Overview
Our goal is to design, build, and test a new launching mechanism to be used for Split Hopkinson Pressure Bar (SHPB) testing. The current striker bar launching method used by REL Inc. for SHPB testing has safety limitations, is inefficient, and does not provide the desired levels of test repeatability. This project is important for REL, Inc. as an industry leader in SHPB testing and manufacturing to design the safest, most efficient, and accurate striker bar launching mechanism for their customers.

Current gas gun launcher used by REL

Utility UAV—Inspection Interface Team

Team Members
Joel Cherney, Eric Parsell, and Nopparuj Saipong, Computer Engineering and Linas Templeton, Electrical Engineering

Advisor
Trever Hassell, Electrical and Computer Engineering

Sponsor
ITC Holdings Corp.

Project Overview
Our team is designing a system of sensors that attaches to a drone to provide the ability for ITC line inspection teams to collect and interpret inspection data in a straightforward, safe, timely, and cost effective manner. Our system provides specific sensor packages, gimbal, visual light video transmission and recording, IR light video transmission and recording, and a prototype build.
Senior Design

240 Oil Chip Separator

A 3D model of the proposed system alpha prototype

Team Members
Hunter Hamlin, Jacob Schoff, Stefano Michaud, Jacob Grobbel, and Ryan Werner, Mechanical Engineering

Advisor
William Endres, Mechanical Engineering-Engineering Mechanics

Sponsors
MacLean-Fogg and ArcelorMittal

Project Overview
MacLean-Fogg requires a device to process and separate metal shavings from the oil used as a lubricant in the cutting process. The current process requires a grinder that is often damaged by errant parts in the waste stream. Our team developed a trommel-based system that no longer requires a grinder and is not affected by errant parts. Oily chips are fed into a four-foot diameter, eight-foot long rotating drum. The chips are agitated by the rotation while being sprayed with hot water. The oil and water is collected in a tank so that it can be separated and the oil can be reused.

241 Tire Tread Extrusion Simulation

Die swell of the extruded tread

Team Members
Sukaina Miftah, Elizabeth Beauvais, Michael Kosut, and Joshua DeVet, Materials Science and Engineering

Advisor
Dr. Jiann-Yang Hwang, Materials Science and Engineering

Sponsor
Continental Tire Company

Project Overview
When meeting design specifications during tire extrusion development, the experience-based method typically used is associated with a loss of time and money. PolyXtue, an extrusion simulation tool, properly identifies properties and components that affect rubber flow during extrusion, by simulating 3D flow of polymer compounds through an extrusion die. This tool is used to optimize the geometry, processing conditions and material selection of extrusion. Through the use of PolyXtrue, our team has developed a tread tire extrusion simulation that accurately models the tread tire extrusion created by Continental Tire Company. The extrusion simulation predicts the tread tire developed under specific processing conditions and die shape.

242 Unassembled Wheelnut Detection System

System concept to sort two-piece unassembled wheel nuts

Team Members
Corey Bakker, Ryan Connor, Ian Hufford, Kevin Miller, and Nicole Wright, Mechanical Engineering

Advisor
Kevin Johnson, Mechanical engineering-engineering Mechanics

Sponsors
MacLean-Fogg and ArcelorMittal

Project Overview
Metform, a division of MacLean-Fogg, produces over 24 million, 2-piece wheelnuts each year. The manufacturing process includes various coating and tumbling operations during which a small percentage of the wheelnuts become unassembled. With offline sorting unavailable, the unassembled parts continue to packaging and end up in the customer’s hands. The goal of our project is to develop an in-line sorting system that meets current production requirements. These requirements include maintaining a non-continuous operating speed, handling oily parts, meeting workplace safety standards, correctly identifying and rejecting non-conforming parts, and having the ability to bypass other part numbers.
Driveline NVH Improvement

Team Members
Alexandria Bonner, Nathan Campbell, Joshua Esch, Neal Magnuson, and Sylvie Rokosh

Advisor
James DeClerck, Mechanical Engineering-Engineering Mechanics

Sponsor
Ford Motor Company

Project Overview
Driveline vibration has been a source of customer dissatisfaction combined with a perceived loss of quality in automobiles. Methods and techniques to reduce driveline vibration have lacked innovation over the past few decades, creating the urgency for new technologies to be developed. To improve customer satisfaction, our team has designed a new method of damping that is compatible with Ford Motor Company’s automobiles. Our method gives Ford an opportunity to innovate a concept and stay ahead of the competition in similar markets.

