A Showcase of Enterprise and Senior Design Student Projects

Michigan Technological University

1885

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ITC IS PROUD TO SPONSOR MICHIGAN TECH'S 2021 DESIGN EXPO

WELCOME TO MICHIGAN TECH'S DESIGN EXPO.

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Welcome to the 2021 MTU Design Expo. We're virtual again this year, but with a twist – using Gatherly – the spatial video chat platform that lets you freely move around and talk to anyone at the event. You'll be astounded at the creativity and sophistication of the demonstrations and displays you'll be able to see. And, using Gatherly, you'll enjoy the interactive experience. It's almost as good as being here in person.

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
Member, MTU Board of Trustees

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Scope

Design Expo highlights hands-on, discovery-based learning at Michigan Tech. More than a thousand students on Enterprise and Senior Design teams showcase their work and compete for awards. A panel of judges—made up of corporate representatives, invited guests, and Michigan Tech staff, faculty members, and graduate students—critique student 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 Pavlis Honors College.

Please note: Enterprise and Senior Design teams were allowed to submit a photo taken pre-COVID-19 instead of taking a new, socially distanced photo. All team photos showing students without face coverings were taken prior to the COVID-19 pandemic.

Design Expo Awards

Senior Design Awards

Based on video submissions

- First place–$400
- Second place–$250
- Third place–$150
- Honorable mention–$100 (four to be awarded)

Enterprise Awards
Based on video submissions

- First place–$500
- Second place–$300
- Third place–$200
- Honorable mention–$100 (one to be awarded)

Image Contest
Based on team photos submitted during Design Expo registration

- First place–$200
- Second place–$100
- Third place–$50

Design Expo Innovation Awards
Based on application

- First place–$250
- Second place–$150
- Third place–$100

Enterprise Awards
Based on nominations–$100 each

Student Awards

- Outstanding Leadership
- Rookie Award
- Industry/Sponsor Relations
- Innovative Solutions

Faculty/Staff Awards

- Outstanding Enterprise Advisor
- Outstanding Sponsor
- Behind the Scenes
- Module Master

More Special Thanks

To the distinguished judges giving their time and talents to help make Design Expo a success, and to the faculty advisors generously and richly supporting Enterprise and Senior Design–thank you for your dedication to our students.

"By researching, analyzing, and posing the question "what if" we are contributing to humankind and the world which makes our research exciting."

David D. Reed,
Vice President for Research

From the Pacific Rim to the Northwoods. Researchers build and test forest biomaterials, dig into mountain peatlands, assess landslide risk on steep slopes, track molt patterns in migrating birds, watch volcanoes from space, and prepare rovers for the darkest craters of the moon.

Tomorrow needs collaboration.
Tomorrow needs Michigan Tech.

mtu.edu/magazine/research

Michigan Technological University
1885

LUNAR ROVER TESTING
Michigan

Students won the 2020 Breakthrough, Innovative and Game-changing (BIG) Idea Challenge run by the National Aeronautics and Space Administration (NASA).

mtu.edu/news/moon

CARBON ACCOUNTING
Colombia

Researchers help Andean nations quantify their carbon stocks—a process that involves coring peat samples, in situ gas emission analysis, and extensive mapping.

mtu.edu/news/peatlands

FOREST BIOMATERIALS
Finland

Michigan Tech faculty presented alongside experts and economic developers to discuss collaborative bioeconomic opportunities including co-creation funding with Finnish companies.

mtu.edu/news/bioeconomy

REMOTE SENSING
India

Dedicated to the thousands of lives lost in landslides, researchers created a new atlas that assesses landslide risk in 13 districts in the Indian state of Kerala.

mtu.edu/news/landslides

VOLCANIC EMISSIONS
Bali

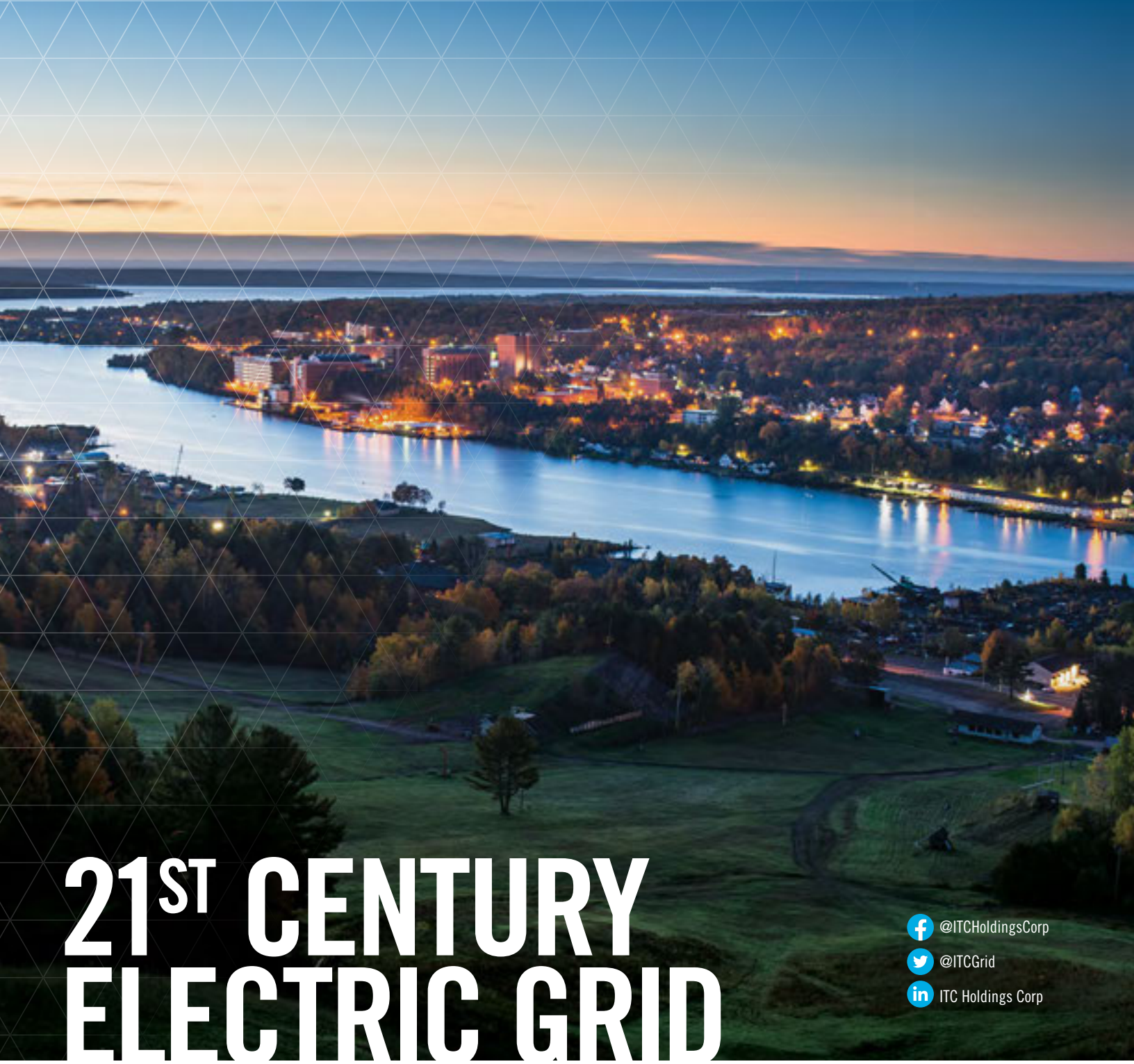
Carbon dioxide measured by a NASA satellite pinpoints sources of the gas from human and volcanic activities, which may help monitor greenhouse gases responsible for climate change.

mtu.edu/news/volcano

SONGBIRD MIGRATION
Equatorial Guinea

Watching molt patterns led scientists to wonder how feather color changes relate to the migrations many birds undertake twice each year.

mtu.edu/news/feathers



21ST CENTURY ELECTRIC GRID

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Smart phones, connected homes, electric vehicles. Every day, technology is changing the way we use and think about electricity. You may not realize it, but in our increasingly electrified society, that's where electricity transmission infrastructure matters most. To meet our twenty-first century energy demands, we need a twenty-first century electric grid.

ITC, the nation's largest independent electricity transmission company, is working every day and investing in our state's infrastructure to modernize the grid in order to move electricity from where it's generated to where it's needed. That means safe, secure, reliable electricity to power economic growth, job opportunities, and our long-term energy future. We're ensuring the grid can meet your energy needs now and long into the future. **At ITC, we're always working for the greater grid.**

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Welcome to Michigan Tech Design Expo 2021!

Welcome to Design Expo, Michigan Tech's annual showcase for experiential, discovery-based learning. Each spring at Michigan Tech we showcase the work of more than 1,000 students from our signature Senior Design and Enterprise programs. This year, our 21st, we offer a fully virtual event. We wish everyone good health as we navigate safely through the pandemic.

At Michigan Tech, we proudly refer to Senior Design as a "first job" rather than a "last class," as it tasks senior-level project teams to address practical, open-ended design challenges. In Enterprise, larger interdisciplinary organizations of first-year through graduate-level students work with clients in a business-like setting to create products, deliver services, and pioneer solutions. Regardless of the pathway our students choose, the projects on hand at Design Expo 2021 are sure to impress!

This year, we reflect on the importance and relevance of Design Expo's foundational pillars: **Imagination, Collaboration, Innovation, and Solutions.**

Imagination is synonymous with creativity and resourcefulness, inviting possibilities and embracing the potential for "what if".

Collaboration, the action of working with others to produce or create something, has never been more important than now. Through experience and perseverance, our Enterprise and Senior Design student teams have learned the value of shared goals, trust, and teamwork.

Innovation, in its simplest definition, means novelty or something new. Coupled with imagination and collaboration, our students have embraced a new virtual event platform for Design Expo. We hope the result will be real-time, synchronous interactions: the key ingredient of a traditional ballroom event.

Finally, **Solutions.** At Michigan Tech, we encourage our students to tackle messy problems but prefer to reframe them as opportunities to generate positive impact. As you learn more about the solutions developed by our students and consider the meticulous safety environment in which they've operated during the pandemic, we hope you share our optimism for a better tomorrow!

Design Expo 2021 is generously supported by industry and university event sponsorship. We are pleased to welcome ITC Holdings as Directing Partner for the 10th consecutive year. Collaborating Partners include OHM, EverSmile, Gateway Foundation, Higher Ground Gear, Husky Innovate, Michigan Tech Office of Innovation and Commercialization, Miracle Recreation, Plexus, and Success by Design. Our Innovating Partner this year is Rock Central. These 11 partners, along with more than 100 project and program supporters, have made a strategic investment in our educational mission. Thank you!

Again, we offer our warmest welcome to Design Expo 2021—enjoy the event, and Go Huskies!

Rick Berkey
Director, The Enterprise Program, and
Chair, Enterprise Governing Board

Leonard Bohmann
Associate Dean for Academic
Affairs, College of Engineering

101
Blizzard Baja

Led by:
Andrew Erickson and Kyle Harris, Mechanical Engineering

Advised by:
Kevin Johnson, Manufacturing and Mechanical Engineering Technology
Steven Ma, Mechanical Engineering-Engineering Mechanics

Sponsored by:
General Motors, Stellantis, Magna, SAE International, Yamaha, Altair, Henkel, IPETRONIK, Oshkosh Corporation, Keysight Technologies, FEV, RapidHarness Wire Harness Software, Danaher, Superior Graphics, AAA, The Henry Ford, Keweenaw Community Forest Company, TeamTECH, Gamma Technologies, Michigan Scientific, The Princeton Review, Watermark Insights, Pilot Systems, PCB Piezotronics, American Muscle, Extreme Terrain, Arconic, Great Lakes Sound and Vibration, Cleveland Cliffs

Background:
Michigan Tech's Blizzard Baja Enterprise builds a single-seat, off-road competition vehicle to compete in the SAE Collegiate Design Series-Baja 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 longstanding University tradition dating back to 1981.

Project Overview:
Our main project this year is creating and implementing a 4WD system for our vehicle. This was broken up into seven different Senior Design projects as follows: Belt Drive, Brake Calipers, Clutches, Frame, Front CVs, Pedals, and an improved Gearbox. With these current projects, the team will have a completed 4WD-capable vehicle for the 2022 competition season.

MTU Blizzard Baja Car

102 Clean Snowmobile Challenge

Led by:
Liam MacGillivray, Mechanical Engineering; Garret Porter, Electrical Engineering

Advised by:
Jason Blough, Mechanical Engineering-Engineering Mechanics

Sponsored by:
General Motors, Skidoo, Stellantis, Magna, SAE International, Yamaha, Altair, Henkel, IPETRONIK, Oshkosh Corporation, Keysight Technologies, FEV, RapidHarness Wire Harness Software, Danaher, Superior Graphics, AAA, The Henry Ford, Keweenaw Community Forest Company, TeamTECH, Gamma Technologies, Michigan Scientific, The Princeton Review, Watermark Insights, Pilot Systems, PCB Piezotronics, American Muscle, Extreme Terrain, Arconic, Great Lakes Sound and Vibration

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, the team submits an engineering design paper, determines a justified MSRP (manufacturer's suggested retail price), and presents an oral design presentation outlining its approach to the clean snowmobile conversion. Following a comprehensive technical inspection, the vehicles undergo dynamic testing including acceleration, handling, cold start, noise, and emissions. Michigan Tech's Clean Snowmobile Challenge Enterprise typically competes in both the gasoline and diesel categories.