Titanium Tow Hook

Team Members
Evan Halloran, Jordan McInnis, Donald Keller, Korey Keipe, and Zachary Mauerman, Mechanical Engineering

Advisor
Antonio Gauchia Babe, Mechanical Engineering-Engineering Mechanics

Sponsor
Fiat Chrysler Automobiles (FCA)

Load measurement device concept

Three-Point Hitch Load Measurement System

Team Members
Zachary Chenier, Travis Claus, Jordan LaCombe, Bethany Schaefer, and Patrick Ylitalo, Mechanical Engineering

Advisor
Eddy Trinklein, Mechanical Engineering-Engineering Mechanics

Sponsor
John Deere

Project Overview
Our team is working with John Deere to design and build a three-point quick hitch that will measure the dynamic load fluctuations between a tractor and its implement during use. The current methods include the use of strain gauges and pin load cells which require complex calibration and custom manufacture. Our new design offers the ability to use off-the-shelf load cells that offer easy calibration and are readily available.
246 Surgical Power Tool Hub Interface Redesign

Team Members
Dean Halonen, Paul St. Louis, Dave Hancock, Zach Andres, and Bradon Kampstra, Mechanical Engineering

Advisor
William Endres, Mechanical Engineering-Engineering Mechanics

Sponsor
Stryker Instruments

Project Overview
Our team is redesigning the ESSx Microdebrider for Stryker Instruments to eliminate leakage from the tool hub interface, improve tool tip rigidity, and make the tool interchange process more user friendly.

247 Axial Worm Gear Damper

Team Members
Michael Baskins, Jonathan Eddy, Justin Lichtenwald, and Andrey Sergeyev, Mechanical Engineering and Nathaniel Evenhouse, Electrical Engineering and Mechanical Engineering

Advisor
James DeClerck, Mechanical Engineering-Engineering Mechanics

Sponsor
Nexteer Automotive

Project Overview
Our project entails creating a worm gear damper to reduce noise, vibration, and harshness (NVH) in a Nexteer electrical column assist power steering system. The damping unit needs to have the capability to improve steering lag on smooth roads while being compliant on rough roads in order to reduce NVH felt by the driver via the steering system. The unit must be compliant enough in all situations to protect the assisting worm/worm gear interface from short and long-term damage. Nexteer has also set limits on unit dimensions, electrical power usage, and many other design aspects.

248 Mercury Marine Flywheel Imbalance Measurement System

Team Members
Aaron Schneider, Ann Silski, Jenna Seaser, Matthew Palo, and Owen Marttila, Mechanical Engineering

Advisor
James DeClerck, Mechanical Engineering-Engineering Mechanics

Sponsor
Mercury Marine

Project Overview
Current industry techniques relating to measuring the balance of a spinning mass, in this case a flywheel, are not adequate because of the lack of repeatability and inconsistent data. Our team was asked not to balance a flywheel, but rather to provide an operator with a tool to measure the imbalance value and a radial vector on which the imbalance is located. Our project arose when it appeared that flywheels being received by Mercury Marine did not actually meet the specifications set forward in their technical drawings. One of our goals is to approach this problem from a different standpoint through fresh eyes.
**249 Mobile Lab**

Team Members
Dakota Oparka, Kristen Florence, Steven Sencyszyn, Caroline Major, Ryan Engman, Justin Mueller, and Foster Hovey, Mechanical Engineering

Advisor
Aneet Narendranath, Mechanical Engineering-Engineering Mechanics

Sponsor
Department of Biological Sciences

Project Overview
Our goal is to create a mobile gas chromatography lab that can be used by the Biological Sciences Department to examine nitrogen content in rivers and streams all around the United States. The lab is to be designed inside of a 2015 Ford Transit Van and must include sleeping arrangements. Space, power and safety are all major factors, as the lab needs to store tanks and run lab equipment, as well as allow an individual to work comfortably inside.

**250 Cummins Fuel Injector Nozzle-Plunger Automated Match-Fit Process**

Team Members
Tyler Childress, Nathan Karlsrud, Ethan Marshall, Matt Neutkens, Casey Olson, and Zhi Wang, Mechanical Engineering

Advisor
Aneet Narendranath, Mechanical Engineering-Engineering Mechanics

Sponsor
Cummins

Project Overview
Cummins’ current process of manually match-fitting fuel injector plungers and nozzles involves heavy human interaction. Operators are required to test and transport the parts through many steps in the current match-fitting process. Cummins believes that this process could benefit from automation. Our project includes a full CAD package and bill of materials for the design accompanied by a return on investment report. Our team implemented lean manufacturing principles to remove non-value-added steps from the process. We created a match-fitting simulation to perform design validation and optimize storage design. The simulation is capable of outputting process time, part counts and match dimensions when input with individual part data.

**251 Fiat Chrysler Automotive Engine Assembly Pallet Cleaner**

Team Members
Joshua Olsen, Derek Stone, Kurt Siebenaller, Jacob Bailey, Keith Lewis, and Erik Lemmen, Mechanical Engineering

Advisor
Eddy Trinklein, Mechanical Engineering-Engineering Mechanics

Sponsors
Fiat Chrysler Automobiles (FCA) and ArcelorMittal

Project Overview
Our project involves the design and construction of an engine block assembly line pallet cleaning station for Fiat Chrysler Automotive’s (FCA) Mack Avenue Engine Plant. Most cleaning stations are expensive, and do not add value to the end product, and are therefore cut out from manufacturing lines. FCA wanted an innovative, cost-efficient solution for this problem. Our team developed a design that meets all of FCA’s design requirements and constructed a prototype to demonstrate the functionality of our design.
Piezo-Actuator Design—Phase 2

Project Overview
The main goal of our project is to create a bone-sculpting tool that operates at low frequencies for use in minimally-invasive surgeries and is powered by piezoelectric stacks. The project is a continuation of a previous senior design project sponsored by Stryker Instruments. Our team tested numerous cutting accessory tips along with a test fixture to evaluate the cutting tips. We also created a graphical user interface, improved the circuit board, and incorporated a power supply.

Team Members
Brad Vinckier, Jeff Halonen, and Luke Heller, Mechanical Engineering and William Weaver, Computer Engineering
Advisor
William Endres, Mechanical Engineering-Engineering Mechanics
Sponsor
Stryker Instruments

Nexteer HiL Design

Project Overview
Currently much of the EPS (Electric Power Steering) system software testing and evaluation is performed in a vehicle undergoing multiple driving maneuvers. This approach can only find problems late in the development cycle when they are expensive to fix. With HiL testing, there exists an ability to evaluate the EPS controller performance in multiple driving maneuvers before the hardware or vehicle is available. Our team projects is focused on saving in-vehicle check-out time and resources as well as increasing the number of test conditions evaluated, to create an overall improvement in quality of the delivered EPS system.

Team Members
Andrew Higginbotham and Noah Payne, Computer Engineering and Adam Cain, Electrical Engineering
Advisor
Jeff Burl, Electrical and Computer Engineering
Sponsor
Nexteer Automotive

Foundry Effects on Brake Rotor Frequency Response Function

Project Overview
Squealing brake systems are an annoyance to drivers and cost GM money through manufacturing inspection and warranty claims. GM suspects that brake squeal is linked to the frequency response function (FRF) of cast brake rotors and is seeking foundry practice, which yields rotors with a consistent FRF. Our team produced gray iron castings in the foundry at Michigan Tech for use as test material. This material was analyzed through a series of mechanical, vibration, and metallographic tests. Our team used the results of these tests to provide GM with recommendations on foundry practice, which will better control the FRF’s of gray cast iron brake rotors.