Project Overview:
The team's primary goal is to make cleaner burning, quieter snowmobiles that are still fun to ride. This year we are competing with a Yamaha Venture chassis as well as an Arctic Cat Bearcat chassis powered by a diesel engine provided by Kohler Engines.

Clean Snowmobile team testing the new equipment

103
Formula SAE

Led by:
Max Urquhart, Electrical Engineering; Nathan Sodini, Engineering Management

Advised by:
James DeClerck, Mechanical Engineering-Engineering Mechanics

Sponsored by:
General Motors, Stellantis, Magna, Ford Motor Company, SAE International, Yamaha, Altair, Henkel, IPETRONIK, Oshkosh Corporation, Keysight Technologies, FEV, RapidHarness Wire Harness Software, Danaher, Superior Graphics, AAA, The Henry Ford, Keweenaw Community Forest Company, TeamTECH, Gamma Technologies, Michigan Scientific, The Princeton Review, Watermark Insights, Pilot Systems, PCB Piezotronics, American Muscle, Extreme Terrain, Arconic, Great Lakes Sound and Vibration, Siemens, Domino's, Denso, Nexteer, Milwaukee, Aramco, Sunoco Race Fuels, Meritor, Elliott Foam Company, Sumitomo, McLaren Engineering, Halla Mechatronics, National Vacuum Equipment, TE Connectivity, Weller, Cadenas Part Solutions, Miller, TechFlex, Homestead Graphics

Background:
Michigan Tech's Formula SAE Enterprise builds a competition vehicle based on the concept of an affordable race car geared toward the weekend autocrosser. The team competes in SAE Collegiate Design Series Formula SAE events held in various locations across the country. For the competition, the team prepares a written design report, a cost analysis, and a business case to present to a panel of judges. After passing a technical inspection, the 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 has gained a reputation for developing cutting-edge designs that help shape the future of racing.

Project Overview:
This year we have several projects bringing advanced technology to our car. We are implementing an electronic limited slip differential, four-wheel steering, active aerodynamics, a drag reduction system, and an electronic throttle. We also have a large undertaking as we are converting our previous car, the F-276, into the e-276. This will be the first electric FSAE car that Michigan Tech has ever constructed! This car and its developments will allow the team to explore new technologies that we will be able to implement on our internal combustion engine vehicle.

104
Supermileage Systems

Led by:
Andy Lambert and Luis Hernandez Morales, Mechanical Engineering

Advised by:
Rick Berkey, Pavlis Honors College | Manufacturing and Mechanical Engineering Technology

Sponsored by:
General Motors, Stellantis, Magna, SAE International, Yamaha, Altair, Henkel, IPETRONIK, Oshkosh Corporation, Keysight Technologies, FEV, RapidHarness Wire Harness Software, Danaher, Superior Graphics, AAA, The Henry Ford, Keweenaw Community Forest Company, TeamTECH, Gamma Technologies, Michigan Scientific, The Princeton Review, Watermark Insights, Pilot Systems, PCB Piezotronics, American Muscle, Extreme Terrain, Arconic, Great Lakes Sound and Vibration, Halla Mechatronics, DENSO, Cleveland Cliffs, VP Racing Fuels

Background:
The 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, the team must engineer a competitive vehicle and submit a written report detailing the vehicle design. The team must also deliver an oral presentation that demonstrates 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 Overview:
Supermileage Systems' focus this year has been revamping how the team tests vehicle components to determine areas where the team can improve for new projects. This year, two Senior Design teams have taken this to heart by redesigning the dynamometer data acquisition system and creating a new drivetrain test stand. Two other Senior Design groups have built new engines for the team to use: one with a reduced cylinder displacement, and the other with a higher compression ratio. These new engines will provide the team with even more fuel-efficient options to power the vehicle.

Supermileage Systems' Vehicle (Photo Credit: Rick Berkey)

105
Advanced Metalworks Enterprise (AME)

Led by:
Eli Harma and Liam McLeod, Material Science and Engineering

Advised by:
Paul Sanders, Materials Science and Engineering

Sponsored by:
Cleveland Cliffs, Mercury Marine

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 four to five 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, develop advanced material modeling techniques, and more.

Project Overview:
This year's project for the AM WAAM team is to 3D print a new generation advanced high-strength steel alloy using wire arc additive manufacturing. The purpose of this project is to assess the mechanical properties of the as-printed material and compare the properties of the as-printed components with components that have been heat-treated using the quench and partitioning (Q&P) heat treatment process.

The AM Toughness team project is focused on determining the ductile to brittle transition temperature of a third-generation high-strength steel. This is being done because Q&P steel is an extremely promising metal in industry, and understanding at what temperatures this steel exhibits either brittle or ductile behavior is very important to its future applications. It also provides insight into other mechanical properties of the material without demanding as much speculation or guessing.

Side view of wire arc additive manufacturing

106
Aerospace Enterprise

Led by:
Nolan Pickett, Mechanical Engineering; Matthew Sietsema, Electrical Engineering

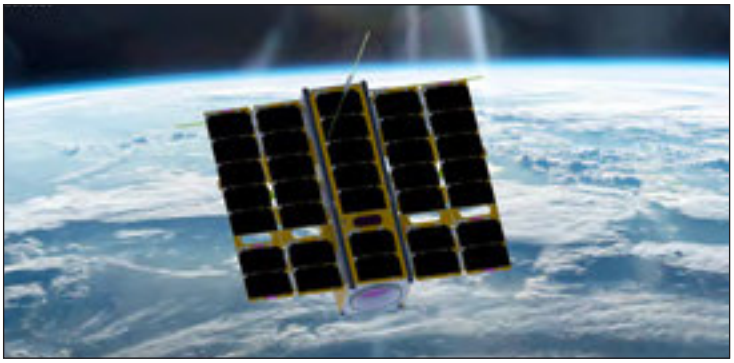
Advised by:
L. Brad King, Mechanical Engineering-Engineering Mechanics

Sponsored by:
Auris: Air Force Research Laboratory, Stratus: NASA

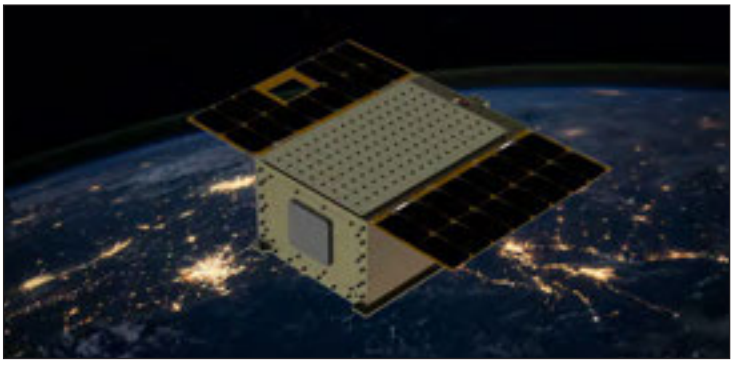
Background:
The Aerospace Enterprise was established to provide hands-on aerospace education and experience to Michigan Tech undergraduate students. The Enterprise works together on innovative and relevant aerospace-related projects with all members contributing toward achieving specific project goals.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

Project Overview:
Auris: The Auris mission is a satellite project based on demonstrating the technical feasibility of a CubeSat's ability to provide situational data. In collaboration with the Air Force Research Laboratory (AFRL), the objectives of the Auris mission are to enhance Space Situational Awareness (SSA) by providing activity and location knowledge of space-based assets from on-orbit. This is achieved by measuring and characterizing radio frequency (RF) emission patterns of a target satellite, as well as by providing an estimate for the location of that target. The Auris mission is intended to serve as a pathfinder toward increasingly complex space systems that leverage the low cost and small form factor of CubeSats to achieve the performance of traditional, monolithic systems.

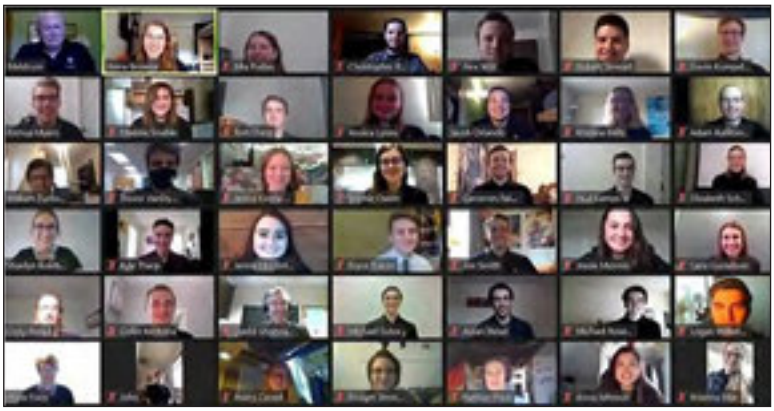
Stratus: The Stratus mission is a satellite project based on demonstrating the collection of atmospheric and weather data from a CubeSat. In collaboration with NASA, the Stratus spacecraft utilizes a thermal imaging sensor to examine the activity of clouds in the upper atmosphere for the purpose of better understanding weather over short timescales. Images generated by the mission will be analyzed on the ground to determine properties of the clouds, such as location and direction of travel. The Stratus mission is intended to serve as a pathfinder toward increasingly complex space systems that leverage the low cost and small form factor of CubeSats to achieve the performance of traditional, monolithic systems.



Stratus: Detailed render of the Stratus spacecraft deployed on-orbit



Auris: Preliminary rendering of the Auris spacecraft in the deployed configuration



107
Alternative Energy Enterprise (AEE)

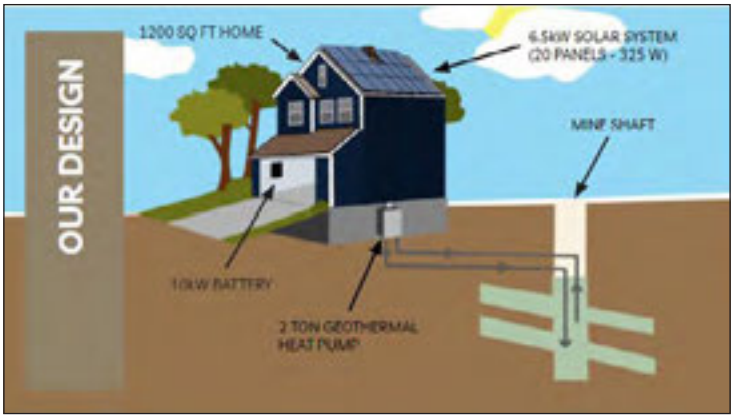
Led by:
Jacob Orlando, Chemical Engineering; Anna Browne, Electrical Engineering

Advised by:
Jay Meldrum, Keweenaw Research Center
David Shonnard, Chemical Engineering

Sponsored by:
Oshkosh Corporation, The Department of Natural Resources, Keweenaw Research Center, Cyberia Coffee, CURB Energy, John Soyring

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 team is interdisciplinary and receives a rewarding hands-on experience while working on challenging problems and seeking innovative solutions.

Project Overview:
The Alternative Energy Enterprise continues to work toward finding sustainable methods for energy production, delivery, and consumption through several interrelated projects. These teams work to develop and implement new technologies that focus on making sustainable development a reality. These teams include the Renewable Energy Mission Module (REMM), Sustainability Demonstration House (SDH), Community Solar for Baraga, Fortune Lake Camp Solar Team, Biofuels and Pyrolysis Team, Composting Team, GeoSolar Team, and Pumped Hydro Team.



OSHKOSH
CURB
Michigan Technological University
Keweenaw Research Center

108
Blue Marble Security (BMS)

Led by:
Paola Quintana and Alex Patterson, Electrical Engineering

Advised by:
Glen Archer, Electrical and Computer Engineering

Sponsored by:
Oshkosh Corporation, Systems Engineering Research Center, General Motors, Michigan Tech J. Robert Van Pelt and John and Ruanne Opie Library, Deringer Ney, Empower906

Background:
Blue Marble Security (BMS) Enterprise is a student-led Enterprise that focuses on securing the future through the thoughtful use of technology. The team specializes in engineering design and product development. BMS has developed a culture that fosters high professional standards, creativity, and productivity. BMS defines the word "national security" through the provision of technological support to the defense, corporate economy, and personal well-being of the nation and all its people.

Project Overview:
BMS Enterprise continues to demonstrate its ability to tackle a diverse set of projects, with seven projects spanning several industry sectors. The GM team is working to develop a commercial off-the-shelf (COTS) vision system for unexpected part detection in the manufacturing process. We have two defense-related projects sponsored by SERC, one of which deals with creating a test bed that can measure the pressure of blank ammunition, and the other which includes the development of an air quality monitoring and purification system for a Dry Combat Submersible. Members of the Oshkosh team designed and tested a suspension system for the Oshkosh LCTV vehicle. Another team is reverse engineering MTU's moving bookshelf system to make it safer and easier to use. Lastly, the Autobot team has built and is coding an autonomous robot to compete in the Intelligent Ground Vehicle Competition (IGVC).

Blue Marble Security Enterprise (Collage of Projects Spring 2021)

109
BoardSport Technologies (BST)

Led by:
Alexandra Deyoung and Nick Olsen, Mechanical Engineering

Advised by:
Ibrahim Miskioglu, Mechanical Engineering-Engineering Mechanics

Sponsored by:
Enterprise Manufacturing Initiative funded by General Motors

Background:
BoardSport Technologies (BST) focuses on the engineering, design, and manufacturing of skis, snowboards, skateboards, longboards, wakeboards, and other boardsport-related products. Through integration of composite materials and creative design approach, the team strives to refine existing boardsport technology and produce new and innovative products.

Project Overview:
BoardSport Technologies (BST) focuses on allowing students to design and manufacture products for recreational use in the boardsport industry. The Enterprise is currently concentrated in three different sports with two Senior Design teams. The three different sports are Snow, Skate, and Wake. The Snow team is currently creating a snowboard from scratch to improve our manufacturability versus relying on companies to provide cores and sidewalls for pressing boards. The Skate team is working on a skateboard design that is resistant to razor tailing and has made a more flexible skateboard deck by including layers of carbon fiber and fiberglass. The Wake team is working on a removable hydrofoil and is wrapping it with carbon fiber to improve strength. One of our Senior Design teams is creating a nonmetal CNC machine to improve the manufacturing process of cutting out boards. The other Senior Design team is creating a three-piece snowboard to decrease the space needed to pack a snowboard when traveling or hiking in the backcountry.

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Built World Enterprise (BWE)

Led by:
Kaitlyn Wehner, Civil Engineering; Jared Parker, Environmental Engineering

Advised by:
Audra Morse, Civil and Environmental Engineering

Sponsored by:
Airport Cooperative Research Program University Design Competition, General Motors

Background:
The Built World Enterprise (BWE) addresses challenges typically solved by civil and environmental engineers including designing infrastructure and solving waste management problems.

Project Overview:
The Built World Enterprise participates in both the Airport Cooperative Research Program (ACRP) University Design Competition and the Environmental Protection Agency (EPA) Rainworks Challenge. Current ACRP challenges being addressed are improving aviation weather conditions reporting and mitigating wildlife strikes at airports. The current EPA teams are working on mitigating stormwater runoff both at Houghton High School and on Michigan Tech's campus near the Administration Building.

111
Consumer Product Manufacturing (CPM)

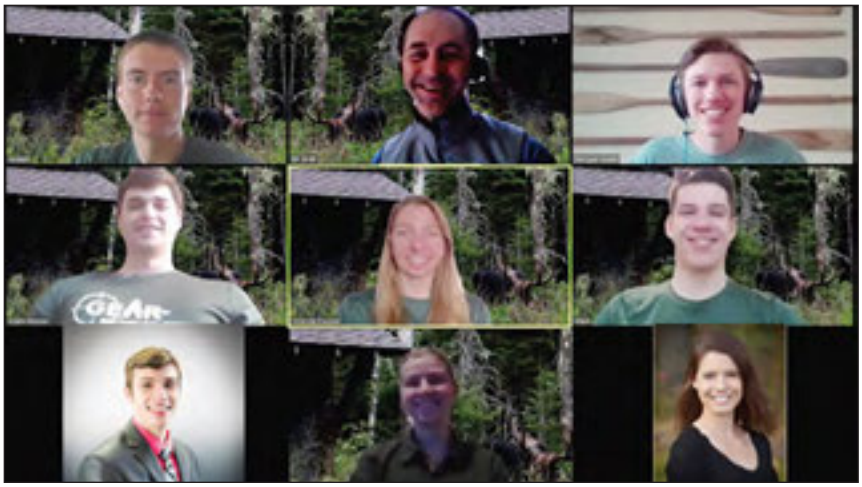
Led by:
Samantha Appleyard, Engineering Management; Jacob Michaud, Chemical Engineering

Advised by:
Tony Rogers, Chemical Engineering

Sponsored by:
Sussex IM, Libbey, Mel and Gloria Visser, Kimberly Clark, General Motors, Doll n' Burgers

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 the 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 Overview:
Consumer Product Manufacturing brands itself as the Enterprise that prepares students for industry. We have 10 commercial-, medical-, and sustainability-focused projects that not only help large corporations, but the local and statewide community as well. Among these, we will be highlighting the efforts of three teams. Shared Air Filtration is a crowdfunded project spurred by the COVID-19 pandemic and aimed at creating a cost-effective HVAC system capable of filtering pathogens. The Libbey Glassware Improvements project works with Libbey Inc. to source a lipid-repellent coating for glassware and ceramics. Clean Diesel is an internally funded project that aims to convert used cooking oil that would be wasted into biodiesel, which can then be used in Michigan Tech's grounds and maintenance equipment.



112
General and Expedition Adventure Research (GEAR)

Logo design by GEAR Enterprise, 2018

Led by:
Mark Ousdigiam and Joseph Van Linn, Mechanical Engineering

Advised by:
Brett Hamlin, Engineering Fundamentals

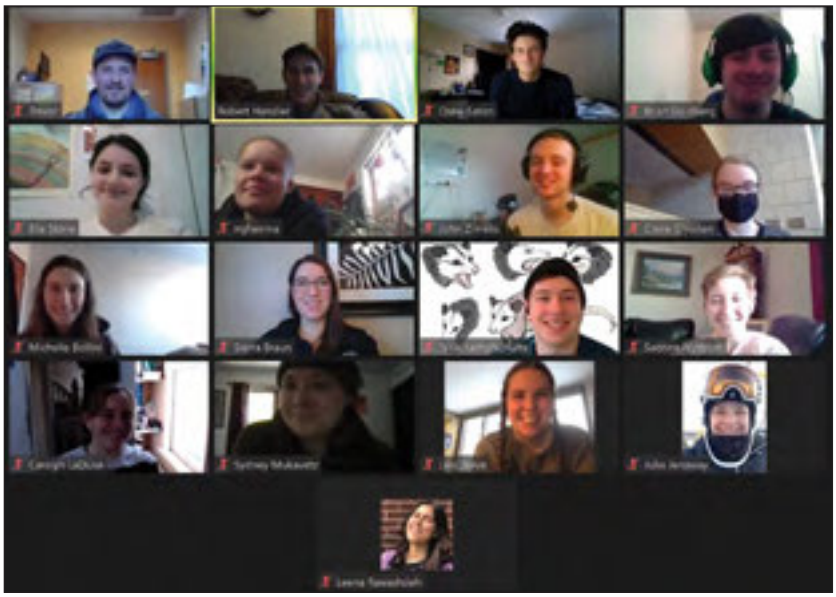
Sponsored by:
Systems Engineering Research Center (SERC) Capstone Marketplace

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. Team members analyze and develop innovative solutions on both internal and industry-sponsored projects. GEAR has worked on soft and hard goods related to backpacking, camping, climbing, snowshoeing, kayaking, canoeing, mountaineering, and military applications.

Project Overview:
Our project is designing a new cross-country sit ski for paraplegic athletes that is more maneuverable and user-friendly than current designs. Standard sit skis have a rigid frame that is difficult to turn, and even experienced skiers struggle to get around corners with them. By designing a more maneuverable frame, we hope to make the sport of cross-country skiing more accessible to paraplegics. This year our focus has been on building a "parallelogram" frame that will allow users to lean while still having both skis touching the ground.

Prototype of the team's parallelogram-frame sit ski (Photo Credit: Joseph Vann Linn)

SYSTEMS ENGINEERING RESEARCH CENTER



113
Green Campus

Led by:
Trevor Brandt and Sierra Braun, Civil Engineering

Advised by:
Robert Handler, Chemical Engineering
Christopher Wojick, Civil and Environmental Engineering

Sponsored by:
Henkel

Background:
Green Campus Enterprise is an organization of students working to make Michigan Technological University's campus more sustainable through both low- and high-profile projects. Green Campus Enterprise annually measures the carbon footprint of Michigan Tech and designs and implements projects to improve the sustainability of the Michigan Tech campus. Green Campus works closely with the Michigan Tech administration to effectively engage the University community in reducing its carbon footprint.

Project Overview:
The steam back-pressure turbine team is evaluating the use of a steam back-pressure turbine in the campus steam distribution system. This turbine would generate electricity while lowering the pressure of the steam to the level required for use in each building (a process currently being performed by check valves losing energy as heat). The tiny house build team designed a tiny house for a Michigan Tech professor and is currently building that tiny house in modules. The house will be installed at a selected site and its performance will be monitored with the goal of being carbon-neutral.

SBPT team steam measurement setup

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HotForest

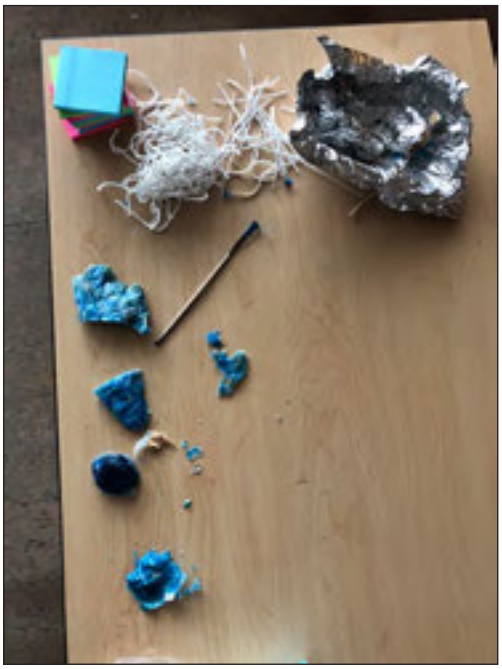
Led by:
Cassidy Grobbel, Chemical Engineering; Dan Unglenieks, Natural Resources Management

Advised by:
Mark Rudnicki, College of Forest Resources and Environmental Science

Sponsored by:
Tech Forward Advanced Materials and Manufacturing, Michigan Technological University Pavlis Honors College's Enterprise Program

Background:
The purpose of HotForest is to innovate technologies and services that advance the circular bioeconomy. An alternative to the current make, use, and dispose practice of the linear economy, the circular bioeconomy is a model for renewable, regenerative practices where we extract maximum value from resources we use, keep them in use as long as possible, and recover and regenerate materials for additional service lives.

Project Overview:
The project is focused on repurposing or recycling disposable masks. We have done one prototype of melting down a handful of masks. This worked and we plan to create a larger sample of this and make something useful like a stool. We have ideas in the works of using the plastics from COVID waste to create a filament for 3D printing.



Mask waste prototype

115
Husky Game Development (HGD)

Led by:
Gabe Oetjens, Computer Science; Keira Houston, Civil Engineering

Advised by:
Scott Kuhl, Computer Science

Sponsored by:
Michigan Technological University Pavlis Honors College's Enterprise Program

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

Project Overview:
There's never a dull moment working as a janitor, especially when you work at FedUP, the craziest shipping company there is. Known for its questionable business practices and less than ideal working conditions, working in this wacky warehouse is shaping up to be more than you bargained for when you took the job. Pick up trash, dodge obstacles, and test your wits in this fast-paced 2D puzzle game packed with lots and lots of high-octane janitorial action.

Michigan Technological University
Pavlis Honors College

116
Innovative Global Solutions (IGS)

Led by:
Lynnsey Hooker and Kat Miller, Biomedical Engineering

Advised by:
Radheshyam Tewari, Mechanical Engineering-Engineering Mechanics
Nathan Manser, Geological and Mining Engineering

Sponsored by:
Tree Frog Aquagric LLC, Ford Fund–Collegiate Community Challenge, General Motors, Cleveland Cliffs

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

Project Overview:
The objective of this project is to design, fabricate, and test a low-cost modular infant incubator to bridge the gap in infant health care for developing areas. This project was chosen because infant mortality rates are still shockingly high in many parts of the world, even though modern medical advances should have aided in drastically decreasing these numbers. Currently, the team has completed functional testing for each of the subsystems and has assembled the project's first fully functional prototype.

Innovative Global Solutions Enterprise's low-cost modular infant incubator (Image Credit: Austin Yakes)

117
IT Oxygen

Led by:
Zack Lewis, Computer Network and System Administration; Lydia Savatsky, Mathematics

Advised by:
James Walker, Computer Science
Nagesh Hatti, Electrical and Computer Engineering

Sponsored by:
Ford Fund-Collegiate Community Challenge, Northern Specialty Health, Western UP Health Department, Destination Calumet LLC, Stevens Institute, Systems Engineering Research Center (SERC)

Background:
IT Oxygen 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 IT solutions. Team members work on real-world projects that foster skill development and utilize business intelligence. Areas of interest include systems and information analysis, software development, database design, data sciences, cybersecurity, and web-based application development.