Team Members
Brian Brook, Mechanical Engineering and Nicole Treinen, Materials Science and Engineering
Advisor
Russ Stein, Materials Science and Engineering
Sponsor
General Motors Company
Positive Energy

At American Transmission Co. there is a special energy among employees – a positive energy. Our employees like it here. In fact, we were named a Best Small and Medium Workplace in the United States by FORTUNE magazine for the past two years. If a great workplace with a positive energy sounds good to you, check out our job openings at atcllc.com/careers.

AtC CAREERS

ATC owns, builds, maintains and operates the electric transmission system in portions of Wisconsin, Michigan, Minnesota and Illinois. We have offices in Pewaukee, Madison and De Pere, Wis., and Kingsford, Mich.

ATC is an equal opportunity employer functioning under an affirmative action plan. We encourage women, minorities, veterans and individuals with a disability to apply.

WE DO THINGS A LITTLE DIFFERENT AT CODE BLUE.

The passion we put into our products, our relentless dedication to safety and the personal service and support we provide has earned the respect and trust of millions of people around the world.

That same spark can be found at Design Expo 2016, which is why Code Blue is proud to support Michigan Tech’s Senior Design teams.

Code Blue. We are Security.
Miller® is about building things that matter. We lead the welding industry in building advanced, solution-focused products and meeting crucial needs for welding safety and health. We’re about the partnership and the work. Our products are designed with our users for manufacturing, fabrication, construction, aviation, motorsports, education, agriculture and marine applications. Miller Electric Mfg. Co., is headquartered in Appleton, Wisconsin, and wholly owned by Illinois Tool Works (NYSE: ITW). The company maintains its industry leadership by setting the standard for reliability, quality and responsiveness. The company began with an innovation that responded to customer needs, growing from a one-man operation in 1929, to the world’s largest manufacturer of arc welding products. Miller keeps the tradition alive by focusing on its top priority: people. Learn more at Millerwelds.com.
WE IGNITE PASSION
WE BELIEVE THAT SUCCESS IS DETERMINED BY MORE THAN A NUMBER. IT’S ALSO MEASURED BY YOUR CHARACTER, YOUR ACTIONS, AND THE WISDOM YOU DEVELOP ALONG THE WAY.

IN ORDER TO EXPERIENCE THE JOURNEY
WE CHOOSE TO BELIEVE IN EACH OTHER.

PUSH OURSELVES INTO UNEXPECTED PLACES, CROSS BOUNDARIES, DEMONSTRATE COURAGE & FORGE NEW CONNECTIONS.

TRAVELING TOGETHER
WE GO FURTHER
WRITE YOUR OWN STORY, THEN SHARE IT. CAPTURE THE SIGNIFICANCE, REFLECT ON THE MEANING.

BELIEVE IN POSSIBILITIES, NOT IMPOSSIBILITIES.

ENCOURAGE THE UNEXPECTED
DO IT • LIVE IT • BECOME IT

MICHIGAN TECHNOLOGICAL UNIVERSITY PAVLIS HONORS COLLEGE
At Michigan Tech we believe that a student’s success is measured by more than GPA, and within the Pavlis Honors College, we are redefining honors education to reflect this belief.

Here, honors education is about the self-motivated, independent-thinking student who takes charge of their education and full advantage of all that Michigan Tech has to offer.

In our programs, students design their own path through the honors program that expands their learning outside the classroom to strategically support their personal and professional goals.

Through interdisciplinary collaboration, experiential learning, and deliberate reflection, we address society’s need for thoughtful, passionate, authentic students who will go on to positively impact the world as innovative scholars and leaders.
Reliable, modernized grid

Energy is essential to the way we live, work and play.

ITC operates, builds and maintains the region’s electric transmission infrastructure. We’re a Michigan-based company working hard to improve electric reliability and increase electric transmission capacity throughout the Midwest.

We’re ITC – your energy superhighway.
Michigan Technological University fosters an environment of industry collaboration and partnership by providing innovative solutions for talent, research, technology, and professional development.

The Office of Innovation and Industry Engagement helps connect the strategic interests of your organization to the appropriate campus programs and constituents, including research, facilities, continuing education, student and alumni talent, and strategic giving opportunities.