Project Overview:
The Destination Calumet Project is creating a fully functional hospitality reservation platform that accommodates several restaurants and high-end vacation and tourism offerings. The website enables business owners to maintain long-term standalone operations, manage their properties, and create strategic partnerships with local area vendors. Visitors and tourists may book reservations, place orders to local restaurants, and securely transmit payment information. The team has incorporated established cybersecurity practices to protect client information and comply with regulations. This project enables students to engage with a real-world client while navigating and applying specific constraints including the technical feasibility of an online system operating in an growing local hospitality industry.

The Automotive OEM Purchasing Strategy Project is developing a predictive model which can be used to guide decisions in the bulk purchasing of semiconductors. Manufacturers that use semiconductors in their products must maintain a steady supply of these components while also attempting to minimize the cost—but the volatility of the semiconductor market can aggravate the decision-making process

ITO members from the Calumet team and IT Operations team work to install a new server in the data center which supports internal development infrastructure for all ITO projects.

related to purchasing. This semester, the second phase of the project has continued the development of the predictive model with the goal of validating the model through a few different means. The collected data will be split into a training and validation set so that the model may be evaluated in terms of its predictive properties on the validation data set. In addition to this, the team is developing simulations of the collected data to which the model can be applied in order to assess the utility of the model for future decision-making in the bulk purchasing of semiconductors.

118
Mining INnovation Enterprise (MINE)

Led by:
Alec Berger and Timothy Hamilton, Mechanical Engineering

Advised by:
Paulus Van Susante, Mechanical Engineering-Engineering Mechanics

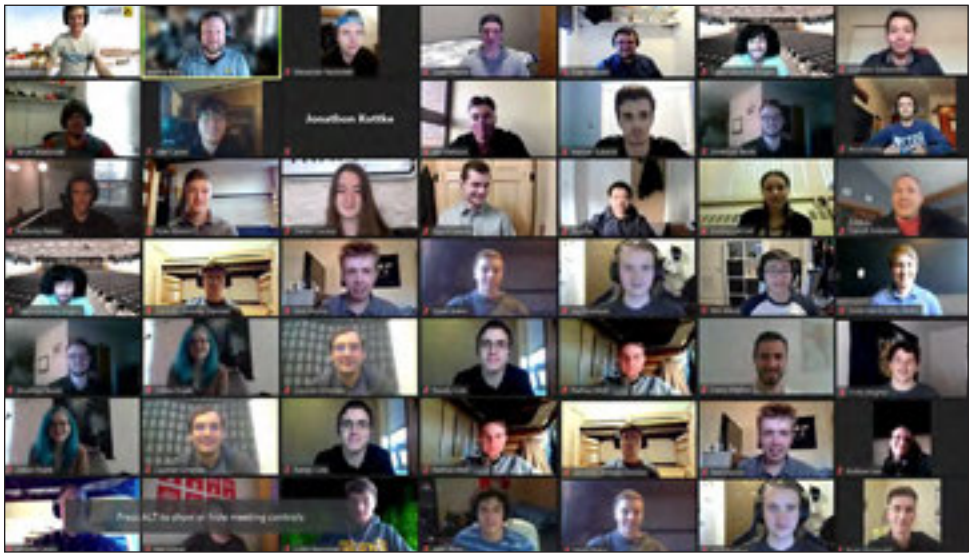
Sponsored by:
General Motors, Cummins, Milwaukee Tool, MISUMI, Michigan Space Grant, Michigan Scientific, ME-EM External Advisory Board, Rekhi Innovation Challenge

Background:
The Mining INnovation Enterprise (MINE) seeks to design, test, and The Mining INnovation Enterprise (MINE) seeks to design, test, and implement mining innovation technologies for industry partners. MINE works 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, and mine and equipment design and optimization.

Project Overview:
The Mining INnovation Enterprise is a student-led, faculty-advised group at Michigan Technological University that focuses on innovation in the mining industry. Currently, the Enterprise focuses on aerospace and deep sea mining technology. We are currently working on six different projects in these areas. Our two main projects are: Lunabotics, a NASA competition for designing and building a lunar rover using a systems engineering approach; and Subsea ROV, which is designing a ROV to explore the depths of the sea. We also have four different Senior Design projects: Geology & Mining of Lake Superior, Lunar Trencher, Field Rover, and Subsea Nodules. Each deals with different mining applications in different scenarios. These include Mars, Lunar, Subsea, and Earthlike conditions, all with respect to innovative mining applications.

Compilation of MINE projects (Photo Credits: various MINE members; compiled by Timothy Hamilton)

Michigan Technological University
Mechanical Engineering-Engineering Mechanics



119
Robotic Systems Enterprise (RSE)

Michigan Tech Robotic Systems Enterprise

Led by:
Jared Engwis, Electrical Engineering; Jake Carter, Computer Engineering

Advised by:
Jeremy Bos, Electrical and Computer Engineering

Sponsored by:
SAE AutoDrive Challenge, Ground Vehicle Systems Center–TACOM, Teleqo

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

Project Overview:
The GVSC: Leader-Follower project at Robotic Systems Enterprise is focused on the creation of a partially manned, autonomous, leader-follower convoy using Clearpath Jackals as our robotic platform. By autotomizing convoys, our sponsor, Ground Vehicle Systems Center (GVSC), hopes to reduce the risk to human life. With this in mind we have identified performance attributes, developed design concepts, and analyzed those concepts against the identified attributes to determine our design plan. We will create a GPS-, IMU-, and lidar-based approach using intervehicle communication to relay GPS breadcrumbs, known obstacles, and any other relevant information. Ultimately, the goal of this project is to make our design a reality in simulation, eventually leading to a real demonstration.

A Clearpath Jackal with a mounted lidar (Photo Credit: Clearpath)

AutoDrive Challenge™

U.S.ARMY DEVCOM GROUND VEHICLE SYSTEMS CENTER SAE INTERNATIONAL

120
Strategic Education through Naval Systems Experiences (SENSE)

Led by:
Andrea Udovich, Mechanical Engineering; Fiona Chow, Management Information Systems

Advised by:
Andrew Barnard, Mechanical Engineering-Engineering Mechanics

Sponsored by:
Air Force Research Laboratory (AFRL), US Coast Guard (USCG), Ford Motor Company, US Special Operations Command (SOCOM), Naval Sea Systems Command (NAVSEA)

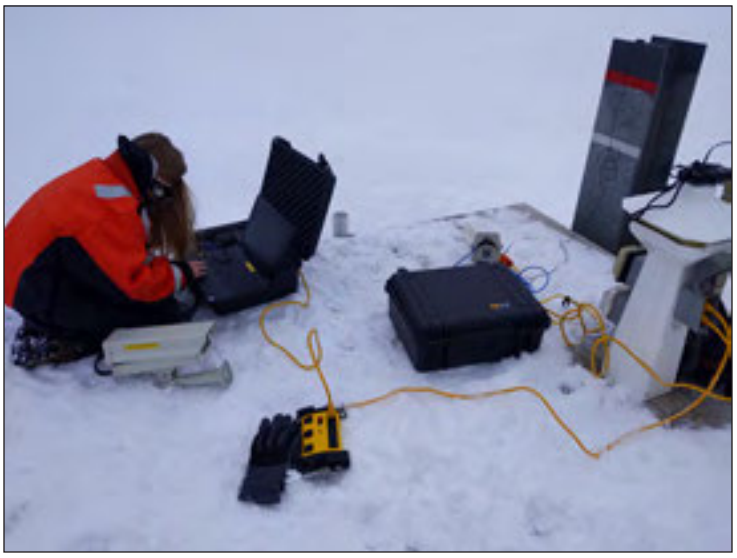
Background:
The Strategic Education through Naval Systems Experiences (SENSE) Enterprise's mission is to enable the workforce of tomorrow to redefine the boundaries for air, land, sea, and cyber supremacy through experiential learning and discovery. Students will design, build, and test engineering systems with a focus on Navy applications in all domains: space, air, land, sea, and undersea. Get hands-on experiences with cutting-edge defense technologies that directly impact the safety and success of the armed forces. Prepare for civilian employment opportunities in Department of Defense research labs or with DoD contractors.

Project Overview:
Our Mass Rescue project, sponsored by the Systems Engineering Research Center (SERC), aims to create an efficient deployment mechanism for lightweight mass rescue device designs.

The Under Ice Acoustic project is sponsored by the Naval Engineering Education Consortium (NEEC). The goal is to test and further develop a machine learning algorithm that tracks noise sources through ice environments.

The Buoyancy team, also sponsored by the SERC, is working to design and prototype a device that can be used by the Navy on small underwater vehicles that can compensate the buoyancy based on changes in salinity.

The Making Experiences with Ford Acoustic Sensor Odysseys (MEFASO) team, sponsored by Ford, is focused on designing and building an acoustic collection system for a vehicle that can be used to explore machine learning applications with large data sets.



Initial testing setup on the docks of the Great Lakes Research Center (Photo Credit: Steven Whitaker)

121
Velovations

Led by:
Ian DeVlieg, Mechanical Engineering Technology; Kurt Egelhaaf, Mechanical Engineering

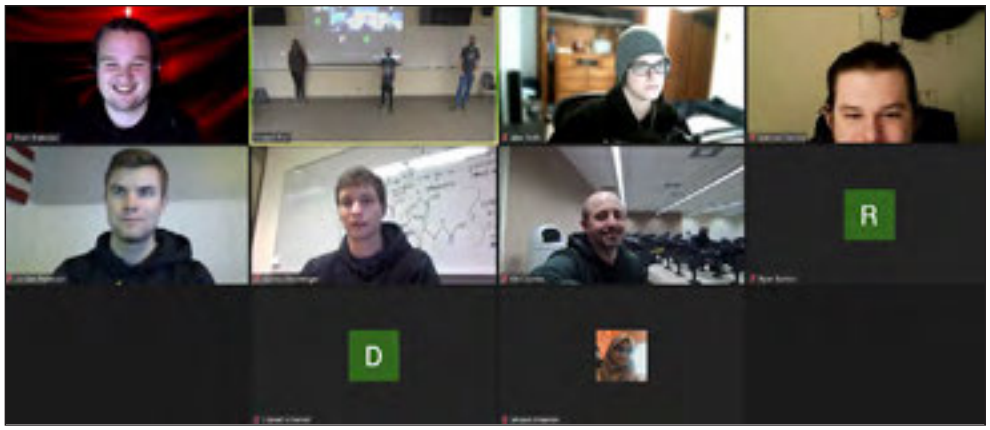
Advised by:
Steve Lehmann, Biomedical Engineering

Sponsored by:
AK Tube LLC, Senger Innovations, Cleveland Cliffs

Background:
Velovations is a bicycle design Enterprise dedicated to collaborating with the bicycle industry to develop new products and processes. The goal is to educate 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. Velovations leverages multiple majors including mechanical, electrical, business, and technical communications to deliver product and process innovations to the bicycle industry.

Project Overview:
This year Velovations is working on five bicycle-related projects. The Electronic Shifter project goal is to design a reasonably priced upgrade option from mechanical shifting to electronic shifting. The Simple Dropper Post project means to engineer a bike seat dropper post with high reliability and low cost that is easy to install, operate, and maintain. The Steel Frame project aims to fabricate a bike out of AK Tube's advanced high-strength steel to explore the viability of using this exciting material. The Heated Contacts project goal is to design rechargeable heated grips and a heated water bottle cage for riding during colder temperatures. Finally, the One Way Clutch project aims to model and validate Senger Innovations' revolutionary rear wheel hub freewheel system.

Bike made from AK Tube's high-strength steel (Photo Credit: Kurt Egelhaaf)



122
Wireless Communication Enterprise (WCE)

Led by:
Kenneth Shivers, Computer Engineering; Joseph Poti, Electrical Engineering

Advised by:
Christopher Cischke, Electrical and Computer Engineering

Sponsored by:
Whirlpool Corporation, Quantalux LLC, Advanced Power Systems Research Center, Nexteer, Systems Engineering Research Center (SERC) Capstone Marketplace, Milwaukee Tool, Stellantis

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

Project Overview:
Wireless Communication Enterprise (WCE) is currently supporting 10 different project groups from an array of different company and internally pitched projects. Some sponsored projects include working with Whirlpool to develop safety features on washing machines, a Milwaukee Tool embedded systems project, and working with Systems Engineering Research Center (SERC) on signal processing. These projects are important and impactful to the sponsors—we are prototyping the next generation of products and services. Some internal projects involve a lot of wireless communication, like a Wi-Fi to radio wave bridge, and others have very little, like an LED fan that can display arbitrary images. The goal is to have students work on what they find interesting while developing key engineering skills. Our lab enables students to work on all these projects with the support of 3D printers, PCB printers, microcontrollers, and almost anything else an electronics lab could need.

123
High School Enterprise– Dollar Bay High School SOAR

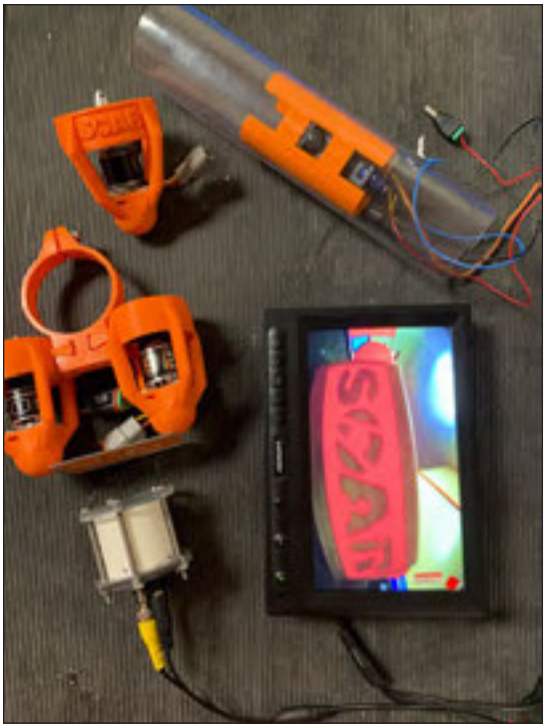
Led by:
Molly Myllyoja and Maggie Gaunt, Dollar Bay High School

Advised by:
Matt Zimmer, Dollar Bay High School

Sponsored by:
DBTC Area Schools, Lake Superior Stewardship Initiative

Background:
The SOAR Enterprise team designs, builds, and deploys underwater remotely operated vehicles (ROVs), provides technical solutions to water-related research challenges, and serves as a resource for additive manufacturing investigations for local businesses. As a place-based service learning Enterprise, SOAR partners with local community organizations to monitor, research, and improve the local watershed. They support local businesses with rapid prototype and small-quantity part runs. Clients of SOAR present their needs and requirements to the Enterprise, and SOAR works to exceed their expectations with the delivery of the product. Current clients include Isle Royale National Park, Delaware Mine, OcuGlass, and Michigan Tech Great Lakes Research Center.

Project Overview:
The current underwater remotely operated vehicles (ROVs) built by the SOAR team are proof-of-concept prototypes and have outlived their life expectancy. The team has set a course to redesign and replace two classes of team-built ROVs. First, the Isle Royale National Park service ROVs. Improved design features will focus on reduced size, decreased thruster power consumption, and rapid in-field power pack replacement. Second, the demonstration ROVs used by the team during student demonstrations and community festivals. Enhancement features will include a cleaner driver's station with operator controls fitting for young hands, a bright screen for outdoor viewing, and compact size for operation in the demonstration tank.



Components of the replacement ROVs designed and produced by SOAR

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cjmorgan@mtu.edu
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201
Advanced Filtration for Flyte Personal Protection System

Stryker's Flyte Personal Protection helmet used in orthopedic surgery (Photo Credit: Gina Chamberlain)

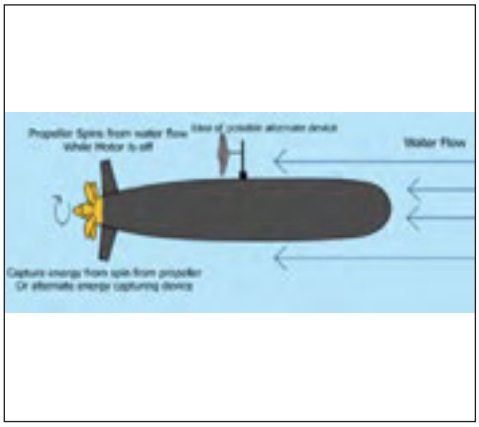
Team Members
Gina Chamberlain, Lea Morath, Molly Niska, and Elizabeth Park, Biomedical Engineering

Advised by:
Bruce Lee and Sang Yoon Han, Biomedical Engineering

Sponsored by:
Stryker

Project Overview:
Our team was tasked with the design of an attachable device for the helmet and hood of Stryker's Flyte Personal Protection System with N95-equivalent filtration, per Occupational Safety and Health Administration (OSHA) and Centers for Disease Control and Prevention (CDC) recommendations. This project addresses the lack of N95-equivalent protection from airborne viruses like SARS-CoV-2.

202
Dry Combat Submersible Regenerative Charging System



Graphic of DCS and potential regeneration systems (Photo Credit: Michael Lewin)

Team Members
Zachary Peitz, Kaylynn Foster, Madelyn Veurink, Michael Lewin, and John Kozacki, Electrical Engineering

Advised by:
Trever Hassell, Electrical and Computer Engineering

Sponsored by:
Systems Engineering Research Center (SERC)

Project Overview:
The purpose of this project is to assist in the development of the SEAL Delivery Vehicle Team TWO (SDVT-2) Dry Combat Submersible (DCS), specifically the energy potential of the onboard battery system, through developing an energy regeneration system to capture energy from underwater tides. The project focuses on two cases: using the main propeller and motor as a source of regeneration; and attaching an additional device to the hull to regenerate energy.

203
ECE Underwater Acoustic Modem

Team Members
Louis Thom and Joshua Langlois, Electrical Engineering; Alex Hare, Computer

Advised by:
Tony Pinar, Electrical and Computer Engineering

Sponsored by:
Zhaohui Wang

Project Overview:
The goal of the underwater acoustic modem project is to develop an inexpensive underwater acoustic modem, including a field programmable gate array (FPGA) based modem, underwater transducer, and power amplifier. The main purpose of this modem is to allow researchers to communicate between underwater nodes and autonomous underwater vehicles (AUVs) in a robust fashion. This project is currently in its second phase. In this phase the team is developing the modem receiver FPGA modules, a custom prototype power amplifier circuit board, and modeling a custom underwater transducer.

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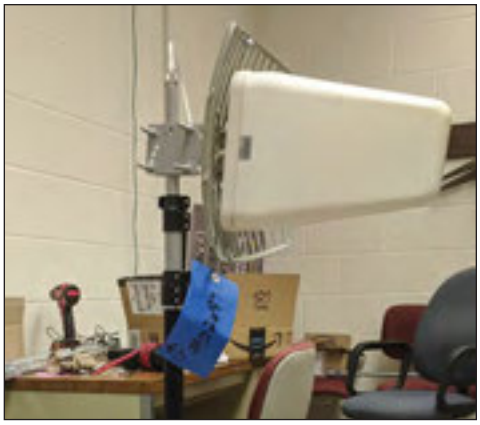
SYSTEMS ENGINEERING RESEARCH CENTER

204
ITC Cell Signal Measurement Tool



Prototype cell signal device with antenna (Photo Credit: Andrew Bratton)

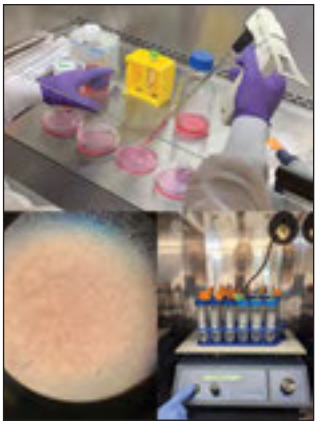
Team Members
Reed VandenBerg and Andrew Bratton, Electrical Engineering; Noah Guyette and Ben Kacynski, Computer Engineering

Advised by:
John Lukowski, Electrical and Computer Engineering

Sponsored by:
ITC Holdings Corp.

Project Overview:
ITC has substations in areas with poor cell signal coverage. Access to communications equipment is needed at these locations, and cell signal boosters can be used to increase the signal. The problem: What direction should the cell signal booster antenna be pointed? The team created a device to measure cell signal across multiple bands. It can be connected to an existing or portable antenna to determine the best direction to point the antenna based on possible service providers. The device was created to provide a methodical way to determine the best direction for the antenna in a way that can be reproduced by ITC employees across the country for under $1,000.

205
Bio-Screening of Toxicity and Bio-Stability for Sampling



Cell culture and extraction study lab work (Photo Credit: Malary Hiney, Max Reaume, Clare LaLonde)

Team Members
Max Reaume, Clare LaLonde, Hunter Dercks, and Malary Hiney, Biomedical Engineering

Advised by:
Roger Guillory and Jeremy Goldman, Biomedical Engineering

Sponsored by:
Medtronic

Project Overview:
The need for rapid testing of long-term biocompatibility in medical devices that have undergone modifications has increased, spurred by manufacturers who wish to release updated versions of their devices that may provide better results than previous models. The goal of this project is to identify, conduct, and evaluate a set of rapid, standardized in vitro tests that determine long-term biocompatibility of implanted neuromodulation leads. The project was completed by conducting an extraction study on the leads in various solutions, cell culturing, and an MTT assay where data were collected, as well as a theorized flowchart of the next steps in testing to be completed based on previous bioevaluation reports provided by Medtronic.

206
Confidential Project

No Photo Available

Due to proprietary information of a commercial nature, the team has withdrawn from judging

Team Members
Anthony Rebera, Austin Kosinski, Josh Klobuchar, Tabitha Walsh, and Tristan Keckonen, Mechanical Engineering

Advised by:
James DeClerck, Mechanical Engineering-Engineering Mechanics

Sponsored by:
Confidential

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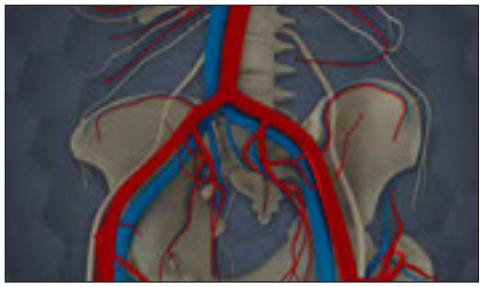
Medtronic

207
3D Modeling of Complex Vascular Anatomies in Anterior Spine Access Surgery



Anterior view of vasculature and spine (Photo Credit: Dr. Jonathan E. Schoeff, Rocky Mountain Advanced Spine Access)

Team Members
Sam Wade, Cem Cedetas, Katie Flom, Madeline Fike, and Keanan Peterson-Rucker, Biomedical Engineering

Advised by:
Orhan Soykan and Jingfeng Jiang, Biomedical Engineering

Sponsored by:
Thompson Surgical Instruments Inc.

Project Overview:
Anterior lumbar interbody fusion (ALIF) surgery allows surgeons the best access at intervertebral discs compared to posterior access. However, when working from the anterior side, a surgeon must first navigate through muscle, intestines, and, most critically, vascular structures. The goal of this project is to create a streamlined process for ALIF surgeons to take medical images and create 3D models of the vascular and bony structures so they may prepare for surgery more thoroughly.

208
Phoenix Haus Panelized Passive Home Mechanical Connection Improvements

(Photo Credit: Phoenix Haus)

Team Members
Nate Huebner and Nathan Duisterhof-DeBoer, Mechanical Engineering; Gabriel Kanouse and Quintin Davis, Electrical Engineering

Advised by:
Tony Pinar, Electrical and Computer Engineering

Sponsored by:
Phoenix Haus

Project Overview:
Phoenix Haus manufactures panelized passive homes. A passive house is very energy efficient and meets the requirements set by the Passive Home Institute US (PHIUS). These houses are constructed in panels in a manufacturing facility, which allows increased build efficiency and quality. The team's role in this project is to research and suggest design process improvements that allow Phoenix Haus to do more in their manufacturing facility before panels are shipped to the job site. These design improvements will allow Phoenix Haus to increase construction efficiency of their panelized passive homes.

209
EMP Mitigation Testing Phase 2

Team members from left: Paul Gjerde, Mikolaj Pal, Chris Avery, David Dumke (Photo Credit: David Dumke)

Team Members
Chris Avery, David Dumke, Paul Gjerde, and Mikolaj Pal, Electrical Engineering

Advised by:
John Lukowski, Electrical and Computer Engineering

Sponsored by:
Systems Control

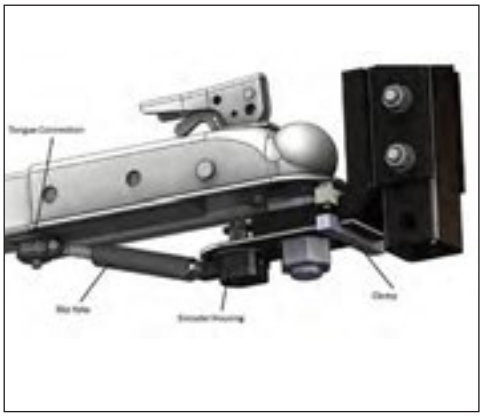
Project Overview:
We developed a procedure for testing the shielding effectiveness of an enclosure produced by Systems Control following the IEEE standard 299. As a supplement to the procedure, the team also provided an equipment specification list, background characterization procedure, and enclosure characterization procedure. The test procedure, including characterization and a completed test report, was conducted on one of the enclosures at Systems Control in Iron Mountain, Michigan.