Learn more by visiting www.mtu.edu/industry

Contact us:
Office of Innovation and Industry Engagement
906-487-2228 • industry@mtu.edu • www.mtu.edu/industry
YOU MAY NOT SEE US AND WE’RE OKAY WITH THAT.

In fact, we take pride in it.

At Black & Veatch we work with our clients to design, build and operate the things that deliver the energy, water and communications services you use every day.

So, when you turn on a light, the tap or use your smart phone, chances are we’re behind it. And everything will work just like we planned and how you expect.

Visit [bv.com/careers](http://bv.com/careers) to learn more.
## Acknowledgements

A HUGE thank you to all Design Expo 2016 Partners and Sponsors

<table>
<thead>
<tr>
<th>Directing Partner</th>
<th>Supporting Partner</th>
<th>Collaborating Partners</th>
<th>Innovating Partners</th>
<th>Enterprise and Senior Design Team Sponsors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Code Blue</td>
<td>Miller Electric</td>
<td>ACIST Medical Systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kimberly-Clark</td>
<td>Plexus</td>
<td>Advanced Sleeve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Michigan Tech Office of Innovation and Industry Engagement (IIE)</td>
<td>Alexander Technologies</td>
<td>Air Force Research Lab (AFRL)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Altair</td>
<td>Alcoa Howmet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Arconics</td>
<td>Arconor Mittal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Aspirus Kewenaw</td>
<td>Arctic Cat</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bow, Jennifer, MD—Surgical Consultant</td>
<td>Argonics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Camso</td>
<td>Aspirus Kewenaw</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Carnahan, Robert, PhD</td>
<td>Bow, Jennifer, MD—Surgical Consultant</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Caterpillar Inc.</td>
<td>Camso</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CN Rail</td>
<td>Carnahan, Robert, PhD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Continental Corporation</td>
<td>Caterpillar Inc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cummins</td>
<td>CN Rail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Curtis Autopro</td>
<td>Continental Corporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DENS0</td>
<td>Curtis Autopro</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Donald Engineering</td>
<td>DENS0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DTE Energy</td>
<td>Donald Engineering</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Eck Industries</td>
<td>DTE Energy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Electrosan Inc.</td>
<td>Eck Industries</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EMS</td>
<td>Electrosan Inc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Expera Specialty Solutions</td>
<td>EMS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FEV North America</td>
<td>Expera Specialty Solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fiat Chrysler Automobiles (FCA)</td>
<td>FEV North America</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fives Cinecorporation</td>
<td>Fiat Chrysler Automobiles (FCA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ford Motor Company</td>
<td>Fives Cinecorporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gates Corporation</td>
<td>Ford Motor Company</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GE Aviation</td>
<td>Gates Corporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>General Motors Company</td>
<td>GE Aviation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gerdau</td>
<td>General Motors Company</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Great Lakes Sound and Vibration</td>
<td>Gerdau</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Halla-Mechatronics</td>
<td>Great Lakes Sound and Vibration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HB Performance Systems, Inc.</td>
<td>Halla-Mechatronics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Helen DeVos Children’s Hospital</td>
<td>HB Performance Systems, Inc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Highland Copper</td>
<td>Helen DeVos Children’s Hospital</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HMK USA</td>
<td>Highland Copper</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HONEYBEE Robotics</td>
<td>HMK USA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Industrial Graphics</td>
<td>HONEYBEE Robotics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ITC Holdings Corp.</td>
<td>Industrial Graphics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>JLG Industries, Inc.</td>
<td>ITC Holdings Corp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Deere and Company</td>
<td>JLG Industries, Inc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ka-Wood Gear and Machine Co.</td>
<td>Deere and Company</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Keweenaw Economic Development Alliance</td>
<td>Ka-Wood Gear and Machine Co.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(KEDA)</td>
<td>Keweenaw Economic Development Alliance (KEDA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kyocera</td>
<td>Kyocera</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MacLean-Fogg</td>
<td>MacLean-Fogg</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Magna Seating Detroit</td>
<td>Magna Seating Detroit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Materialise</td>
<td>Materialise</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Medtronic</td>
<td>Medtronic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mercury Marine</td>
<td>Mercury Marine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Meritort</td>
<td>Meritort</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Michigan Department of Agriculture and Rural Development (MDARD)</td>