Thompson SURGICAL INSTRUMENTS

PHOENIX HAUS

SYSTEMS CONTROL

210
Trailer Articulation Sensing System



Graphical model of trailer articulation sensing system

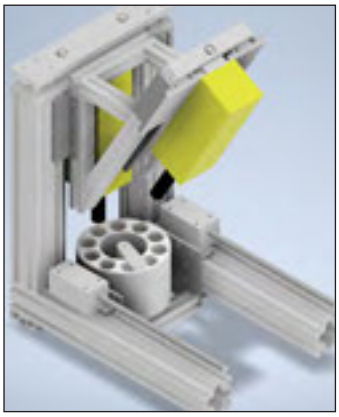
Team Members
Gunnar Gregoire and John Robenault, Electrical Engineering; Case Kamminga, Owen Krautkramer, Nathan Krueger, and Alec Milliron, Mechanical Engineering

Advised by:
James DeClerck, Mechanical Engineering-Engineering Mechanics

Sponsored by:
Horizon Global

Project Overview:
Our project was to create a system that tracks the angle between a trailer and the respective towing vehicle. The goal is for Horizon Global to be able to implement our system to feed a trailer backup assist feature and track trailer sway while driving. The system we have created is attached underneath the trailer tongue and hitch, and employs a capacitive encoder turned by a slip yoke to track the trailer angle. Arduino is currently being used to gather the angular data.

211
Sampling System for Hypothesized Surface



Model of sampling system

Team Members
Joseph Weber, Christopher Stone, and Liam Kosloski, Mechanical Engineering; Josh Beck and David Bellinger, Electrical Engineering

Advised by:
William Endres and Fei Long, Mechanical Engineering-Engineering Mechanics

Sponsored by:
ASU-NASA

Project Overview:
Our team designed and prototyped a hypothetical sampling system to be used in a hypothetical Psyche mission. This system will gather physical samples from the Psyche asteroid and be integrated into a proposed mobile platform or robotic explorer, designed by a separate SCD team.

212
Bone Access and Bone Analog Characterization

Materials tested and characterized throughout the project

Team Members
Sarah Hirsch, Mechanical Engineering; Elisabeth Miller and Christiana Strong, Biomedical Engineering; Morgan Duley, Electrical Engineering; Katelyn Ramthun, Biomedical Engineering

Advised by:
Hyeun Joong Yoon and Orhan Soykan, Biomedical Engineering

Sponsored by:
Stryker Interventional Spine Team

Project Overview:
Bone access systems are used for diagnostic purposes, surgical procedures, and medical device implantation. One of the most important variables to determine the success of the access procedure is the cutting effectiveness of the needle. Currently, interventional bone access procedures are typically performed with a manual technique, but are moving toward a powered method to reduce procedure time and patient pain. This project will determine a bone analog to test the current powered system and needle designs as well as characterize powered and manual needles currently on the market.

213
Substation Transformer Monitoring System

Lansing Board of Water and Light

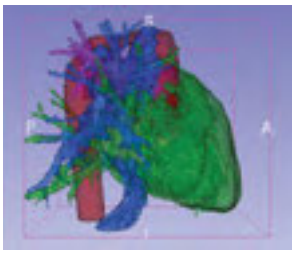
Team Members
Sam Collins, Jacob Allen, Spencer Howe, Stone Oley, and Ben Rumney, Electrical Engineering

Advised by:
John Lukowski, Electrical and Computer Engineering

Sponsored by:
Lansing Board of Water and Light

Project Overview:
The mission of this project is to get a great background and understanding of dissolved gas analysis (DGA) and what it means inside a transformer, then use that knowledge to determine a DGA monitoring system that best fits the needs of Lansing Board of Water and Light. There is a wide variety of monitors available. This project includes making a plan to deploy the monitoring systems across the Lansing Board of Water and Light power system. Additional research of standard concentrations, how different oils affect DGA, and remediation when the DGA results indicate a problem is also done.

214
Development of an Artificial Intelligence-based Image Segmentation Method for Heart Procedures



Heart model created from patient data

Team Members
Luke Cherney, Sam Fuhrman, Braeden Rai, Jesse Jacobusse, and Austin Bucknell, Electrical Engineering

Advised by:
Jingfeng Jiang and Sean Kirkpatrick, Biomedical Engineering

Sponsored by:
Helen DeVos Children's Hospital

Project Overview:
Automatic image segmentation of cardiac scans is currently slow and inaccurate, creating a need for trained personnel to perform manual corrections. Digital Imaging and Communications in Medicine (DICOM) files obtained from CT scans will be used to create an accurate model of the patient's heart. Open-source AI packages will be used to perform the same task with greater efficiency and accuracy. A segmentation software called 3DSlicer will be used with TensorFlow AI packages to create a process where a clinician can input CT scans and receive a 3D model in an STL file. Initial models will be compared against those created manually. This process will be validated until AI detection of cardiac abnormalities has reached the desired accuracy.

215
Hedgemony Online

Hedgemony War Room is a worldwide game of military strategy

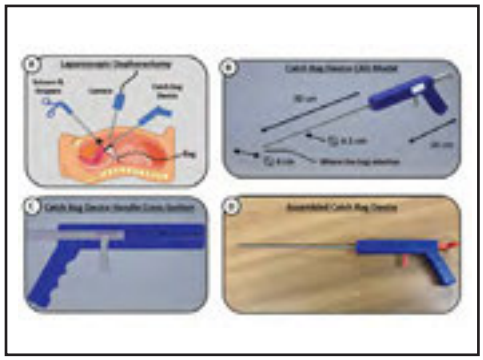
Team Members
Mark Andrusiak, Matthew Loehr, Ethan Laytner, and Josh Goldberg, Computer Engineering

Advised by:
Tony Pinar, Electrical and Computer Engineering

Sponsored by:
Systems Engineering Research Center (SERC), Barry Scott

Project Overview:
Our goal was to create a web-hosted digital version of the board game Hedgemony created by the RAND Corporation. The purpose of this game is to teach strategic decision-making to players of the game such as students or military professionals. The biggest problem faced by players is the inability to play in person right now with the high number of players required. This digital version of the game will allow players to connect remotely and perform all the actions necessary for their role while maintaining social distance with everyone else in the game. The result of this project will be a digital port of all the game's components, which the players will be able to interact with at will.

216
Product Redesign for Anatomical Diversity



(A) Laparoscopic oophorectomy procedure
(B) CAD model of catch bag device
(C) Cross-section of device handle
(D) Undeployed device

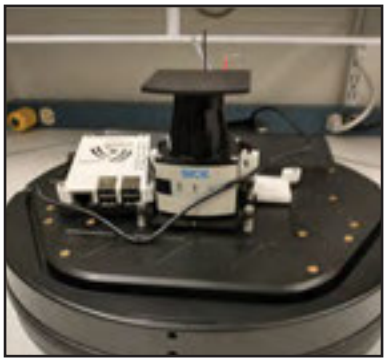
Team Members
Alana Young, Kaylee Meyers, Will Ark, and Jeremy Wales, Biomedical Engineering

Advised by:
Houda Hatoum and Smitha Rao, Biomedical Engineering

Sponsored by:
Boston Scientific

Project Overview:
Boston Scientific tasked our team with the redesign of a laparoscopic tissue retrieval catch bag to consider patient-specific parameters like anatomical dimensions and disparity in the targeted organs/entities. The team focused on two major components of the device: the handle and the bag opening. Improvements by the team include better grip, single-hand manipulation, and a trigger mechanism to manipulate the size of the catch bag opening to aid in navigating the surgical area. This design significantly improved the area and roundness of the catch bag opening, making it better suited for the removal of ovaries and cysts. This work could improve quality of care for patients while also aiding in ease of use for physicians.

217
SICK Lidar Challenge: Autonomous Collision Detection and Avoidance



Autonomous Turtlebot with lidar mounted (Photo Credit: Travis Momsen)

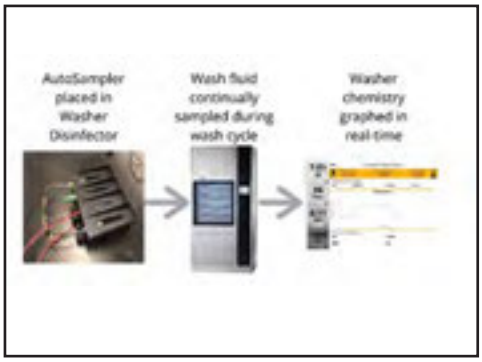
Team Members
Adam Misch, Mechanical Engineering; Alex Langerak, Jared Smith, and Travis Momsen, Electrical Engineering

Advised by:
Mike Roggemann, Electrical and Computer Engineering

Sponsored by:
SICK Inc.

Project Overview:
This project was an entry to SICK Inc.'s Tim 10K Lidar Challenge. Our entry is combining a lidar machine and a camera using sensor fusion to create commands to output to a robot, allowing it to dynamically observe a space and avoid collisions while moving. This project on a small scale would be creating a better and more efficient Roomba machine, while on a large scale could be implemented in autonomous vehicles.

218
Hospital Washer AutoSampler



Schematic of the intended AutoSampler process: continually collecting samples then outputting real-time data

Team Members
Michael Bachman, McKenzie Schulist, Madison Hicks, and Dairion Hartshorn, Biomedical Engineering

Advised by:
Sang Yoon Han and Houda Hatoum, Biomedical Engineering

Sponsored by:
Stryker

Project Overview:
Our team was tasked with improving the mechanical functionality and design of a washer device as part of the project development phase II for Stryker. Washing and sterilizing hospital instruments after every use is key to preventing tool damage. Therefore, achieving a leakproof washer design that allows the real-time extraction of the chemical characteristics of the resulting fluid after every wash is the ultimate goal. This device will help in assessing the effects of wash environments on medical instruments and in optimizing washing cycles. Parameters that were tested for include temperature, pH, conductivity, and oxidation-reduction potential. The output of data was not achieved by the previous team—created by Team 2 collectively.

Boston Scientific

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219
Algorithm Camouflage: Obfuscation from Machine Learning-trained Image and Audio Recognition Models

Facial recognition (left) by YOLOv3 and obscuration (right) using LED lights (Pictured: Christopher Valentine)

Team Members
Zoe Quinn, Jon Garber, Addison Krueger, Christopher Valentine, and Leigha Woelffer, Electrical Engineering

Advised by:
Tony Pinar, Electrical and Computer Engineering

Sponsored by:
US Special Operations Command (SOCOM)

Project Overview:
Urban terrain is littered with surveillance equipment that is increasingly capable of image and voice recognition, and unmanned ground and aerial systems are capable of carrying a payload that can detect intrusion using both visual and audio data. This project studies the potential methods Army Special Forces may use to obfuscate themselves from image- and audio-trained machine learning models in an airport or open expanse of terrain.

220
Thermal Gel and Fixture

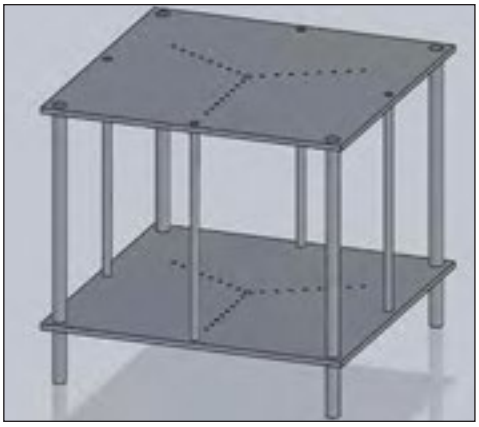


Figure 1. The fixture is designed to sit above the sample, providing precise probe placement (Image Credit: Marina Visser, SolidWorks)

Team Members
Lindsay Sandell, Nathan Marus, Marina Visser, Zonghan Lyu, and Kathryn Waineo, Biomedical Engineering

Advised by:
Jeremy Goldman and Hyeun Joong Yoon, Biomedical Engineering

Sponsored by:
Stryker

Project Overview:
Radiofrequency (RF) ablation is a common minimally invasive procedure used to treat nerve pain. In this procedure, heat-affected regions of tissue (lesions) are produced to cauterize nerves. The development of new RF ablation technologies is hindered by crude simulations relying on chicken breast. Chicken lacks uniformity, adaptability, and reusability. For this project, we have been tasked to design a fixture and testing procedure to collect thermal conductivity and impedance data in an experimental gel relative to the chicken standard. The development of an appropriate testing fixture would allow for repeatable RF ablation tests, a more accurate lesion heat map, and reduced measurement variability, which will accelerate product validation.

221
Blubber Only Implantable Satellite Tag Anchoring System

Prototype of the mechanical retraction tip design

Team Members
Quinn Murphy, Lidia Johnson, Joshua Robles, Katy Beesley, and Kyle Pike, Biomedical Engineering

Advised by:
Bruce Lee, Biomedical Engineering;

Sponsored by:
NOAA

Project Overview:
We are designing a whale telemetry tag tip that will self-blunt its sharp edges once implanted into whale blubber and reduce long-term tissue inflammation in the whale. With the current version, the tag and tip are implanted in the whale blubber, then sharp edges of the tip cause chronic inflammation to the surrounding tissue. We have designed two tag tips with blunting mechanisms to solve this issue. One design is a biodegradable polymer tip that will blunt once implanted from degradation, which will reduce the sharpness of the edges. The second design is a retractable tip that will hide the sharp edges after an inner biodegradable cylinder degrades, allowing a spring to pull the tip back into a casing.

222
MTU Scaled-down Sanitation Chamber

Inside view of refrigerator before build process (Photo Credit: Austin Purdy)

Team Members
Austin Purdy, John Kubiszewski, and Daniel Woirol, Mechanical Engineering Technology

Advised by:
Scott Wagner, Mechanical Engineering Technology

Sponsored by:
MTU iCORP, Scott W. Wagner

Project Overview:
Using an industrial-sized Master-Bilt refrigerator, our objective for this project is to create a scaled-down mobile sanitation chamber that will allow for safe and effective decontamination of personal protective equipment during the COVID-19 pandemic and similar circumstances in the future. Our plan of action is to equip the current refrigerator with a combination of heat, water, and chemicals used to disinfect hospital rooms and equipment, all controlled using a Raspberry Pi as our operating system. The combination of these three systems allows for many possible run cycles to provide the most effective solution to the current sanitation of products.

223
Phase VI Transcatheter Single Ventricle Device Development

Phase VI benchtop apparatus to test the applications of the novel T-SVD device

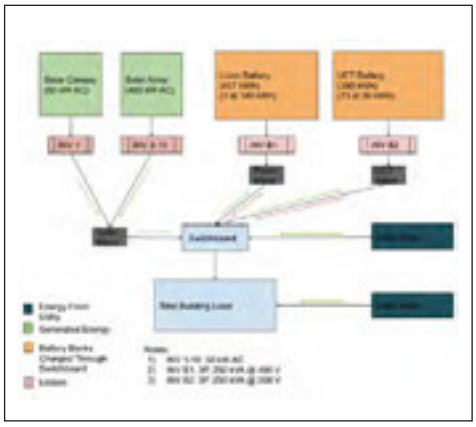
Team Members
Erican Santiago, Shaina Royer, Zach Miller, and Skylar Pond, Biomedical Engineering

Advised by:
Smitha Rao and Roger Guillory, Biomedical Engineering

Sponsored by:
Helen DeVos Children's Hospital

Project Overview:
Hypoplastic left heart syndrome (HLHS) is a congenital defect wherein the left heart is underdeveloped and affects normal blood flow. Currently, a staged surgery is required with a stage I palliation (SIP) performed within the first week of life. The Norwood procedure or hybrid procedure is usually selected for SIP. For the hybrid procedure, a stent is percutaneously placed in the ductus arteriosus (DA) to maintain systemic circulation with banding of the pulmonary arteries via sternotomy to decrease pulmonary blood flow. Our project seeks to develop a novel approach to replace SIP with a transcatheter approach using additive-manufactured, nitinol-based, and patient-specific stents to maintain systemic circulation by keeping the DA patent and decreasing pulmonary blood flow with a Dacron membrane.

224
ITC Battery Energy Storage Scheduler



Graphic of the overall system structure

Team Members
Hannah Green, Ben Holladay, Amanda Young, and Dan Leppanen, Electrical Engineering

Advised by:
John Lukowski, Electrical and Computer Engineering

Sponsored by:
ITC Holdings Corp.

Project Overview:
We were tasked with creating a program that will generate a daily optimized battery charging and discharging schedule for ITC's battery system. This schedule is based off of next-day load predictions using weather as an indicator. The goal of this project is to eliminate the possibility of the solar having to be turned off due to overproduction while also optimizing the use of the battery system.

225
Tube Roller

3D model of the tube roller

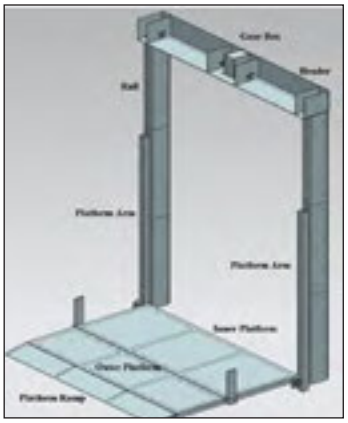
Team Members
Duncan Seidel, Jacob Grund, and Joe Staszek, Mechanical Engineering Technology

Advised by:
Nicholas Hendrickson, Mechanical Engineering Technology

Sponsored by:
Michigan Tech Machine Shop, Cleveland Cliffs

Project Overview:
Our project is a tube roller for the machine shop here at Michigan Tech. The goal of the roller is to bend one-inch to three-inch OD tube for other students to use. The design of the tube roller will be driven by hand and mounted to a table. The tube roller would be able to get picked up and moved to another location if necessary, but would be required to be bolted down in the new location.

226
Power Platform



NX rendering of the entire assembly

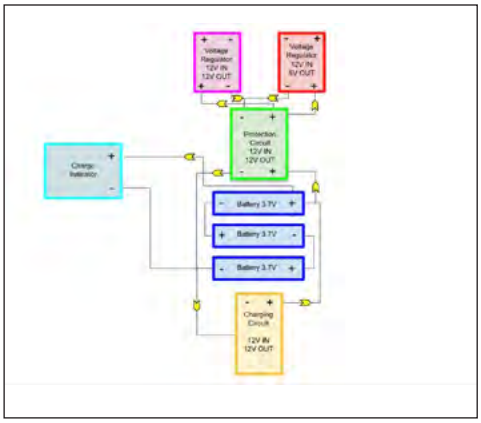
Team Members
Noah Agata, Hayden Huttula, Hunter Jeffreys, Brandon Linna, Justin Novotny, and Austin Selle, Mechanical Engineering

Advised by:
James DeClerck, Mechanical Engineering-Engineering Mechanics

Sponsored by:
Delfab Inc., Power Platform Inc., Cleveland Cliffs

Project Overview:
Delfab Inc. out of Gladstone, Michigan, has requested our help in developing a powered lift-gate platform for use on the back of commercial trucks. Delfab has requested that the lift enable both truck-to-ground loading/unloading and also loading/unloading at commercial loading docks. They've also asked for a chain and sprocket drive system as opposed to the typical hydraulic system

227
Wearable Technology



Team Members
Logan Thomas, Mechanical Engineering; Daniel Beebe and Braden Van Camp, Computer Engineering; Daniel Beebe and Shayne Pallas, Electrical Engineering

Advised by:
Tony Pinar, Electrical and Computer Engineering

Sponsored by:
Systems Engineering Research Center (SERC)

Project Overview:
Our project is an energy management system designed to provide a durable and lightweight backup battery supply for foot soldiers. This energy management system needs to be waterproof, airworthy, and able to withstand extreme conditions, such as high or low temperatures and being dropped from various heights.

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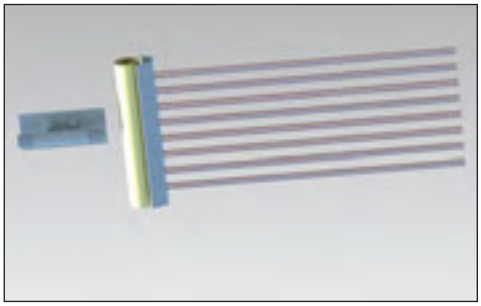
228
Locomotive Traction Motor Field Service Apparatus



LTMFSA cutting apparatus 3D model

Team Members
Abby Bevilacqua, Blake Aakhus, Clayton Hubred, Hayden DeLong, Philip Schaub, and Justin Owen, Mechanical Engineering

Advised by:
Robert Page, Mechanical Engineering-Engineering Mechanics

Sponsored by:
BNSF

Project Overview:
Our team has been engaged by BNSF to design a subsystem of a locomotive traction motor field service apparatus (LTMFSA) to innovate the repair process for seized locomotive axles. The current process utilizes an oxyacetylene torch, which is hazardous for the operating technician. The job completion time can also vary from 20 minutes to five hours. The project that Team 20 is focusing on is the cutting method, which will be integrated with an already existing feed apparatus designed by Team 52 last semester. Using an array of thermal lances and oxygen, the time for completion as well as the risk factor will be reduced dramatically.

229
Accelerated Aluminum Scandium Dispersoid Kinetics for Wire Arc Additive Manufacturing

Relativity rocket (Photo Credit: Relativity Space)

Team Members
Morgan Drumm, Ross Patterson, and Devin Deaton, Materials Science and Engineering

Advised by:
Paul Sanders, Materials Science and Engineering

Sponsored by:
Relativity Space

Project Overview:
Our sponsor, Relativity Space, is wire arc additive manufacturing rockets using an Al-Mg-Sc alloy. After printing, the rocket is then artificially aged in a furnace (a big one), which is costly and time insensitive, to ensure the alloy meets specifications. The aim of this project is to develop a modified 5xxx aluminum series alloy modified by additions of Si, Sc, Zr, Er, and Yb alloy with enhanced kinetics upon solidification. A series of wedge molds were cast to vary the cooling rate and assess the effect cooling rate had on the hardness and conductivity of the alloy. Isochronal and isothermal heat treatments were conducted to understand the peak aging temperature and which alloy possessed the best precipitation kinetics, respectively.

230
Electric Tongue Jack Redesign

Project team members (Photo Credit: Brandon Tolsma)

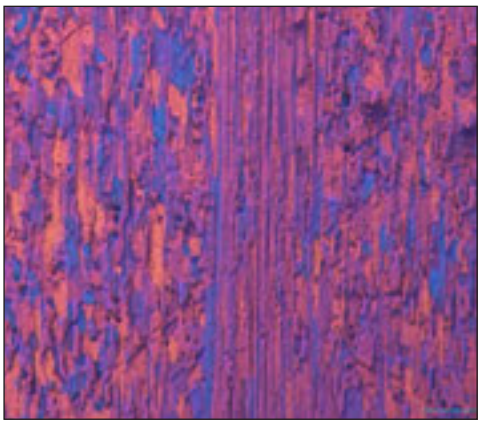
Team Members
Jack Redesign and Brandon Tolsma, Mechanical Engineering; Collin Jandreski, Christian Fallon, Warren Falicki, and Andrew Keskimaki, Electrical Engineering

Advised by:
Trever Hassell, Electrical and Computer Engineering

Sponsored by:
Stromberg Carlson

Project Overview:
The sponsor of this project, Stromberg Carlson, makes RV products and is famous for an electric trailer tongue jack. The purpose of this design project is to redesign their electric tongue jack to incorporate features that make the product more competitive with other market offerings. Features like auto-leveling and hitch height memory add convenience for the customer. Bluetooth connectivity will be added to allow the customer to access these features from a smartphone as opposed to using the buttons on the jack. The technology used will be scalable to more products, such as corner leveling systems. The biggest constraint in this project is cost. In order to stay competitive, the cost of these upgrades will need to stay below $15.

231
Effect of Mn Content Variation on Al Welding Wire Processing and Mechanical Properties



Grain structure of Al 5356 after drawing and annealing (Image Credit: Michael Gazdecki)

Team Members
Tyler Latta, Michael Gazdecki, Spencer Hunt, and Ryan Weiss, Materials Science and Engineering

Advised by:
Paul Sanders, Materials Science and Engineering

Sponsored by:
Hobart Brothers LLC

Project Overview:
The project seeks to better understand the trade-off between wire drawability and weld strength. Currently there is only data on 0.2 and 0.6 weight percent Mn contents, from alloys 5356 and 5556, respectively. In this project, additional alloys will be cast, extruded, and drawn to assess wire and weld microstructure as well as drawability and as-welded mechanical properties.

232
Situational Sensor Automated Insertion Suite

Team Members
Alex Roelant, Trevor Smith, Nick Weykamp, Alex Schneider, Justin Henderson, Dawson Vore, Andrew Bretz, Jake Oomkes, Matt Hoefle, and Lucas Wenderski, Mechanical Engineering; Becca Held, Electrical Engineering; TJ Christian, Computer Engineering

Advised by:
William Endres, James DeClerck, and Cameron Hadden, Mechanical Engineering-Engineering Mechanics

Sponsored by:
Air Force Research Laboratory

Project Overview:
The Air Force Research Laboratory has tasked MTU with creating an automated insertion suite to deploy situational awareness sensors for use by Special Operations Forces (SOF). This project will focus on design, prototype, and demonstration of a device or system that will provide robotic emplacement of unattended sensors in denied areas, indoors or outdoors, and in land, water, or aboveground scenarios.