<td>Michigan Department of Agriculture and Rural Development (MDARD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Michigan Technological University</td>
<td>Michigan Technological University</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Biological Sciences</td>
<td>Biological Sciences</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Biomedical Engineering</td>
<td>Biomedical Engineering</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Broomball Committee</td>
<td>Biomedical Engineering</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Geological and Mining</td>
<td>Broomball Committee</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Engineering and Science</td>
<td>Geological and Mining</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Great Lakes Research Center</td>
<td>Engineering and Science</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Jackson Center for Teaching and Learning</td>
<td>Great Lakes Research Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Keweenaw Research Center</td>
<td>Jackson Center for Teaching and Learning</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kinesiology and Integrated Physiology</td>
<td>Keweenaw Research Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pavlis Honors College</td>
<td>Kinesiology and Integrated Physiology</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Outdoor Adventure Program</td>
<td>Pavlis Honors College</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rail Transportation Program</td>
<td>Outdoor Adventure Program</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>School of Forest Resources and Environmental Science</td>
<td>Rail Transportation Program</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>School of Technology</td>
<td>School of Forest Resources and Environmental Science</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Miller Electric</td>
<td>School of Technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Milwaukee Tool Corporation</td>
<td>Miller Electric</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Misumi Group, Inc.</td>
<td>Milwaukee Tool Corporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mitsubishi Electric</td>
<td>Misumi Group, Inc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>nanoMAG—A Thixomat Company</td>
<td>Mitsubishi Electric</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nexteer Automotive</td>
<td>nanoMAG—A Thixomat Company</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Norfolk Southern Corp.</td>
<td>Nexteer Automotive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NURail Center</td>
<td>Norfolk Southern Corp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oshkosh Corporation</td>
<td>NURail Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PCB Piezotronics</td>
<td>Oshkosh Corporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Performance Electronics</td>
<td>PCB Piezotronics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Phormula</td>
<td>Performance Electronics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Polaris</td>
<td>Phormula</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Razor Edge Systems</td>
<td>Polaris</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>REL Inc.</td>
<td>Razor Edge Systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Renco</td>
<td>REL Inc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Snap On</td>
<td>Renco</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sound Down</td>
<td>Snap On</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Southern Corporation</td>
<td>Sound Down</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Spectrum Health Innovations</td>
<td>Southern Corporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>State of Michigan Research Excellence Fund</td>
<td>Spectrum Health Innovations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stryker Instruments</td>
<td>State of Michigan Research Excellence Fund</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Target Corporation</td>
<td>Stryker Instruments</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TeamTech Motorsports Safety, Inc.</td>
<td>Target Corporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tech Products Corporation</td>
<td>TeamTech Motorsports Safety, Inc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Upper Peninsula Recycling Coalition</td>
<td>Tech Products Corporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>US Air Force Research Laboratory</td>
<td>Upper Peninsula Recycling Coalition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>US Office of Naval Research</td>
<td>US National Park Service</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vconverter Corporation</td>
<td>US Office of Naval Research</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vans Pattern</td>
<td>Vconverter Corporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Waupaca Foundry</td>
<td>Vans Pattern</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Waytek</td>
<td>Waupaca Foundry</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wisconsin Southern Railroad</td>
<td>Waytek</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Woody's Specialty Design Products</td>
<td>Wisconsin Southern Railroad</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Worham Acres LLC</td>
<td>Woody's Specialty Design Products</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yamaha Motor Corporation</td>
<td>Worham Acres LLC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yazaki North America</td>
<td>Yamaha Motor Corporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ZF TRW—ZF Friedrichshafen AG</td>
<td>Yazaki North America</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
WE ARE PROUD TO RECOGNIZE
OUR MICHIGAN TECH DESIGN EXPO
2016 PARTNERS:

DIRECTING PARTNER

SUPPORTING PARTNER

BLACK & VEATCH

COLLABORATING PARTNERS

INNOVATING PARTNERS

Michigan Tech Office of Innovation and Industry Engagement

Michigan Alumni Relations

www.expo.mtu.edu