233
Forklift Auto Level

Team members from left: Brett Thode, Andrew Wyman, and Lennie Westenberg in front of a telehandler cab

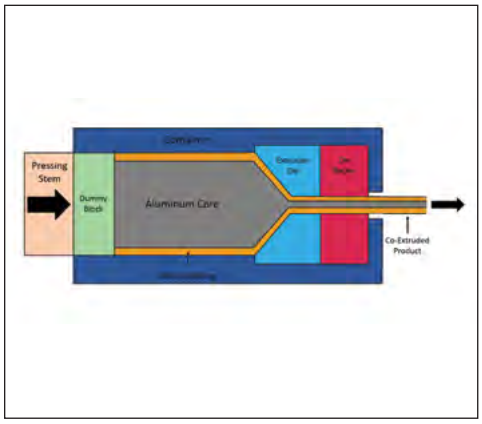
Team Members
Brett Thode, Andrew Wyman, and Lennie Westenberg, Mechanical Engineering Technology

Advised by:
David Labyak, Mechanical Engineering Technology

Sponsored by:
Pettibone, Balluff

Project Overview:
The goal of this project is to create a system to auto-level the forks on a telehandler. The current system uses hydraulics that are dependent on each other to auto-level the forks. This causes lag when the forks are first re-leveled and could be dangerous. Our system looks to use sensors to eliminate the need for dependent cylinders and to stop the lag.

234
Development of a Beta Brass Alloy for Co-Extrusion



Coextrusion schematic
(Image Credit: Maria Rochow)

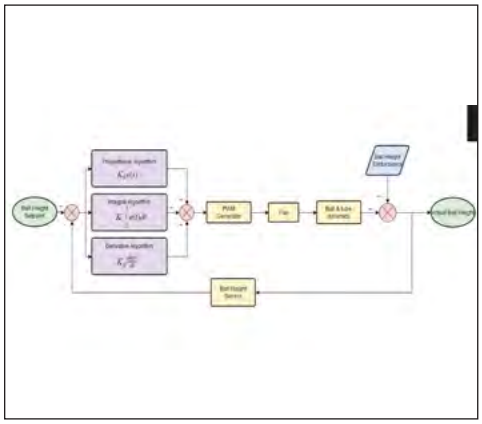
Team Members
Anna Isaacson, Sidney Feige, Lauren Bowling, and Maria Rochow, Materials Science and Engineering

Advised by:
Paul Sanders, Materials Science and Engineering

Sponsored by:
College of Engineering

Project Overview:
Due to the COVID-19 outbreak, the use of copper for highly trafficked touch surfaces throughout communities is of interest due to the element's natural antimicrobial properties. However, because of copper's relatively high density and cost, alternatives to the pure material must first be established and considered. One manufacturing process in particular that will decrease both the cost and density of the finalized alloy is coextrusion, where a copper-rich alloy acts as cladding to a lower-density core material such as aluminum. This study alloyed selected elements from the aforementioned groups with brass and generated a design of experiments to be used to predict the most optimal cladding composition for coextrusion that maintains antimicrobial efficacy.

235
Proportional Integral Derivative (PID) Control Curriculum for EET



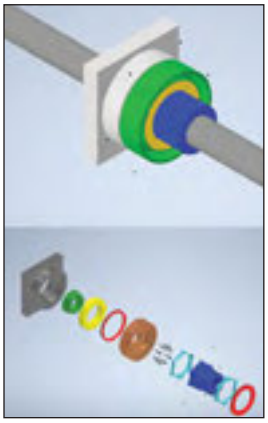
Team Members
Kevin Zender, Corey Blankenship, and Tyson Bethke, Electrical Engineering Technology

Advised by:
Nathir Rawashdeh, Applied Computing

Sponsored by:
College of Computing

Project Overview:
Our team was charged with developing a course curriculum using proportional–integral–derivative (PID) control for future electrical engineering technology (EET) students at Michigan Tech. Our goal is to provide students with learning opportunities that can enrich the curriculum with the control techniques used in industry.

236
EPS Ball Nut Degrees of Freedom Optimization



Assembled and exploded view of the redesigned ball nut subsystem

Team Members
Brad Halonen, Rocket Hefferan, Luke Pietila, Peadar Richards, and David Rozinka, Mechanical Engineering

Advised by:
James DeClerck, Mechanical Engineering-Engineering Mechanics

Sponsored by:
Nexteer

Project Overview:
Our team is working with Nexteer Automotive to improve the design of a rack-assisted electric power steering system by creating a virtual prototype in Altair MotionView, with a focus on redirecting the load path of belt tension acting on a pulley-driven ball nut and utilizing elastomers to reduce noise, vibration, and harshness (NVH) while negating the effects of misalignment between the ball nut and ball screw.

237
WAAM Die Components

MIG welding robot printing a steel part (Photo Credit: Mike Groeneveld)

Team Members
Mike Groeneveld, Ty Timmermann, and Noah Ekdom, Mechanical Engineering

Advised by:
Paul Sanders, Materials Science and Engineering

Sponsored by:
Mercury Marine

Project Overview:
This project is the exploration of the technology and methods of using robotic wire arc additive manufacturing (WAAM) for the production of die components. The sponsor is one of the nation's largest high-pressure die casting houses, and has routinely high tooling production costs to support. WAAM can be used to add extended features to plate products to significantly reduce the time and cost associated with removing excess material, and provides more flexibility and turnaround than casting. The focus is in lower-cost basic steels and existing MIG welding technology.

238
Decreasing Coating System Cost to Performance Index in Steel Fasteners for Pressure Treated Lumber

EIS accelerated corrosion testing (Photo Credit: Henry Vandermark)

Team Members
Nate Carey, Anna Hildebrandt, Jason Seeterlin, and Henry Vandermark, Materials Science and Engineering

Advised by:
Paul Sanders, Materials Science and Engineering

Sponsored by:
Altenloh, Brinck & Co. US Inc.

Project Overview:
Corrosion resistance of coated steel fasteners has been an issue since 2003, when the treated lumber industry switched to a micronized copper-based treatment. The micronized copper treatments created a greater galvanic potential in the wood, which causes accelerated corrosion of fasteners. Currently, approved fastener coatings for micronized copper have a high cost-to-performance index, leading to an expensive product. This project seeks to explore other coating systems that decrease cost while increasing corrosion resistance, as well as use electrochemical impedance spectroscopy (EIS) to accelerate the coating system testing and selection process.

239
Small Engine Flow Bench

(Photo Credit: Adam Thomas)

Team Members
Andrew Hull, Virginia Janes, Adam Thomas, and Lukas Evans, Mechanical Engineering Technology

Advised by:
Scott Wagner, Mechanical Engineering Technology

Sponsored by:
Kohler

Project Overview:
Our team is designing a custom engine flow bench that is tuned to the needs of the sponsor. Our flow bench will include sensors to accurately measure atmospheric conditions as well as pressure drop at the test piece and flow data. Our flow bench will also be capable of running in two separate configurations–it must be able to reach the target flow rate during both push and pull.

240
Advanced PPE Filtration System

Graphical image of the filter pack design (Image Credit: Mary Repp)

Team Members
Matthew Johnson, Electrical Engineering; Bryce Hudson, Mary Repp, Carter Slunick, Mike Stinchcomb, Braeden Anex, Brandon Howard, Josh Albrecht, and Hannah Bekkala, Mechanical Engineering

Advised by:
Jaclyn Johnson and Aneet Narendranath, Mechanical Engineering-Engineering Mechanics

Sponsored by:
Stryker

Project Overview:
We were tasked to design an N95-rated filtration system to be used with Stryker's existing Flyte helmet and hood in order to protect surgeons against COVID-19 and other airborne viruses. The teams designed and prototyped a filtration pack to be worn around the user's waist. Filtered air is routed from the pack through tubing leading to the back of the helmet, where air is directed through the hood to the user.

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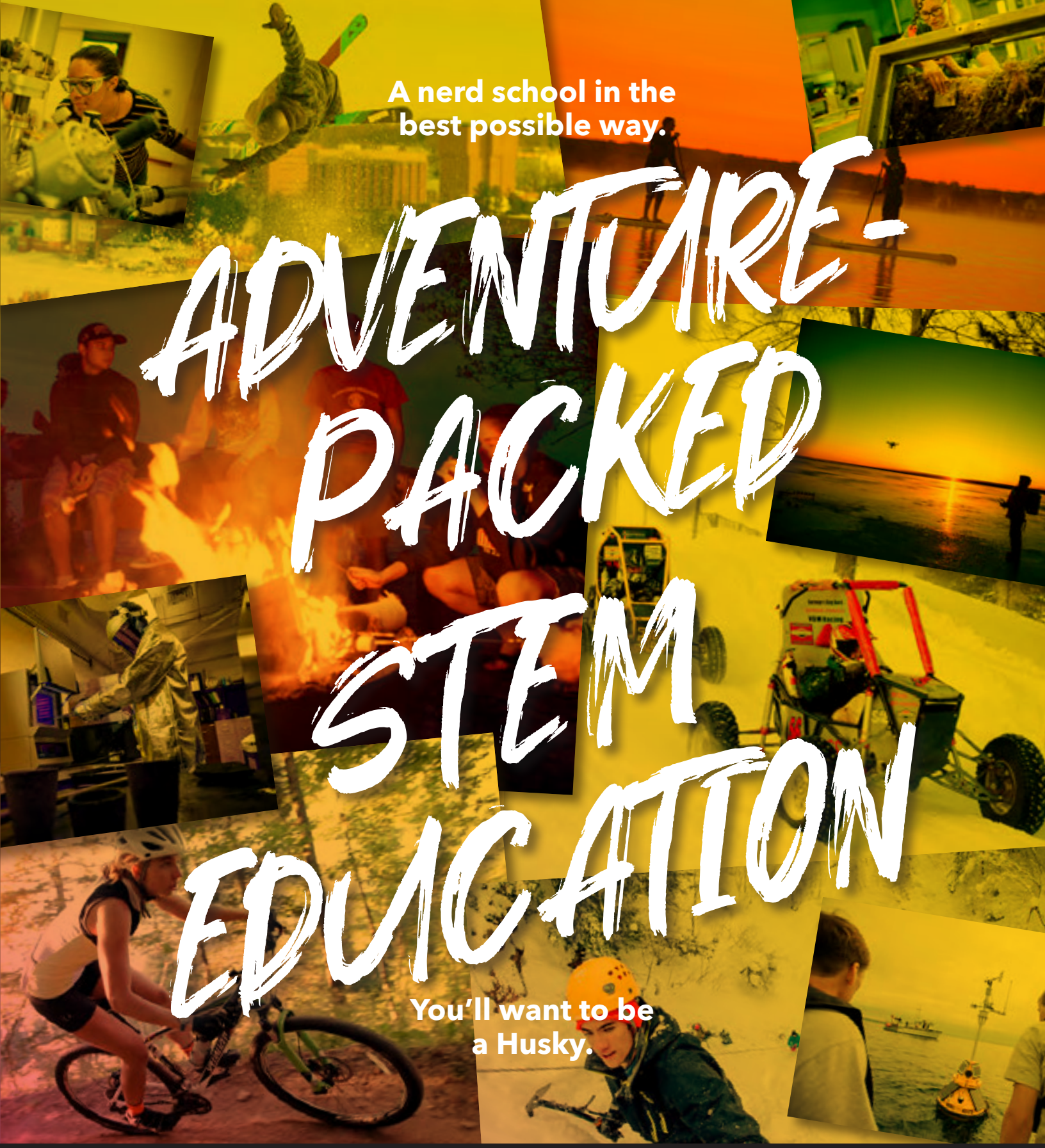

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Within one year at Michigan Tech, Tessa Steenwinkel went from working as an undergraduate research assistant in Thomas Werner's genetics lab to co-authoring their book, *Drosophilids of the Midwest and Northeast*. Now she's working on her own study that examines the effects of nutrition on fertility and life expectancy.

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Ford Motor Company
Gamma Technologies
General Motors
Great Lakes Sound and Vibration
GVSC (Ground Vehicle Systems Center-TACOM US ARMY)
Helen DeVos Children's Hospital
Henkel AG & Co.
Horizon Global
Independent Machine Company
ITC
John Deere
John Jacobson
Keweenaw Community Forest Company
Keysight Technologies
Kimberly Clark
Lansing Board of Water and Light
Libbey
Little Brothers-Friends of the Elderly
Magna
Medtronic
Mel and Gloria Visser
Mercury Marine
Michigan Scientific Corp.
Michigan Tech Van Pelt and Opie Library
Milan and Shailee Lathia
Milwaukee Tool
NASA/Lunabotics
New Eagle
Nexteer Automotive
Northern Specialty Health
Oshkosh
PCB Piezotronics
Pettibone
Phoenix Haus
Pilot Systems
Quantalux LLC
Relativity Space
SAE
SAE AutoDrive Challenge
Senger Innovations
SERC
Siemens Energy Inc.
SMC USA
Stevens Institute of Technology (SERC)
Stromberg Carlson
Stryker
Sussex IM
Systems Control
Team Tech Motorsports
Teleqo
The Carbide End Mill Store
The Henry Ford Museum
The Princeton Review
Thompson Surgical
Tree Frog Aquagric LLC
Watermark Insights
Western UP Health Department
Whirlpool
Yamaha

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